WaterLegacy (Paula Maccabee)

The attached Comments and Exhibits 1-36 are respectfully submitted on behalf of WaterLegacy.

Sincerely yours,
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September 22, 2025

Uploaded Online
Katrina Kessler, Commissioner
Minnesota Pollution Control Agency
520 Lafayette Rd.
St. Paul, MN 55155

RE: U.S. Steel Corp. NPDES/SDS Permit for Keetac Mining Area (MN0031879)
U.S. Steel Corp. NPDES/SDS Permit for Keetac Tailings Basin (MN0055948)
U.S. Steel Corp. Application for Variance from Wild Rice Sulfate Standard

Dear Commissioner Kessler, MPCA Staff,

These comments are submitted on behalf of WaterLegacy in connection with the Minnesota Pollution Control Agency's ("MPCA") draft NPDES/SDS permits for the U.S. Steel Corporation ("U.S. Steel") Keetac mining area (MN0031879) and Keetac tailings basin (MN0055948), and the MPCA's preliminary determination to deny U.S. Steel's application for a variance from compliance with Minnesota's wild rice sulfate standard at these Keetac facilities.

WaterLegacy supports MPCA draft permit requirements that U.S. Steel (or any successor permittee) comply with Minnesota's 10 milligrams per liter ("mg/L") wild rice sulfate standard applicable to Keetac mining area and tailings basin discharge to surface waters. WaterLegacy also supports MPCA's preliminary determination to deny U.S. Steel (recently purchased by Nippon Steel) a variance from compliance with the wild rice sulfate standard. The first section of WaterLegacy's comments provides additional support for these positions taken by MPCA.

A. **Sulfate Limitations** (pages 2-14). Water quality-based effluent limitations ("WQBELs") in MPCA's draft permits for the Keetac mining area and tailings basin to achieve compliance with Minnesota's wild rice sulfate standard are supported by Keetac history, law, current peer-reviewed science, and overwhelming evidence pertaining to impacts of Keetac sulfate discharge on wild rice in Hay Lake.

B. **Preliminary Denial of U.S. Steel Variance Application** (pages 14-16). MPCA's preliminary determination to deny U.S. Steel a variance from compliance with Minnesota's wild rice sulfate standard at the Keetac mining area and tailings basin is correct because U.S. Steel's application fails to support a variance under applicable law.

C. **Additional Support for Variance Denial** (pages 16-18). Additional information in U.S. Steel's disclosures and new facts arising from Nippon Steel's purchase of U.S. Steel further underscore the appropriateness of MPCA's denial of the requested variance.

In addition to supporting these critical issues that have been subject to public controversy, WaterLegacy believes that MPCA's draft permits for the Keetac facilities have some significant

gaps and insufficiencies. WaterLegacy's requests for changes, additional analyses, and clarifications prior to MPCA's issuance of final permits are summarized below:

1. **Time for Compliance** (pages 18-20). MPCA should not give U.S. Steel another five years to comply with Minnesota's wild rice sulfate standard. Based on federal regulations and compliance history, no Keetac permit compliance schedule is appropriate or necessary.

2. **WQBELs Specific Conductance** (pages 20-23). MPCA should establish numeric WQBELs for specific conductance in Keetac permits consistent with toxicity thresholds for Minnesota Ecoregion 50 effective concurrent with final sulfate effluent limitations.

3. **Biological Assessments and Toxicity Testing** (pages 23-24). MPCA should require that U.S. Steel conduct macroinvertebrate and fish biological assessments and begin chronic whole effluent toxicity testing upon Keetac permit issuance.

4. **Mass Loading and Non-Degradation** (pages 24-27). MPCA should provide mass loading limits for Keetac sulfate WQBELs, analyze discharge volumes and sulfate loading, and provide antidegradation and net precipitation analysis and requirements in final permits.

5. **Functional Equivalent Analysis** (pages 27-29). MPCA should require broader functional equivalent analysis in the Keetac permits and monitoring of waste streams, groundwater, and surface water to support this analysis and the exercise of MPCA authority to regulate discharge through groundwater to surface water under both the NPDES and SDS programs.

6. **Groundwater Protection** (pages 30-32). MPCA should require groundwater monitoring at the Keetac mining area, reservoirs, and tailings basin to determine whether discharge to groundwater violates Minnesota groundwater standards or threatens local drinking water.

7. **Unauthorized Discharge** (pages 32-33). MPCA should clarify the prohibition on unauthorized discharge in Keetac permits to ensure that both surface water and groundwater are protected from unauthorized releases.

8. **Impaired Waters** (pages 33-34). In addition to Hay Lake, Keetac permits and fact sheets should identify other impaired waters potentially affected by Keetac discharge and describe the benefits of sulfate reduction to reduce nutrients, methylmercury contamination of fish, and extirpation of sensitive biota.

I. MPCA'S REQUIREMENTS FOR SULFATE EFFLUENT LIMITATIONS IN KEETAC PERMITS AND ITS PRELIMINARY VARIANCE DENIAL ARE WELL SUPPORTED BY LAW AND EVIDENCE.

A. History, Law, Current Science, and Facts at Hay Lake Require that Keetac Discharge Comply with Minnesota's Statewide Wild Rice Sulfate Standard.

WaterLegacy supports final Phase 2 water quality-based effluent limitations ("WQBELs") in MPCA's draft Keetac permits limiting sulfate to 14 mg/L (monthly average) and 24 mg/L (maximum) at outfalls SD 002, SD 003, and SD 012 at the Keetac mining area and at SD 001, SD

005, and future SD 009 at the Keetac tailings basin.[1] WaterLegacy also agrees with MPCA's Phase 1 interim sulfate effluent limitations of 167 mg/L at SD 002, 81 mg/L at SD 003, 30 mg/L at SD 012, 135.3 mg/L at SD 001, and 135.3 mg/L at SD 005. *Id*. (same permit pages). U.S. Steel's proposal to allow an increase in sulfate discharge at each of these surface discharge locations by 20% over the maximum recorded sulfate concentration[2] would result in degradation of water quality and increase impairment of beneficial use of waters for production of wild rice.

Opposition to enforcement of Minnesota's 10 mg/L wild rice sulfate standard is ingrained in a segment of Minnesota's population for long-standing cultural as well as economic reasons. History specific to the Keetac facilities and applicable federal and state law require that Keetac permits contain effluent limits to ensure compliance with the wild rice sulfate standard. Vehement assertions made by supporters of U.S. Steel's interests that there is no science supporting the sulfate standard since the field work published by John Moyle in the 1940s and that wild rice in Hay Lake is "thriving" are simply false.

1. *History Requires Keetac Compliance with the Wild Rice Sulfate Standard*.

The MPCA adopted the wild rice sulfate standard of 10 mg/L in waters used for the production of wild rice in 1973. That standard was approved by the U.S. Environmental Protection Agency ("EPA") and applied in 1975 to limit sulfate discharge from the Clay Boswell coal-fired power plant.[3]

The MPCA issued U.S. Steel Keetac mining area (MN0031879) and tailings basin (MN0055948) NPDES/SDS permits in October 2011 that required compliance with WQBELs derived from Minnesota's wild rice sulfate standard.[4] U.S. Steel did not challenge those permits.[5] The 2011 Permits set sulfate limits with a 14 mg/L calendar month average and 24 mg/L maximum for surface discharge from mining area and tailings basin discharge stations.[6]

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[1] Draft NPDES/SDS Permit for U.S. Steel Keetac Mining Area MN0031879 ("Mine Permit") at 44-47; Draft NPDES/SDS Permit for U.S. Steel Keetac Tailings Basin MN0055948 ("TB Permit") at 50-54.

[2] Application for a Variance from the Class 4A Sulfate Water Quality Standard for Waters Used for Production of Wild Rice NPDES/SDS Permit No. MN0055948 and No. MN0031879, prepared for U.S. Steel by Barr Engineering, May 2025 ("Variance Application") at 13.

[3] *Minn. Chamber of Com. v. Minn. Pollution Control Agency*, No. 62-CV-10-1184, 2012 WL 2872026 (Minn. Dist. Ct., 2nd Jud. Dist., May 10, 2012), Exhibit 1, at ¶¶ 3, 7-8.

[4] MPCA Board Packet*, In re U.S. Steel Corp., Minnesota Ore Operations, Keetac NPDES/SDS Permits MN0031879 and MN0055948*, October 14, 2011 ("2011 Keetac Permits"), Exhibit 2.

[5] *Minn. Chamber of Com. v. Minn. Pollution Control Agency*, A12-0950, 2012 WL 6554544 at *2 (Minn. Ct. App. Dec. 17, 2012).

[6] 2011 Keetac Permits, Exhibit 2 at pdf 61-62, Mine Permit at 11-12 (limits at SD 002, SD 003, SD 012); pdf at 97-98, TB Permit at 9-10 (limits at SD 001, SD 005, SD 009).

The 2011 Keetac permits included a lengthy schedule of compliance with several studies and milestones, finally requiring compliance with the sulfate effluent limits for discharge from the Mine "as soon as possible and in no case later than August 17, 2018 for non-tailings basin discharges, and August 17, 2019 for tailings basin discharges, unless the permit is modified pursuant to 40 C.F.R. 122.62."[7] The 2011 Keetac permits were neither modified nor revoked. But Keetac mining area and tailings basin discharge monitoring reports ("DMRs") from 2018 through 2024 reflect hundreds of exceedances of the sulfate effluent limits.[8]

The EPA investigated Keetac DMRs from January 2019 through September 2022 and found 253 permit violations at the Keetac mining area and 46 violations at the tailings basin.[9] The EPA issued a Notice of Violation on May 15, 2024, finding that by October 2022, U.S. Steel had violated its Keetac permits nearly 300 times: "Each instance in which U.S. Steel discharged sulfate in amounts exceeding the final sulfate effluent limits contained in the Mining Operations Permit or the Tailings Basin Permit is a violation of NPDES Permit No. MN0031879 or NPDES Permit No. MN0055948, respectively . . . U.S. Steel has violated the terms of these permits a total of 299 times.[10] EPA explained that "U.S. Steel's failure to comply with the final effluent limits in the Mining Operations and Tailings Basin Permits at the Facility is a violation of Section 301(a) of the CWA, 33 U.S.C. § 1311(a)." *Id*., ¶ 30. EPA's Notice of Violation was provided to U.S. Steel.[11]

2. *MPCA is Required by Law to Apply Minnesota's Sulfate Standard to Hay Lake*.

MPCA lacks discretion to apply a less stringent sulfate standard or weaker effluent limits to Keetac mining area or tailings basin discharge. In 1974, Minnesota sought and secured approval from EPA to administer the federal Clean Water Act ("CWA") NPDES permit program for discharges into waters of the United States within Minnesota.[12] MPCA's authority to issue NPDES permits for U.S. Steel discharge to Hay Lake or any other point source discharge to navigable waters is contingent on compliance with the CWA. 33 U.S.C. § 1342(a)-(c).

The CWA and its implementing regulations require that NPDES permits include effluent

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[7] Exhibit 2 at pdf 25, Findings of Fact ¶¶ 39-40.

[8] Discharge Monitoring Reports, Bulk Exports for Keetac Permits MN0031879, MN0055948 Sulfate and Specific Conductance, 2018-2024, Exhibit 3.

[9] EPA, NEIC Civil Investigation Report, U.S. Steel – Keetac, Keewatin, Minnesota, 55753, October 2022 ("EPA Keetac Investigation"), Exhibit 4, at 16-17.

[10] EPA, *In re U.S. Steel Corp. Keetac Mining Operations and Tailings Basin*, Notice of Violation, May 15, 2024 ("EPA Keetac NOV"), Exhibit 5 at ¶ 29.

[11] EPA, Letter to C. Bartovich, U.S. Steel Environmental Director, re Notice of Clean Water Act Violations, May 14, 2024 ("EPA NOV Letter"), Exhibit 6.

[12] Approval of Minnesota's NPDES is found at 39 Fed. Reg. 26061 (July 16, 1974). The Memorandum of Agreement between the EPA and the MPCA for the Approval of the State NPDES Program is available at https://www.epa.gov/sites/default/files/2013-09/documents/mn-moa-npdes.pdf.

limitations necessary to achieve a state's approved water quality standards. 33 U.S.C. § 1311(b)(1)(C); 40 C.F.R. §§ 122.44(d)(1)-(5), 123.25(a)(15). A standard approved by EPA——as Minnesota's wild rice sulfate standard was in 1973——becomes the "standard for the applicable waters of that State" and can only be modified or repealed if the new standard is approved by the EPA. 33 U.S.C. § 1313(c)(2)-(3). Although the MPCA undertook rulemaking efforts to change the wild rice sulfate standard pursuant to a 2011 Session Law,[13] the Office of Administrative Hearings rejected MPCA's proposal to repeal the 10 mg/L wild rice sulfate rule as unreasonable and in conflict with CWA requirements.[14]

The EPA advised MPCA in February of 2022 that Minnesota's 2015 and 2016 Session Laws that attempted to limit MPCA's ability to include effluent limits in NPDES permits to comply with Minnesota's federally-approved wild rice sulfate standard and to invalidate existing sulfate effluent limits in state permits are "inconsistent with the Clean Water Act (CWA)."[15] The EPA stated it "disapproves the program revision affected by these laws as an improper modification to MPCA's authority to implement the NPDES program." *Id*. (citing 40 C.F.R. § 123.62(b)(3)). The EPA confirmed, "EPA expects that MPCA's NPDES permits will include effluent limitations to meet all federally-approved WQS as required by the CWA, federal regulations, and EPA-approved Minnesota laws and rules." *Id*. at 2.

U.S. Steel then sought a site-specific sulfate standard for Hay Lake nearly 800% less stringent than Minnesota's statewide 10 mg/L standard in 2022. MPCA rejected that 79 mg/L site-specific sulfate standard as inconsistent with federal and state law.[16] MPCA determined that U.S. Steel failed to demonstrate any of the following: 1) that "the wild rice beneficial use is met, or will be met, in Hay Lake" at the proposed less stringent standard[17]; 2) that the method proposed by U.S. Steel to derive its proposed standard was "scientifically defensible"[18]; or 3) that Hay Lake had "unique" or "exceptional" circumstances that "would allow wild rice to thrive and the beneficial use to be

[13] *See* 2011 Minn. Laws, 1st Spec. Sess., ch. 2, art. 4, § 32(a).

[14] Report of the Administrative Law Judge ("ALJ"), *In re Proposed Rules of the MPCA Amending the Sulfate Water Quality Standard Applicable to Wild Rice (In re Sulfate Standard)*, 80-9003-34519, 2018 WL 1059648 at *4 (Minn. Off. Admin. Hr'gs Jan. 9, 2018); Report of the Chief ALJ, *In re Sulfate Standard,* 80-9003-34519, 2018 WL 1059649 at *1 (Minn. Off. Admin. Hr'gs Jan. 11, 2018); Order of the Chief ALJ, *In re Sulfate Standard*, 80-9003-34519, 2018 WL 2000782 at *11(Minn. Off. Admin. Hr'gs Apr. 12, 2018).

[15] EPA, Letter to MPCA Commissioner Kessler re Minnesota laws revising MPCA's authority to regulate sulfate in NPDES permits, Feb. 16, 2022 ("EPA NPDES Letter"), Exhibit 7 at 1.

[16] MPCA, Denial of U.S. Steel Application for a Sulfate Site-Specific Standard for Hay Lake, February 14, 2024 ("Denial of Site-Specific Standard"), Exhibit 8.

[17] *Id*. at 2, citing 40 C.F.R. § 131.11(a)(1).

[18] *Id*. at 3, citing 40 C.F.R. § 131.11(a)(1) and (b)(1)(iii).

protected under a less stringent standard at this location" and make a modified standard "more appropriate than the statewide standard"[19]

The Minnesota Court of Appeals upheld MPCA's denial of a 79 mg/L site-specific standard for Hay Lake. *In re Sulfate Site-Specific Standard for Hay Lake*, A24-0428, 2025 WL 959092 (Minn. Ct. App. Mar. 31, 2025). The Court of Appeals cited Minnesota Supreme Court precedent to conclude, "MPCA has the duty and authority to enforce the wild rice rule by issuing National Pollutant Discharge Elimination System (NPDES) permits and State Disposal System (SDS) permits." *Id*. at *1 (citing *In re Denial of Contested Case Hearing Requests and Issuance of NPDES/SDS Permit for Proposed NorthMet Project*, 993 N.W.2d 627, 638 (Minn. 2023)).[20]

MPCA's Brief to the Court of Appeals in the *Sulfate Site-Specific Standard* case summarized, "MPCA has no choice but to apply the Sulfate Standard to Hay Lake. Further, any state legislation that purports to prevent the MPCA from doing so is preempted by the MPCA's obligations under the CWA. *See Hous. And Redev. Auth. of Duluth v. Lee*, 832 N.W.2d 868, 873 (Minn. Ct. App. 2013) ('[S]tate law is preempted to the extent that it actually conflicts with federal law.')."[21] MPCA has also informed the public that "the 1973 sulfate water quality standard remains in effect. MPCA is committed to implementing this standard."[22] Further, "MPCA is currently working to "fully implement" the 10 mg/L sulfate standard "to protect wild rice from excess sulfate." *Id*.

Not only must MPCA apply the 10 mg/L wild rice sulfate standard to Keetac mining area and tailings basin surface discharge at Hay Lake, MPCA must set sulfate effluent limitations that are at least as stringent as those in the 2011 Keetac NPDES permits. As stated *supra* 2-3, those 2011 Keetac permits required U.S. Steel to limit sulfate to a 14 mg/L average and a 24 mg/L maximum at all surface discharge outfalls.

In addition to requiring that permits set water quality-based effluent limitations (WQBELs), CWA regulations also prevent permit issuers from "backsliding" in renewing or reissuing an NPDES permit. With very limited exceptions, these regulations state that "when a permit is renewed or reissued, interim effluent limitations, standards or conditions must be at least as stringent as the final effluent limitations, standards, or conditions in the previous permit." 40 C.F.R. 122.44(l)(1)-(2). U.S. Steel cannot prove any exceptions, such as that new information would have justified a less stringent effluent limitation in 2011, that a less stringent effluent limit is needed because of events outside permittee's control, or that treatment required under the prior permit was properly installed and operated and still has not yet attained compliance. 40 C.F.R. 122.45(2)(i)-(ii).

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[19] *Id*. at 3-4, citing Minn. R. 7050.0220, subp. 7.

[20] The Minnesota Supreme Court denied U.S. Steel's petition for further review in the *Hay Lake* case on June 25, 2025.

[21] MPCA Brief, *In re Sulfate Site-Specific Standard for Hay Lake,* Oct. 11, 2024, Exhibit 9 at 27.

[22] MPCA, Protecting Wild Rice Waters, last visited Sept. 11, 2025, Exhibit 10.

MPCA is required by federal and state law and Minnesota court cases to reissue permits for Keetac mining area and tailings basin surface discharge that contain effluent limitations to achieve compliance with Minnesota's 10 mg/L sulfate standard that are at least as stringent as limits previously set in 2011 for these U.S. Steel facilities.

3. *Current Peer-Reviewed Science Overwhelmingly Supports Application of Minnesota's 10 mg/L Wild Rice Sulfate Standard to Hay Lake.*

Opponents of enforcement of Minnesota's wild rice sulfate standard criticize the MPCA for exclusively relying on field studies published by John Moyle in the 1940s. They are misguided. First, Moyle's comprehensive field studies published in the 1940s are still valid today, and cannot be replicated due to the impacts of sulfate pollution and other anthropogenic conditions since then on wild rice. Moyle, who worked for decades at the Minnesota Department of Natural Resources ("DNR") estimated that the Minnesota harvest of wild rice was 1,586,000 pounds or 793 tons of parched or processed grain.[23] Moyle found that "no large stands of rice occur in waters having a SO4 [sulfate] content greater than 10 p.p.m. [equivalent to mg/L], and wild rice generally is absent from water with more than 50 p.p.m." *Id*.

In accordance with Minnesota's 2011 Session Law, scientists at the MPCA and the University of Minnesota ("UMN") updated scientific research on the relationship between sulfate and wild rice population growth and viability. Although the ALJ did not reject the theory behind MPCA's proposed equation-based rule in denying MPCA's proposal to repeal Minnesota's wild rice sulfate standard, the ALJ stated *In re Sulfate Standard*, 2018 WL 1059648 at *47, that MPCA "did not offer a convincing response" to Dr. John Pastor's wild rice "mesocosm research" which conducted controlled experiments simulating aquatic environments in large outdoor tanks. The ALJ summarized:

> Dr. Pastor's continuing mesocosm research has indicated that, while increased iron may counter the toxicity of sulfide to wild rice seedlings in the springtime, iron sulfide plaques form and precipitate on the plants' roots during the flowering and seed production phases of the wild rice life cycle. These plaques result in fewer and smaller seeds, with reduced nitrogen content, leading to extinction of the wild rice plant within 4 or 5 years at about 300 mg/L of sulfate, and greatly reducing wild rice plant population viability at lower concentrations of sulfate.

Id. The sole reason why the ALJ did not reject MPCA's proposed equation-based rule as scientifically inadequate was that Dr. Pastor's research regarding the harmful effects of increased sulfate despite increased iron were "not yet the subject of peer-reviewed publication." *Id*. at *48. That situation was soon remedied.

Later in 2018, published research by UMN scientists John Pastor, Sophia LaFond-Hudson, Nathan Johnson, and others confirmed that iron sulfide plaques formed on wild rice roots when rice was exposed to added sulfate and iron, resulting in "fewer and lighter seeds with less nitrogen than

[23] Moyle JB (1944) Wild rice in Minnesota. *J. Wildlife Management* 8(3):177-84, Exhibit 11 at 178.

unamended plants."[24] Their research, *id*. at 100, provided the illustration below of wild rice roots in water to which sulfate and iron had and had not been added.



Fig. 2 Sulfate-amended (left) and unamended (right) roots. Sulfate-amended root has black color extending from about 0.5 cm above the root ball down to the tips of the roots. Unamended root has amber color characteristic of iron (hydr)oxides, especially in the 2–3 cm below root ball. (LaFond-Hudson *et al.* 2018).

Additional research published in 2019 by UMN and MPCA scientists confirmed that sulfate converted to sulfide in anoxic sediments, resulting over time in "sulfide-dominated porewater chemistry" accompanied by "detrimental effects to, and eventually extirpation of, self-perpetuating wild rice populations."[25]

Ongoing research published in 2020 detailed the effects of sulfate and iron on wild rice, explaining that iron sulfide precipitation on wild rice root surfaces happened at "the beginning of seed production," and sulfate-amended plants had lower nitrogen in seeds, fewer seeds, lower seedhead mass, and lower biomass (leaves and stems) during late flowering, all to a statistically significant degree.[26] By 2022, this peer-reviewed research confirmed that high iron concentrations did not protect wild rice from elevated sulfate over time. The plain language summary explained: "Nearly

[24] LaFond-Hudson S, Johnson NW, Pastor J, Dewey B (2018) Iron sulfide formation on root surfaces controlled by the life cycle of wild rice (*Zizania palustris*). *Biogeochemistry* 141:95-106, Exhibit 12 at 95.

[25] Johnson NW, Pastor J, Swain EB (2019) Cumulative sulfate loads shift porewater to sulfidic conditions in freshwater wetland sediment. *Environmental Toxicology and Chemistry* 38(6):1231-1244, Exhibit 13 at 1231, 1242.

[26] LaFond-Hudson S, Johnson NW, Pastor J, Dewey B (2020) Interactions between sulfide and reproductive phenology of an annual aquatic plant, wild rice (*Zizania palustris*). *Aquatic Botany* 164:103230, Exhibit 14 at 5.

all plant populations exposed to high sulfate had died by 6 years into the experiment, regardless of iron concentration or litter removal."[27]

MPCA's webpage committing to enforcement of the wild rice sulfate standard, Exhibit 10, cited these and other modern peer-reviewed publications by UMN and MPCA scientists from 2017 through 2022, as well as John Moyle's field work published in 1944. In denying U.S. Steel's application for a site-specific standard, MPCA also cited these and other recent publications to conclude that U.S. Steel's proposed standard was not scientifically defensible and that "recent concerns have emerged that suggest the degree of protection against sulfide that is afforded by iron may not be as great as originally conceived." Denial of Site-Specific Standard, Exhibit 8 at 3; cited in *In re Sulfate Site-Specific Standard for Hay Lake,* 2025 WL 959092 at *4. The Court of Appeals concluded that MPCA used reasoned judgment and was not arbitrary and capricious "when determining that the sediment-based equation was not scientifically defensible." *Id*. at *5.

In its argument on appeal in the Hay Lake case, U.S. Steel cited one study prepared by its own consultant, O'Niell Tedrow at Northeast Technical Services, Inc.[28] Even with its unorthodox methodology (reseeding one paddy mid-experiment and loss of seeds due to "freezer failure," *id*. at 940, 944) and short duration, the Tedrow study showed reductions in seed biomass, seeds per panicle, stem height and shoot biomass within a year or two in paddies where sulfate was added. *Id*. at 948. The court of appeals found that MPCA did not act unreasonably in rejecting the Tedrow study. *In re Sulfate Site-Specific Standard for Hay Lake,* 2025 WL 959092 at *6.

Current peer-reviewed science, along with field studies published before the mining industry had degraded wild rice waters, provide clear and overwhelming support for MPCA's draft Keetac permit effluent limits applying Minnesota's wild rice sulfate standard of 10 mg/L to U.S. Steel Keetac mining area and tailings basin discharge affecting wild rice beneficial use in Hay Lake.

4. *Data Collected by U.S. Steel from 2009-2021 and Current Conditions in Hay Lake Demonstrate that Wild Rice in Hay Lake is Impaired and Unhealthy*.

Although U.S. Steel's application for a 79 mg/L site-specific sulfate standard for Hay Lake sought to demonstrate that wild rice in Hay Lake was healthy despite ongoing sulfate levels in excess of 10 mg/L, data in its application proved the opposite.[29] Sulfate discharges from the U.S. Steel Keetac mining area and tailings basin both flow into Hay Lake. Exhibit 17 at MPCA000727. As a

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[27] LaFond-Hudson S, Johnson NW, Pastor J, Dewey B (2022) Sulfur geochemistry destabilizes population oscillations of wild rice (*Zizania palustris*). J. *Geophysical Research Biogeosciences* 10.1029, Exhibit 15 at 1.

[28] Tedrow O, and Lee P (2022) Use of Wild Rice (*Zizania palustris L*.) in paddy-scale bioassays for assessing potential use of mining-influenced water for irrigation. *Mine Water and the Environment* 41:938-953, Exhibit 16.

[29] U.S. Steel, Application for Sulfate Site-Specific Standard, August 2022, Exhibit 17 (excerpts). Page citations use Bates numbering in the administrative record of *In re Sulfate Site-Specific Standard for Hay Lake*.

result, from 2009-2021, average sulfate in Hay Lake was 34 mg/L, and from 2017-2022 average sulfate input to Hay Lake was 47.63. *Id*. at MPCA000735 (text), MPCA000744.

MPCA's brief opposing a less stringent sulfate site-specific standard for Hay Lake in the court of appeals illustrated that, under existing sulfate conditions, U.S. Steel's wild rice monitoring was inadequate to demonstrate unimpaired wild rice. Exhibit 9 at 19.

Summary Chart of U.S. Steel's Wild Rice Monitoring Outcomes

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Wild Rice Density	>75%	25%-50%	0%	10%-50%	N/A	>75%	N/A	N/A	N/A	N/A	N/A	N/A	0%	N/A

In fact, U.S. Steel's application for a sulfate site-specific standard for Hay Lake documented impairments of wild rice by harvest time in both 2009 and 2011. DNR's field report from September 2009 was included in the application. DNR found that by September the wild rice in Hay Creek "was very un-healthy and had virtually no seeds" and the wild rice in Hay Lake "was severely damaged (rotten) and appeared to be un-harvestable." Exhibit 17 at MPCA000789. Photos from the application shown below illustrate these conditions. *Id*. at MPCA000792-93.



The poor condition of Hay Lake wild rice by harvest time in 2009 was not an anomaly.

In 2011, U.S. Steel's application acknowledge that by August in Hay Lake "the majority of wild rice stands were found uprooted and dead in the water." *Id.* at MPCA000736. Photos from U.S. Steel's 2011 Hay Lake wild rice survey are reproduced on the next page. *Id*. at MPCA001190.

HAY LAKE SURVEY - 16 AUG 2011



Photograph H-15. Hay Lake, August 16, 2011.



Photograph H-16. Hay Lake, August 16, 2011.

U.S. Steel's application did not document the condition of wild rice in 2010 or in any year from 2013 through 2021.

But in 2021 U.S. Steel's application stated that early growth was noted in June, wild rice was "sparse" in July, and that "[n]o wild rice was observed after July." *Id.,* MPCA000737. Thus, no rice was present in August or September for seed production, support of wildlife, or harvesting. Based on U.S. Steel's site-specific standard application, in 50% of the years for which U.S. Steel reported data—2009, 2011, and 2021—wild rice was rotten or absent from Hay Lake after July.

Summary of Wild Rice Monitoring in U.S. Steel Application														
YEAR	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2018	2019	2020	2021
Wild Rice Data	X	X	X	X	No	X	No	No	No	No	No	No	No	X
Present After July	Rotten	Yes	No	Yes		Yes								No

U.S. Steel's application for a site-specific standard also demonstrated that real-world conditions at Hay Lake produce toxic levels of sulfide in porewater. In 2021, measured porewater sulfide exceeded MPCA's wild rice toxicity threshold of 0.12 mg/L in one-third of the Hay Lake samples and exceeded levels where MPCA experts found that wild rice cover declines (0.10 mg/L) in almost half of the Hay Lake samples, as shown in the table attached as Exhibit 17.[30] This porewater chemistry provides additional confirmation that sulfate conversion to sulfide in sediments has created an unfavorable environment for wild rice in Hay Lake.

Various commenters suggested at the MPCA's September 3, 2025 public hearing on the Keetac permits that wild rice in Hay Lake is thick and thriving. It is not.

[30] Hay Lake Porewater Sulfide Monitoring Results Summary and Evaluation Table, Exhibit 18, is based on Exhibit 17 at MPCA002445 and MPCA's July 2017 SONAR pages in the Exhibit.

After the Keetac hearing on September 3, 2025, Hibbing resident and former miner Mike Maleska went to Hay Lake to see for himself the condition of wild rice.[31] Mr. Maleska's photos below show wild rice on Hay Lake on September 7, 2025. The wild rice was sparse and unhealthy, with many bent, broken, or rotten stems and few, if any, filled seed heads. Exhibit 19.



Hay Lake wild rice Sept. 7, 2025.



Hay Lake wild rice Sept. 7, 2025 (close-up).

Hay Lake and Hay Creek are shown below on a photo taken from a small plane July 1, 2025. *Id*. Mr. Maleska has designated on this photo where wild rice was observed on September 7, 2025 (left) as compared with the historic extent of wild rice approximately 50 years ago (right). *Id.*



Location of Hay Lake wild rice on September 7, 2025, (red line) by Mike Maleska



Historic location of Hay Lake wild rice (black lines) by Mike Maleska

[31] Michael Maleska Declaration with Photos taken at Hay Lake on September 7, 2025, and Sketches of Wild Rice Locations at Hay Lake, Exhibit 19.

Independently, northern Minnesota resident Shanai Matteson went with a friend to Hay Lake on September 10, 2025 to view the condition of the wild rice. Photographs taken on September 10, 2025 show sparse wild rice among the lily beds.[32]



Hay Lake wild rice and lily pads on September 10, 2025

Ms. Matteson's declaration explains, "Up close, we could see that many wild rice stems were cracked or rotten-looking. There were few heads containing seeds and the seeds we found looked dry and unripe." Exhibit 20 at ¶5.



Hay Lake wild rice on September 10, 2025

[32] Shanai Matteson Declaration with Photos taken at Hay Lake on September 10, 2025, Exhibit 20.

Ms. Matteson explained that on the same September 10, 2025 day that Hay Lake had wild rice that was "sick and broken," she saw "lush, healthy, productive wild rice at the Sandy Lake Flowage." *Id*. at ¶¶ 6-7. At Hay Lake, there was "no wild rice that would support wildlife and certainly none that people could harvest." *Id*. at ¶7.

The history of Keetac permitting and violations, state and federal law, current peer-reviewed science, and overwhelming evidence of wild rice impairment in Hay Lake support and require WQBELs to comply with Minnesota's 10 mg/L wild rice sulfate standard in Keetac permits.

B. MPCA's Preliminary Denial of Variance to U.S. Steel is Well Supported.

WaterLegacy supports MPCA's preliminary denial of U.S. Steel's application for a variance from the wild rice sulfate standard in the draft Keetac permits. In its preliminary denial,[33] MPCA staff determined that "the Permittee has not satisfied the conditions necessary to receive a variance under either Factor 3 [40 C.F.R. § 131.10(g)(3); Minn. R. 7050.0190, subp. 4(A)(3)] or Factor 6 [40 C.F.R. § 131.10(g)(6); Minn. R. 7050.0190, subp. 4(A)(6)] and, as a result, recommend[ed] the Commissioner deny the sulfate variance request."

MPCA explained that Factor 3 variances can be appropriate where pollution is from an indirect cause outside the control of the permittee. But U.S. Steel did not even attempt to explain how Keetac sulfate pollution is a human caused condition "not caused or contributed to by their own processes and discharge." *Id*. at 4. U.S. Steel did not satisfy this Factor 3 variance condition.

MPCA also rejected U.S. Steel's argument under the second clause of Factor 3 that either the pollution cannot be treated or that treatment will cause more environmental harm than leaving the pollution in place. *Id*. at 5. MPCA correctly found that U.S. Steel's variance application actually demonstrates that sulfate pollution *can* be treated to meet permit WQBELs using the identified treatment. *Id*. In fact, Barr determined for U.S. Steel, "Based on Barr's experience, previous studies, and pilot testing, the water treatment technology proposed in this study is expected to allow Keetac to meet these permit limits for sulfate."[34] MPCA agreed that the treatment methods proposed by Barr for U.S. Steel would be effective. Preliminary Variance Denial at 5.

MPCA found that U.S. Steel's application addressed environmental costs of treatment, such as energy use and waste management, but failed to address the benefits of treatment, thus failing to make a Factor 3 showing. *Id.* WaterLegacy supports MPCA's analysis and suggests that a more comprehensive discussion of impaired waters would underscore the benefits of treatment to wild rice, aquatic life, reduction of excessive nutrients, and public health.

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[33] MPCA, Water Quality Program Facility-specific Preliminary Determination Water Quality Standard Variance for Sulfate, U. S. Steel Corp. U.S. Steel Keetac Facility and Tailings Basin Permits MN0031879 and MN0055948, July 8, 2025 ("Preliminary Variance Denial") at 2.

[34] Barr Engineering, Application for a Variance from the Class 4A Sulfate Water Quality Standard for Waters Used for Production of Wild Rice NPDES/SDS Permit Nos. MN0055948 and No. MN0031879, Prepared for U.S. Steel Corp., May 2025 ("Variance Application") at 3.

Both MPCA and U.S. Steel applied the tests in longstanding EPA guidance to determine whether the costs of treatment of Keetac sulfate pollution would result in "substantial and widespread" economic impacts or "economic burden" to justify a Factor 6 variance under either federal regulations or state rules. Preliminary Variance Denial at 5-7; Variance Application at 15. U.S. Steel's Variance Application stated that a reduction of profits by nine percent was significant, but did not suggest there were any issues with the corporation's solvency. *Id*.

MPCA concluded that U.S. Steel does not meet the requirements for a Factor 6 variance because: 1) "U.S. Steel has sufficient profits to pay for pollution control costs," and its profit rate with or without pollution controls would still be seven percent using 2024 fiscal data and U.S. Steel's estimated costs; 2) U.S. Steel's average liquidity ratio for the past three years is 1.76, which does not show serious liquidity problems, even though it is slightly lower than EPA's general recommendation; and 3) U.S. Steel's long-term solvency is strong, with an average ratio for the past three years of 0.52, substantially above the 2.0 ratio recommended by EPA. Preliminary Variance Denial at 6-7. WaterLegacy believes that this conclusion is correct.

Additional information in U.S. Steel's Application also weighs against the requested variance. U.S. Steel asked that variances from application of the sulfate standard "remain in place for ten years" to "allow U.S. Steel to collect additional data" regarding water quality and sulfate reduction alternatives. Variance Application at 14. No federal or state law authorizes the grant of a variance to collect better data; such a practice would swallow up any requirement to apply water quality standards. Since 14 years have already elapsed since sulfate WQBELs were set for Keetac mining area and tailings basin discharge, in effect U.S. Steel's variance application is requesting a quarter century of delay.

Variance Application estimates of water treatment costs may also be somewhat high. The Variance Application states in its text at page 14 that capital expenditures are estimated at $595,000,000, but Appendix B of the Application at page 2, Table 1, estimates total capital expenditures of $538,000,000 within a wide range (30 percent less to 50 percent more) of uncertainty. U.S. Steel's cost projections are based on construction of four similar treatment systems, "one for each active surface discharge station," *id*. at 9, although one discharge station (SD 002) only intermittently discharges to a wild rice waters and another (SD 005) "does not discharge" under high demand and/or low water inventory conditions. *Id*. at 12. The Variance Application does not evaluate whether capital and operating costs for four treatment systems are higher than if fewer treatment plants were built. But Barr does acknowledge that actual costs of treatment may be less than projected, "necessitating the requirement to reevaluate the worksheets and financial evaluation." *Id*. at 15, 21.

Although U.S. Steel's Variance Application cites "economic hardship, notably one that others in the industry and within the state do not share," *id*. at 14, U.S. Steel does not claim in its Application, let alone demonstrate, that Keetac mine facilities would be closed or that operations would be suspended if a variance were not granted. Without minimizing either the real economic costs of treatment or the need for fair application of pollution control requirements within the industry, U.S. Steel's Variance Application does not meet the requirements for a variance from the

wild rice sulfate standard. MPCA's preliminary determination to deny the variance is well-supported.

C. Additional Information in U.S. Steel Disclosures and Arising from Nippon Steel's Purchase of U.S. Steel Supports Denial of the Variance.

U.S. Steel was required to file an Annual Report (Form 10-K) pursuant to the Securities Exchange Act of 1934 for the fiscal year ending on December 31, 2024, the substance of which was declared true and accurate by U.S. Steel's CEO and other top officials as required to avoid perjury under securities laws.[35] That Annual Report contains disclosures that further support MPCA's denial of a variance for environmental compliance with Minnesota's wild rice sulfate standard.

U.S. Steel's 2024 Annual Report explains that its overall environmental expenditures from 2022 through 2024 represented "approximately 2 percent of U.S. Steel's total costs and expenses in 2024, 2023, and 2022." *Id*. at 19. U.S. Steel's total capital expenditures were $2.576 billion in 2023 and $2.287 billion in 2024. *Id*. at 58. Yet, in 2024 U.S. Steel "repaid approximately $128 million in debt, and we ended the year with $3.62 billion of total liquidity." *Id*. at 11. U.S. Steel's total assets at the end of 2024 were $20.235 billion. *Id*. at 80.

U.S. Steel's 2024 Annual Report specifically acknowledged that it was subject to environmental laws, including the wild rice sulfate standard: "Our U.S. facilities are subject to environmental laws applicable in the U.S., including . . . the Clean Water Act (CWA). . . The State of Minnesota has a sulfate wild rice water quality standard (WQS) set at 10 mg/L, which was established in 1973." *Id*. at 20. The Annual Report explained that environmental expenditures "are capitalized if the costs mitigate or prevent future contamination or if the costs improve existing assets' environmental safety or efficiency." *Id*. at 76. U.S. Steel explicitly acknowledged: "New or expanded environmental requirements, which could increase U.S. Steel's environmental costs, may arise in the future." *Id*. at 62. Immediately after recognizing the potential for increased costs, U.S. Steel's Annual Report added the sentence, "U.S. Steel intends to comply with all legal requirements regarding the environment." *Id*.

These statements in U.S. Steel's 2024 Annual Report support MPCA's findings that U.S. Steel has sufficient assets and liquidity to pay for water quality treatment needed for environmental compliance. The Report also suggests that—at its highest levels—U.S. Steel has considered the need to comply with the wild rice sulfate standard as another potential capitalized cost of lawful environmental compliance.

In addition, the 2024 Annual Report undermines claims that environmental compliance creates a competitive disadvantage for U.S. Steel. The Report states: "We believe that our major North American and many European integrated steel competitors are confronted with substantially similar environmental regulatory conditions and therefore do not believe that our relative position

[35] U.S. Steel Corp., Annual Report Pursuant to Section 13 or15(d) of the Securities Exchange Act of 1934 (Form 10-K) for the fiscal year ended on December 31, 2024, ("Annual Report"), Exhibit 21 at 129. False statements in SEC filings are criminalized in 18 U.S.C. § 1001 and ch. 240 SEC rules.

with regard to such competitors will be materially affected by the impact of environmental laws and regulations." *Id*. at 7.

Information arising from Nippon Steel's purchase of U.S. Steel also supports MPCA's denial of a variance from environmental compliance. As of June 18, 2025, U.S. Steel is now a wholly-owned subsidiary of parent corporation Nippon Steel.[36] Nippon Steel is the largest producer of crude steel in Japan and the fourth largest in the world.

Nippon Steel bought U.S. Steel for $14.9 billion in June 2025.[37] On August 28, 2025, Nippon Steel then announced that it would make an $11 billion investment, running through 2028, to transfer advanced technologies to U.S. Steel and increase U.S. Steel's profit contribution to Nippon Steel to $1.70 billion (250 billion yen) a year. *Id*. This is more than triple the amount of profit (80 billion yen) expected to be contributed by U.S. Steel this year. *Id*.

Although U.S. Steel has made no such claims, commenters opposing Keetac compliance with Minnesota's sulfate standard have stated that Keetac and other U.S. Steel facilities will close rather than pay the costs of water treatment. These fears are baseless.

The Keetac mine still has 153.3 million tons measured and indicated mineral resources and 125.9 million tons probable mineral reserves. Annual Report, Exhibit 21 at 39. Publicly reported information suggests that Keetac facilities are uniquely valuable to U.S. Steel—and now to Nippon Steel—because they were recently upgraded at a cost of $150 million to produce high value direct reduction pellets that feed electric arc furnaces for low-carbon steel production.[38]

Moreover, when U.S. Steel was purchased by Nippon Steel on June 18, 2025, U.S. Steel's Certificate of Incorporation was amended to include a National Security Agreement stating that the Corporation, absent a Force Majeure Event "shall not, either directly or indirectly . . . prior to June 18, 2035, close, idle or sell" any U.S. Steel Production Location.[39] "Production Location" for this prohibition on closure, idling, or sale, is specifically defined to include "Minnesota Ore Operations (including Keetac and Minntac)." *Id*. Article VI(2)(d). In addition, a schedule attached to U.S. Steel's Fifth Amended Certificate of Incorporation pledged an investment of $800 million in Minnesota's Keetac/Minntac facilities from 2025 through 2028.[40]

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[36] U.S. Steel Corp., Current Report (Form 8-K) Pursuant to Section 13 or15(d) of the Securities Exchange Act of 1934, June 18, 2025 ("Form 8-K Report"), Exhibit 22 at Item 5.01.

[37] Obayashi, Y. (2025, August 28) Nippon Steel bets on $11 billion investment, tech transfer to lift U.S. Steel profit, *Reuters*, Exhibit 23.

[38] Lovrien, J. (2024, May 23) Keetac's new DR-grade plant up and running, *Duluth News Tribune*, Exhibit 24.

[39] Form 8-K Report, Exhibit 22 at Ex. No. 3.1, Fifth Amended and Restated Certificate of Incorporation of the Company at Article VI(1)(d).

[40] *Id.*, Schedule 2 to Fifth Amended and Restated Certificate of Incorporation.

U.S. Steel's reports to the Securities Exchange Commission confirm that MPCA should deny U.S. Steel a variance from compliance with Minnesota's wild rice sulfate standard. Even before Nippon Steel's purchase of the corporation, U.S. Steel had sufficient liquidity to capitalize environmental compliance costs, recognized the potential need to comply with Minnesota's sulfate standard, and denied that environmental compliance resulted in a competitive disadvantage. Nippon Steel's purchase of U.S. Steel has increased U.S. Steel's resources, promised greater U.S. Steel annual profitability—which would make membrane water quality treatment more affordable—and specifically committed to $800 million in capital investments at Keetac and Minntac by 2028. The prohibition on closure of Keetac or Minntac before June 18, 2035 both undermines any claim of widespread economic impacts and suggests that timing of capital improvements for Keetac sulfate compliance to take place without delay would be beneficial.

II. RECOMMENDATIONS FOR CHANGE, ADDITIONAL ANALYSIS, AND CLARIFICATION OF MPCA DRAFT KEETAC PERMITS.

MPCA's draft permits for the Keetac mining area (MN0031879) and Keetac tailings basin (MN0055948) and their corresponding fact sheets contain compelling analysis to support sulfate WQBELs requiring U.S. Steel's compliance with the wild rice sulfate standard at Hay Lake. However, on other issues pertinent to NPDES/SDS compliance and protection of surface water and groundwater, these documents contain ambiguities and gaps which may undermine their efficacy in achieving pollution control. The balance of WaterLegacy's comments address these areas where changes, additional analysis, or clarification are needed before MPCA approves final permits.

1. Keetac Permits Should Require Timely Construction of Water Treatment.

MPCA's draft Keetac mine and tailings basin permits provide a compliance schedule and require that final, Phase 2 effluent limits be achieved "as soon as possible, but no later than April 30, 2030." *See* Mine Permit at 19 (5.13.59); TB Permit at 23 (5.24.83). WaterLegacy supports MPCA's inclusion of a deadline for compliance. However, WaterLegacy agrees with EPA that a compliance schedule is not supportable under federal antibacksliding regulations. A compliance schedule is also redundant and unnecessary since planning, agreement on the type of proposed treatment, and pilot studies have already been completed. U.S. Steel's compliance deadline should be based solely on the time need to develop design specifications, construct, and test the operation of the "proposed water treatment system" described by Barr in Appendix B of U.S. Steel's Variance Application.

The timeframe for developing design specifications should start now, if it hasn't already begun, and compliance could be achieved in 2027, rather than 2030. That timeframe would better coordinate with Nippon Steel's promises of capital investment as well as more effectively protecting water quality and wild rice.

1. Federal law does not support an additional compliance schedule.

The Keetac permits issued in 2011 contained a detailed compliance schedule to meet identical sulfate effluent limitations by August 17, 2018, in the case of mining area permit (MN0031879) and by August 17, 2019, in the case of the tailings basin permit (MN0055948). These permits are

still in effect. As the EPA commented in its 2024 review of the drafts for Keetac permit reissuance: "By extending the date for compliance with the WQBELs beyond the dates specified in the current permits, the draft permits include less stringent effluent limitations and conditions than the prior permits. This approach is in conflict with the backsliding prohibition in 33 U.S.C. § 1342(o) and 40 C.F.R. § 122.44(l)(1) unless one of the exceptions in those statutory and regulatory provisions applies, which does not appear to be the case."[41]

EPA further found that MPCA had not made a finding supported by evidence that the draft compliance schedule was appropriate, 40 C.F.R. § 122.47, or that it required compliance with final sulfate effluent limitations "as soon as possible." *Id*. at (a)(1).

MPCA has agreed that "Sulfate WQBELs were introduced in Keetac's NPDES permits in 2011 and are enforceable under the federal Clean Water Act." Preliminary Variance Denial at 1. These current effluent limitations set a 14 mg/L monthly average and 24 mg/L daily maximum for sulfate. *Id*. However, MPCA argues that a 2016 Minnesota Session Law provides "new information" qualifying the compliance schedule in the draft Keetac permits "for the exception to antibacksliding." Mine Fact Sheet at 43.

WaterLegacy disagrees that the 2016 Session Law supports an antibacksliding exception allowing a new compliance schedule. In fact, the Session Law's plain language precludes this interpretation. The 2016 Session law stated that the "final sulfate limits resulting from implementation of the wild rice sulfate water quality standard . . .are no longer valid" and that permit conditions "relating to those final limits" are no longer valid. Minn. Laws 2016, Ch. 165, Sec. 1(a). However, the Session Law also stated, "Nothing in this section shall relieve the permittee from its obligation to satisfy requirements contained in any schedule of compliance that is in effect as of May 1, 2016." *Id*., Sec. 1(b). The Legislature clearly intended that U.S. Steel was obligated to meet all compliance requirements up to the point of expending money to design and implement sulfate treatment technology. *See also* Minn. Laws 2015, 1st Spec. Sess., Ch. 4, Art. 4, Sec. 136.

By January 2017, with MPCA oversight, U.S. Steel had done just that. The Company performed various studies and selected an ultrafiltration and nanofiltration treatment technology to meet the wild rice sulfate standard. U.S. Steel then piloted that treatment and reported positive results in December 2016. *See* Attachment 1 to Mine and TB Fact Sheets. The only remaining steps before actual compliance with the Keetac permits' final Phase 2 WQBELs for sulfate are for U.S. Steel to prepare detailed design specifications, construct the proposed water treatment, and verify its operations. These steps do not require an exception to antibacksliding or a schedule of compliance.

2. Final Keetac permits should require construction of the selected membrane treatment.

U.S. Steel and MPCA have agreed on the proposed wastewater treatment to attain compliance with the wild rice sulfate standard at the Keetac mining area and tailings basin facilities. MPCA's

[41] EPA, Comments on Review of Two Draft NPDES Permits, U.S. Steel Keetac Mining Area (MN0031879) and U.S. Steel Keetac Tailings Basin (MN0055948), Keewatin, Minnesota, Sept. 6, 2024 ("EPA Permit Comments"), Exhibit 25 at 1. EPA noted that all cited federal regulations are made applicable to states by 33 U.S.C. §§ 1314(i), 1342(c)(2) and 40 C.F.R. § 123.25.

Preliminary Variance Denial approved the treatment proposal selected by U.S. Steel, summarized as follows: "The selected wastewater treatment system relies on linking commercially available physical and chemical processes and involves the installation of equalization basins, lime softening, ultrafiltration, nanofiltration, high-efficiency reverse osmosis, evaporators, crystallizers, filter presses, and centrifuges." Preliminary Variance Denial at 5. Barr confirmed for U.S. Steel that "the water treatment proposed" in its variance application "is expected to allow Keetac to meet these permit limits for sulfate." Variance Application at pdf 76, Appendix B.

The final Keetac permits should move forward to achieve construction of the selected treatment, rather than sliding back into a planning process. WaterLegacy requests that the final Keetac fact sheets document the legal and practical reasons to proceed with design and construction of the wastewater treatment. The final Keetac permits should then include a summary of the treatment system selected and a compliance date based on the shortest reasonable time for design and construction. That design process may already be underway.

Other than a scheduled milestone for MPCA design review and a plan for inspections and consultation in the event of unforeseen circumstances, the permit would require compliance be achieved as soon as possible and at the latest by a fixed date in 2027, with a brief grace period for non-compliance to allow for operational adjustments. No compliance schedule is necessary or appropriate for Keetac to achieve compliance with wild rice sulfate standard WQBELs.

2. MPCA should Establish Numeric WQBELs for Specific Conductance Based on Minnesota's Toxicity Thresholds for Ecoregion 50.

In its comments on the draft Keetac permits, the EPA criticized MPCA's failure to evaluate "whether the discharge of specific conductance or constituent ions from any outfalls will cause, have the reasonable potential to cause, or contribute to an excursion above any state water quality standard, including narrative water quality standards." EPA Permit Comments, Exhibit 25 at 3. The EPA cited CWA regulations requiring effluent limits to ensure compliance with narrative as well as numeric water quality standards and determinations both by EPA and MPCA that specific conductance may cause violations of Minnesota's narrative water quality criteria. *Id*., citing 40 C.F.R. § 122.44(d)(1)(i).

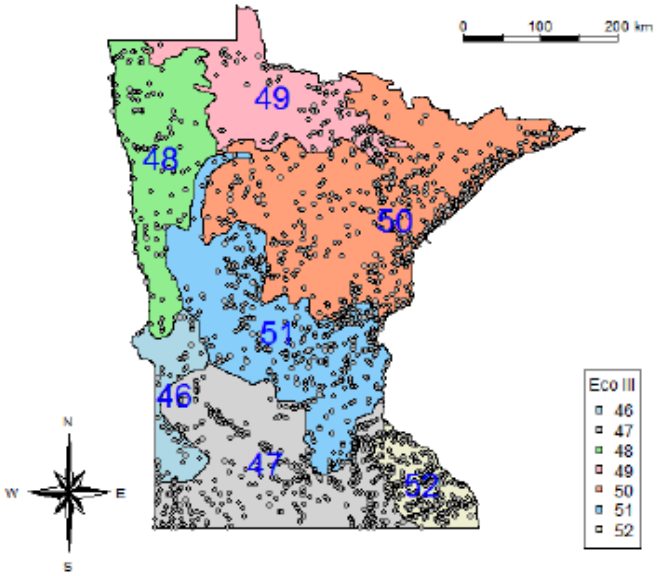
MPCA's Keetac fact sheets stated that the agency "did not perform a numeric translation of the narrative aquatic life standard to then determine whether Keetac is causing or contributing to an exceedance of the narrative aquatic life standard with regards to specific conductance" because there was "no clear evidence that aquatic life downstream of Keetac are below applicable IBI criteria." Mine Fact Sheet at 35, TB Fact Sheet at 35.

WaterLegacy believes that MPCA incorrectly made protection of an aquatic community from toxicity contingent on index of biological integrity ("IBI") findings.

Minnesota rules set general narrative standards to protect aquatic life from undesirable conditions. Minn. R. 7050.0150, subp. 3. In addition, Minnesota rules set objectives to protect surface waters from "toxic pollutants." Minn. R. 7050.0217. Such rules state that "site-specific water quality criteria for toxic pollutants or chemicals developed in the absence of numeric standards" should

protect "the propagation and maintenance of aquatic biota." *Id*., subp. 1. For these criteria, "[p]rotection of the aquatic community from the toxic effects of pollutants means the protection of no less than 95 percent of all the species in any aquatic community." *Id*., subp. 2A.

Local scientists, EPA, and MPCA agree that the specific conductivity threshold needed to protect 95 percent of all species in the aquatic community in the Keetac mining area—EPA Ecoregion 50 shown below—is no higher than 329 micro Siemens per centimeter ("µS/cm").



In 2015, retired Minnesota agency scientists Bruce Johnson and Maureen Johnson compared data on aquatic genera and sensitivities in northeastern Minnesota with EPA's study setting a specific conductance benchmark for aquatic life in Appalachia; they determined that EPA's analysis should apply to northeastern Minnesota.[42] EPA's Office of Research and Development ("ORD") evaluated the Johnsons' paper in 2016 and concluded, "Overall, the weight of evidence supports the inference that effluents that increase waterbody SC [specific conductance] to more than 300 µS/cm have adverse effects in northeast Minnesota waters."[43]

EPA then analyzed an independent data set of paired benthic invertebrate and specific conductance data from Ecoregion 50 in Minnesota. *Id*. at 2-9. Based on the paired data, EPA confirmed that "more than 5% of genera would be extirpated in streams greater than 320 µS/cm." *Id.* at 10. The history of development of a specific conductance criterion in Minnesota's Ecoregion 50 is summarized in EPA's approval of the Fond du Lac Band of Lake Superior Chippewa's 2020 water quality standards revisions adopting a standard of 300 µS/cm in Reservation waters.[44]

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[42] Johnson BL, Johnson MK, An Evaluation of a Field-Based Aquatic Life Benchmark for Specific Conductance in Northeastern Minnesota, November 2015, Exhibit 26.

[43] Susan Cormier, EPA ORD, Review of "An Evaluation of a Field-Based Aquatic Benchmark for Specific Conductance in Northeast Minnesota," Prepared by B. L. Johnson and M. K. Johnson, February 4, 2016 ("EPA Review"), Exhibit 27 at 2.

[44] EPA, Review of Revisions to the Fond du Lac Band of Lake Superior Chippewa's Water Quality Standards Under Section 303(c) of the Clean Water Act, October 5, 2020, Exhibit 28 at pdf 9-15.

MPCA conducted its own analysis using a statewide dataset collected by its biological monitoring program from 1996-2018 to set "criterion continuous concentration" values reflecting chronic exposure and "designed to be protective of 95% of the native genera for a region."[45] MPCA determined criterion continuous concentrations to provide regional benchmarks for specific conductance. In Minnesota Ecoregion 50—Northern Lakes and Forests—MPCA's criterion continuous concentration value was 329 µS/cm. *Id*. at 6.

There is no dispute that levels of specific conductance in U.S. Steel's direct discharge to surface water are more than double the chronic criterion concentration for Ecoregion 50, where the Keetac mine and tailings area are located. Discharge monitoring reports from 2018 to 2024 in Exhibit 3 show that specific conductance discharged from SD 002 (mining area) averaged 789 µS/cm[46] umhos/cm, while specific conductance discharged from SD 005 (tailings basin) averaged 797 µS/cm.

MPCA's proposal that a reasonable potential analysis need not be done for specific conductance––despite these exceedances—until IBI assessments shows "clear evidence" of impairment fails to recognize the difference between protection of aquatic life from extirpation and documenting or remediating conditions once genera have already been killed by toxic pollutants. Minnesota rules recognize that class 2 water quality standards "do not address all pollutants that may be discharged to surface waters and cause toxic effects." Minn. R. 7050.0218, subp. 2.

Moreover, "chronic criterion" concentrations such as those developed by the MPCA for specific conductance are the methods used "to meet the objectives in part 7050.0217" and protect surface waters from toxic pollutants. Minn. R. 7050.0218, subp. 1, subp. 3(Q). As noted previously, the objectives in part 7050.0217 require "protection of no less than 95 percent of all the species in any aquatic community"; they may even apply greater protection "if economically, recreationally, or ecologically important species are very sensitive." Minn. R. 7050.0217, subp. 2(A).

If site-specific criteria and effluent limits were only set for toxic pollutants after MPCA found "clear evidence" of impairments documented by IBI assessments—which are infrequent and only performed only for selected waters—it must be expected that more than 5 percent of sensitive genera will be extirpated in many waterbodies long before any reasonable potential analysis is done or effluent limit established. Further delay in controlling Keetac discharge of toxic specific conductance is inconsistent with rules setting criteria for toxic pollutants. It cannot be justified.

WaterLegacy agrees with the EPA that a reasonable potential analysis for specific conductance should be done prior to issuance of the final Keetac permits. If—as is highly likely based on discharge monitoring reports—WQBELs are required to protect aquatic biota, final effective limits for specific conductance should be imposed as soon as possible and in no event later than the date when sulfate WQBELs become effective. That timing will ensure that the proposed water treatment is designed to effectively and efficiently control all harmful ionic pollutants. Since wild

[45] MPCA, S-5 Implementing the Aquatic Life Narrative Standard, SONAR for Proposed Class 3 and 4 Rule Revisions, December 14, 2020 ("MPCA S-5"), Exhibit 29 at 6.

[46] The discharge monitoring reports use the measurement unit of umhos/cm, which is equivalent to µS/cm.

rice is also sensitive to specific conductance pollution at approximately the same level as invertebrates,[47] simultaneous controls of specific conductance and sulfate will also increase the likelihood that water treatment will be effective in reducing impairment of downstream wild rice.

3. MPCA Should Require Biological Assessments and Chronic Whole Effluent Toxicity Testing Upon Permit Issuance.

WaterLegacy believes that the draft Keetac Permits downplay the likelihood of impairments of invertebrates in waters affected by Keetac discharge and could allow another five years of delay before sampling of streams in the project area. This delay fails to protect aquatic life.

The 2025 environmental assessment worksheet ("EAW") for tailings basin expansion contains the following table of streams in Keetac project area, three of which were surveyed in 2015. [48]

Table 12.4: Water Quality and Index of Biotic Integrity Scores for Streams in the Project Area, 2015 survey*

Stream	Identification No.	Biological Stream Station ID	Nitrogen (mg/L)	Total Phosphorus (mg/L)	TSS (mg/L)	Ammonia (mg/L)	Dissolved Oxygen (mg/L)	pH	Fish IBI Score	Invertebrate IBI Score
Hay Creek	07010103-545	99UM061	n/a	0.039	4.8	< 0.1	8.51	8.02	60—good	60—Fair
Swan River	07010103-753	10EM194	< 0.05	0.03	< 4	< 0.1	n/a	n/a	68—good	65—Fair
O'Brien Creek	07010103-583	15UM069	< 0.05	0.022	8.8	< 0.1	9.85	7.3	59—good	63—Fair
Welcome Creek	07010103-581		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

**No data were available for the West Swan River.*

MPCA's fact sheets acknowledge, that—when last evaluated in 2015—the three surveyed waters above had "fair" invertebrate scores. In addition, there was a 23 point decline in macroinvertebrate index of biological integrity ("M-IBI") scores at Hay Creek from 1999 to 2015. Mine Permit and TB Fact Sheets at 35. Although some staff believed that Hay Creek "appears to be in a declining pattern and likely in need of additional protection" due to "the decline in both fish and macroinvertebrate scores from 1999-2015," their suggestion to collect additional sampling was stayed and the MPCA declined to list Hay Creek as impaired for invertebrates even though its IBI scores were below lower confidence intervals. *Id*.

WaterLegacy believes that each of the tailings basin area streams surveyed in 2015 should be sampled again upon permit issuance to allow MPCA to evaluate conditions over time and identify impaired waters. WaterLegacy also supports MPCA's proposal for sampling of Hay Creek (07010103-545) both upstream and downstream of its confluence with Unnamed Creek (15UM070 & 99UM061) and also sampling Unnamed Creek (07010103-706), which flows immediately from Reservoir 2. In addition, WaterLegacy would suggest that two other stream segments be surveyed:

[47] *See* MPCA S-5, Exhibit 29 at 8.

[48] EAW, U.S. Steel Keetac Tailings Storage Facility Project, August 7, 2025, Exhibit 30 at 39.

Welcome Creek (07010103-581) from Reservoir 2 to O'Brien Lake, which is listed in DNR's Table 12.4 above, and the segment of O'Brien Creek (07010103-589) flowing into rather than out from O'Brien Lake.

The critical issue is timing. The draft permit for the Keetac tailings basin requires the permittee to sample fish and macroinvertebrates "once every five years for the life of the permit." TB Permit at 20 (5.22.43). This vague requirement would allow U.S. Steel to wait another five years to begin any bioassessment—creating a 10-year assessment gap for streams that were already declining in 2015. That requirement should be changed to require sampling "once every five years for the life of the permit, beginning on the year of permit issuance."

Current and complete biological assessments in these streams upon permit issuance are needed to provide a foundation to protect of fish and macroinvertebrates in Keetac watersheds.

Similarly, the draft Keetac permits must be strengthened to protect aquatic life from chronic toxicity. The draft Keetac permits delay quarterly chronic whole effluent toxicity ("WET") testing until year three of the permits. *See* Mine Permit at 9, 11, 13; TB Permit at 10, 12, 14. This delay is not justified. Further, while the Keetac permits state that chronic toxicity will be measured against a "monitoring threshold value" of 1.0 chronic toxicity unit (TUc) and require submittal of a plan for "toxicity reduction evaluation" if repeated tests confirm toxicity, there is no time after which permits require that toxicity be reduced below 1.0 TUc. *See* Mine Permit at 10-15, TB Permit at 11-16.

WaterLegacy requests that quarterly WET testing for toxicity begin the year of permit issuance that the permits require toxicity reduction if the calculated chronic toxicity unit (TUc) exceeds 1.0.

4. MPCA Should Include Mass Loading Limits in Sulfate WQBELs and Analyze Discharge Volumes and Pollutant Loading.

Sulfate effluent limits in draft Keetac permits lack mass loading limits, and the permits specify neither actual nor allowable discharge volume. The draft Keetac permits do not include an antidegradation analysis of changes in tailings size, discharge levels, and sulfate discharge concentrations over time. Although the Keetac permits describe the federal net precipitation formula that limits total discharge, neither the permits nor fact sheets apply this formula. WaterLegacy requests that the Keetac permits include mass loading limits for sulfate to prevent dilution, and a transparent and quantitative antidegradation analysis and projection of net precipitation discharge limits under federal regulations.

a. Mass Loading Limits for Sulfate.

Effluent limitations in the draft Keetac permits should contain limits on the mass loading of sulfate in discharge. Under CWA regulations, "effluent limitations" include restrictions on "quantities, discharge rates, and concentrations" of pollutants. 40 C.F.R. § 122.2. Except for pollutants (like temperature or pH) that cannot appropriately be expressed by mass, "[a]ll pollutants limited in permits shall have limitations, standards, or prohibitions expressed in terms of mass." 40 C.F.R. 122.45(f)(1). Permits may have limits on both mass and concentration and the permit "shall require

the permittee to comply with both limitations." *Id.* (f)(2). If a case-by case determination is made that mass-based limits are not feasible, permit conditions must "ensure that dilution will not be used as a substitute for treatment." *Id*. (f)(1)(iii).

Minnesota rules define "effluent limitation" to mean a restriction "on quantities, discharge rates, and concentrations of pollutants" discharged from point sources. Minn. R. 7001.1020, subps. 13. For antidegradation and NPDES permits, Minnesota rules also define "loading" as "the quantity of pollutants, expressed as mass, resulting from a discharge or proposed discharge to a surface water." Minn. R. 7050.0255 subps. 1, 22. Where downstream waters are impaired and no TMDL study has set waste load allocations, Minnesota courts have approved effluent limitations that limit both concentration and mass loading to ensure that "the effluent limits comply with the applicable narrative water quality standard and protect the lake against any further degradation until the TMDL study is completed." *In re Alexandria Lake Sanitary Dist. NPDES/SDS Permit*, 763 N.W. 2d 303, 314 (Minn. 2009). For the Keetac permits, no draft or final waste load allocations have been established for any of the downstream impairments. TB Fact Sheet at 39.

Effluent load limits are particularly important for the Keetac permits because Keetac discharge volumes fluctuate depending on processing needs, creating the potential for dilution. *See* Mine Permit at 4, TB Permit at 4. Discharge flow volumes are neither clear nor consistently stated. The draft Mine Permit states that there is *periodic* discharge from SD 001 at less than 0.01 million gallons per day ("mgd"); *average* discharge from SD 002 of 2.56 mgd; *average* discharge from SD 003 of 2.7 mgd; and an *allowable* discharge rate from SD 012 at an average rate of 1.77 mgd. Mine Permit at 4. The draft Tailings Basin Permit states that the *maximum* rate of discharge through SD 001 (from outfalls 011, 012, and 013) is 9.4 mgd; *average* flow from SD 005 is 4.6 mgd; and the *allowable* flow from yet unconstructed SD 009 is 4.7 mgd. *Id*. Neither actual nor allowable discharge volumes are stated or can be calculated from this information.

WaterLegacy requests that the MPCA include sulfate mass loading limits as well as concentration limitations in the final Keetac mining area and tailings basin permits. The permits should also provide a transparent analysis of average and allowable surface discharge volumes.

2. Antidegradation analysis of discharge volume and pollutant loading.

MPCA's fact sheets dismiss the need for an antidegradation analysis, stating that that the permits issued in 2011 "permitted an expansion of the taconite processing plant and included new proposed discharge from the Sargent Pit. There have been no changes to the facility since the last permit issuance." TB Fact Sheet at 13. The fact sheets state: "There are no associated changes in the sources of wastewater, no changes to the existing wastewater discharges, no net increase in sulfate mass loading, and no increase of flow in the wastewater discharges associated with this project." *Id.*; Mine Fact Sheet at 12.

However, these statements are not well supported. Neither the draft Keetac permits nor the 2011 Keetac permits state the baseline for comparison, the permitted discharge flow, or the maximum loading of pollutants authorized by the permits. Without this quantitative information, there is no way to substantiate if there have been or will be changes in flow or loading of sulfate and other pollutants requiring an antidegradation analysis or additional actions to prevent degradation.

WaterLegacy was able to locate an antidegradation analysis in U.S. Steel's 2009 application for an NPDES/SDS permit and tailings basin modification.[49] U.S. Steel's consultants calculated that the allowable discharge flow rate in 1986 was 5,297 million gallons a year (14.5 mgd). *Id*. at 22. Based on 1988 discharge monitoring reports showing an average sulfate concentration of 62.1 mg/L in tailings basin discharge, U.S. Steel's application calculated a maximum allowable sulfate discharge of 1,370 tons per year. *Id*. at 23.

The draft Keetac permits and fact sheets do not review this or any other historic flow rate or compare current or allowable discharge volumes. However, Keetac sulfate levels in 2018-2024 DMRs exceed 1988 levels, with average sulfate of 141 mg/L at SD 002 (mine site) and 105 mg/L at SD 005 (tailings basin). Exhibit 3. Sulfate monitoring submitted to MPCA for the most recent 12 months shows an average of 144 mg/L at SD 002. Mine Fact Sheet at 14.

The final Keetac permits and fact sheets should provide a transparent antidegradation analysis that compares the discharge flow rates, sulfate concentrations, and sulfate mass loading in 1986 and 1988 to proposed permit conditions during both Phase 1 and Phase 2. This analysis will ensure both that future wasteload allocations can be set to restore impaired waters and that dilution cannot be used to circumvent sulfate concentration limits.

3. Estimates of annual net precipitation discharge limits with proposed project.

The final Keetac permit and fact sheet for the tailings basin should also estimate the annual net precipitation limit on discharge using the formula set in federal regulations, 40 C.F.R § 440.104(b)(2)(i), based on current and predicted tailings basin acreage and open water areas. *See* TB Permit at 26-27 (5.27.137). This transparency is important since the factors from which the federal regulatory limit on discharge is set are likely to change.

Annual net precipitation is subject to change if the area covered by mine tailings increases or the open water area of the tailings basin decreases. *Id*. MPCA has estimated the tailings basin area as 6,178 acres. TB Fact Sheet at 11. But U.S. Steel is currently proposing to modify the tailings basin, including extending the dam and dikes and *increasing* tailings basin acreage by approximately 608.6 acres. Keetac EAW, Exhibit 30 at 6, 10, Fig. 8-1. The proposed Project would also *decrease* open water within the tailings storage facility area by approximately 420 acres. *Id*. at 21. Since the net precipitation formula[50] *increases* allowable discharge both when tailings acreage increases and when open water decreases, these changes are additive, rather than countervailing. Both would increase allowable discharge from the Keetac tailings basin, creating additional potential for degradation or increased mass loading of pollutants even if concentrations remain similar.

[49] U.S. Steel Corp., Minnesota Ore Operations, Keetac Tailings Basin NPDES/SDS Permit Application, December 2009 ("2009 U.S. Steel Application"), Exhibit 31.

[50] In simple terms for Keetac, annual net precipitation (amount of allowable discharge) = (area of tailings basin plus drainage area X annual precipitation) – (area of tailings basin open water plus Reservoir 6 area X annual evaporation from open water). TB Permit at 26-27.

WaterLegacy requests that the final Keetac permits and fact sheets provide a transparent analysis of antidegradation and annual net precipitation limits on discharge, along with including sulfate mass loading limits during Phase 1 and Phase 2 for the Keetac tailings basin and mining area.

5. MPCA Should Require Broader Functional Equivalent Analysis and Comprehensive Data Collection to Support its Regulatory Authority.

MPCA's draft Keetac permit for the tailings basin acknowledges the need to determine whether discharge through groundwater to surface water should "be considered the functional equivalent to a NPDES direct discharge" and regulated under the CWA. TB Permit at 26 (5.27.131-34). WaterLegacy appreciates the Agency's recognition of its obligation to comply with the Supreme Court decision in *County of Maui, Hawaii v. Hawaii Wildlife Fund*, 140 S. Ct. 1462 (2020).

However, the draft Keetac permits and facts sheets are insufficient to address the requirements of *Maui* for the following reasons: 1) the scope of functional equivalent analysis is improperly restricted to the Keetac tailings basin; 2) permit requirements fail to gather sufficient data to allow a functional equivalent analysis; and 3) MPCA hasn't yet assumed its full responsibility for protecting surface waters affected by discharge through groundwater.

1. Insufficient scope of functional equivalent analysis.

EPA's comments on review of the draft Keetac permits recommended that the mining area permit be revised to specifically prohibit "point source discharges to waters of the United States through ground water that are the functional equivalent of direct discharges" under the *Maui* case. Exhibit 25 at 4. A similar prohibition is already provided in the draft Keetac permit for the tailings basin. TB Permit at 26 (5.27.132).

WaterLegacy agrees that this change is needed. Mine area facilities containing contact and process water should be evaluated to determine if they are the functional equivalent of point sources discharging to surface water. The final permit for the Keetac mining area should also clarify which mine pits and facilities are within and outside of the "permitted facility" boundaries.[51]

There may be an additional regulatory gap. Reservoirs 2 and 6 seem to be active water containment facilities for Keetac mining and processing operations that contain surface drainage from the tailings basin, process water from the tailings basin, groundwater from the mine pits, and facility wastewater. TB Fact Sheet at 7-8, 11-12.[52] They may be sources of discharge through groundwater that are the functional equivalent of direct NPDES discharge. It is not clear how the MPCA regulates these Reservoirs, which appear neither to be included in the "Facility Description" for the mining area nor for the tailings basin. Mine Permit at 6; TB Permit at 6.

WaterLegacy requests that the MPCA ensure that its final Keetac permits encompass all Keetac

[51] Mine Permit at 6-7; *see also* 2009 U.S. Steel Application, Exhibit 31, Appendix A Figures 1-3 at pdf 46-48 showing Keetac facilities.

[52] *See also* Exhibit 31 at 15-17 and Appendix A Figures 2-3 at 47-48.

process water containment facilities, including mine facilities and reservoirs, and require evaluation whether these facilities are point sources discharging pollutants through groundwater that is the functional equivalent of direct discharge to surface water.

2. Insufficient data collection to support a functional equivalent evaluation.

EPA performed a functional equivalent analysis of the U.S. Steel Minntac tailings basin applying the seven factors identified by the Supreme Court in *Maui* and concluded in July 2023 that the Minntac tailings basin and its components "are a point source that discharges pollutants to jurisdictional surface waters in the Sand and Dark River watersheds."[53] MPCA should use this analysis as a model and ensure that monitoring is sufficient to evaluate the seven *Maui* factors: 1) transit time, 2) distance traveled, 3) the nature of the material through which the pollutant travels, 4) the extent to which the pollutant is diluted or chemically changed as it travels, 5) the amount of pollutant entering the navigable waters relative to the amount of the pollutant that leaves the point source, 6) the manner by or area in which the pollutant enters the navigable waters, and 7) the degree to which the pollution (at that point) has maintained its specific identity. *Maui*, 140 S. CT. at 1476-77. EPA's analysis suggests that at least the following data are needed for a functional equivalent evaluation:

> Historic and background surface water and groundwater quality;
> Water quality information in facility waste streams, groundwater, and proximate and downstream surface waters;
> Subsurface flow in groundwater, hydrological connection between groundwater and surface water, and surface water flow[54];
> Chemical composition data to evaluate if there is dilution or chemical change; and
> Applicable water quality standards and the location of impaired waters.

The draft Keetac permits collect insufficient data for a functional equivalent analysis. Neither Keetac draft permit requires any groundwater monitoring. The draft mining area permit does not require monitoring of surface water or mine pit water quality. Mine Permit at 6-7. The draft tailings basin permit requires monitoring at only two waste streams within the tailings basin, three surface water stations, and five downstream locations—all on the same side of the basin—and only a single surface water site potentially impacted by a reservoir. TB Permit at 6-7. Monitoring required in the Keetac draft permits is well-suited to address sulfate discharge flowing to Hay Lake, but insufficient to support a functional equivalent analysis.

WaterLegacy requests that the final Keetac permits include hydrological flow investigation, groundwater monitoring at the mining area, tailings basin, and reservoirs, waste stream monitoring within mine pits and reservoirs, and additional surface monitoring at the perimeter of the tailings basin, reservoirs, and any other potential point sources where discharge through groundwater to

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[53] EPA, U.S. Steel's Minntac Tailings Basin Wastewater Discharge, Functional Equivalent of a Direct Discharge Technical Assistance, July 2023 (EPA Maui Analysis), Exhibit 32 at viii.

[54] *See id*. at 49, describing thermal imagery for hydrological investigation; at 54, describing monitoring wells, soil borings, geoprobes, and piezometers.

surface water may be functionally equivalent to direct surface water discharge. MPCA should also identify and monitor the nearest surface waters in various directions, recognizing that discharge through groundwater may contain other parameters of concern in addition to sulfate.

WaterLegacy recommends that MPCA consult with technical experts to determine the type, number, and location of wells, surface sampling, piezometers, and other data collection methods that should be required in final Keetac permits.

3. Responsibility to consider all impacts of discharge through groundwater.

The draft Keetac permit places responsibility on the permittee to "conduct an evaluation of whether there is a functionally equivalent discharge of seepage from the tailings basin to nearby surface waters." TB Permit at 46-47 (6.21.11). However, the Supreme Court in *Maui* did not propose that permittees would determine functional equivalence, but that regulators would do so. *See Maui* 140 S. Ct. at 1477 ("EPA and the States have often considered the Act's application to discharges through groundwater . . . EPA and the States also have tools to mitigate those harms, should they arise, by (for example) developing general permits for recurring situations.")

WaterLegacy believes that U.S. Steel (Nippon Steel) should be required to gather data for submittal to MPCA on a specific schedule. But the final Keetac permits should state that the MPCA will make the determination whether any Keetac discharges through groundwater are the functional equivalent of direct discharge to surface water.

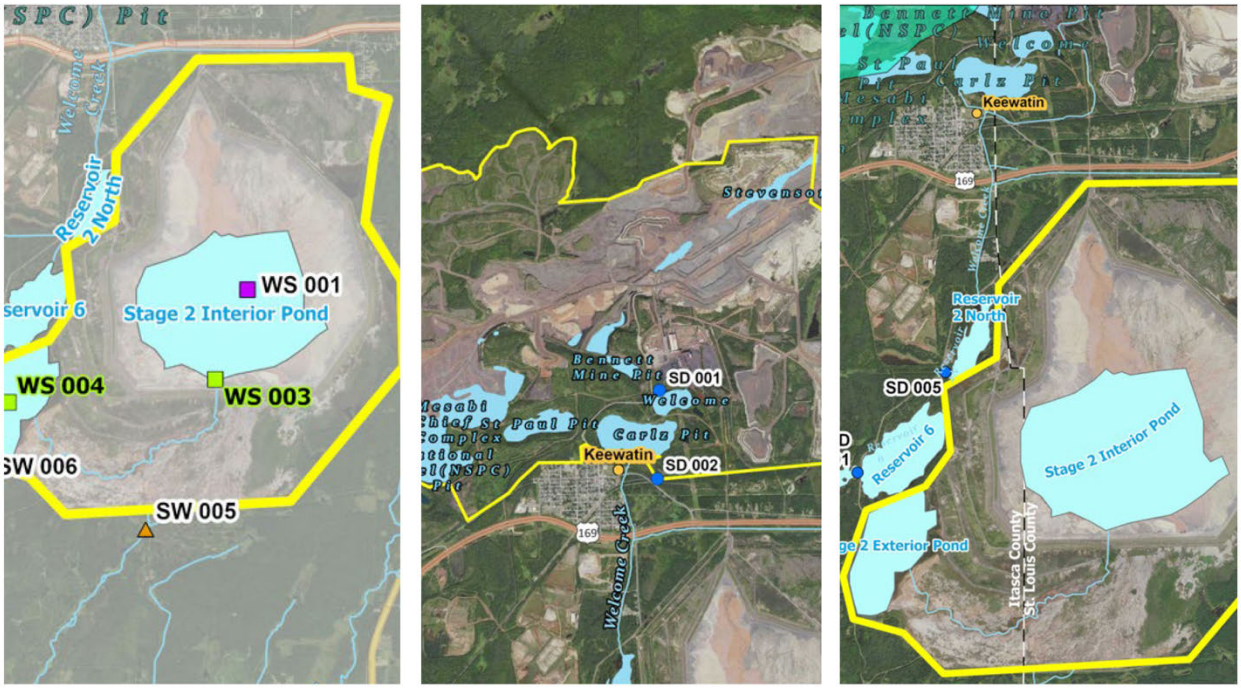
In addition, MPCA should consider that its SDS authority includes regulating discharge through groundwater to surface water that may cause or contribute to exceedances of surface water quality standards. *See* Minn. Stat. § 115.03; Minn. R. 7001.1000. MPCA's SDS authority applies to all pollutants affecting waters of the State, not just to sulfate. For example, Keetac's internal waste stream WS 012, which is routed to the tailings basin, has contained an average of 810 nanograms per liter (ng/L) of mercury in recent years and one measurement of 4,980 ng/L, more than 710 times higher than Minnesota's surface water quality standard for mercury.[55] MPCA's functional equivalent analysis and exercise of SDS authority should evaluate the fate and transport of mercury and other pollutants that discharge through groundwater to surface water and have the potential to harm and contaminate aquatic life consumed by wildlife and humans.

To fully address the *Maui* factors and protect water quality, Keetac permits should require functional equivalent analysis for mine area facilities and reservoirs—as well as the tailings basin; should require comprehensive monitoring and hydrological investigation to support the analysis; and should reflect MPCA's authority under both NPDES and SDS rules to regulate discharge of pollutants through groundwater that cause or contribute to violations of surface water quality standards.

[55] Discharge Monitoring Reports, Bulk Exports for Keetac Permit MN0031879, Mercury in scrubber blowdown after treatment, 2018-2024, Exhibit 33. Minnesota's water quality standard for mercury in surface water near Keetac is 6.9 ng/L. Minn. R. 7050.0220, subp. 5a(11).

6. MPCA Should Require Groundwater Monitoring and Evaluate the Potential for Exceedances of Groundwater Rules and Class 1 Standards.

In addition to the need for groundwater monitoring to support functional equivalent analysis, MPCA should also require groundwater monitoring at the Keetac mine area, tailings basin, and reservoirs to determine whether Keetac discharge violates groundwater standards. As illustrated by the maps below,[56] the draft Mine Permit and Tailing Basin Permit do not require U.S. Steel to conduct any groundwater monitoring.



The Minnesota Supreme Court has already determined that Minnesota groundwater protection rules apply to water beneath mine waste containment facilities. *In re Denial of Contested Case Hearing Requests and Issuance of NPDES/SDS Permit for the Proposed NorthMet Project ("In re NorthMet NPDES/SDS Permit")*, 993 N.W.2d 627, 664 (Minn. 2023) ("We conclude that the prohibition on a 'discharge or deposit' that 'may pollute the underground waters' under Rule 7060.0600, subpart 2, applies with equal force to groundwater within the planned containment systems at the NorthMet facility as it does to groundwater outside the planned containment system. Nothing in chapter 7060 contemplates an exclusion for the underground waters within a containment system.").

MPCA has historically interpreted its rules to mean that "all groundwater is Class 1 water" protected as an actual or potential source of drinking water, whether or not it has been specifically classified as such. *In re Reissuance of an NPDES/SDS Permit to U.S. Steel*, 954 N.W.2d 572, 581-82 (Minn. 2021). In the *U.S. Steel* case, the Minnesota Supreme Court ruled that MPCA's

[56] Maps are copied from Mine Permit at 6, TB Permit at 6-7.

interpretation of chapters 7050 and 7060 to mean that all groundwater is a Class 1 water is "reasonable, longstanding, and supported by the evolution of the regulatory scheme"; that "groundwater is a Class 1 water"; and that MPCA "properly exercised its authority in applying the Class 1 secondary drinking water standards," including the sulfate standard, to groundwater. *Id*., at 583.

Thus, Minnesota groundwater rules and Class 1 standards apply to groundwater beneath the Keetac tailings basin and mining area facilities. Monitoring groundwater in Keetac permits is particularly important due to the number of domestic drinking water wells (royal blue) in proximity to Keetac tailings basin, reservoirs, and mine features, as shown below.[57]



MPCA's final Keetac permits should require groundwater monitoring for parameters such as arsenic, aluminum, lead, manganese, nitrate, and PFAS that are sometimes elevated in connection with mining activities and have adverse health effects in drinking water at concentrations that do not harm aquatic life. Manganese, for example, causes neurologic harm to children at very low concentrations in drinking water, but is not regulated to protect class 2 aquatic life.[58]

[57] Map was produced from publicly available ArcGIS layers.

[58] *See* Minn. R. 7050.0220, subp. 4a(B)(15), providing a manganese limit of 50 µg/L for surface water used for drinking and Minn. R. 7050.0220, subp. 5a providing no manganese limit to protect of aquatic life. Minn. R. 4717.7860 sets a health risk limit of 100 µg/L due to "developmental, nervous system" endpoints.

In addition to comprehensive groundwater monitoring, final Keetac permits should include a reopener clause allowing MPCA to require pollution evaluation and reduction if monitoring discloses a reasonable potential for exceedances of groundwater standards.

7. MPCA Should Clarify Prohibitions on Unauthorized Discharge to Protect Groundwater and Surface Water from Run-off and Seepage.

General prohibitions against unauthorized releases of wastewater in the Keetac permits contain ambiguities that may interfere with protection of both surface water and groundwater. Draft Keetac permits prohibit "releases of wastewater or materials to the environment, whether intentional or not, except for discharges from outfalls specifically authorized by this permit." Mine Permit at 34 (5.20.377); Tailings Basin Permit at 38-39 (5.29.377).

First, as stated *supra* 27, WaterLegacy supports the EPA's recommendation that the final Keetac mining area permit specifically prohibit "point source discharges to waters of the United States through ground water that are the functional equivalent of direct discharges."

Second, because "environment" is not defined in the permits, WaterLegacy suggests in light of the Minnesota Supreme Court decision enforcing prohibitions on discharge into groundwater, *In re NorthMet NPDES/SDS Permit*, 993 N.W.2d at 664, *supra* 30, that the paragraphs pertaining to unauthorized releases be clarified to specifically include "discharges into the saturated or unsaturated zone of groundwater."

Third, WaterLegacy recommends that MPCA revise provisions in the draft Keetac permit for the tailings basin that seem to authorize surface drainage outside authorized outfalls, while providing no monitoring or actionable steps to prevent that surface drainage from causing or contributing to exceedance of surface water quality standards.

MPCA acknowledges that "[s]urface drainage from the tailings basin area, in the form of surface run-off from the exterior dikes, flows to the West Swan River, unnamed wetlands, Hay Creek to Swan Lake, Reservoir 2, Reservoir 2 North and Welcome Creek." TB Permit at 4. MPCA and the courts have agreed that the wild rice sulfate standard must apply to surface seepage from a tailing basin dam exterior. *In re Reissuance of NPDES/SDS Permit to U.S. Steel Corp*., 937 N.W. 2d at 789 ("MPCA states that it 'would enforce the wild rice sulfate water quality standard by imposing a WQBEL on U.S. Steel's surface seepage discharges, if applicable.'").

The draft Keetac permit seems to be addressing surface drainage in stating that the permittee "shall operate and maintain the facility and shall control runoff, including stormwater, from the facility to prevent the exceedance of water quality standards specified in Minnesota Rules, chs. 7050 and 7060." TB Permit at 28 (5.28.284). This provision should be clarified to include "surface seepage" as well as "run-off."

The permit requirement for "capping" when "necessary to minimize pollutant discharges," *id.* at 33 (5.28.325), also seems to be an attempt to address surface seepage as well as run-off. To make this provision actionable and protective, the final Keetac permit should require monthly inspections of the tailings dam perimeter and identification and monitoring of areas where surface

seepage or run-off flow is detected. The final permit should also set specific flow thresholds for surface drainage, including seepage or run-off, that require action to cap or collect and treat surface drainage to ensure compliance with numeric and narrative water quality standards.

8. MPCA Should Identify all Impaired Waters Potentially Affected by Keetac Discharge and Consider all Benefits of Controlling Sulfate Pollution.

Applying wild rice sulfate WQBELs to Hay Lake to address direct surface discharge is a critical objective for the Keetac permits. However, WaterLegacy believes that final Keetac permits and fact sheets should also recognize the adverse effects of excess sulfate on water quality, aquatic life and human health. Peer-reviewed literature authored by UMN and MPCA scientists in 2017 found that increasing sulfate could double release of nitrogen and phosphorus from sediments, double the release of mercury from sediments, and increase mercury methylation nearly six-fold.[59]

Release of sulfate through outfalls, groundwater, and surface drainage could indirectly result in impairments for fish consumption due to mercury in fish tissue and impairment of aquatic life. In addition, release of sulfate, ionic pollutants, or metals could cause impairments of receiving and downstream waters.

WaterLegacy requests that MPCA identify all potentially affected impaired waters, including but not limited to the following:

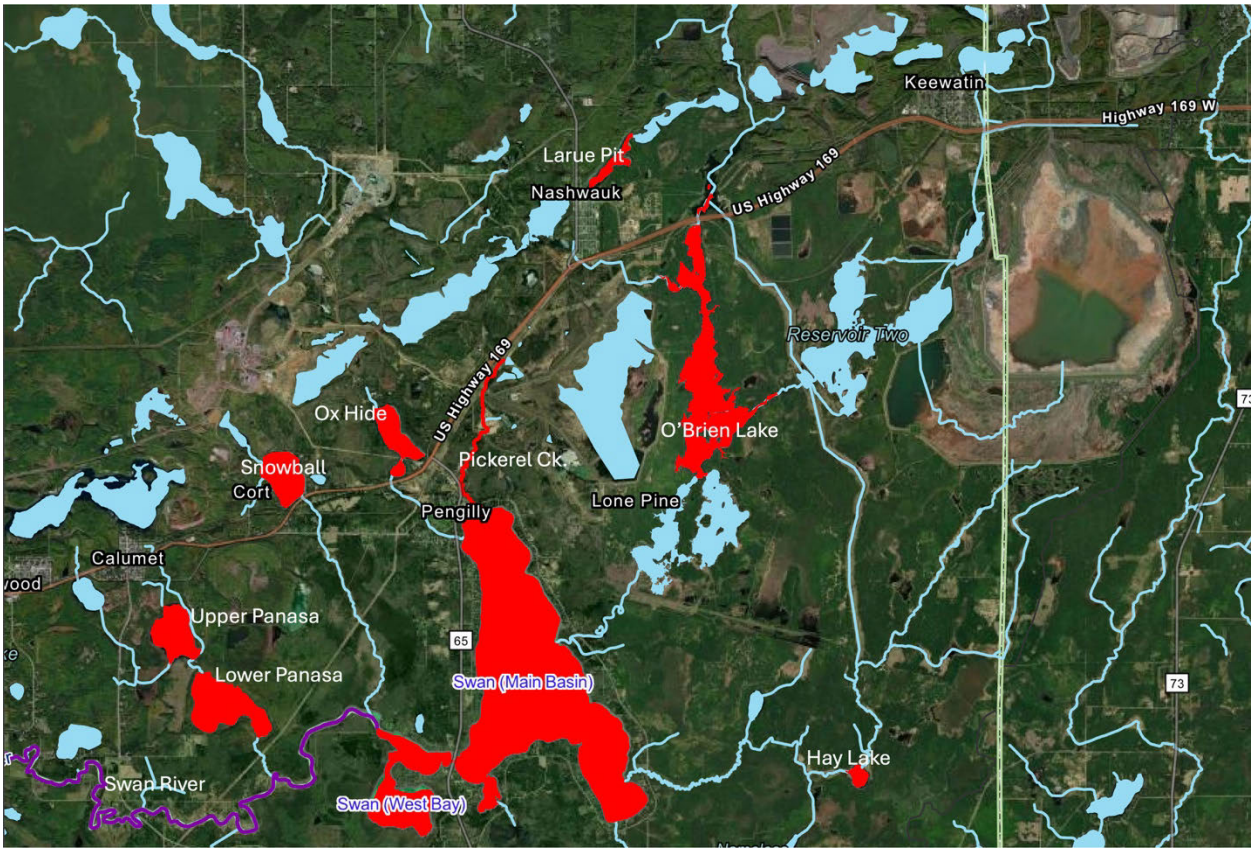
Waterbody	ID#	Impairment
Hay Lake	31-0037-00	Sulfate - wild rice
O'Brien Lake (North)	31-0032-01	Mercury - fish consumption
O'Brien Lake South	31-0032-02	Mercury - fish consumption
Swan Lake (Main Basin)	31-0067-02	Mercury - fish consumption
Swan Lake (Southwest Bay)	31-0067-03	Sulfate - wild rice
Swan Lake (West Basin)	31-0067-01	Mercury - fish consumption
Swan River	07010103-753	Sulfate - wild rice Mercury - fish consumption E. coli

As shown by MPCA data, levels of mercury in fish tissue in both Swan Lake and O'Brien Lake have been measured at more than twice the safe level set in Minnesota water quality standards[60] in order to protect the health of humans who consume fish.

[59] Myrbo A, Swain EB, Johnson NW, Engstrom DR, Pastor J, Dewey B, Monson P, Brenner J, Dykhuizen Shore M, Peters EB (2017) Increase in nutrients, mercury, and methylmercury as a consequence of elevated sulfate reduction to sulfide in experimental wetland mesocosms. *J. Geophysical Research: Biogeosciences* 10.1002: 2769-85, Exhibit 34 at 2774, Table 1.

[60] MPCA Allfish (mercury in fish tissue) data for O'Brien Lake, O'Brien Reservoir, and Swan Lake, through January 19, 2024, Exhibit 35. Average concentration is more than twice the 0.2 parts per million (mg/kg) mercury in edible fish tissue limit in Minn. R. 7050.0220, subp. 5a(B)(12).

The map below[61] shows the above impaired waters, along with other impaired waters in proximity to the Keetac mining area and tailings basin that may be affected primarily by other mining facilities.



MPCA's final Keetac permits should identify and consider impacts to all pertinent impaired waters—along with the loss of beneficial use of wild rice in Hay Lake—to support additional analysis and control of pollution. This broader analysis may also make it more difficult for opponents of compliance to trivialize the requirement that U.S. Steel Keetac facilities comply with the wild rice sulfate standard reflected in effluent limitations in the draft Keetac permits and MPCA's preliminary denial of U.S. Steel's application for a variance.

CONCLUSION

On the basis of the evidence and arguments in these comments, attached exhibits, and documents submitted to and prepared by the MPCA, WaterLegacy strongly supports the MPCA in its highly contested permitting decisions related to the Keetac mining area and tailings basin discharge: 1) requiring U.S. Steel (Nippon Steel) to comply with effluent limits of 14 mg/L average and 24 mg/L maximum based on Minnesota's 10 mg/L wild rice sulfate standard; and 2) making the

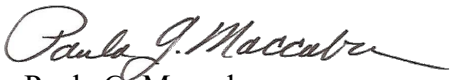
[61] Map of Additional Keetac Area Impaired Waters produced from MPCA impaired waters data and other publicly available ArcGIS databases, Exhibit 36.

preliminary determination that U.S. Steel's application for a variance from this standard should be denied.

In addition to providing analysis and materials that support MPCA's draft permits and preliminary determination, WaterLegacy has offered eight recommendations to strengthen protection of surface and groundwater in compliance with state and federal law. We would welcome the opportunity to discuss these recommendations with MPCA staff or to provide any additional references that might be requested.

In the context of scientific investigations, federal oversight, agency progress, and court rulings over the past decade, the Keetac NPDES/SDS permits provide a unique opportunity to set a standard that will remove uncertainty and increase protection of water, wild rice, aquatic life, and human health for decades to come. WaterLegacy respectfully requests that the MPCA embrace this opportunity.

Respectfully submitted,



Paula G. Maccabee
Executive Director and Counsel for WaterLegacy

Enclosure: Exhibit List and Exhibits 1-36 are enclosed with these comments.

cc: Sent by electronic mail with link to Exhibits
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WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT LIST

Exhibit 1 *Minn. Chamber of Com. v. Minn. Pollution Control Agency*, No. 62-CV-10-1184, 2012 WL 2872026 (Minn. Dist. Ct., 2nd Jud. Dist., May 10, 2012).

Exhibit 2 MPCA Board Packet *In re U.S. Steel Corp., Minnesota Ore Operations, Keetac NPDES/SDS Permits MN0031879 and MN0055948*, October 14, 2011.

Exhibit 3 Discharge Monitoring Reports, Bulk Exports for Keetac Permits MN 0031879, MN0055948 Sulfate and Specific Conductance, 2018-2024.

Exhibit 4 EPA, NEIC Civil Investigation Report, U.S. Steel – Keetac, Keewatin, Minnesota, 55753, October 2022.

Exhibit 5 EPA, *In re U.S. Steel Corp. Keetac Mining Operations and Tailings Basin*, Notice of Violation, May 15, 2024.

Exhibit 6 EPA, Letter to C. Bartovich, U.S. Steel Environmental Director, re Notice of Clean Water Act Violations, May 14, 2024.

Exhibit 7 EPA, Letter to MPCA Commissioner Kessler re Minnesota laws revising MPCA's authority to regulate sulfate in NPDES permits, Feb. 16, 2022.

Exhibit 8 MPCA, Denial of U.S. Steel Application for a Sulfate Site-Specific Standard for Hay Lake, February 14, 2024.

Exhibit 9 MPCA Brief, *In re Sulfate Site-Specific Standard for Hay Lake,* Oct. 11, 2024 (excerpt).

Exhibit 10 MPCA, Protecting Wild Rice Waters, September 2025.

Exhibit 11 Moyle JB (1944) Wild rice in Minnesota. *J. Wildlife Management* 8(3):177-84.

Exhibit 12 LaFond-Hudson S, Johnson NW, Pastor J, Dewey B (2018) Iron sulfide formation on root surfaces controlled by the life cycle of wild rice (*Zizania palustris*). *Biogeochemistry* 141:95-106.

Exhibit 13 Johnson NW, Pastor J, Swain EB (2019) Cumulative sulfate loads shift porewater to sulfidic conditions in freshwater wetland sediment. *Environmental Toxicology and Chemistry* 38(6):1231-1244.

Exhibit 14 LaFond-Hudson S, Johnson NW, Pastor J, Dewey B (2020) Interactions between sulfide and reproductive phenology of an annual aquatic plant, wild rice (*Zizania palustris*). *Aquatic Botany* 164:103230.

Exhibit 15 LaFond-Hudson S, Johnson NW, Pastor J, Dewey B (2022) Sulfur geochemistry destabilizes population oscillations of wild rice (*Zizania palustris*). J. *Geophysical Research Biogeosciences* 10.1029.

Exhibit 16 Tedrow O, and Lee P (2022) Use of Wild Rice (*Zizania palustris L.*) in paddy-scale bioassays for assessing potential use of mining-influenced water for irrigation. *Mine Water and the Environment* 41:938-953.

Exhibit 17 U.S. Steel, Application for Sulfate Site-Specific Standard, August 2022 (excerpt).

Exhibit 18 Hay Lake Porewater Sulfide Monitoring Results Summary and Evaluation Table with MPCA July 2017 SONAR Pages.

Exhibit 19 Michael Maleska Declaration with Photos taken at Hay Lake on September 7, 2025, and Sketches of Wild Rice Locations at Hay Lake.

Exhibit 20 Shanai Matteson Declaration with Photos taken at Hay Lake on September 10, 2025.

Exhibit 21 U.S. Steel Corp., Annual Report Pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934 (Form 10-K) for the fiscal year ended on December 31, 2024.

Exhibit 22 U.S. Steel Corp., Current Report (Form 8-K) Pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934, June 18, 2025.

Exhibit 23 Obayashi, Y. (2025, August 28) Nippon Steel bets on $11 billion investment, tech transfer to lift U.S. Steel profit, *Reuters*.

Exhibit 24 Lovrien, J. (2024, May 23) Keetac's new DR-grade plant up and running, *Duluth News Tribune.*

Exhibit 25 EPA, Comments on Review of Two Draft NPDES Permits, U.S. Steel Keetac Mining Area (MN0031879) and U.S. Steel Keetac Tailings Basin (MN0055948), Keewatin, Minnesota, Sept. 6, 2024.

Exhibit 26 Johnson BL, Johnson MK, An Evaluation of a Field-Based Aquatic Life Benchmark for Specific Conductance in Northeastern Minnesota, November 2015.

Exhibit 27 Susan Cormier, EPA ORD, Review of "An Evaluation of a Field-Based Aquatic Benchmark for Specific Conductance in Northeast Minnesota," Prepared by B. L. Johnson and M. K. Johnson, February 4, 2016.

Exhibit 28 EPA, Review of Revisions to the Fond du Lac Band of Lake Superior Chippewa's Water Quality Standards Under Section 303(c) of the Clean Water Act, October 5, 2020.

Exhibit 29 MPCA, S-5 Implementing the Aquatic Life Narrative Standard, SONAR for Proposed Class 3 and 4 Rule Revisions, December 14, 2020 (excerpt).

Exhibit 30 EAW, U.S. Steel Keetac Tailings Storage Facility Project, August 7, 2025.

Exhibit 31 U.S. Steel Corp., Minnesota Ore Operations, Keetac Tailings Basin NPDES/SDS Permit Application, December 2009.

Exhibit 32 EPA, U.S. Steel's Minntac Tailings Basin Wastewater Discharge, Functional Equivalent of a Direct Discharge Technical Assistance, July 2023.

Exhibit 33 Discharge Monitoring Reports, Bulk Exports for Keetac Permit MN0031879, Mercury in scrubber blowdown after treatment, 2018-2024.

Exhibit 34 Myrbo A, Swain EB, Johnson NW, Engstrom DR, Pastor J, Dewey B, Monson P, Brenner J, Dykhuizen Shore M, Peters EB (2017) Increase in nutrients, mercury, and methylmercury as a consequence of elevated sulfate reduction to sulfide in experimental wetland mesocosms. *J. Geophysical Research: Biogeosciences* 10.1002: 2769-85.

Exhibit 35 MPCA Allfish (mercury in fish tissue) data for O'Brien Lake, O'Brien Reservoir, and Swan Lake, through January 19, 2024.

Exhibit 36 Map of Additional Keetac Area Impaired Waters.

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 1

Minn. Chamber of Com. v. Minn. Pollution Control Agency, No. 62-CV-10-1184, 2012 WL 2872026 (Minn. Dist. Ct., 2nd Jud. Dist., May 10, 2012).

Minn. Chamber of Commerce v. Minn. Pollution Control Agency

Minnesota District Court, County of Ramsey, Second Judicial District

May 10, 2012, Decided; May 10, 2012, Entered

Court File No. 62-CV-10-11824

Reporter
2012 Minn. Dist. LEXIS 194 *

Minnesota Chamber of Commerce, Plaintiff, vs. Minnesota Pollution Control Agency, Defendant, and WaterLegacy, Defendant-Intervenor.

Subsequent History: Affirmed by Minn. Chamber of Commerce v. Minn. Pollution Control Agency, 2012 Minn. App. Unpub. LEXIS 1199 (Minn. Ct. App., Dec. 17, 2012)

Prior History: Minnesota Chamber of Commerce v. Minnesota Pollution Control Agency, 469 N.W.2d 100, 1991 Minn. App. LEXIS 388 (Minn. Ct. App., 1991)

Core Terms

wild rice, sulfate, waters, water quality standards, void for vagueness, stands, cultivated, irrigation, narrative, plant, rice, summary judgment, discharges, unconstitutionally vague, Clean Water Act, agricultural, designated, wildlife, levels, vague, declaratory judgment, matter of law, susceptible, injunction, Pollution, aquatic

Counsel: **[*1]** For Plaintiff: Thaddeus Lightfoot, Esq.

For Minnesota Pollution Control Agency, Defendant: Robert B. Roche, Assistant Attorney General.

For WaterLegacy, Defendant-Intervenor: Paula Maccabee, Esq.

Judges: HON. MARGARET M. MARRINAN, JUDGE OF DISTRICT COURT.

Opinion by: MARGARET M. MARRINAN

Opinion

FINDINGS OF FACT, CONCLUSIONS OF LAW AND ORDER FOR JUDGMENT

This matter came on for hearing on the parties' cross motions for summary judgment on March 1, 2012. Thaddeus Lightfoot, Esq., appeared on behalf of Plaintiff; Assistant Attorney General Robert B. Roche appeared on behalf of Defendant Minnesota Pollution Control Agency; Paula Maccabee, Esq., appeared on behalf of Defendant-Intervenor WaterLegacy.

Plaintiff has withdrawn its claim regarding Count I of the Amended Complaint.

Plaintiff seeks partial summary judgment on the remaining following counts:

1) Count II: in which it alleges that the "Wild Rice Rule" is unconstitutionally vague and thus a violation of due process. The basis for this allegation is that the term "when rice may be susceptible to damage from high sulfate levels" is not defined.

2) Count III: in which it alleges that Defendant's actions applying the "Wild Rice Rule" exceed Defendant's statutory authority **[*2]** and are arbitrary and capricious because:

a. Defendant would apply them to all waters in the state rather than limit them to waters used for agricultural irrigation in the production of wild rice; and

b. Defendant has created a narrative wild rice classification for Class 4A waters without specifically listing or otherwise classifying those waters; and

c. Defendant has required that Plaintiff members perform wild rice surveys to determine whether waters fall within the narrative sub-classification.

3) Count IV: in which it asks the Court to construe the Wild Rice Rule under the authority of the Minnesota Declaratory Judgments Act (Minn. Stat. Ch.555).

Defendant and Defendant-Intervenor seek summary judgment regarding all of Plaintiff's claims.

FINDINGS OF FACT

1. The Minnesota Legislature has adopted wild rice as the official grain of the State of Minnesota and has explicitly recognized the importance of protecting it. Minn. Stat. § 1.148, subd. 1 (2010).

2. In keeping with the policy set by Minn. R. 7050.0186,[1] and in order to comply with the United States Environmental Protection Agency (EPA) requirements under the Federal Water Pollution Control Act Amendments of 1972, in 1973 the Minnesota Pollution Control Agency **[*3]** (MPCA) adopted water quality standards for Class 4 waters of the state.

The rationale for protection of these waters is addressed by Minn. R. 7050.0224, subp.1:

> The *numeric* and *narrative* [emphasis supplied] water quality standards in this part prescribe the qualities or properties of the waters of the state that are necessary for the agriculture and wildlife designated public uses and benefits. Wild rice is an aquatic plant resource found in certain waters within the state. The harvest and use of grains from this plant serve as a food source for wildlife and humans. In recognition of the ecological importance of this resource, and in conjunction with Minnesota Indian tribes, selected wild rice waters have been specifically identified [WR] and listed in part 7050.0470, subp.1.[2] The quality of these waters and the aquatic habitat necessary to support the propagation and maintenance of wild rice plant species must not be materially impaired or degraded. If the standards in this part are exceeded in waters of the state that have the Class 4 designation, it is considered indicative of a polluted condition which is actually or potentially deleterious, harmful, detrimental, or injurious with **[*4]** respect to the designated uses.

Minnesota's wild rice sulfate standard is found in Minn. R. 7050.0224, subp. 2 (2011). The rule provides in pertinent part:

> Class 4A waters. The quality of Class 4A waters of the state shall be such as to permit their use for irrigation without significant damage or adverse effects *upon any crops or vegetation usually grown in the waters or area*, [emphasis supplied] including truck garden crops. The following standards shall be used as a guide in determining the suitability of the waters for such uses ...: Sulfates (SO_4) 10 mg/L, applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels.
>
> Minn. R. 7050.0224, subp. 2 (2011).

Of the subparts to the water quality standards in Minn.R. 7050.0224, subpart 2 (Class 4A waters) is the only one that specifically refers to crops and vegetation. Classes 4B and C have as their focus livestock and wildlife.

3. The MPCA adopted a wild rice numeric sulfate standard of 10 milligrams per liter ("mg/L") for water used for production of wild rice based on recommendations by the Minnesota Department of Natural Resources ("MDNR") that sulfate concentrations above that level are a serious detriment to the natural and cultivated growth of wild rice.

4. In addition to the numeric standard, Minnesota Rules

[1] "It is the policy of the state to protect wetlands and prevent significant adverse impacts on wetland beneficial uses caused by chemical, physical, biological or radiological changes. The quality of wetlands shall be maintained to permit the **[*5]** propagation and maintenance of a healthy community of aquatic and terrestrial species indigenous to wetlands, preserve wildlife habitat, and support biological diversity of the landscape. In addition these waters shall be suitable for.... irrigation... as specified in part 7050.0224, subpart 4...."

[2] This rule specifically identifies as [WR] the sub-set of wild rice waters in the Lake Superior watershed.

also adopted a narrative standard that applies only to specifically identified wild rice waters. Minn.R. 7050.0224, subp.1, *supra*.

5. Whether standing alone, or viewed in tandem with the above rules, the term "when the rice may be susceptible to damage by high sulfate levels" is straightforward and understandable: if the rice is at a point in development when sulfates can damage it, the maximum sulfate **[*6]** level is 10 mg/L.

6. Testimony from the hearing on the initial adoption of the wild rice sulfate standard clearly establishes that, from the time of its initial adoption, the MPCA intended the wild rice sulfate standard to protect both naturally growing and cultivated wild rice.[3]

7. The first time that the MPCA imposed a discharge limit based on the wild rice sulfate rule (Minn. R. 7050.0224, Subp. 2) was in a 1975 permit for the Clay Boswell Steam Electric Station ("Clay Boswell Permit").

8. The record of the administrative hearing for the Clay Boswell Permit reflects that the hearing examiner supported application of a sulfate limit in that permit in order to protect natural stands of wild rice, not agricultural irrigation of cultivated wild rice.[4]

9. The MPCA issued sulfate limits three other times: a June 17, 2010 permit modification for U.S. Steel Corporation (Keetac mining area) and two October 25, 2011 permits for U.S. Steel (Keetac mining area and tailings basin). It is notable that the areas **[*7]** in question affect *natural* stands of wild rice, not the agricultural irrigation of cultivated rice. The direct receiving waters included both listed waters (Welcome Creek and O'Brien Creek) and unlisted waters (Welcome Lake and O'Brien Reservoir). All of these waters were classified as Class 4A and 4B waters. U.S. Steel neither requested an administrative hearing nor challenged the permit at the Court of Appeals.

10. In 2010, the EPA, addressing the issue of sulfate discharge for the Keetac mine expansion and the proposed PolyMet NorthMet mining project, advised Defendant MPCA that the wild rice protection rule must be applied to limit that discharge in receiving waters. Both of those projects affected natural stands of wild rice, rather than agricultural irrigation for cultivated rice[5] The waters to which this sulfate limit applied included lakes, rivers and creeks not specifically listed as wild rice waters in Minn. R. 7050.0470, Subp. 1.[6]

11. The MPCA has approximately ten years of sulfate data for mining discharges because it has monitored wastewater discharges from **[*8]** mining operations in order to evaluate their overall toxicity and their potential to adversely affect groundwater. The agency concluded that this data could be useful in evaluating the potential impact of mining discharges on the wild rice sulfate standard.[7]

12. To determine whether sulfate dischargers are potentially interfering with attaining the wild rice sulfate standard, the MPCA reviews permit applications on a case-by-case basis. Where the data suggests that a discharge has high levels of sulfates upstream of a water identified as one potentially used for production of wild rice, the agency may request dischargers to conduct surveys to determine if the discharge is, in fact, upstream of a water used for production of wild rice. This authority derives from M.S. 115.03, subd. 1 (e) (7) **[*9]** which gives the agency the authority to require owners and operators of such discharge systems to do so.

13. As part of the permit review process, the MPCA reviews the following information: (i) available wild rice records and databases that the MDNR maintains; (ii) consultation with aquatic plant biologists at the MDNR; (iii) information received from external stakeholders, including, but not limited to, Native

[3] Affidavit of Gerald Blaha, Ex. C, p. 27: testimony of John McGuire, Chief of the Section of Standards and Surveys, Division of Water Quality, MPCA.

[4] Affidavit of Gerald Blaha, Paragraph 9.

[5] Affidavit of Paula Maccabee, Ex. 8 and 9.

[6] Swan Lake, Swan River, Hay Creek, Hay Lake and Upper Partridge River. *Id.*

[7] The MPCA does not yet have similar data for municipal discharges, but is in the process of obtaining it as part of a broader MPCA strategy to evaluate the impact of wastewater discharges on Class 3 and Class 4 water standards. It intends to use the monitoring data to determine whether additional discharge limits are necessary to protect Class 3 and 4 water quality standards, including the wild rice sulfate standard.

American tribes and environmental groups; and (iv) information provided by the discharger.

14. The MDNR's list of waters where wild rice has been identified is not an exhaustive list of waters used for production of wild rice. Where a permit applicant discharges upstream of a water that is not on the MDNR list, but which has been identified as potentially producing wild rice, the MPCA has requested that the permit applicant conduct a survey of any wild rice stands in the receiving waters to help determine whether the receiving water is a water used for production of wild rice.

15. Any party who disagrees with the MPCA's determination of 1) whether a water qualifies as a water used for production of wild rice or 2) whether the permit needs to include a sulfate limit **[*10]** has the option of requesting a contested case hearing before an administrative law judge on the issue pursuant to Minn. R. 7000.1800. Although Plaintiff's members allege they have been affected by the wild rice sulfate standard, they failed to request such a hearing, and have sought relief under Chapter 555 of the Minnesota Statutes.

16. During the 2011 Minnesota Legislative Session, it was proposed that the application of Minnesota's wild rice sulfate standard be suspended, or that the sulfate standard be increased from 10 mg/L to 50 mg/L. In response to those proposals, on May 13, 2011 the U.S. EPA[8] wrote the sponsoring legislators warning that:

> 1) "[L]egislation changes [to] the EPA-approved water quality standards for Minnesota...must be submitted to EPA for review...and are not effective for Clean Water Act (CWA) purposes, including [National Pollutant Discharge Elimination System] permits, unless and until approved by EPA; and
> 2) If it "determined that a state is not administering its federally approved NPDES program in accordance with requirements of the CWA, EPA has the authority to...withdraw authorization of the program...."

17. Rather than passing either of the above bills, the 2011 Minnesota legislature passed, and the governor signed, a bill regarding the wild rice sulfate standard. Minn. Laws 2011 1 Sp. c. 2, art. 4, § 32. That law requires the MPCA to form an advisory group and conduct an extensive study of the impacts of sulfates and other substances on wild rice. *Id*. at § 32(c)&(d). Once that research is complete, the bill requires the MPCA to amend the wild rice sulfate standard to:

> (i) address water quality for both natural stands of wild rice and cultivated wild rice;
>
> (ii) specifically designate waters to which the wild rice sulfate standard applies; and
>
> (iii) designate the times of year when the standard applies. *Id*. at § 32(a)(1)-(3).

18. Pursuant to that legislation, the MPCA has formed an advisory group and held three meetings of that group to date (October 10, 2011, November 30, 2011 and March 27, 2012), established a study protocol, published a Request for Proposals to undertake research outlined in the study protocol, submitted a legislative report as required by December 15, 2011, and awarded a contract to the University of Minnesota to conduct the **[*12]** wild rice/sulfate studies.

CONCLUSIONS OF LAW

1. Plaintiff has withdrawn its claim that the MPCA's application of the wild rice sulfate standard has violated the Equal Protection Clause of the United States Constitution. Summary Judgment in favor of the MPCA and Defendant-Intervenor is therefore proper as to that claim.

2. Summary judgment is appropriate under the Minnesota Rules of Civil Procedure, when "the pleadings, depositions, answers to interrogatories, and admissions on file, together with the affidavits, if any, show that there is no genuine issue as to any material fact and that either party is entitled to judgment as a matter of law. Minn.R.Civ.P. 56.03.

3. There are no genuine issues of material fact and the MPCA has demonstrated that it is entitled to judgment as a matter of law on each of Plaintiff's alleged claims.

A. Counts II and Count III: The Wild Rice Rule does not violate due process. It is not unconstitutionally

[8] The EPA has delegated the administration of the federal **[*11]** Clean Water Act in Minnesota to the MPCA.

vague, nor is the application of the rule arbitrary and capricious.

4. An agency rule is unreasonable (and therefore invalid) when it fails to comport with substantive due process because it is not rationally related to the objective sought to be achieved.[9] **[*13]** The rationale underlying the Wild Rice Rule (Minn. R. 7050.0224, subp. 2) is found in the subparagraph preceding it: since wild rice is a food source for both wildlife and humans, the quality of the waters and the aquatic habitat necessary to support its propagation and maintenance must not be materially impaired or degraded. The policy upon which this rationale is based (Minn.R.7050.0186) is the protection of the quality of wetlands so as to "permit the propagation and maintenance of a healthy community of...species indigenous to wetlands...In addition these waters shall be suitable for...irrigation...."

5. Where a rule is challenged as "invalid as applied", Minnesota law allows only limited judicial inquiry into the validity of an administrative regulation in question. The party challenging the rule bears a heavy burden and must establish that the rule is not rationally related to the legislative ends sought to be achieved or that in adopting the rule the MPCA exceeded its statutory authority.[10]

6. **[*14]** Plaintiff has not met its burden of proving that the MPCA's application of the wild rice sulfate rule conflicts with statutory authority or is otherwise not rationally related to the legislative goal of protecting the environment. MPCA's application of the wild rice sulfate rule is reasonably related to achieving the legitimate goal of protecting Minnesota's environment.

7. Minnesota's Class 4 waters, which encompass the sub-classification of Class 4A waters, are "waters of the state that are or may be used for any agricultural purposes, including stock watering and irrigation, or by waterfowl or other wildlife, and for which quality control is or may be necessary to protect terrestrial life and its habitat or the public health, safety, or welfare." Minn. R. 7050.0140, subp. 5 (2011).

8. Minnesota's Class 4A water quality standards are intended to protect both naturally occurring vegetation grown in the waters themselves and cultivated crops in the area around the water. The MPCA's application of the wild rice sulfate standard to protect naturally growing wild rice in ambient waters of the state is legally valid because it is consistent with the plain language of the water quality standard. **[*15]** Minn. R. 7050.0224, subp. 2.

9. Under Minnesota law, "[t]he object of all interpretation and construction of laws is to ascertain and effectuate the intention of the legislature." Minn. Stat. § 645.16 (2010). Minnesota courts apply the provisions of chapter 645 to both statutes and administrative rules. The administrative and legislative records clearly demonstrate that the MPCA has always intended the wild rice sulfate rule to protect both cultivated and natural stands of wild rice. The agency's application of the rule to waters with natural stands of wild rice is legally valid because it is consistent with the administrative history and intention of the regulation.

10. The MPCA's application of the wild rice sulfate rule to protect waters with natural stands of wild rice is also consistent with a number of established legislative policies and statutory duties, among them the duty to ensure that the State of Minnesota maintains its responsibility to administer the federal Clean Water Act in Minnesota.[11]

11. In the 2011 special session, the legislature specifically directed the MPCA to adopt an amended rule which shall "address water quality standards for waters containing natural beds of wild rice, as well as for irrigation waters used for production of wild rice . . . ." Minn. Laws 2011 1 Sp. c. 2, art. 4, § 32 (a)(1). The MPCA's application of the wild rice rule to protect natural stands of wild rice is consistent with legislative policy that explicitly recognizes the importance of wild rice to the State of Minnesota.

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[9] *Mammenga v. Dep't of Human Services*, 442 N.W. 2d 786, 789 (Minn. 1989).

[10] *Mammenga v. Dep't of Human Services*, 442 N.W. 2d 786 (Minn. 1989); *Hirsch v. Bartley-Lindsay Co*., 537 N.W.2d 480 (Minn. 1995).

[11] Minn. Stat. § 115.03, subd. 5 (2010) ("the agency shall have the authority to . . . establish and appl[y] rules . . . and permit conditions, consistent with and, therefore not less **[*16]** stringent than the provisions of the Federal Water Pollution Control Act, as amended, applicable to the participation by the State of Minnesota in the national pollutant discharge elimination system (NPDES)")

12. The wild rice sulfate standard is a numeric standard set forth in Minn. R. 7050.0224, subp. 2. Minn. R. 7050.0224, subp.1 also includes a narrative standard that applies only to specifically identified wild rice waters. Minn. R. 7050.0470, subp. 1 (2011), in turn, specifically identifies [WR] the sub-set of wild rice waters in the Lake Superior watershed to which this narrative applies.

To the extent Plaintiff claims that the narrative wild rice standard does **[*17]** not identify the waters to which that narrative standard applies, the claim fails as a matter of law.

13. Under Minnesota law, "[a] statute that does not implicate First Amendment freedoms is facially void for vagueness only if it is vague in all its applications. Unless the statute proscribes no comprehensible course of conduct at all, it will be upheld against a facial challenge."[12]

14. The Plaintiff has not established that the wild rice sulfate rule is vague in all of its applications or that it proscribes no comprehensible course of conduct at all. The MPCA applied this rule in the Clay Boswell Permit and an independent hearing examiner supported the application of the rule in that case. The MPCA has recently applied the rule in the reissuance of the U.S. Steel Keewatin Taconite permit. U.S. Steel neither requested an administrative hearing nor challenged the permit in the Court of Appeals.

15. Under Minnesota law, a party challenging a law on constitutional grounds, including vagueness, bears a heavy burden **[*18]** of proof.[13] The Plaintiff must overcome every presumption of constitutionality and show that the wild rice sulfate standard is unconstitutionally vague as applied to Plaintiff's members. Plaintiff has not met this burden.

Sulfate Standard not Void for Vagueness

16. Contrary to Plaintiff's assertion, the fact that the wild rice sulfate standard does not include an explicit definition for the term "when the rice may be susceptible to damage by high sulfate levels" does not render the rule void as applied. The void for vagueness doctrine demands **[*19]** only that laws be drafted with "sufficient definiteness that ordinary people can understand what conduct is prohibited."[14] Even if a law speaks in "broad, flexible standards that require persons subject to a statute to exercise judgment," or requires persons to "rely on common sense and intelligence to determine whether their conduct complies with the law [it] does not render the law unconstitutionally vague."[15]

17. The civil, regulatory nature of the wild rice sulfate standard is subject to a "vagueness test" that is less strict than for criminal statutes. "To find a civil statute void for vagueness, the statute must be 'so vague and indefinite as really to be no rule or standard at all.'"[16] The challenged law must "define the forbidden or required act in terms so vague that individuals must guess at its meaning . . . ."[17] Put another way: "a statute will be upheld against a facial challenge unless [it] proscribes no comprehensible course of conduct at all".[18]

18. Civil laws regulating business are less likely to be void for vagueness than criminal laws "because businesses, which face economic demands to plan behavior carefully, can be expected to consult relevant

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[12] *State v. Normandale Properties, Inc*., 420 N.W.2d 259, 262 (Minn. Ct. App. 1988) (citing *Village of Hoffman Estates v. Flipside Hoffman Estates, Inc*., 455 U.S. 489, 102 S.Ct. 1186, 1191, 71 L. Ed. 2d 362 (1982).

[13] "In attacking a rule on due process grounds, including a vagueness challenge, the challenger bears a heavy burden [cit. om.] The standard for determining vagueness is well-settled: [it is] void for vagueness if it fails to give a person of ordinary intelligence a reasonable opportunity to know what is prohibited or fails to provide sufficient standards for enforcement...The rule should be upheld unless the terms are so uncertain and indefinite that after exhausting all rules of construction it is impossible to ascertain legislative intent." *Minnesota Chamber of Commerce v. Minnesota Pollution Control Agency*, 469 N.W.2d 100, 107 (Mn.App. 1991).

[14] *State v. Romine*, 757 N.W.2d 884, 891 (Minn. Ct. App. 2008) (quoting *Kolender v. Lawson*, 461 U.S. 352, 103 S. Ct. 1855, 1858, 75 L. Ed. 2d 903 (1983)).

[15] *State v. Enyeart*, 676 N.W.2d 311, 321 (Minn. Ct. App. 2004).

[16] *Seniors Civil Liberties Ass'n v. Kemp*, 965 F.2d 1030, 1036 (11th Cir. 1992).

[17] *Humenansky v. Minn. Bd. of Med. Examiners*, 525 N.W.2d 559, 564 **[*20]** (citing Kolender v. Lawson, 461 U.S. 352, 103 S. Ct. 1855, 1858, 75 L. Ed. 2d 903 (1983).

[18] *State v. Normandale Properties, Inc*., 420 N.W.2d 259, 262 (Minn. App 1988).

legislation in advance of action. Indeed, the regulated enterprise may have the ability to clarify the meaning of the regulation by its own inquiry, or by resort to an administrative process."[19]

19. The application of the wild rice sulfate rule to Plaintiff in this case is not unconstitutionally vague under this standard. Plaintiff's members are not left to guess as to what conduct is prohibited or required under this rule.

20. The wild rice sulfate rule is an ambient water quality standard. As such, it describes the desired condition of Minnesota's waters, but is not a discharge standard and does not proscribe or prohibit conduct.[20] The only way that the MPCA can require or prohibit action based on the wild rice sulfate standard is through a permitting action.[21]

21. Before the MPCA issues a permit for a point source such as Plaintiff's members, it is legally required to publish a draft of the permit for public review and comment. Minn. R. 7001.0100 (2011). If Plaintiff's proposed permit includes a limit based on that rule, then Plaintiff's members have thirty days to review, comment on, and question that proposed limit. Any party who disagrees with the terms of a proposed MPCA permit has the right to request a contested case hearing before an administrative law judge to review and clarify the terms of the proposed permit. Minn. R. 7000.1800 (2011). Any party who is aggrieved by the agency's final decision in a permitting action has a right of certiorari review by the Court of Appeals. Minn. Stat. § 115.05, subd. 11 (2010). Plaintiff **[*22]** has not and cannot show that any of its members have been left guessing as to what conduct is required or prohibited. Plaintiff's void for vagueness challenge fails as a matter of law.

22. The term "when the rice may be susceptible to damage by high sulfate levels" is straightforward and can be understood using plain language. If wild rice is at a point in its life cycle when sulfates will damage the plant, then the receiving water must not exceed 10 mg/L. Because the rule can be applied based on its plain language, it is not void for vagueness. The goal of the law is to protect production of wild rice in Minnesota. In view of that goal it is reasonable to conclude that the standard applies at a point in the wild rice life cycle when sulfate is found to damage the plant. The rule is not void for vagueness.

"Bodies of Water" not Void for Vagueness

23. The fact that the MPCA does not specifically list every body of water to which the wild rice sulfate standard applies neither violates the Due Process clause of the Constitution nor does it exceed MPCA's statutory authority: neither the Constitution nor Minnesota or federal statutes require a state to list expressly every surface water to **[*23]** which a water quality standard applies. Such a requirement would be particularly absurd in a state such as Minnesota.[22]

24. Nor does the lack of a specific listing render the rule unconstitutionally vague. Plaintiff's members are not left guessing as to whether the wild rice sulfate standard applies to a particular water or as to what is required of them under the standard because the proposed permit details exactly what is required of Plaintiff's members.

25. The wild rice sulfate standard is likewise consistent with state and federal statutory requirements.

State Law

26. Under Minnesota law, the MPCA has the duty and the authority "to establish and alter such reasonable pollution standards for any waters of the state in relation to the public use to which they are or may be put as it shall deem necessary for the purposes of this chapter . . . ." Minn. Stat. § 115.03, subd. 1(c) (2010). Nothing in the statute suggests that the MPCA is required to list

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[19] *Village of Hoffman Estates*, 102 S.Ct. at 1193

[20] Minn. R. 7050.0224, subp. 2.

[21] See, for **[*21]** example., 40 C.F.R. § 122.44(d)(1) (2011) (requiring permitting authority to impose discharge limits in permits where evidence shows that discharge has reasonable potential to cause or contribute to a violation of a water quality standard in a receiving water); Minn. R. 7001.0150, subp. 2 (2011) (requiring MPCA issued permits to include terms necessary to achieve compliance with applicable state and federal law).

[22] According to the Minnesota Legislative Manual (2011-2012) there are 11,842 lakes of more than 10 acres, 3 major river systems, and 6,564 (69,200 miles) rivers and streams.

every single water to which a water quality standard applies. The **[*24]** legislature has given the MPCA broad discretion as to how to best structure Minnesota's water quality standards and has expressly recognized that it is proper for the MPCA to establish water quality standards for *groups* of waters instead of listing every single water to which a standard applies. The legislature has required the MPCA to "group the designated waters of the state into classes, and adopt classifications and standards of purity and quality therefore." Minn. Stat. § 115.44, subd. 2 (2010).

27. The MPCA's administrative rules likewise recognize the need for the agency to employ grouping in the establishment of water quality standards.[23] The assertion that Minnesota law requires a specific list of each water to which a water quality standard applies is without merit.

28. In adopting the wild rice sulfate standard, the MPCA established a group of waters to which the standard applies. That group of waters consists of "waters used for production of wild rice." Minn. R. 7050.0224, subp. 2 (2011). This type of grouping is expressly authorized under Minnesota **[*25]** law.

29. As the EPA made clear in its May 13, 2011 letter to the Minnesota Legislature, the EPA has formally approved Minnesota's wild rice sulfate standard. When the EPA approves a state's water quality standard, it must determine whether the standard is "consistent with the requirements of the Clean Water Act." 40 C.F.R. § 131.5 (a)(1). In approving the wild rice sulfate standard, the EPA concluded that the standard is consistent with the federal Clean Water Act. Plaintiff's assertion that the wild rice sulfate standard is in any way inconsistent with the Clean Water Act lacks merit.

Federal Law

30. There is no requirement in federal law for the state to list expressly every single water to which a water quality standard applies in order for the standard to apply. On the contrary, the federal Clean Water Act allows for application of water quality standards to water bodies that are implicated without being expressly listed on an individual basis.

31. Minn. Laws 2011 1 Sp. c. 2, art. 4, § 32(a)(2) directs the MPCA to initiate rulemaking regarding identification of waters to which this wild rice sulfate standard applies. Plaintiff's assertion that state and federal law would require such **[*26]** a listing is inaccurate and would significantly impede the MPCA's ability to fulfill its statutory obligation to promulgate and enforce water quality standards for the State of Minnesota.

32. The Wild Rice Rule (Minn. R. 7050.0224, subp.2) is rationally related to both the stated policy and rationale of the rules and is not void for vagueness.

B. Count IV: Plaintiff's are not entitled to a Declaratory Judgment.

33. M.S. 555.02 specifies the actions a court may construe under the Declaratory Judgment Act:

> Any person...whose rights, status or other legal relations are affected by a statute, municipal ordinance, contract, or franchise may have determined any question of construction or validity arising [under the same] and obtain a declaration of rights, status or other legal relations thereunder.

34. This act is not an express independent source of jurisdiction[24]: it does not create an independent cause of action. Because Plaintiff's substantive claims all fail as a matter of law, Plaintiff's Declaratory Judgment Act claim must also be dismissed.

35. To the extent that Plaintiff's claims are **[*27]** based on permitting actions that the MPCA may take in the future, those claims are conjectural and not subject to court action at this time.[25]

36. Given the above, Plaintiff has adequate remedies at law and is not entitled to a declaratory judgment.

C. Request for Equitable Relief

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[23] *See* Minn. R. 7050.0140, subp. 1 ("the waters of the state are grouped into one or more of the classes in subparts 2 to 8.")

[24] *Alliance for Metropolitan Stability v. Metropolitan Council*, 671 N.W.2d 905, 915 (Minn. App. 2003).

[25] Any such quasi-judicial action is reviewable via certiorari to the Court of Appeals under M.S. 115.05, subd. 11(2010).

37. Plaintiff has requested that the Court "preliminarily and permanently" enjoin the MPCA from imposing any of the sulfate discharge limitations discussed above. Case law addressing Minn.R.Civ. P. 65.02 (temporary injunctions) has established five factors determining whether such an injunction should be granted: a) the nature of the relationship; b) relative hardships; c) likelihood of success on the merits; d) public policy; and e) administrative burdens.[26]

38. Analyzed under those factors, Plaintiff's request should be denied. As with Minn. R. Civ.P.65.01, the threshold question is whether there is immediate and irreparable injury that constitutes a ground for the issuance of the injunction and whether that party **[*28]** does not have an adequate remedy at law.[27] The failure to meet this burden is, in and of itself, a sufficient basis on which to deny the relief.[28] In this case, each of Plaintiff's claims are based on actions that the MPCA allegedly *may* take in the context of permitting proceedings. Plaintiff has an adequate remedy at law for any MPCA permitting decision: the right to request a contested case hearing before an administrative law judge on any MPCA permitting matter,[29] and a statutory right of certiorari review of any final MPCA permitting decision before the Minnesota Court of Appeals.[30] Because Plaintiff clearly has adequate remedies at law in this case its request for equitable relief must be denied.

39. Analyzed under the *Dahlberg* factors, the Court reaches the same conclusion. In this case the determinative factors under *Dahlberg* are a) the likelihood of success on the merits (see discussion, *supra*;) and b) public policy[31] Balancing the relative hardships between **[*29]** the parties, the analysis also favors the Defendant. While complying with the rules may be more costly to the Plaintiff's members, the rationale for Defendant's action is clearly stated in Minn.R. 7050.0224, subp.1:

> "...The harvest and use of grains from this plant serve as a food source for wildlife and humans...the quality of these waters and aquatic habitat necessary to support the propagation and maintenance of wild rice plant species must not be materially impaired or degraded...

40. Plaintiff's argument that its members may have to take action to comply with the wild rice sulfate standard during the interim period in which the MPCA conducts the research necessary to amend the rule as directed by the Legislature is without merit. The Legislature has already addressed how the wild rice sulfate standard is to be applied during that interim period.[32]

For this Court to second-guess the Legislature's determination of how the standard should be applied while the standard is in the process of being amended is inappropriate. Plaintiff's request for injunctive relief **[*30]** should be denied.

NOW THEREFORE, IT IS HEREBY ORDERED:

1. The motion for summary judgment of Defendant MPCA and Defendant-Intervenor WaterLegacy's is granted in its entirety.
2. Plaintiff's motion for a "preliminary and permanent" injunction is denied.
2. Plaintiff's partial motion for summary judgment is denied in its entirety.
3. Plaintiff's Complaint is dismissed in its entirety with prejudice and on the merits.

10 May 2012

/s/ Margaret M. Marrinan

HON. MARGARET M. MARRINAN

JUDGE OF DISTRICT COURT

End of Document

[26] *Dahlberg Bros., Inc. v. Ford Motor Co*., 272 Minn. 264, 137 N.W.2d 314 (1965).

[27] *Unlimited Horizon Mktg., Inc. v. Precision Hub, Inc*., 533 N.W. 2d 63 (Minn. App. 1995).

[28] *Morse v. City of Waterville*, 458 N.W. 2d 728 (Minn. App. 1990).

[29] Minn. R. 7000.1800 (2011).

[30] Minn. Stat. § 115.05, subd. 11(1) (2010).

[31] See discussion supra at p. 3 regarding Minn.R. 7050.0186, M.S. 1.148, subd. 1.

[32] Minn. Laws. 2011 1 Sp. c. 2, art. 4, § 32 (e).

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 2

MPCA Board Packet *In re U.S. Steel Corp., Minnesota Ore Operations, Keetac NPDES/SDS Permits MN0031879 and MN0055948*, October 14, 2011.

Minnesota Pollution Control Agency
520 Lafayette Road North | St. Paul, Minnesota 55155-4194 | 651-296-6300
800-657-3864 | 651-282-5332 TTY | www.pca.state.mn.us | Equal Opportunity Employer

October 14, 2011

RE: United States Steel Corporation, Minnesota Ore Operations, Keetac - Request for Approval of Findings of Fact, Conclusions of Law, and Order and Authorization to Issue National Pollutant Discharge Elimination System/State Disposal System Permits MN0031879 and MN0055948

TO: INTERESTED PARTIES

Enclosed for your information is a copy of the Minnesota Pollution Control Agency (MPCA) Citizens' Board (Board) Item documents for the proposed United States Steel Corporation, Minnesota Ore Operations – Keetac National Pollutant Discharge Elimination System/State Disposal System Permits MN0031879 and MN0055948 (Permits), Itasca County, and a copy of the Board Agenda. The Board packet includes:

- Proposed Findings of Fact, Conclusions of Law, and Order for the National Pollutant Discharge Elimination System/State Disposal System (NPDES/SDS) Permits
- Comment letters received on the Draft Permits
- Responses to written comments received on the draft permits
- Table of changes to draft Permits
- Proposed Permits
- Statement of Basis for the Proposed Permits
- Map of the facility

The United States Steel Corporation, Minnesota Ore Operations – Keetac - Request for Approval of Findings of Fact, Conclusions of Law, and Order and Request and Authorization to Issue National Pollutant Discharge Elimination System/State Disposal System Permits MN0031879 and MN0055948 Board Packet may also be viewed at the MPCA St. Paul Office and on our MPCA Web site at http://www.pca.state.mn.us/about/board/bdagenda.html.

The draft Permits and Statement of Basis documents are very lengthy. In an effort to save postage and resources, the draft Permit and Statement of Basis will not be included in this mailing. All Board Item documents, including the draft Permit and Statement of Basis may be reviewed at the MPCA offices in St. Paul and on the MPCA Web site at http://www.pca.state.mn.us/about/board/bdagenda.html. Requests for copies of these documents may be made by contacting the St. Paul office at 651-757-2084.

The Board Item will be presented at the MPCA Board Meeting on October 25, 2011. Please refer to the enclosed Board Agenda for specific location, dates, and times. We encourage your attendance at the Board Meeting. If you have any questions regarding the enclosed Board Item or the specifics of the meeting, feel free to contact Brandon Smith of our staff at 651-757-2740.

Sincerely,

Ann Foss

Ann M. Foss
Director
Strategic Projects Sector
Industrial Division

AMF:rm

Enclosures

MINNESOTA POLLUTION CONTROL AGENCY

Industrial Division
Strategic Projects Sector

Board Item Cover Sheet

MEETING DATE:	October 25, 2011	**DATE MAILED:**	October 14, 2011
Presenter(s):	Brandon Smith BES	**Phone Number:**	651-757-2740
Project Manager:	Brian Timerson BT	**Phone Number:**	651-757-2785
Sector Director:	Ann Foss AMF	**Phone Number:**	651-757-2366
Division Director:	Jeff Smith	**Phone Number:**	651-757-2735
Asst. Co.: (if issue applies to water or air issue)	Rebecca Flood	**Phone Number:**	651-757-2022
Deputy Commissioner:	John Stine JSR	**Phone Number:**	651-757-2014
Attorney:	Robert Roche	**Phone Number:**	651-757-1372

TITLE OF BOARD ITEM: United States Steel Corporation, Minnesota Ore Operations - Keetac, Keewatin, Minnesota - Request for Approval of Findings of Fact, Conclusions of Law, and Order and Request for Authorization to Issue National Pollutant Discharge Elimination System/State Disposal System Permits MN0031879 and MN0055948.

LOCATION: Keewatin (City/Township); Itasca (County)

TYPE OF ACTION: Permit Issuance

RECOMMENDED ACTION: Authorization to Issue National Pollutant Discharge Elimination System/State Disposal System Permits MN0031879 and MN0055948.

ISSUE STATEMENT:

The Minnesota Pollution Control Agency (MPCA) staff requests that the MPCA Citizens' Board (Board) approve reissuance of National Pollutant Discharge Elimination System (NPDES)/State Disposal System(SDS) Permits MN0031879 and MN0055948 (Permits) for the United States Steel Corporation – Minnesota Ore Operations (Permittee) – Keetac Mining Area facility. The MPCA staff prepared the draft Permits for the Keetac Mining Area facility, and submitted the draft Permits for public comments on June 27, 2011. The public comment period for the Permits was extended twice, closing on August 19, 2011. Prior to extending the public comment period to end on August 19, 2011, the MPCA received 179 requests for extension of the public comment period, 177 were received in substantially identical e-mails. In addition to the requests for extension of the public comment period, the MPCA received 117 comment letters regarding the Permit, 106 of which were received in substantially identical e-mails. Comments received on the draft Permits centered primarily on the relationship between the Permits and a proposed expansion on mining at the Keetac facility, water quality-based effluent limitations, and a compliance schedule in the draft Permits for the application of final effluent limitations for sulfate, which are based on an ambient water quality standard for wild rice production waters. In response to comments received, the MPCA staff has modified the draft Permits to clarify and improve enforceability of compliance schedule requirements. The MPCA staff recommends that the Board approve the reissuance of each of the Permits.

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This material can be made available in other formats, including Braille, large type or audio tape, upon request.

ATTACHMENTS:

1. Proposed Findings of Fact, Conclusions of Law, and Order Permit No. MN0031879
2. Proposed Findings of Fact, Conclusions of law and Order Permit No. MN0055948
   Appendix A – Comment Letters received on the Draft Permits
   Appendix B – Responses to Comments Received on the Draft Permits
   Appendix C – Table of Changes to Draft NPDES/SDS Permits
3. Proposed NPDES/SDS Permit No. MN0031879
4. Proposed NPDES/SDS Permit No. MN0055948
5. Statement of Basis Permit No. MN0031879
6. Statement of Basis Permit No. MN0031879
7. Map of Facility

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This material can be made available in other formats, including Braille, large type or audio tape, upon request.

MINNESOTA POLLUTION CONTROL AGENCY
Industrial Division
Land and Water Quality Permits Section

United States Steel Corporation, Minnesota Ore Operations, Keetac
National Pollutant Discharge Elimination System/State Disposal System
Permits MN0031879 and MN0055948

October 25, 2011

ISSUE STATEMENT

The Minnesota Pollution Control Agency (MPCA) staff requests that the MPCA Citizens' Board (Board) approve reissuance of National Pollutant Discharge Elimination System (NPDES)/State Disposal System(SDS) Permits MN0031879 and MN0055948 (Permits) for the United States Steel Corporation – Minnesota Ore Operations (Permittee) – Keetac facility. The MPCA staff prepared the draft Permits for the Keetac facility, and submitted the draft Permits for public comments on June 27, 2011. The public comment periods for the Permits were extended twice, closing on August 19, 2011. Prior to extending the public comments period to end on August 19, 2011, the MPCA received 179 requests for extension of the public comments period, 177 were received in substantially identical e-mails. In addition to the requests for extension of the public comment periods, the MPCA received 117 comment letters regarding the Permits, 106 of which were received in substantially identical e-mails. Comments received on the draft Permits centered primarily on the relationship between the Permits and a proposed expansion on mining at the Keetac facility, water quality-based effluent limitations, and a compliance schedule in the draft Permits for the application of final effluent limitations for sulfate, which are based on an ambient water quality standard for wild rice production waters. In response to comments received, the MPCA staff has modified the draft Permits to clarify and improve enforceability of compliance schedule requirements. The MPCA staff recommends that the Board approve the reissuance of each of the Permits.

I. BACKGROUND:

A. Facility Description

The principal activity at the Keetac facility is the open pit mining of taconite from the Biwabik Iron Formation for processing into taconite pellets. The Keetac facility is currently subject to NPDES/SDS Permits MN0031879 and MN0055948, which regulate discharges from the mining/processing facility and the tailings basin system, respectively. The permitted activities under NPDES/SDS Permit MN0031879 consist of discharges from the Permittee's Keetac plant area, all mine excavations, mining waste disposal areas, plant areas, materials and equipment storage areas, and wastewater disposal facilities. The

permitted activities under NPDES/SDS Permit MN0055948 consist of discharges of process and dewatering wastewaters associated with the Keetac tailings basin system.

The Permittee has proposed an expansion to its mining and pellet production operations at the Keetac facility, which will increase production from 6.0 million short tons of pellets per year to 9.6 million short tons per year. A short ton equals 2,000 pounds. The proposed expansion exceeded the threshold for requiring mandatory environmental review. Pursuant to Minn. R. 4410.2000, subp. 3.B., the Permittee and the Minnesota Department of Natural Resources (DNR) agreed that a discretionary Environmental Impact Statement should be prepared pursuant to Minn. R. 4410.4400 subp. 8, and the DNR would be the Responsible Governmental Unit for the State of Minnesota.

B. Procedural History

On January 11, 2010, the MPCA received applications for modification of both of the Permits to address proposed mining expansion. The proposed expansion does not change the operation of the previously permitted disposal systems associated with the Keetac mine area and processing plant or the discharge of wastewater associated with the previously permitted disposal systems.

In February, 2010, the MPCA determined waters downstream from the discharges authorized by the Permits to be waters used for the production of wild rice.

In August, 2010, the MPCA staff determined that the requested modifications to the Permits should be included with the upcoming reissuance of each of the Permits.

On December 30, 2010, the DNR determined the final EIS for the proposed Keetac mine expansion to be adequate.

On June 27, 2011, the MPCA staff public noticed the draft Permits for reissuance.

On July 27, 2011, the MPCA staff extended the public comment period for the Permits to end on August 12, 2011, to account for business days lost due to the Minnesota State government service interruption that occurred in July.

On August 12, 2011, the US Environmental Protection Agency (EPA) formally requested a 30 day review of the draft Permits, starting from August 2, 2011, and ending on September 2, 2011.

On August 12, 2011, the MPCA staff extended the public comment period for the Permits to end on August 19, 2011, in response to requests for additional time to submit public comments.

On August 19, 2011, the public comment period for the draft Permits ended.

On September 2, 2011, the MPCA staff received comments from the EPA review of the draft Permits. The comments requested corrections and clarifications to the language in the draft Permits regarding the compliance schedule for sulfate.

II. DISCUSSION:

The draft permits do not authorize, and the permittee had not requested expansion of any of the permitted discharges above the volumes and mass loadings authorized under the previous permits. The substantial changes to the Permits, as compared to previous permits issued to this facility, occurred as a result of the determination that discharges from the facility impact downstream waters, which are used for the production of wild rice.

As required by federal Clean Water Act regulations, the MPCA staff performed an analysis to determine whether the discharge would have the reasonable potential to cause or contribute to a violation of any water quality standards in the receiving waters. Under the regulation, where the MPCA determines that a discharge of a particular pollutant has the reasonable potential to cause or contribute to a violation of an applicable water quality standard in a receiving water, the permit must include a water quality based effluent limit for that pollutant. This "reasonable potential" analysis results in water quality based effluent limit recommendations, which are included in the draft permits.

On February 2, 2010, the MPCA staff completed the effluent limit recommendations and associated nondegradation review for NPDES/SDS Permit MN0031879, in accordance with all state and federal regulations, as well as MPCA policies governing such reviews.

On April 7, 2011, the MPCA staff completed the effluent limits recommendations and associated nondegradation review for NPDES/SDS Permit MN0055948, in accordance with all state and federal regulations, as well as the MPCA policies governing such reviews.

Minnesota's water quality standards include a 10 mg/L sulfate limit for waters used for the production of wild rice when the rice may be susceptible to damage by high sulfate levels. The reasonable potential analysis for sulfate in the mine area discharges resulted in the inclusion of an effluent limit based on that standard. The sulfate effluent limits are 14 mg/L calendar month average and a 24 mg/L daily maximum. These effluent limits were calculated utilizing the same statistical procedures that are used to determine water quality-based effluent limitations for NPDES/SDS permits throughout Minnesota.

Because U. S. Steel is currently unable to comply with the sulfate effluent limits, the MPCA staff developed a compliance schedule based on the time required for the completion of evaluations and implementation of the final plans to attain compliance with the sulfate effluent limits. The compliance schedule was developed in accordance with the requirements of 40 CFR § 122.47, and Minn. R. 7001.0150, subp. 2 (A).

Commentors expressed a variety of concerns regarding the topics identified above. These comments are addressed in the Response to Comments document (Appendix B of Attachment 2). In response to comments made by EPA, changes were made to the draft permit, which are defined in Appendix C of Attachment 2. The following is a summary of the changes made to the draft permit: (1) the MPCA modified the tailings basin permit to include reference to the compliance schedule for non-tailings basin discharges found in the mining operations permit. (2) Interim effluent limits for sulfate were added to the permit for outfalls where full-scale treatment evaluation is approved. (3) Full-scale treatment evaluation is required for outfalls representative of wastewater type. (4) Additional monitoring requirements for selenium added to the permit.

Many of the other comments received from environmental groups and concerned citizens related to the effluent limits for sulfate, including whether the effluent limits were calculated appropriately and the assumptions used in the calculations, as well as concerns regarding the appropriate length of the compliance schedule to achieve the sulfate limits. Comments also included requests to increase the frequency of sulfate monitoring and to include additional monitoring and effluent limits for hardness and other parameters.

The issue before the Board is whether to reissue each of the two Permits as prepared by the MPCA staff. The MPCA's decision to reissue Permits is governed by Minn. R. 7001.0140 subp. 1, which states:

> *Subpart 1.Agency action. Except as provided in subpart 2, the agency shall issue, reissue, revoke and reissue, or modify a permit if the agency determines that the proposed permittee or permittees will, with respect to the facility or activity to be permitted, comply or will undertake a schedule of compliance to achieve compliance with all applicable state and federal pollution control statutes and rules administered by the agency, and conditions of the permit and that all applicable requirements of Minnesota Statutes, chapter 116D, and the rules adopted under Minnesota Statutes, chapter 116D, have been fulfilled. For solid waste facilities, the requirements of Minnesota Statutes, section 473.823, subdivisions 3 and 6, must also be fulfilled.*

The MPCA staff believes that the requirements of Minn. R. 7001.0140 subp. 1 have been fulfilled.

III. CONCLUSIONS:

For the reasons discussed above and more fully described in the Findings of Fact, Conclusions of Law and Order, in the staff's response to comments, and in the Statement of Basis for the Mining Operations, the MPCA staff believes that Permit No. MN0031879 should be issued.

For the reasons discussed above and more fully described in the Findings of Fact, Conclusions of Law and Order, in the staff's response to comments, and in the Statement of Basis for the Tailings Basin, the MPCA staff believes that Permit No. MN0055948 should be issued.

IV. RECOMMENDATION:

The MPCA staff recommends that, in accordance with the standard and criteria set forth in Minn. R. 4410.1700, the Board vote to approve issuance of NPDES/SDS Permits MN0031879 and MN0055948 for the United States Steel Corporation, Minnesota Ore Operations – Keetac facility.

SUGGESTED STAFF RESOLUTION

Authorization to Issue NPDES/SDS Permits MN0031879 and MN0055948

BE IT RESOLVED, that the Minnesota Pollution Control Agency (MPCA) approves and adopts the attached Findings of Fact, Conclusions of Law, and Order (Attachment 1 and Attachment 2) in support of its approval of issuance of the NPDES/SDS Permits for United States Steel Corporation, Minnesota Ore Operations - Keetac Project.

BE IT FURTHER RESOLVED, that the Commissioner is authorized to do the following: (1) execute the Findings of Fact, Conclusions of Law, and Order (Attachment 1 and Attachment 2) on behalf of the MPCA; (2) issue NPDES/SDS Permits MN0031879 and MN0055948 on behalf of the MPCA; and (3) undertake all actions necessary for issuance and effectiveness of the water permit.

STATE OF MINNESOTA
MINNESOTA POLLUTION CONTROL AGENCY

IN THE MATTER OF THE PROPOSAL TO
REISSUE THE NPDES/SDS
PERMIT NO. MN0031879
FOR UNITED STATES STEEL – MINNESOTA ORE OPERATIONS - KEETAC
MINING
KEEWATIN, MINNESOTA

FINDINGS OF FACT
CONCLUSIONS OF LAW
AND ORDER

The above-entitled matter came before the Minnesota Pollution Control Agency (MPCA) Citizens' Board at a regular meeting held in St. Paul, Minnesota on October 25, 2011. Based on the MPCA staff review, comments and information received during the comment period, and other information in the record of the MPCA, the MPCA hereby makes the following Findings of Fact, Conclusions of Law, and Order:

FINDINGS OF FACT

This matter involves the application of United States Steel Corporation for reissuance of National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit No. MN0031879 for the Minnesota Ore Operations - Keetac – Mining Facility. For the purposes of these Findings, Conclusions of Law and Order, the United States Steel Corporation is referred to as U. S. Steel or the Permittee and the Minnesota Ore Operations Keetac – Mining Facility is referred to as Keetac. The permit reissuance includes: 1) a description of the proposed expansion of the taconite processing plant with which the permitted operations are associated; 2) effluent limitations based on the 10 mg/L sulfate water quality standard for "waters used for the production of wild rice;" and 3) continuation of the currently effective compliance schedule for the sulfate effluent limitations, which was added as part of a major permit modification issued on June 17, 2010. The MPCA must decide whether, under applicable statutes and rules, it should reissue the permit.

DESCRIPTION OF THE PROJECT

1. United States Steel Corporation ("U. S. Steel Corp.") owns and operates a taconite (iron ore) mine and processing plant in Keewatin, Minnesota. The facility, U. S. Steel Corporation, Minnesota Ore Operations - Keetac ("Keetac"), produces taconite pellets for use as a primary raw ingredient at iron and steel mills.

2. Iron ore mining and taconite pellet production have been on-going at the Keetac facility since 1967. The original Phase I taconite processing plant began operation in 1969. At that time, the Keetac facility included one operating taconite production line.

3. In 1977, the Phase II expansion added a second operating line. The Phase I line was idled in December 1980 under the ownership of National Steel Pellet Corporation. U. S. Steel Corp. purchased the National Steel Corporation in 2003, including the Keetac facility.

4. Currently, there is one operational pellet producing line (Phase II) with annual production of approximately 6.0 million tons of taconite pellets per year (MTPY). The facility has proposed an expansion to its mining and pellet production operations, which will increase production from 6.0 MTPY to 9.6 MTPY. A joint state and federal Environmental Impact Statement (EIS) was completed for the proposed expansion, and was determined to be adequate by the Minnesota Department of Natural Resources on December 30, 2010.

5. The reissuance of NPDES/SDS Permit No. MN0031879 is requested to authorize continued operation of permitted disposal systems associated with the Keetac mine area and processing plant, and the discharge of wastewater associated with the permitted disposal systems.

6. The current mining facility has four surface water discharge points. The proposed expansion does not change the operation of currently permitted disposal systems associated with the Keetac mine area and processing plant, or the discharge of wastewater associated with the currently permitted disposal systems, each of which is described below.

7. The water supply treatment plant, located just north of Welcome Lake, currently discharges backwash wastewater from the sand filters on a periodic basis through culvert outfall SD001, at a rate of less than 0.010 million gallons per day (MGD), to Welcome Lake.

8. A Diversion Ditch System consisting of a series of sedimentation basins and a conveyance channel, currently discharges treated runoff from the Keetac plant area and stockpile areas, as well as overflow discharges of mine pit dewatering and runoff from a holding and treatment basin identified as Reservoir 5, at an average rate of 2.3 MGD to Welcome Creek via weir outfall SD001.

9. Mine pit dewatering from the Mesabi Chief Pit may be pumped and discharged through pipe outfall SD003, at an average rate of 5.85 MGD, to O'Brien Creek, which flows to the O'Brien Reservoir.

10. Discharges of mine pit dewatering from the Perry Pit, which includes stormwater from stripping and stockpiling activities west of the Mesabi Chief mining area, are directed through pipe outfall SD012 at rate of up to 4.32 MGD to O'Brien Creek.

APPLICABLE STANDARDS

Technology-based Treatment Standards

11. Minn. R. 7053.0225 subp. 1.A requires that all point source dischargers of industrial or other wastes shall comply with applicable federal standards, including those listed in 40 CFR pt. 401 through 469. The MPCA has determined that the specific industrial category and federal effluent limitation guidelines (Categorical Standards) applicable to this facility are those described in 40 CFR pt. 440 subp. A, for the iron ore mining and dressing point source category.

12. The facility constitutes an existing source, and is therefore not subject to the New Source Performance Standards for this industry. The Categorical Standards for Best Practicable Control Technology currently available (BPT) and Best Available Technology economically achievable (BAT) have been applied for the conditions in this permit.

13. The applicable BPT and BAT standards for mining area discharges are for Total Suspended Solids (TSS) and Total Iron, as limited in the currently effective Permit.

14. The applicable standards for the discharge of water supply treatment plant backwash water are based on the State Discharge Restrictions for pH and TSS pursuant to Minn. R. 7053.0225, as limited in the currently effective Permit.

Water Quality Standards

15. The immediate receiving waters affected by this permit reissuance include: Welcome Lake, Welcome Creek, O'Brien Creek, and the O'Brien Reservoir.

16. All waters of the state of Minnesota must be classified based on considerations of best usage in the interest of the public and in conformance with the requirements of the applicable statutes, as described in Minn. R. 7050.0140. Based on these considerations, Welcome Creek and O'Brien Creek are classified as Class 2C waters as listed in 7050.0470 subp. 4.A. items (127) and (236), respectively. According to Minn. R. 7050.0410, any listed water in part 7050.0470 is also classified as a Class 3C, 4A, 4B, 5, and 6 water. Welcome Lake and O'Brien Reservoir are not listed waters in Minn. R. 7050.0470. As detailed in Minn. R. 7050.0430, all surface waters of the state that are not listed in part 7050.0470 and that are not wetlands as defined in part 7050.0186, subp. 1a, are classified as Class 2B, 3C, 4A, 4B, 5, and 6 waters.

17. Based on the applicable classifications, the receiving waters named above are designated for use in the forms of aquatic life and recreation, industrial consumption, agriculture and wildlife, aesthetic enjoyment and navigation, and other uses.

18. In addition, the MPCA staff has made the determination that discharges from the facility reach downstream waters, which are "used for the production of wild rice" as stated in Minn. R. 7050.0224 subp. 2. The wild rice determination was made prior to the permit modification dated June 17, 2010, and no revisions to the determination were made during the permit reissuance process.

19. As required by 40 C.F.R. § 122.44(d)(1), the MPCA evaluated the proposed discharge to determine whether it has a reasonable potential to cause or contribute to an excursion above applicable water quality standards.

20. Effluent limitations have been included in the draft Permit for total sulfate based on the results of the reasonable potential analysis.

21. In addition to the numeric water quality standards for applicable use classifications, Minn. R. 7050.0185 governs nondegradation for all waters. Nondegradation review is required by the MPCA for significant new and expanding discharges as defined in Minn. R. 7050.0185 to determine whether additional controls beyond compliance with water quality standards are warranted to prevent degradation of waters of the state. For this Permit, a significant new or expanded discharge would be defined as one in which the maximum design flow expands by more than 200,000 gallons per day above the existing baseline flow, or would increase the concentration of a toxic pollutant in the receiving water by greater than one percent. No expansion of the maximum

daily design flows above the currently permitted levels is authorized by the Permit. Additionally, the EIS for the proposed Keetac expansion project indicates that water chemistry in the discharges authorized by the Permit is not anticipated to change due to continuation of similar mining and dewatering activity following the expansion. Therefore, the discharges authorized by the Permit do not constitute significant new or expanded discharges, and nondegradation review is not required for the proposed reissuance of the Permit.

22. Minn. R. 7050.0180 governs nondegradation for Outstanding Resource Value Waters (ORVWs). None of the discharges authorized by the Permit are directly to ORVWs, therefore nondegradation with regard to ORVWs under the Permit is limited to verifying that new or expanding flows are controlled to prevent degradation of downstream ORVWs. As previously discussed, permitted flows are required to remain within the range currently permitted, and changes to the chemistry of the permitted discharges are not expected to occur. Therefore, degradation of downstream ORVWs is not anticipated, and additional controls are not required pursuant to Minn. R. 7050.0180.

PROTECTION OF WATERS USED FOR THE PRODUCTION OF WILD RICE

23. The reasonable potential analysis for sulfate in the mine area discharges resulted in the inclusion of an effluent limit based on the 10 mg/L stated applicable to "waters used for the production of wild rice." The sulfate effluent limits are 14 mg/L calendar month average and 24 mg/L daily maximum.

24. The effluent limitations for sulfate have been calculated utilizing statistical methods derived from the EPA Technical Support Document for Water Quality-Based Toxics Control. The limits are calculated assuming no dilution capacity in the receiving waters, maximum flow from the permitted discharges, and a waste load allocation of 10 mg/L sulfate based on the ambient water quality standard for waters used for the production of wild rice. Compliance with the calculated effluent limitations provides reasonable assurance that the Permittee's discharges are not causing or contributing to excursions above the water quality standard within the water bodies where the standard applies.

25. U. S. Steel is currently unable to comply with the sulfate effluent limits. Due to the complex nature of the wastewater disposal systems at the Keetac facility, a facility-wide compliance solution must be investigated that incorporates both water management and treatment solutions. The MPCA staff determined that inclusion of a compliance schedule in the permit is appropriate. Therefore, the permit reissuance includes a schedule for attaining compliance with the final effluent limitations for total sulfate on a facility-wide basis.

26. The compliance schedule in the draft Permit requires the completion of a Water Management Study and a Sulfate Reduction Strategy Study, which are required to inform the development and implementation of a Sulfate Reduction Plan. The implementation of the Sulfate Reduction Plan is required to lead to compliance with the final effluent limitations for sulfate as soon as possible. The Sulfate Reduction Plan must provide justification for the proposed timeframe for attaining compliance.

27. The schedule requires attainment of compliance as soon as possible and in no case later than August 17, 2018. The maximum term of the compliance schedule is based on potential time required for completion of evaluations by the Permittee, as well as time for implementation of any final plans for attaining compliance, including time for obtaining various regulatory approvals. The schedule does not automatically grant the maximum timeframe, but requires the MPCA approval at interim steps and requires that all interim steps proceed to compliance with final effluent limitations as soon as possible. The schedule requires the Permittee to make reductions in sulfate concentration to the extent practical prior to the end of the compliance schedule.

28. Interim requirements for the compliance schedule prior to the final attainment of compliance include completion of the Water Management Study and Sulfate Reduction Strategy Study currently underway, preparation and submittal of the Sulfate Reduction Plan, implementation of the Sulfate Reduction Plan following MPCA approval of the plan, and progress reporting. The Permit specifies maximum timeframes for completion of interim requirements. Implementation of the actions contained in the Sulfate Reduction Plan following the MPCA approval will also be enforceable actions due to implementation of the approved plan being an enforceable condition of the Permit.

29. Additional enforceable interim requirements are built into the schedule contingent upon the proposals in the Sulfate Reduction Plan. Distinct timeframes for the attainment of compliance following MPCA approval of the plan are required, and are dependent on whether or not the MPCA approves full-scale testing of treatment technology on representative outfalls prior to final implementation on all discharges. The Permit allows time for completion of such testing in the event that such a proposal is approved by the MPCA, but specifies maximum timeframes for completion of the testing, and requires that interim effluent limitations for sulfate be met at the representative outfalls following treatment evaluations. If full-scale treatment evaluation is not approved by the MPCA, the Permit requires compliance to be attained in a shorter timeframe.

REVISIONS TO THE SULFATE COMPLIANCE SCHEDULE FOLLOWING PUBLIC COMMENT PERIOD

30. The U.S. Environmental Protection Agency (EPA) requested to review the draft permit, outside of the public comment period, under federal oversight authority. The EPA submitted a comment letter to the MPCA dated September 2, 2011. Specific comments and the MPCA responses regarding the sulfate compliance schedule are discussed below. These changes were made following public notice of the Permit.

31. The EPA requested the MPCA to revise draft NPDES/SDS Permit No. MN0055948 either to incorporate by reference the compliance schedule in draft NPDES/SDS Permit No. MN0031879, or provide the same level of detail as is included in draft NPDES/SDS Permit No. MN0031879.

32. The MPCA staff modified draft NPDES/SDS Permit No. MN0055948 to include the compliance schedule contained in draft NPDES/SDS Permit No. MN0031879 by reference.

33. The EPA requested the MPCA to revise the compliance schedule so that the different paths within the compliance schedule following the MPCA approval or disapproval of treatment technology pilot studies are independent, and contain distinct enforceable actions leading to compliance with the effluent limits for sulfate.

34. The MPCA staff modified the language in draft NPDES/SDS Permit No. MN0031879 to indicate two distinct schedules, with distinct requirements for attainment of compliance with final effluent limitations for each case regarding the MPCA approval or disapproval of a request for full-scale treatment evaluation on representative outfalls.

35. The EPA requested the MPCA to revise the compliance schedule so that it is clear that the full scale treatment technology pilot studies are required for a representative outfall of each type of discharge, specifically tailings basin, dewatering pit, and Reservoir 5/sedimentation basins. The EPA asked that the MPCA staff specify that the representative dewatering pit outfall will be one included in draft NPDES/SDS Permit No. MN0031879 and therefore fall under that schedule.

36. The MPCA staff modified the compliance schedule in draft NPDES/SDS Permit No. MN0031879 to require evaluation of full-scale treatment evaluation for outfalls representative of wastewater type. The MPCA did not specify the three waste types contained in the EPA comments, due to the possibility of these waste types changing due to operational modifications, dependent on the results of the Water Management Study that is currently in progress. As an equivalent measure, the MPCA is requiring the Permittee to base any request for testing on representative outfalls on consideration of physical condition of the wastewater, wastewater chemistry, and the size/frequency of the discharge within the Sulfate Reduction Plan. The permit language has also been modified to specify compliance dates based on the type of wastewater discharged as requested.

37. The EPA stated that the schedules of compliance require successful full-scale pilot treatment of outfalls representing the various types of discharges at the facility. The EPA requested the MPCA to require interim limits for sulfate at each outfall selected for the full-scale pilot studies, effective upon completion of the testing phases specified in paragraphs 1.11, 1.12 and 1.13 of draft NPDES/SDS Permit No. MN0031879.

38. The MPCA staff modified the language to require compliance with an interim effluent limitation for total sulfate of 14 mg/L as a calendar quarter average. This effluent limitation will be applied on any outfalls for which full scale treatment evaluation is approved, following the completion of those evaluations, to ensure continued progress toward compliance with final effluent limitations.

39. The EPA requested the MPCA to correct the dates specified in the draft NPDES/SDS permits to reflect that the sulfate effluent limits shall be attained as soon as possible but no later than August 17, 2018, as opposed to the August 2019 date specified in the draft NPDES/SDS Permit No. MN0031879.

40. The MPCA staff corrected the final compliance date to require compliance with final effluent limitations as soon as possible and in no case later than August 17, 2018, for non-tailings basin discharges.

41. The revised compliance schedule language, based on EPA comments, is included in the permit document found in Attachment 3. The compliance schedule has been developed in accordance with the requirements of Minn. R. 7001.0150, subp. 2 (A) and 40 CFR § 122.47. The Permit requires that compliance with final effluent limitations be attained as soon as possible, and that completion of

interim steps result in continued progress toward compliance with final effluent limitations. Where the time between specific interim steps exceeds one year, the compliance schedule requires progress reports to be submitted to the MPCA at a minimum of every 6 months to provide details regarding the implementation of the requirements of the schedule and verify continued progress toward achieving compliance as soon as possible.

PROCEDURAL HISTORY

42. Pursuant to Minn. R. 7001.0100, a draft permit was prepared by the MPCA staff for the proposed permit reissuance.

43. The public comment period for the draft permit began on June 27, 2011, and ended on August 19, 2011. The initial 30-day comment period ended on July 27, 2011. Due to circumstances with the state government shutdown, which ran from July 1, 2011, to July 21, 2011, the comment period was extended to August 12, 2011, and a second extension was granted until August 19, 2011.

44. During the comment period, the MPCA received 2 comment letters from government agencies and received 11 comment letters from citizens.

45. The MPCA reviewed each of the comments and prepared responses to all comments received during the public comment period. Comment letters received have been hereby incorporated by reference as Appendix A to these findings. The MPCA responses to comments received are hereby incorporated by reference as Appendix B to these findings.

46. The MPCA concurs with the reasoning of MPCA staff in its Responses to Comments document (Attachment B) and adopts the reasoning by reference on these findings. The EPA comments and MPCA responses to those comments are also included in the Appendix A and Appendix B, respectively.

SELECTED COMMENTS AND MPCA RESPONSES

47. During the public comment period for the Permit, the MPCA received 179 requests for extension of the public comments period, 177 were received in substantially identical e-mails.

48. In addition to the requests for extension of the public comment periods, the MPCA received 117 comment letters regarding the Permit, 106 of which were received in substantially identical e-mails.

49. Comments received on the draft Permit centered primarily on the relationship between the Permits and a proposed expansion on mining at the Keetac facility, water quality-based effluent limitations, and a compliance schedule in the draft Permits for the application of final effluent limitations for sulfate, which are based on an ambient water quality standard for wild rice production waters.

50. In response to comments received, the MPCA staff has modified the draft Permit to clarify and improve enforceability of compliance schedule requirements.

51. The comments received on this Permit and NPDES/SDS Permit MN0055948, as well as the MPCA responses to the comments, are detailed in Appendix B.

FINAL DETERMINATION OF WHETHER TO REISSUE PERMIT

52. The MPCA finds there is jurisdiction for U. S Steel's NPDES/SDS permit reissuance in accordance with Minn. R. 7001.0100, subp. 1 which states:

> *Subpart 1. After a permit application is complete, the commissioner shall make a preliminary determination as to whether the permit should be issued or denied.*

53. The MPCA has followed the procedures for the reissuance of the NPDES/SDS Permit according to the provisions in Minn. R. ch. 7001.

54. The MPCA's decision to reissue the NPDES/SDS Permit is governed by its permit rule, Minn. R. 7001.0140, which in part, states:

> *Subpart 1. Except as provided in subpart 2, the agency shall issue, reissue, revoke and reissue, or modify a permit if the agency determines that the proposed permittee or permittees will, with respect to the facility or activity to be permitted, comply or will undertake a schedule of compliance to achieve compliance with all applicable state and federal pollution control statutes and rules administered by the agency, and conditions of the permit and that all applicable requirements of Minnesota Statutes, chapter 116D, and the rules adopted under Minnesota Statutes, chapter 116D, have been fulfilled. For solid waste facilities, the requirements of Minnesota Statutes, section 473.823, subdivisions 3 and 6, must also be fulfilled.*

CONCLUSIONS OF LAW

55. The MPCA is authorized and required to administer and enforce all laws relating to the pollution of the air and water of the state. Minn. Stat. chs. 115 and 116.

56. The MPCA has authority to reissuance this NPDES/SDS Permit. Minn. Stat. chs. 115 and 116 and Minn. R. chs. 7000, 7001, 7009, and 7020.

57. Under the federal Clean Water Act, the MPCA is delegated the authority from the EPA to issue NPDES permits. 33 U.S.C. §1342; Minn. Stat. § 115.03, subd. 5.

58. A draft permit for the facility was prepared and public noticed in accordance with the requirements of Minn. R. 7001.0100 and public comments on the draft permit were addressed in accordance with the MPCA rule requirements.

59. The requirements of Minn. R. ch. 7001, including Minn. R. 7001.0100 reissuance of a NPDES/SDS Permit, have been met including all applicable provisions of Minn. Stat. ch. 116D and Minn. R. ch. 4410. The MPCA determines that the Permittee will comply and will undertake the schedule of

compliance to achieve compliance with all applicable state and federal pollution control statutes and rules administered by the MPCA, and conditions of the reissued NPDES/SDS Permit.

60. The NPDES/SDS Permit contains effluent limitations and requirements that are protective of the environment and human health.

61. The findings of the MPCA justify reissuance of the NPDES/SDS Permit and do not support denial of the permit.

62. Areas where the potential for significant environmental effects may have existed have been identified and appropriate mitigation measures have been incorporated into the project design and permits. The project is expected to comply with all the MPCA standards.

63. Any findings that might properly be termed conclusions and any conclusions that might properly be termed findings are hereby adopted as such.

ORDER

The Minnesota Pollution Control Agency approves the reissuance of the National Pollutant Discharge Elimination System/State Disposal System Permit No. MN0031879 to U.S. Steel Corporation for the Minnesota Ore Operations Keetac - Mining Facility.

IT IS SO ORDERED

_____
Commissioner Paul W. Aasen
Chair, Citizens' Board
Minnesota Pollution Control Agency

_____
Date

STATE OF MINNESOTA
MINNESOTA POLLUTION CONTROL AGENCY

IN THE MATTER OF THE PROPOSAL TO
REISSUE THE NPDES/SDS
PERMIT NO. MN0055948
FOR UNITED STATES STEEL – MINNESOTA ORE OPERATIONS – KEETAC
TAILINGS BASIN
KEEWATIN, MINNESOTA

FINDINGS OF FACT
CONCLUSIONS OF LAW
AND ORDER

The above-entitled matter came before the Minnesota Pollution Control Agency (MPCA) Citizens' Board at a regular meeting held in St. Paul, Minnesota on October 25, 2011. Based on the MPCA staff review, comments and information received during the comment period, and other information in the record of the MPCA, the MPCA hereby makes the following Findings of Fact, Conclusions of Law, and Order:

FINDINGS OF FACT

This matter involves the application of United States Steel Corporation for reissuance of National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit No. MN0055948 for the Minnesota Ore Operations - Keetac Tailings Basin. For the purposes of these Findings, Conclusions of Law and Order, the United States Steel Corporation is referred to as U. S. Steel or the Permittee and the Minnesota Ore Operations - Keetac Tailings Basin Facility is referred to as Keetac. The permit reissuance includes: 1) a description of the proposed expansion of the taconite processing plant with which the permitted operations are associated; 2) a new outfall constructed to facilitate direct discharge of Sargent Pit dewatering, which is currently directed to other outfalls that are covered under NPDES/SDS Permit No. MN0031879; and 3) a compliance schedule to meet the sulfate effluent limits based on the 10 mg/L sulfate water quality standard for "waters used for the production of wild rice."

DESCRIPTION OF THE PROJECT

1. United States Steel Corporation ("U. S. Steel Corp.") owns and operates a taconite (iron ore) mine and processing plant in Keewatin, Minnesota. The facility, U. S. Steel Corporation, Minnesota Ore Operations - Keetac ("Keetac"), produces taconite pellets for use as a primary raw ingredient at iron and steel mills.

2. Iron ore mining and taconite pellet production have been on-going at the Keetac facility since 1967. The original Phase I taconite processing plant began operation in 1969. At that time, the Keetac facility included one operating taconite production line.

3. In 1977, the Phase II expansion added a second operating line. The Phase I line was idled in December 1980 under the ownership of National Steel Pellet Corporation. U. S. Steel Corp. purchased the National Steel Corporation in 2003, including the Keetac facility.

4. Currently, there is one operational pellet producing line (Phase II) with annual production of approximately 6.0 million tons of taconite pellets per year (MTPY). The facility has proposed an expansion to their mining and pellet production operations, which will increase production from 6.0 MTPY to 9.6 MTPY. A joint state and federal Environmental Impact Statement (EIS) was completed for the proposed expansion, and was determined to be adequate by the Minnesota Department of Natural Resources on December 30, 2010.

5. The current facility has two surface water discharge points. The proposed expansion does not change the operation of previously permitted disposal systems associated with the Keetac mine area and processing plant, or the discharge of wastewater associated with the previously permitted disposal systems as described below.

6. Reservoir 6 is a holding and treatment basin used for water storage, and contains water decanted from the tailings basin. Return water for the plant water supply is pumped from a station on Reservoir 6. This reservoir discharges through siphon outfall SD001, at a combined maximum rate of 9.4 million gallons per day (MGD), to Reservoir 2, which is a water of the state that flows to the O'Brien Diversion Channel.

7. Outfall SD005 was established to discharge water from the tailings basin to Reservoir 2 North and Welcome Creek, to Reservoir 2, at a maximum flow of approximately 23 MGD. The proposed expansion to the mining and pellet manufacturing process will result in a vertical expansion of the tailings basin, and changes to the volumes discharged to and from the tailings basin. Discharges to surface water from the tailings basin following the expansion will not exceed the pre-expansion volumes.

8. The reissuance of NPDES/SDS Permit No. MN0055948 (Permit) is requested to authorize continued operation of permitted disposal systems associated with the Keetac tailings basin and the discharge of wastewater associated with the permitted disposal systems.

9. In order to better meet the operational needs of the facility, the Permittee requested a new outfall for dewatering the Sargent Pit, which is an existing mine pit where the dewatering water is currently directed to outfall SD003 authorized under NPDES/SDS Permit No. MN0031879 (Keetac Mining).

10. While the dewatering activity is similar to other mine pit dewatering operations authorized in NPDES/SDS Permit MN0031879, due to the proposed discharge location, MPCA staff determined that the direct discharge of mine pit dewatering from the Sargent Pit to an unnamed ditch should be included in NPDES/SDS Permit No. MN0055948.

11. The immediate receiving waters affected by this permit reissuance include: Reservoir 2, Reservoir 2 North, Welcome Creek, and an unnamed ditch, which discharges to Welcome Creek.

APPLICABLE STANDARDS

Technology-based Treatment Standards

12. Minn. R. 7053.0225 subp. 1.A requires that all point source dischargers of industrial or other wastes shall comply with applicable federal standards, including those listed in 40 CFR pt. 401 through 469. The MPCA has determined that the specific industrial category and federal effluent limitation guidelines (Categorical Standards) applicable to this facility are those described in 40 CFR pt. 440 subp. A, for the iron ore mining and dressing point source category.

13. The facility constitutes an existing source, and is therefore not subject to the New Source Performance Standards for this industry. The Categorical Standards for Best Practicable Control Technology currently available (BPT) and Best Available Technology economically achievable (BAT) have been applied for the conditions in this permit.

14. The applicable BPT and BAT standards for mining area and tailings basin discharges are total Suspended Solids (TSS) and Total Iron, as limited in the currently effective Permit.

Water Quality Standards

15. All waters of the state of Minnesota must be classified based on considerations of best usage in the interest of the public and in conformance with the requirements of the applicable statutes, as described in Minn. R. 7050.0140. Based on these considerations, Welcome Creek is classified as Class 2C waters as listed in 7050.0470 subp. 4.A. item (236). According to Minn. R. 7050.0410, any listed water in part 7050.0470 is also classified as a Class 3C, 4A, 4B, 5, and 6 water. Reservoir 2, Reservoir 2 North, and the unnamed ditch leading to Welcome Creek are not listed waters in Minn. R. 7050.0470. As detailed in Minn. R. 7050.0430, all surface waters of the state that are not listed in part 7050.0470 and that are not wetlands as defined in part 7050.0186, subp. 1a, are classified as Class 2B, 3C, 4A, 4B, 5, and 6 waters.

16. Based on the applicable classifications, the receiving waters named above are designated for use in the forms of aquatic life and recreation, industrial consumption, agriculture and wildlife, aesthetic enjoyment and navigation, and other uses.

17. In addition, the MPCA staff has made the determination that discharges from the facility reaches downstream waters, which are “used for the production of wild rice” as stated in Minn. R. 7050.0224 subp. 2. The determination was made prior to the permit modification dated June 17, 2010, and no revisions to the determination were made during the permit reissuance process.

18. As resquired by 40 C.F.R. § 122.44(d)(1), MPCA evaluated the proposed discharge to determine whether the discharge has a reasonable potential to cause or contribute to a violation of applicable water quality standards.

19. Effluent limitations have been included in the draft Permit for total sulfate based on the results of the reasonable potential analysis.

20. In addition to the numeric water quality standards for applicable use classifications, Minn. R. 7050.0185 governs nondegradation for all waters. Nondegradation review is required by the MPCA for significant new and expanding discharges as defined in Minn. R. 7050.0185 to determine whether additional controls beyond compliance with water quality standards are warranted to prevent degradation of waters of the state. For this Permit, a significant new or expanded discharge would be defined as one in which the maximum design flow expands by more than 200,000 gallons per day above the existing baseline flow, or would increase the concentration of a toxic pollutant in the receiving water by greater than one percent. Nondegradation review has been completed for this Permit as detailed below.

21. Given that the new discharge location for Sargent Pit dewatering to the unnamed ditch represents an expansion of the facility's permitted discharge to this receiving water by more than 0.2 mgd, and an increased loading of one or more pollutants over the baseline quality in the receiving water, the discharge of dewatering effluent has been reviewed in accordance with Minn. R. 7050.0185. The review includes consideration of the quantity and quality of the proposed discharge and the potential for violating water quality standards in the receiving water. The statistical reasonable potential analysis shows that the proposed project will not impair the designated beneficial uses of the receiving waters. Sargent Pit dewatering effluent is currently directed to other pits, and discharged via outfalls permitted under NPDES/SDS Permit MN0031879, therefore the new outfall only constitutes a new or expanded discharge to the extent that it discharges to waters that do not currently receive Sargent Pit dewatering effluent. The O'Brien Diversion Channel was determined to be a water of the state that already receives the proposed discharge, therefore nondegradation review was limited to waters of the state upstream from that water body. The proposed discharge has been permitted to protect water quality standards in the water bodies upstream of the O'Brien Diversion Channel. The EIS for the proposed Keetac expansion project indicates that water chemistry in the discharge is not anticipated to change due to continuation of similar mining and dewatering activity following the expansion, therefore degradation of the O'Brien Diversion Channel and its downstream waters is not expected. Additional controls to prevent degradation in the immediate receiving waters upstream of the O'Brien Diversion Channel have not been determined to be warranted pursuant to Minn. R. 7050.0185.

22. No expansion of the maximum daily design flows above the currently permitted levels is authorized by the Permit for stations SD001 or SD005. Additionally, the water chemistry in these discharges is not anticipated to change because the Permittee has committed to install additional treatment technology on internal waste streams to maintain baseline quality as defined in Minn. R. 7050.0185. Therefore, discharges via SD001 and SD005 authorized by the Permit do not constitute significant new or expanded discharges, and nondegradation review is not required for these discharges for the proposed reissuance of the Permit.

PROTECTION OF WATERS USED FOR THE PRODUCTION OF WILD RICE

23. The reasonable potential analysis for sulfate in the mine area discharges resulted in the inclusion of an effluent limit based on the 10 mg/L stated applicable to "waters used for the production of wild rice." The sulfate effluent limits are 14 mg/L calendar month average and 24 mg/L daily maximum.

24. The effluent limitations for sulfate have been calculated utilizing statistical methods derived from the U.S. Environmental Protection Agency (EPA) Technical Support Document for Water Quality-Based Toxics Control. The limits are calculated assuming no dilution capacity in the receiving waters, maximum flow from the permitted discharges, and a waste load allocation of 10 mg/L sulfate based on the ambient water quality standard for waters used for the production of wild rice. Compliance with the calculated effluent limitations provides reasonable assurance that the Permittee's discharges are not causing or contributing to excursions above the water quality standard within the water bodies where the standard applies.

25. U. S. Steel is currently unable to comply with the sulfate effluent limits. Due to the complex nature of the wastewater disposal systems at the Keetac facility, a facility-wide compliance solution must be investigated that incorporates both water management and treatment solutions. The MPCA staff determined that inclusion of a compliance schedule in the Permit is appropriate. Therefore, the Permit reissuance includes by reference a schedule contained in NPDES/SDS Permit MN0031879 for attaining compliance with the final effluent limitations for total sulfate on a facility-wide basis.

26. The compliance schedule in the draft Permit requires the completion of a Water Management Study and a Sulfate Reduction Strategy Study, which are required to inform the development and implementation of a Sulfate Reduction Plan. The implementation of the Sulfate Reduction Plan is required to lead to compliance with the final effluent limitations for sulfate as soon as possible. The Sulfate Reduction Plan must provide justification for the proposed timeframe for attaining compliance.

27. The schedule requires attainment of compliance as soon as possible and in no case later than August 17, 2018. The maximum term of the compliance schedule is based on potential time required for completion of evaluations by the Permittee, as well as time for implementation of any final plans for attaining compliance, including time for obtaining various regulatory approvals. The schedule does not automatically grant the maximum timeframe, but requires MPCA approval at interim steps and requires that all interim steps proceed to compliance with final effluent limitations as soon as possible. The schedule requires the Permittee to make reductions in sulfate concentration to the extent practical prior to the end of the compliance schedule.

28. Interim requirements for the compliance schedule prior to the final attainment of compliance include completion of the Water Management Study and Sulfate Reduction Strategy Study currently underway, preparation and submittal of the Sulfate Reduction Plan, implementation of the Sulfate Reduction Plan following the MPCA approval of the plan, and progress reporting. The Permit specifies maximum timeframes for completion of interim requirements. Implementation of the actions contained in the Sulfate Reduction Plan following MPCA approval will also be enforceable actions due to implementation of the approved plan being an enforceable condition of the Permit.

29. Additional enforceable interim requirements are built into the schedule contingent upon the proposals in the Sulfate Reduction Plan. Distinct timeframes for the attainment of compliance following the MPCA approval of the plan are required, and are dependent on whether or not the the MPCA approves full-scale testing of treatment technology on representative outfalls prior to final implementation on all discharges. The Permit allows time for completion of such testing in

the event that such a proposal is approved by the MPCA, but specifies maximum timeframes for completion of the testing, and requires that interim effluent limitations for sulfate be met at the representative outfalls following treatment evaluations. If full-scale treatment evaluation is not approved by the MPCA, the Permit requires compliance to be attained in a shorter timeframe.

REVISIONS TO THE SULFATE COMPLIANCE SCHEDULE

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32. The MPCA staff modified draft NPDES/SDS Permit No. MN0055948 to include the compliance schedule contained in draft NPDES/SDS Permit No. MN0031879 by reference.

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completion of the testing phases specified in paragraphs 1.5, 1.6, and 1.7 of draft NPDES/SDS Permit No. MN0055948.

38. The MPCA staff modified the language to require compliance with an interim effluent limitation for total sulfate of 14 mg/L as a calendar quarter average. This effluent limitation will be applied on any outfalls for which full scale treatment evaluation is approved, following the completion of those evaluations, to ensure continued progress toward compliance with final effluent limitations.

39. The EPA requested the MPCA to correct the dates specified in the draft NPDES/SDS permits to reflect that the sulfate effluent limits shall be attained as soon as possible but no later than August 17, 2018, as opposed to the August 2019, date specified in the draft NPDES/SDS Permit No. MN0031879. Draft NPDES/SDS Permit No. MN0055948 also appears to specify the incorrect date. Please revise the dates specified in both draft permits to correct the discrepancy.

40. The MPCA staff corrected the final compliance dates to require compliance with final effluent limitations as soon as possible and in no case later than August 17, 2018, for non-tailings basin discharges, and August 17, 2019, for tailings basin discharges.

41. The revised compliance schedule language, based on EPA comments, is included in the permit documents found in Appendix XX. The compliance schedule has been developed in accordance with the requirements of Minn. R. 7001.0150, subp. 2 (A) and 40 CFR § 122.47. The Permit requires that compliance with final effluent limitations be attained as soon as possible, and that completion of interim steps result in continued progress toward compliance with final effluent limitations. Where the time between specific interim steps exceeds one year, the compliance schedule requires progress reports to be submitted to the MPCA at a minimum of every 6 months to provide details regarding the implementation of the requirements of the schedule and verify continued progress toward achieving compliance as soon as possible.

PROCEDURAL HISTORY

42. Pursuant to Minn. R. 7001.0100, a draft permit was prepared by the MPCA staff for the proposed permit reissuance.

43. The public comment period for the draft permit began on June 27, 2011, and ended on August 19,2011. The initial 30-day comment period ended on July 27, 2011. Due to circumstances with the state government shutdown, which ran from July 1, 2011 to July 21, 2011, the comment period was extended to August 12, 2011, and a second extension was granted until August 19, 2011.

44. During the comment period, the MPCA received 2 comment letters from government agencies and received 11 comment letters from citizens.

45. The MPCA reviewed each of the comments and prepared responses to all comments received during the public comment period. Comment letters received have been hereby incorporated by reference as Appendix A to these findings. The MPCA responses to comments received are hereby incorporated by reference as Appendix B to these findings.

46. The MPCA concurs with the reasoning of the MPCA staff in its Responses to Comments document (Attachment B) and adopts the reasoning by reference on these findings. The EPA comments and the MPCA responses to those comments are also included in the Appendix A and Appendix B, respectively.

SELECTED COMMENTS AND MPCA RESPONSES

47. During the public comment period for the Permit, the MPCA received 179 requests for extension of the public comments period, 177 were received in substantially identical e-mails.

48. In addition to the requests for extension of the public comment periods, the MPCA received 117 comment letters regarding the Permit, 106 of which were received in substantially identical e-mails.

49. Comments received on the draft Permit centered primarily on the relationship between the Permits and a proposed expansion on mining at the Keetac facility, water quality-based effluent limitations, and a compliance schedule in the draft Permits for the application of final effluent limitations for sulfate, which are based on an ambient water quality standard for wild rice production waters.

50. In response to comments received, the MPCA staff has modified the draft Permit to clarify and improve enforceability of compliance schedule requirements.

51. The comments received on this Permit and NPDES/SDS Permit MN0031879, as well as the MPCA responses to the comments, are detailed in Appendix B.

FINAL DETERMINATION OF WHETHER TO REISSUE PERMIT

52. The MPCA finds there is jurisdiction for U. S. Steel's NPDES/SDS permit reissuance in accordance with Minn. R. 7001.0100, subp. 1 which states:

> *Subpart 1. After a permit application is complete, the commissioner shall make a preliminary determination as to whether the permit should be issued or denied.*

53. The MPCA has followed the procedures for the reissuance of the NPDES/SDS Permit according to the provisions in Minn. R. ch. 7001.

54. The MPCA's decision to reissue the NPDES/SDS Permit is governed by its permit rule, Minn. R.7001.0140, which in part, states:

> *Subpart 1. Except as provided in subpart 2, the agency shall issue, reissue, revoke and reissue, or modify a permit if the agency determines that the proposed permittee or permittees will, with respect to the facility or activity to be permitted, comply or will undertake a schedule of compliance to achieve compliance with all applicable state and federal pollution control statutes and rules administered by the agency, and conditions of the permit and that all applicable requirements of Minnesota Statutes, chapter 116D,*

and the rules adopted under Minnesota Statutes, chapter 116D, have been fulfilled. For solid waste facilities, the requirements of Minnesota Statutes, section 473.823, subdivisions 3 and 6, must also be fulfilled.

CONCLUSIONS OF LAW

55. The MPCA is authorized and required to administer and enforce all laws relating to the pollution of the air and water of the state. Minn. Stat. chs. 115 and 116.

56. The MPCA has authority to reissuance this NPDES/SDS Permit. Minn. Stat. chs. 115 and 116 and Minn. R. chs. 7000, 7001, 7009, and 7020.

57. Under the federal Clean Water Act, the MPCA is delegated the authority from EPA to issue NPDES permits. 33 U.S.C. §1342; Minn. Stat. § 115.03, subd. 5.

58. A draft permit for the facility was prepared and public noticed in accordance with the requirements of Minn. R. 7001.0100 and public comments on the draft permit were addressed in accordance with MPCA rule requirements.

59. The requirements of Minn. R. ch. 7001, including Minn. R. 7001.0100 reissuance of a NPDES/SDS Permit, have been met including all applicable provisions of Minn. Stat. ch. 116D and Minn. R. ch. 4410. The MPCA determines that the Permittee will comply and will undertake the schedule of compliance to achieve compliance with all applicable state and federal pollution control statutes and rules administered by the MPCA, and conditions of the reissued NPDES/SDS Permit.

60. The NPDES/SDS Permit contains effluent limitations and requirements that are protective of the environment and human health.

61. The findings of the MPCA justify reissuance of the NPDES/SDS Permit and do not support denial of the permit.

62. Areas where the potential for significant environmental effects may have existed have been identified and appropriate mitigation measures have been incorporated into the project design and permits. The project is expected to comply with all MPCA standards.

63. Any findings that might properly be termed conclusions and any conclusions that might properly be termed findings are hereby adopted as such.

ORDER

The Minnesota Pollution Control Agency approves the reissuance of the National Pollutant Discharge Elimination System/State Disposal System Permit No. MN0055948 to U. S. Steel Corporation for the Minnesota Ore Operations – Keetac Tailings Basin.

IT IS SO ORDERED

_____

Commissioner Paul W. Aasen
Chair, Citizens' Board
Minnesota Pollution Control Agency

_____

Date

APPENDIX A

Minnesota Pollution Control Agency

United States Steel Corporation, Minnesota Ore Operations, Keetac
National Pollutant Discharge Elimination System/State Disposal System
Permits MN0031879 and MN0055948

LIST OF COMMENT LETTERS RECEIVED

1. Lenard Anderson, Cloquet Citizen. Letter received electronically August 12, 2011.
2. Larry Dolphin, Izaak Walton League of America. Letter received August 19, 2011.
3. Lotti Matkovits, Golden Valley Citizen, Letter received electronically August 11, 2011.
4. Kathryn Hoffman, Minnesota Center for Environmental Advocacy (MCEA), Letter received electronically August 19, 2011.
5. Kevin M. Pierard, U. S. EPA Region 5. Letter received September 2, 2011.
6. Paula Goodman Maccabee, Esq., Just Change Law Offices, WaterLegacy. Letter received electronically August 18, 2011.
7. Nick Axtell, 1854 Treaty Authority. Letter received electronically August 12, 2011.
8. Mason C and Gwen S Myers, Minnetonka Citizens, Letter received electronically August 19, 2011.
9. Susan Stewart, Mahtomedi Citizen, Letter received electronically August 18, 2011.
10. Christine Hoffman, Alexandria Citizen, Letter received electronically August 14, 2011.
11. Gale Havrilla, Silver Bay Citizen, Letter received electronically August 12, 2011.
12. Comments from Group of Concerned Citizens – Extension Request. Letters received electronically August 10, 2011, to August 20, 2011.
13. Comments from Group of Concerned Citizens. Letters received electronically August 15, 2011 to September 8, 2011.

Comments from Group of Concerned Citizens – Extension Request:

Greg Overlid, Tracy Napp, Jean Ross, Michele Nihipali, Mary Dosch, Harriet Mccleary, Stephen Rossitter, Elizabeth Mullen, William Herzberg, Mikanuk "Larry D. Adams," Kim Clymer Kelly, Diane Jankord, Rose Ramsey, Maxene Linehand, Cary Anderson, Beth Lewis, Ryan Anderson, Stephen Jay, Rebecca Lucking, Jacquelin Bartosh, Steven Koschak, Jane Koschak, Jamie Hoerter, Linville Doan, Steven Tracy, Amy Gardner, Lawrence Krantz, Melinda Sueflow, Stuart Knappmiller, Frank Moe, Kay Hempel, Ann Galbraith Miller, James Dushane, Pat Stevesand, Judith Rosenblatt, Paul Schollmeier, Carolyn Clements, Kay Labanca, Sue and Mike Prom, Guy Bateman, Elinor Ogden, Brian Major, Christine Hoffman, Christopher Boldt, Nathaniel Mordal, Paulette Anholm, Roger Michael, Jim Bambenek, Kay Koelkerwestby, Madelynn Frazier, Verba Weaver, Jamie Kaiser, Jan Scofield, Margaret Klette, Robert Robbings, Jayne Johnson, Judith Stoltzfus, William Dustin, Robert Davis, Frank Verderame, Colles Larkin, Terry Hokenson, Honor Schauland, Will Tajibnapis, Andy Pearson, Margie and David Back, Leslie Limberg, Lewsi Kuhlman, Amy Rus, Matt Johansen, Patricia Liquard, Sandra Keller, Anne Uehling, Gavin Sparby, Roger Muellner, Ann Marie, Mike Conrad, Betsey Porter, Mollie Schierman, David Howd, Susan Stewart, Jeanne Piehl, Karen Brugger, Kimberly Nieman, Martin Makinen, Kim Fishburn, Jim Carlen, Carol Mockovak, Dan Iverson, Kristi Kraling, Terry McCarthy, Sharon Meister, Jane Jasperson, John Paul Roy, Marie Digatono, James and Sara Conway, Alexander Heid, Jeffrey Kirst, Jim Scheidt, Mark Sulander, Dick Bently, Barbara Janssen, Alex Barbeau, John Schmitt, Jesse Lucking, Christopher Loch, Allan Hancock, Nan Corliss, Elizabeth Merz, Annie Gardner, Diadra Decker, Kurt Seaberg, Glady's Schmitz, SSND, Christopher Norbury, Seymour Gross, Kevin Koschak, John Viacrucis, Donald Janes, Ann Beane, Krissy Hughes, Chad Oness, Peter Veits, Mary Moriarty, Ordell Vee, David Higgins, Corinne Livesay, Rosemary Welch, Art Wilkinson, Susan Scherer, Michael Kinney, Tony Doom, Karen Matthew, Erin Strauss, Ann Mikkelsen, Mark Kassal, Sue Halligan, Elisabeth Johnson, Robert Bullis, Erik Roth, Candice Mohammad, Janice Hallman, Janice Greenfield, Gail Grabow, Alma Ronningen, Judy Nelson, Gary Rost, Mimi Gngold, Katherine Doerr, Brian Thornbjornsen, Barb Knoth, Robert Desjarlait, Sharon Fortunak, Walk Gordon, Andrea Heier, John Pegg, Kathleen Moraski, Brent Gurtek, Carol Schaaf, Loren Stoner, Karrie Vrabel, Marie Nickell, Kate Ford, Michael Rice, Rebecca Stoner, Jeffrey Masco, A Bonvouloir, Jon Damon, Catherine Chayka, Ann Herdna, Martha Krikava, Douglas Limon, Lynn Lang, Kathy Kormanik, Bryan Hansel, Sandy Dvorsky, Mark Jepson, Lotti Matkovits

Comments from Group of Concerned Citizens:

A. Bonvouloir, Allan Hancock, Analiese Miller, Ann Chemin, Ann Marie, Annie Gardner, Arnie Roos, Art Wilkinson, Barbara Janssen, Barbara Stamp, Betsey Porter, Bruce McKay, Carlos Zhingre, Carolyn Clemnts, Cheryl Dannenbring, Chris Burda, Christine Hoffman, Christopher Carlson, Corinne Livesay, David Higgins, Deborah Huskins, Diane Tuff, Dorie Reisenweber, Edjee Jonson, Edward Bouril, Erik Roth, Gail Grabow, Greg Klave, Gregory King, Guy Bateman, Harriet Mccleary, Herbert Davis, Honor Schauland, Ian Johnson, Jacqueline Bartosh, James Merkling, Jan Karon, Janice Greenfield, Jenna Conley, Jim Hart, Jim Hawkins, Jody Slocum, Joe Thorne, Johann Chemin, John Bussjaeger, John Schmitt, John Viacrucis, Karen Brugger, Karen Raccio, Kay Hempel, Kay Koelkerwestby, Krissy Hughes, Kristi Kraling, Kristin Olson, Lawrence Krantz, Lea Foushee, Lewis Kuhlman, Linda Morris, Lois Norrgard, Loren Stoner, Louis Asher, Lynn Lang, M. Richardson, Margie and David Back, Mark Kowaliw, Mark Salamon, Mary Lou Wilm, Mary Smith, Mary Suelflow, Mary Thompson, Mary Zink, Mikanuk "Larry D. Adams," Mike Ferguson, Mike Link, Mike Mjelde, Nan Corliss, Nancy Conger, Ordell Vee, Paul Thompson, Retha Dooley, Robert Davis, Roberta Avidor, Robin Poppe, Roger Muellner, Rosie Neher, Ryan Anderson, Sally Fineday, Sandra Keller, Saraphine Metis, Sharon Fortunak, Terry Hokenson, Terry Williams, Tony Doom, Tracy Napp, Tyler Henkels, Verba Weaver, Vikki Howard, Wanda Ballentine, Wendy Robertson, Will Tajibnapis, William Barton, William Dustin, William Herzberg

APPENDIX B

Minnesota Pollution Control Agency

United States Steel, Minnesota Ore Operations
Keetac – Tailings Basin NPDES/SDS Permit No. MN0055948
Keetac – Mining Operations NPDES/SDS Permit No. MN0031879

RESPONSES TO COMMENTS ON THE DRAFT PERMITS

1. Comments by Leonard Anderson, Cloquet Citizen. Letter received electronically August 12, 2011.

Comment 1-1: The sulfate limit allowed in this permit is in violation of the Minnesota standard for sulfate in wild rice.

Response: The comment indicates that the final effluent limitations contained in the draft permits are not consistent with the ambient water quality standard of 10 milligrams per liter (mg/L) sulfate for the protection of wild rice production waters, and that the maximum daily effluent limitation of 24 mg/L total sulfate is simply based on the highest observed value. The effluent limitations contained in the permit are based directly on the 10 mg/L total sulfate standard, and were calculated utilizing the same statistical procedures that are used to determine water quality-based effluent limitations (WQBEL) for National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) permits throughout Minnesota. The maximum measured value of 23.4 mg/L was not used in any way to determine the appropriate effluent limitations, but rather was used as a basis for comparison to determine whether or not the discharges authorized by the permits exhibited reasonable potential to cause or contribute to an excursion above the applicable water quality standard in the receiving water body. Based on the statistical analyses that were completed, the Minnesota Pollution Control Agency (MPCA) technical staff have determined that compliance with the effluent limitations contained in the draft permits will ensure that the permittee is not causing or contributing to excursions above 10 mg/L total sulfate in the receiving waters.

Comment 1-2: It is wrong to write an agreement between United States Steel Corporation (USS). and the State of Minnesota that allows them to violate the 10 mg/L standard until August 17, 2019.

Response: The MPCA disagrees with the characterization of the permits as agreements. The permits are regulatory instruments that require compliance with applicable environmental protection requirements. MPCA also disagrees with the assertion that the permits allow U.S. Steel Corporation to violate the 10 mg/L water quality standard until 2019. This statement is incorrect, as the permits are regulatory documents that contain a schedule of compliance that requires the Permittee to comply with the final effluent limitations for sulfate as soon as possible. The permits require progress toward compliance throughout the duration of the compliance schedule, and do not automatically grant the maximum amount of time allowed by the schedule, but instead require continual progress toward compliance, and require approval of proposed timeframes by the Minnesota Pollution Control Agency (MPCA).

Comment 1-3: Fish tissue mercury should also be considered. Increased sulfate discharges will in turn increase mercury methylation and therefore increase the fish tissue mercury.

Response: The permits do not authorize discharge of additional sulfate above the nondegradation baseline under the current permits for the referenced waters. The sulfate and mercury monitoring requirements in the permits during the interim period prior to the attainment of compliance with the final effluent limitations are consistent with the MPCA policy for addressing mercury impairments, including fish tissue impairments affected by mercury methylation. The effluent limitations of 14 mg/L as a calendar month average and 24 mg/L as a daily maximum represent decreases from the current discharge concentrations; therefore it is incorrect to state that they will result in any additional degradation beyond currently observed levels. Furthermore, the compliance schedules in the draft permits require the Permittee to take actions to reduce sulfate concentrations to the extent practical as soon as possible during the interim period.

Comment 1-4: The sulfate limit in the permit should be 10 mg/L.

Response: The final effluent limitations in the draft Permits have been calculated based on a waste load allocation of 10 mg/L total sulfate, and are applied to ensure that the Permittee's discharges do not cause or contribute to excursions above the applicable ambient water quality standard for sulfate, thereby ensuring that the Permits are protective of waters used for the production of wild rice. The limits are applied with a schedule of compliance in accordance with all state and federal regulations. Therefore, the Permits have not been modified as requested in your letter.

2. <u>Comments by Larry Dolphin, Izaak Walton League of America. Letter received August 19, 2011.</u>

Comment 2-1: The Minnesota Division Izaak Walton League of America opposes the issuance of a permit that allows a 10 mg/L sulfate standard until August 17, 2019 and supports the comments of member Len Anderson.

Response: See responses to comment 1-1 through 1-4.

3. <u>Comments by Lotti Matkovits, Golden Valley Citizen, Letter received electronically August 11, 2011.</u>

Comment 3-1: The commenter opposes the issuance of the permits without imposing limits on mercury and other toxic metals.

Response: The MPCA has reviewed site-specific data from the permit applications, including effluent data for mercury and metals, and determined that the discharges do not exhibit reasonable potential to cause or contribute to an excursion above the applicable water quality standards in the receiving water body for those pollutants. This reasonable potential evaluation was completed consistent with applicable state and federal requirements and is detailed in the statement of basis documents supporting the draft permits. Furthermore, the mercury monitoring requirements in the draft permits are consistent with MPCA policy for addressing mercury impairments in receiving and downstream waters.

Comment 3-2: The commenter also requests more time to comment on the permits.

Response: The MPCA extended the original public comment period for the permits, with the final comment period closing on August 19, 2011. The information related to the Keetac expansion has previously been available for public review during the public notice of intent to major modify

NPDES/SDS Permit MN0031879, which was open from May 14, 2010, to June 14, 2010; the public comment period for the Environmental Impact Statement (EIS) scoping process, which was open from September 8, 2008 to October 8, 2008; the public comment period for the draft EIS, which was open for 45 days, ending on January 26, 2010; the public comment period for the final EIS, which was open from November 12, 2010, to December 20, 2010; and public meetings regarding the EIS on October 1, 2008, and January 11, 2010. Additionally, the public will have the opportunity to present comments regarding the proposed reissuance of the permits at the MPCA Citizens Board meeting on October 25, 2011, where the permits will be presented for final determination on the reissuance. Additional information regarding the meeting can be found on the MPCA website, at the following address: http://www.pca.state.mn.us/index.php/about-mpca/mpca-overview/mpca-citizens-board/mpca-citizens-board.html

4. Comments by Kathryn Hoffman, Minnesota Center for Environmental Advocacy (MCEA), Letter received electronically August 19, 2011.

Comment 4-1: MCEA requests that the MPCA Citizens Board consider the issuance of the NPDES permits.

Response: The MPCA has agreed to present the permits to the Citizens Board for final determination on the proposed reissuances, pursuant to requests received during the public comment period.

Comment 4-2: MCEA requests that changes be made to Permit MN0055948 to clarify the location and limit derivation for SD008.

Response: Page 6 of the permit lists SD008 as the sum of the outfalls associated with SD001 and SD005. This is not an additional outfall, but simply a mathematical summation of the discharge flows associated with SD001 and SD005 to ensure that the total volume discharged from the tailings basin meets federal regulations. Given that the interim and final periods referenced in the permit are associated with effluent limitations for sulfate at individual outfalls, the permit has been corrected to reflect that the monitoring and reporting requirements for SD008 are applicable during both the interim and final periods.

Comment 4-3: The compliance schedule is contrary to Minnesota law. It exceeds the maximum time period for compliance, and does not meet the statutory or regulatory definitions of a compliance schedule.

Response: The comments indicate that the compliance schedules contained in the draft permits exceed the maximum timeframe of five years allowed under Minn. R. 7052.0260 subp. 3. Please note that Minn. R. ch. 7052 applies specifically to the Lake Superior Basin. Given that the compliance schedule in the permits regulates point source discharges to the Mississippi River basin, the rules regarding compliance schedules under Minn. R. 7052.0260 are not applicable in this case. The compliance schedule has been developed in accordance with the requirements of Minn. R. 7001.0150 subp. 2.A.

The comments additionally state that the compliance schedules contained in the permits do not meet the requirements for a compliance schedule by failing to lead to compliance with applicable Minnesota Rules. The comment also states that the compliance schedules do not lead to compliance, as the schedule does not specify the means by which the limitations must be met, or

require interim benchmarks other than further study. These statements are incorrect, as the requirements of the compliance schedules are explicitly written with the requirement to attain compliance with the final effluent limitations for total sulfate contained in the permits. The requirements to complete the Water Management Study and the Sulfate Reduction Strategy Study, both currently in progress pursuant to NPDES/SDS Permit MN0031879, have the express purpose of informing the development of a Sulfate Reduction Plan that the Permittee is required to implement following MPCA review and approval to attain compliance with the final effluent limitations contained in the permits. The permits have been modified to clarify how the actions required by the compliance schedules must lead to compliance with the final effluent limitations for total sulfate.

The comments indicate that the compliance schedules in the permits fail to require interim measures that lead to compliance with the final effluent limitations, specifically stating that the interim requirements do not lead to compliance within five years, that interim reductions in pollutant load or concentration must be made to achieve compliance with final effluent limitations as soon as possible, and that the interim requirements of the schedules fail to meet the intent of the federal regulations governing compliance schedules in NDPES permits. As previously discussed, the five year maximum timeframe referenced in your comments is not applicable to the compliance schedules contained in the permits, and the schedules meet the applicable requirements under Minn. R. 7001.0150. Please note that the compliance schedules require the Permittee to continue minimizing sulfate concentrations in the discharge to the extent possible prior to the compliance date, a requirement which will be informed by the completion of the required Water Management Study and Sulfate Reduction Strategy Study currently in progress. Additionally, in response to comments received following public notice of the intent to reissue the permits, the MPCA has added requirements to comply with interim effluent limitations following completion of any approved treatment evaluations to ensure that continued progress is made toward compliance with the final effluent limitations prior to the end of the compliance schedules. Following completion of the required Water Management Study and Sulfate Reduction Strategy Study, the permits require the Permittee to implement the actions contained in an approved Sulfate Reduction Plan, which is required by permit language to lead to compliance with final effluent limitations as soon as possible. The language in the permits has been modified to clarify how implementation of the Sulfate Reduction Plan will lead to compliance with final effluent limitations.

The comments raise concern that no progress has been made toward compliance with effluent limitations based on the ambient water quality standard for sulfate in wild rice production waters. It should be noted that, as stated in the permits, the Permittee submitted plans for the Water Management Study and the Sulfate Reduction Strategy Study following modification of NPDES/SDS Permit MN0031879 on June 17, 2010, and both plans were approved by the MPCA on October 6, 2010. Both of the studies are currently in progress, as indicated by the first progress report, which was submitted in accordance with the requirements of NPDES/SDS Permit MN0031879 on April 6, 2011.

Additionally the comments correctly note that 40 CFR 122.47(a)(1) requires that compliance schedules must be written to require compliance as soon as possible. It should also be noted that the permits have been drafted to explicitly require that “Compliance with the final effluent limitations shall be attained as soon as possible, and in no case shall compliance be attained later than August 17, 2018, for non-tailings basin discharges, and August 17, 2019, for tailings basin

discharges, unless the permit is modified pursuant to 40 CFR 122.62." Additionally, the permits do not automatically grant the maximum amount of time, but rather require approval by the MPCA of proposed timeframes for the attainment of compliance, and ongoing demonstration by the Permittee through progress reports on the implementation of the Sulfate Reduction Plan that compliance is being attained as soon as possible.

The comments further state that the schedules in the draft permits fail to lead to compliance with the applicable effluent limitations because the compliance schedules do not mandate specific solutions that must be evaluated and implemented to lead to compliance with final effluent limitations. Please note that this is the express purpose of the required Water Management Study and Sulfate Reduction Strategy, and the implementation of solutions that will result in compliance with final effluent limitations for sulfate as soon as possible is the express purpose of the required Sulfate Reduction Plan. The language in the permits has been modified to clarify the intent of these actions.

Comment 4-4: The compliance schedule is contrary to federal law.

Response: The comments indicate that MPCA has violated federal regulation by failing to enforce the ambient water quality standard for sulfate in wild rice production waters, and has exercised authority in violation of federal law by failing to require compliance as soon as possible. As previously discussed, the draft permits include schedules, which specifically require the reduction of sulfate concentrations in the permitted discharges to the extent practical prior to achieving compliance with the final effluent limitations, and require the Permittee to evaluate and implement facility-wide water management strategies and sulfate reduction options with the explicit requirement to comply with final effluent limitations based on the applicable water quality standard as soon as possible. The schedule of compliance contained in the Permits requires that compliance be attained in accordance with all federal regulations. Comments further suggest that the inclusion of language regarding collection of data and research implies that the Permittee may select this as an alternative to compliance with final effluent limitations as required by the permits. Language included in Chapter 1, Section 2 of NPDES/SDS Permit MN0031879 in no way allows the Permittee to select an alternative to compliance with the final effluent limitations in the permits unless the permits are modified in accordance with all state and federal regulations. The language has not been removed at this time.

Comment 4-5: The permits do not reflect the additional pollution burden of the proposed expansion of Keetac mining operations.

Response: The comment indicates that the permits do not require mitigation of impacts on wastewater discharges resulting from the proposed increase in mining and taconite processing activities at the Keetac facility. Please note that the draft Permits do not authorize discharge of sulfate above the nondegradation baseline established by the currently effective Permits, and the Permittee has proposed to implement the mitigation for pollutant increases indicated in the final EIS for the proposed Keetac expansion project in order to prevent the unmitigated impacts predicted by the EIS, as indicated in the applications for the permits. Although the draft permits do not require the Permittee to implement specific mitigation actions, the Permittee is required to implement actions as necessary to prevent degradation of downstream waters and comply with all rules governing nondegradation. The permits do not authorize expansion or change to the characteristics of wastewater discharges that conflict with the requirements of Minn. R.

7050.0180 and Minn. R. 7050.0185 regarding nondegradation for waters of the state, therefore the Permittee must implement mitigation to prevent degradation above currently permitted levels. Furthermore, the compliance schedules previously discussed require the Permittee to further reduce sulfate-related impacts from existing levels. Therefore the impacts on wastewater discharges from the Keetac facility as a result of the proposed mining expansion are not expected to increase from the currently permitted levels. The permits have not been changed to require additional mitigation.

Comment 4-6: The commenter states that "reasonable potential" and WQBEL calculations should be done for all receiving waters, not just immediate receiving waters.

Response: The comment states that the calculations used to determine whether or not the Keetac discharges exhibit reasonable potential to cause or contribute to an excursion above the water quality standards are incomplete, as they have not evaluated the potential to exceed water quality standards in the receiving waters downstream from those immediately receiving the discharge. This statement is incorrect, as the MPCA does evaluate the potential to exceed water quality standards in downstream water bodies. This review is the basis for inclusion of effluent limitations for total sulfate in the draft permits. The immediate receiving waters have not been determined to be waters used for the production of wild rice, however the reasonable potential to cause or contribute to excursions above the ambient water quality standard for the protection of wild rice has been evaluated specifically because of the fact that downstream receiving waters have been determined by the MPCA to be waters used for the production of wild rice. Additionally, the comments state that the reasonable potential calculations do not take into account the higher flows for the downstream receiving waters where the ambient water quality standard for the protection of wild rice would actually apply. The MPCA has taken a conservative approach by applying the effluent limitations as calculated for the immediate receiving water, as the critical low flow rate of zero in the receiving water requires the Permittee to meet the water quality standard without any allowance for dilution in the receiving water, as reflected by the waste load allocation of 10 mg/L used in the reasonable potential calculations for sulfate.

Comment 4-7: When calculating the sulfate effluent limits, MPCA should use the actual coefficient of variation (CV) from the Keetac facility, not a hypothetical CV of 0.6.

Response: The comment indicates that effluent limitations for total sulfate should be calculated utilizing a CV of 0.106 based on the current variability observed in discharges via SD005, instead of an assumed CV of 0.6, as it results in a lower effluent limitation, which MCEA believes to be more conservative. The CV is a statistical value, which describes the variability associated with treatment operations, and the default value of 0.6 taken from U.S. Environmental Protection Agency (EPA) guidance is based on typical variability of effluent concentrations when treatment processes are utilized prior to discharge. Given the likelihood that some form of treatment will be necessary in order to comply with the final effluent limitations for the outfalls currently authorized by the permits, the assumption that the variability of effluent concentrations will remain the same as observed under current operations, in which there is no treatment process in operation specifically for the reduction of sulfate, is not justified. Additionally, the assumption of higher effluent variability is a more conservative assumption, as this assumes that a lower long-term average effluent concentration must be targeted in order to ensure that the effluent waste load allocation of 10 mg/L is met. The effluent limitations for the draft permits have not been

recalculated.

Comment 4-8: Based on USS's history, MPCA should require USS to monitor its outfall effluent daily, rather than twice a month. This will result in more accurate testing and more stringent limits.

Response: The permits require that a minimum of two samples per month be collected to demonstrate compliance with sulfate limitations. This sampling frequency is consistent with the MPCA practice for water quality-based effluent limitations in NPDES/SDS permits throughout Minnesota. Although the use of a higher sampling frequency in the statistical reasonable potential calculations does result in lower effluent limitations, the lower effluent limitation does not correlate to a better environmental impact, as the waste load allocation for the discharge of pollutants and the long term average pollutant concentration following treatment do not change. Given that the additional sampling is not believed to be necessary to ensure compliance with environmental standards, the monitoring frequencies required by the draft permits have not been changed.

5. Comment by Kevin M. Pierard, U. S. EPA Region 5. Letter received September 2, 2011.

Comment 5-1: Please revise draft NPDES/SDS Permit MN0055948 either to incorporate by reference the schedule in draft NPDES/SDS Permit MN0031879, or provide the same level of detail as is included in draft Permit MN0031879.

Response: NPDES/SDS Permit MN0055948 has been modified to include the compliance schedule contained in NPDES/SDS Permit MN0031879 by reference.

Comment 5-2: Please revise the schedules so that the different compliance schedules following MPCA approval or disapproval of treatment technology pilot studies are independent, and contain distinct enforceable actions leading to compliance with the WQBEL for sulfate.

Response: The language in NPDES/SDS Permit MN0031879 has been modified to indicate two distinct schedules, with distinct requirements for attainment of compliance with final effluent limitations for each case regarding the MPCA approval or disapproval of a request for full-scale treatment evaluation on representative outfalls.

Comment 5-3: Please revise the schedules so that it is clear that the full scale treatment technology pilot studies are required for a representative outfall of each type of discharge, specifically tailings basin, dewatering pit, and Reservoir 5/sedimentation basins. Please specify that the representative dewatering pit outfall will be one included in draft NPDES/SDS Permit MN0031879 and therefore fall under that schedule.

Response: The compliance schedule has been modified in NPDES/SDS Permit MN0031879 to require evaluation of full-scale treatment evaluation for outfalls representative of wastewater type. The MPCA has not specified the three waste types contained in your comments, due to the possibility of these waste types changing due to operational modifications, dependent on the results of the Water Management Study that is currently in progress. As an equivalent measure, the MPCA is requiring the Permittee to base any request for testing on representative outfalls on consideration of physical condition of the wastewater, wastewater chemistry, and the size/frequency of the discharge within the Sulfate Reduction Plan. The permit language has also been modified to

specify compliance dates based on the type of wastewater discharged as requested.

Comment 5-4: The schedules of compliance require successful full-scale pilot treatment of outfalls representing the various types of discharges at the facility. The schedules should require interim limits for sulfate at each outfall selected for the full-scale pilot studies, effective upon completion of the testing phases specified in paragraphs 1.11, 1.12, and 1.13 of draft NPDES/SDS Permit MN0031879 and paragraphs 1.5, 1.6, and 1.7 of draft NPDES/SDS Permit MN0055948.

Response: The language has been modified to require compliance with an interim effluent limitation for total sulfate of 14 mg/L as a calendar quarter average. This effluent limitation will be applied on any outfalls for which full scale treatment evaluation is approved, following the completion of those evaluations, to ensure continued progress toward compliance with final effluent limitations.

Comment 5-5: Please correct the dates specified in the draft permits to reflect that the sulfate WQBELs shall be attained as soon as possible but no later than August 17, 2018, as opposed to the August 2019 date specified in draft NPDES/SDS Permit MN0031879 permit. Draft NPDES/SDS Permit MN0055948 also appears to specify the incorrect date. Please revise the dates specified in both draft permits to correct the discrepancy.

Response: The final compliance dates have been corrected to require compliance with final effluent limitations as soon as possible and in no case later than August 17, 2018, for non-tailings basin discharges, and August 17, 2019, for tailings basin discharges.

Comment 5-6: There is significant public interest in this facility and both of these permits. MPCA should upload the facility discharge monitoring reports (DMRs) and permit compliance status and history for both permits to EPA's Integrated Compliance Information System (ICIS) database.

Response: At this time, the MPCA is not uploading the Permittee's DMRs and compliance status to the ICIS database. The MPCA recognizes the public interest in this facility, and the associated NPDES/SDS permits, and has noted EPA's comments regarding this issue. Please note that all public information regarding NPDES/SDS Permits MN0031879 and MN0055948, as well as the Permittee's compliance with these permits, is available for inspection and copying by any person pursuant to Minn. R. 7000.1200.

Comment 5-7: The data provided with the applications indicate that selenium has been detected at several outfalls. Selenium monitoring requirements are included in the draft permits for SD009 only. At a minimum, please add a monitoring requirement for selenium at SD005 in accordance with 40 CFR §§ 122.44 and 122.48.

Response: The MPCA has added a monitoring requirement for selenium at SD005 as requested.

6. <u>Comment by Paula Goodman Maccabee, Esq., Just Change Law Offices, WaterLegacy. Letter received electronically August 18, 2011.</u>

Comment 6-1: The draft permits for the Keetac Mine Area and Keetac Tailings Basin result from a major expansion of mining activity requiring a comprehensive nondegradation analysis.

Response: As a point of clarification, note that expansion of industrial activity does not trigger a requirement for a nondegradation analysis. The requirement to complete a nondegradation analysis is based on an increase in permitted discharge flow. Although the Permittee has proposed an expansion to the industrial activity conducted at the Keetac facility, the MPCA has determined that a nondegradation analysis is not required for most of the changes to the operation of the permitted disposal systems and the wastewater discharges associated with those systems as a result of the proposed expansion.

The comments correctly note that the applications, which were used for the reissuance of the permits, were originally submitted with the intent to address changes to the permitted operations at the Keetac facility as a result of the proposed mining expansion. It is also correct to state that there will be an increase in the area used for stockpiling, the volume of tailings and associated process wastewater sent from the processing facility to the tailings basin, wastewater discharges from the tailings basin system and dewatering waste streams, and chemical usage associated with taconite processing. However, the proposed changes to operations regulated by permits are primarily within the range currently allowed by the permits, and therefore would not require nondegradation review. In accordance with Minnesota Rules, nondegradation review was completed to the extent that the discharges authorized by the draft Permits constitute significant new or expanded discharges, as discussed in greater detail below.

As indicated in the comments, Minn. R. 7050.0185 subp. 4 require a nondegradation analysis for any new or expanded discharge that is a significant discharge as defined in Minn. R. 7050.0185 subp. 2.G. in order for the MPCA to determine whether additional control measures can reasonably be taken to minimize the impact of the discharge on the receiving water. As detailed in Minn. R. 7050.0185 subp. 5, for discharges of industrial and other wastes, the flow rate to be used to determine whether the discharge is significant is the design maximum daily flow rate. With the exception of the Permittee's proposal to discharge dewatering effluent from the Sargent Pit directly to an unnamed ditch flowing to Reservoir 2, the maximum design discharge flow rates anticipated for this permitting action are equivalent to or lower than the currently permitted flow rates, as indicated in the applications for the permits. For that reason, nondegradation analysis was not completed for the permitted wastewater outfalls that do not meet the definition of significant new or expanded discharges. Pursuant to Minn. R. 7050.0185, a nondegradation analysis was completed for the new discharge of Sargent Pit dewatering effluent to the unnamed ditch to the extent that the new discharge will impact the receiving water bodies, as indicated in the Statement of Basis for NPDES/SDS Permit MN0055948.

The comments further indicate that WaterLegacy believes that the draft Permits will result in degradation of downstream receiving waters, including ORVWs. As discussed in greater detail in the response to Comments 6-2 and 6-3, the MPCA has verified that the draft Permits prevent degradation of downstream receiving waters as required by the provisions of Minn. R. 7050.0180-7050.0185.

Comment 6-2: The Keetac mine expansion nondegradation review should analyze potential impacts to downstream waters of outstanding resource value and Lake Superior Basin waters.

Response: As previously discussed, a nondegradation review was completed for the new discharge of Sargent Pit dewatering effluent to an unnamed ditch leading to Reservoir 2, in accordance with Minn. R. 7050.0185, and that nondegradation review for the other permitted discharges was

determined by the MPCA not to be necessary as they do not meet the definition of a significant discharge. The comment indicates that additional nondegradation review is required to address impacts to water bodies downstream of the immediate water body that are Outstanding Resource Value Waters (ORVWs) as defined in Minn. R. 7050.0180.

The comments correctly state that the MPCA is required to control new and expanded discharges upstream of an ORVW to assure no deterioration in the quality of the downstream ORVW, pursuant to Minn. R. 7050.0180 subp. 9. The comments indicate that the MPCA has failed to apply this requirement based on a discretionary decision for the permits, citing a statement from the application for NPDES/SDS Permit MN0055948 reading "MPCA personnel indicated that for the purposes of this application, the MPCA would not apply ORVW nondegradation review, but would rely on the "all waters" classification of the water bodies discharged into and nearby downstream points." This statement should not be interpreted to mean that the MPCA has elected to selectively apply only Minn. R. 7050.0185 for nondegradation requirements applying to all waters, but rather that the MPCA has determined that the water bodies to which the nondegradation review must apply are limited to non-ORVW water bodies, specifically those between the immediate discharge and the O'Brien Diversion Channel, as discussed below.

As documented in the final EIS for the proposed Keetac mining expansion, and as indicated by the wastewater flow diagram in Appendix A, Figure 2 of the permit application for NPDES/SDS Permit MN0055948 illustrating current conditions, dewatering effluent from the Sargent Pit is currently discharged to O'Brien Creek via the Mesabi Chief Pit, as authorized by NPDES/SDS Permit MN0031879. Wastewater discharged via this outfall flows through the O'Brien Reservoir to the O'Brien Diversion Channel. The proposed direct discharge of Sargent Pit dewatering under NPDES/SDS Permit MN0055948 will also eventually discharge to the O'Brien Diversion Channel after flowing through Reservoir 2. Therefore, given that the effluent from this dewatering operation already reaches the proposed receiving waters downstream of Reservoir 2, the discharge does not constitute a new or expanded discharge to the O'Brien Diversion Channel, or any of the receiving waters downstream from that point, including the downstream ORVW water bodies. Therefore, the nondegradation analysis has been completed for the unnamed ditch to which Sargent Pit dewatering effluent will be discharged, as well as Reservoir 2, as they are the only water bodies that will be receiving a new or expanded discharge. Minn. R. 7050.0185 for Nondegradation for All Waters is the applicable rule governing nondegradation for these water bodies. Given that the proposed discharge is not a new or expanded discharge to water bodies downstream of the O'Brien Diversion Channel, the discharge is not expected to affect the water quality of downstream ORVWs, therefore additional controls to prevent degradation of downstream ORVWs pursuant to Minn. R. 7050.0180 subp. 9 are not warranted.

The comments further indicate that nondegradation analysis should be completed to determine impacts resulting from the expansion on Outstanding International Resource Waters (OIRWs) in the Lake Superior Basin due to some portions of the Keetac facility's operations being located within the Lake Superior watershed. As discussed in the EIS for the Keetac expansion, water transfers between basins and rerouting of surface runoff as a result of mining activity are regulated by the Department of Natural Resources, and are outside the scope of the permits. Furthermore, the additional runoff to the Lake Superior Basin resulting from the additional stockpiling activities meets the definition of an expanded discharge of industrial stormwater as described in Minn. R. 7052.0310. Therefore, the MPCA has determined that the requirements to maintain best management practices for the control of industrial stormwater as detailed in the

permits are adequate to protect the water quality of the Lake Superior Basin, and further analysis beyond the potential impacts evaluated in the EIS for the proposed Keetac expansion is not required.

Comment 6-3: The Keetac Mine and Tailings Basin permits should set maximum discharge loading limits and require conditions for treatment efficacy needed to prevent degradation of Minnesota Waters.

Response: The comments indicate that the permits should require mass loading limits and internal treatment improvements in order to ensure compliance with nondegradation requirements for hardness and sulfate. The baseline flows and associated pollutant loadings described in Minn. R. 7050.0185 are not intended to be effluent limitations, but instead are triggers for the evaluation of the need for additional requirements in the event that the Permittee proposes to expand their permitted discharge in such a way that it becomes a significant discharge as defined in the rule. The draft Permits do not authorize increased pollutant loading in the permitted discharges in such a way that the permitted discharge flows and baseline effluent quality as defined under Minn. R. 7050.0185 subp. 2.C. would be exceeded, and failure to maintain discharge loading below these values is a violation of the Permits due to incorporation of nondegradation rules by reference. The Permittee has proposed installation of treatment technology to ensure compliance with nondegradation rules, and the MPCA believes that the monitoring requirements for sulfate and hardness related parameters in the draft Permits are sufficient to verify that nondegradation rules are not violated following the operational changes associated with the proposed expansion of mining activity, therefore additional limitations and monitoring requirements have not been added.

Additionally, the comments identify the requirement to comply with final effluent limitations as an outcome following additional sulfate loading. As a point of clarification, the schedules for compliance with final effluent limitations for sulfate are not related to the Permittee's proposal to install additional treatment equipment to reduce sulfate loading to the tailings basin. The Permittee will be required to maintain sulfate loading in the tailings basin discharge below the baseline quality established by Minn. R. 7050.0185 immediately, and must manage water quality in the discharge as necessary to ensure compliance with the nondegradation requirements that are incorporated by reference in the permits. The schedules of compliance included in the permits are for additional reductions that the Permittee is required to make in order to comply with final effluent limitations for sulfate that are based on ambient water quality standards for the protection of wild rice.

The comments also request evaluation of the potential for iron and mercury to degrade water quality, and indicate a request for the inclusion of effluent limitations to restrict mass loading for these parameters to ensure compliance with nondegradation rules. As previously discussed, a nondegradation review was completed in accordance with Minn. R. 7050.0185 for the proposed new direct discharge of Sargent Pit dewatering effluent, in which the MPCA determined that the monitoring requirements for mercury, and the effluent limitations and related monitoring requirements for iron, are adequate to ensure that the water quality standards for the receiving waters will be met in accordance with Minn. R. 7050.0185 subp. 3, and that additional controls to prevent degradation of the receiving waters pursuant to Minn. R. 7050.0185 subp. 4 are not warranted. For the remaining Keetac discharges, as discussed on page 4-52 of the EIS for the proposed mining expansion, water quality associated with wastewater discharges is not anticipated to change for typical parameters of concern with the exception of the impacts associated with the scrubber blowdown waste stream and the treatment of that waste stream. Given that the pollutant

concentrations for iron and mercury are expected to remain within the ranges currently observed under the Keetac facility's existing operations, and, as previously discussed, the proposed changes to wastewater flows do not trigger nondegradation review for any discharges other than the Sargent Pit dewatering outfall, the MPCA has determined that the effluent limitations for iron and the monitoring requirements for mercury are sufficient to ensure compliance with the nondegradation requirements that are incorporated by reference in the permits.

Comment 6-4: The Keetac Mine and Tailings Basin permits should impose current effluent limits for sulfate. The schedules of compliance in the draft permits are inconsistent with applicable law.

Response: The comments correctly note the rule citations describing the requirements for schedules of compliance contained in NPDES/SDS permits. The MPCA has applied the state rules and federal regulations that are detailed in the comments in the permits.

The comments indicate that there is not necessarily a connection between the Water Management Study and the Sulfate Reduction Strategy Study (Studies) that are currently in progress pursuant to the requirements of the current NPDES/SDS Permit MN0031879 and a change in sulfate effluent. This is incorrect, as the express purpose of the Studies is to inform the required development of a Sulfate Reduction Plan, which the Permittee is required to implement following MPCA review and approval. The Sulfate Reduction Plan must identify the actions that will be taken by the Permittee with the specific purpose of complying with the final effluent limitations for sulfate. The comments further indicate that the permits do not meet the requirements of state and federal law by failing to require compliance as soon as possible. Please note that the language in the permits explicitly states that "compliance with final effluent limitations shall be attained as soon as possible…" The Permits are structured to require compliance based on a series of actions that could potentially last through August of 2018 for non-tailings basin discharges, and 2019 for tailings basin discharges; however the Permittee is required to comply with the final limitations more expeditiously if possible.

The comments indicate that the MPCA must require immediate compliance with effluent limitations that are based on water quality standards adopted before July 1, 1977. However, EPA precedent indicates that compliance schedules may be allowed for discharges subject to water quality-based effluent limitations derived from standards that are new, revised, or reinterpreted after July 1, 1977. The waters downstream from the Keetac facility's discharges are not specifically named in Minnesota Rules as waters used for the production of wild rice. Based on case-specific review of the information currently available, the MPCA newly interpreted the 10 mg/L sulfate standard in Minn. R. 7050.0224 subp. 2 to be applicable to water bodies downstream from the Keetac discharges in 2010. Therefore, compliance schedules have been determined to be allowed pursuant to Minn. R. 7001.0150.

Comment 6-5: Permits for the Keetac Mine and Tailings Basin should contain WQBELs for selenium, specific conductance, hardness and mercury.

Response: The comment correctly notes that the statement of basis for NPDES/SDS Permit MN0055948 indicates that limits are included in the draft permit for selenium and specific conductance. This statement was included in error, as the MPCA policy is not to include effluent limitations based on limited data. The MPCA has reviewed the data from the permit application for NPDES/SDS Permit MN0055948, and determined that additional monitoring is warranted for selenium and specific conductance at outfall SD009, however there is not sufficient data to determine whether or not reasonable potential exists to exceed water quality standards to warrant an effluent limitation for

either of these parameters.

The comments indicate that the MPCA has maximized the potential for dilution in evaluating the reasonable potential to exceed water quality standards by applying maximum design flow in the analysis. In fact, by applying the maximum design flow for the facility's discharge, and the 7Q10 low flow condition for the receiving stream, the MPCA has maximized the potential impact of the discharge on the receiving water concentration as required for these analyses. The critical conditions utilized in these analyses effectively model the reasonable potential to exceed water quality standards in the receiving stream assuming the highest predicted pollutant concentration in the effluent, the highest flow of effluent from the outfall, and the lowest dilution potential in the receiving stream.

The comments regarding hardness indicate that the reasonable potential analysis for this parameter is inadequate due to use of maximum dilution and an incorrect water quality standard. Please note that the water quality standard of 250 mg/L for hardness referenced in the comments is not a Class 2B water quality standard, but is a Class 3B water quality standard as detailed in Minn. R. 7050.0223 subp. 3, and is one of three standards referenced in Minn. R. 7050.0220 subp. 5a.A.(8). This standard is not applicable to the receiving waters for the Keetac discharges, as all of the applicable receiving waters have a Class 3C designation, for which the applicable ambient water quality standard for hardness is 500 mg/L, as utilized in the reasonable potential calculations. As previously discussed, the reasonable potential calculations assume critical conditions that model the minimum dilution; therefore the proper conditions have been evaluated.

The comments regarding mercury suggest that effluent limitations for mercury must be included in the Permits, and recommend an effluent limitation of 6.9 ng/L for the permitted discharges, and 1.3 ng/L for any discharges to the Lake Superior Basin. Please note that reasonable potential analyses have been completed for total mercury at all outfalls authorized by the Permits utilizing a waste load allocation of 6.9 ng/L based on the applicable water quality standards for the water bodies receiving the permitted discharges. None of the permitted discharges are to the Lake Superior Basin, therefore the 1.3 ng/L standard is not applicable. As previously discussed, the critical flow conditions used in the reasonable potential analyses do not maximize dilution potential, but rather account for minimal receiving water dilution. Given that the procedures used to account for mercury water quality standards in the Permits, as described in the final EIS, have not shown reasonable potential, effluent limitations have not been included in the draft Permits. Effluent monitoring requirements have been applied in the Permits, consistent with MPCA policy and the implementation plan for the state-wide mercury Total Maximum Daily Loads.

Comment 6-6: Permits for the Keetac Mine and Tailings Basin should require additional monitoring for hardness (calcium and magnesium), aluminum and manganese and multiple monitoring sites should be required to identify impacts of mine expansion.

Response: The comments indicate that monitoring requirements should be required for calcium in the tailings basin based on nondegradation concerns as previously discussed. As previously noted, the MPCA has included monitoring requirements on the influent waste stream to the tailings basin that is anticipated to contribute to additional hardness, which is believed to be adequate to ensure that nondegradation requirements are met for discharges from the tailings basin. Therefore, additional monitoring requirements have not been included.

The comments further indicate that hardness monitoring should be required on discharges from the Keetac mining area due to anticipated increased use of magnesium chloride as a dust suppressant as a result of the increased footprint of the mine following the proposed expansion. Please note that the mechanism by which this additive contributes to hardness is from precipitation runoff. The increase in the amount of the dust suppressant applied based is anticipated to be accompanied by an equivalent increase in runoff volume, therefore the hardness concentrations observed in the currently discharges are not anticipated to be affected by the proposed expansion, therefore additional monitoring requirements have not been included in the draft Permits.

The comments indicate that aluminum monitoring must be required due to the use of aluminum chlorhydrate in the turbidity treatment system that is used for discharges via SD002. Due to the use of this additive as a flocculent, the aluminum associated with the product becomes bound to the suspended solids from the wastewater. Due to the high removal of solids associated with the turbidity treatment system, aluminum concentrations are not anticipated to increase appreciably, therefore additional monitoring has not been required.

The comments request ongoing monitoring for manganese due to measured concentrations for that parameter in the Keetac tailings basin in excess of the Minnesota Health Risk Limit (HRL), and monitoring data from other mine facilities. Please note that the HRL referenced in the comments is not a water quality standard applicable to the discharges authorized by the Permits, therefore monitoring requirements have not been included in the draft Permits based on this comparison.

The comments express concerns regarding the monitoring frequency required for the permitted discharges. Monitoring requirements have been assigned consistent with MPCA practices for NPDES/SDS permits throughout Minnesota based on consideration of the detention times for the wastewater discharges authorized by the Permits, and the variability in concentrations associated with the industrial activities at the Keetac facility. Additionally, with regard to the comments on the sampling frequency required for mercury, the quarterly sampling requirement is included based on MPCA policy for mercury monitoring for industrial discharges.

Based on review of site-specific information from the Keetac expansion EIS and the data received to support the permit reissuance process, the MPCA has determined that the monitoring requirements are sufficient to characterize the permitted disposal systems and the associated discharges.

Comment 6-7: The permit review process should address additional concerns: mercury methylation, rating of mine expansion permits as "minor," and accessibility of public information.

Response: Your comments indicate concern that sulfate discharges from the Keetac facility will result in additional mercury methylation in receiving waters. Please note that, as previously discussed, the levels of sulfate in the permitted discharges are not authorized to exceed the currently permitted levels due to rules governing nondegradation. Futhermore, the compliance schedule for sulfate in the draft Permits requires that the Permittee further reduce sulfate loading to receiving waters, thereby further reducing the impact of sulfate on mercury methylation over the long-term. The ongoing monitoring requirements for both mercury and sulfate are consistent with MPCA policies for reducing mercury impacts in waters of the state.

Your comments regarding the process for rating NPDES permits as "major" or "minor" have been noted. Please note that the rating worksheet used by the MPCA is the same used for NPDES permits

issued by the U.S. Environmental Protection Agency (EPA), and that the EPA's ability to review NPDES/SDS permits issued by the MPCA is not affected by the permit rating.

Your comments regarding public process have been noted. Please note that all public information regarding NPDES/SDS Permits MN0031879 and MN0055948, as well as the Permittee's compliance with these permits, is available for inspection and copying by any person pursuant Minn. R. 7000.1200. Information regarding the presentation of the draft permits for final determination by the MPCA Citizens Board will be made available online at the following address: http://www.pca.state.mn.us/index.php/about-mpca/mpca-overview/mpca-citizens-board/mpca-citizens-board.html.

7. Comment by Nick Axtell, 1854 Treaty Authority. Letter received electronically August 12, 2011.

Comment 7-1: The 1854 Treaty Authority would like to see the reasonable potential analysis that was used to determine this average concentration level rather than the standard of 10 mg/L sulfate.

Response: Refer to the response to comment 1-1. In addition, the statement of basis supporting documents for each permit presents information on the reasonable potential analyses for sulfate.

Comment 7-2: The 1854 Treaty Authority is concerned with the length of time the compliance schedules will take and would like to see limitations on sulfate levels prior to the final effluent limits in 2019.

Response: Please refer to the response to comment 5-4.

8. Comment by Mason C and Gwen S Myers, Minnetonka Citizens, Letter received electronically August 19, 2011.

Comment 8-1: The permit will exceed air quality standards without treating wastewater.

Response: Comments have been noted by the MPCA, however, please note that air related comments do not pertain to the Keetac Mine and Keetac Tailings Basin permits identified in your e-mail, and the comments were received following completion of the public comment period for the air emissions permit.

Comment 8-2: The proposed permits are discouraging, given the mercury-related fish consumption restrictions on Minnesota lakes and rivers.

Response: Please refer to the responses to comments 1-3 and 3-1.

9. Comment by Susan Stewart, Mahtomedi Citizen, Letter received electronically August 18, 2011.

Comment 9-1: The commenter voices concern regarding water quality and the fragile nature of wild rice and the impact that mining operations have on these resources.

Response: Comment noted.

10. Comment by Christine Hoffman, Alexandria Citizen, Letter received electronically August 14, 2011.

Comment 10-1: The commenter voiced concerns regarding the natural resources of the area and the impact that mining activities have on the area.

Response: Comment noted.

11. Comment by Gale Havrilla, Silver Bay Citizen, Letter received electronically August 12, 2011.

Comment 11-1: Limits on mercury and other toxic metals should be set in accordance with existing regulations.

Response: Please refer to the response to comment 3-1.

Comment 11-2: The commenter is concerned about the levels of pollution in fish and wild rice in the area.

Response: Please refer to the response to comment 1-3.

12. Comments from Group of Concerned Citizens – Extension Request, Letters received electronically August 10, 2011, to August 20, 2011.

Comment 12-1: The public notices do not explain the proposed mining expansion at the Keetac facility.

Response: The Public Notice of Intent documents for each of the Permits that were distributed in accordance with Minnesota Rules on June 27, 2011, and again on July 27, 2011, when the public comment period was extended to August 12, 2011, to account for business days lost due to the Minnesota government shutdown, explicitly state "The facility has proposed an expansion to their mining and pellet production operations, which will increase production from 6.0 million short tons of pellets per year to 9.6 million short tons per year. The conditions of this permit reflect the changes associated with that expansion." Further, the permits and the statements of basis identify the changes in permitted activities that are anticipated for each of the permits as a result of the proposed mining expansion. As a point of clarification, it should be noted that the permits do not authorize an expansion of mining, but rather authorize the operation of disposal systems and the wastewater discharges associated with those systems. The expected changes associated with the permitted wastewater operations at the Keetac facility following the mining expansion have been well documented in the EIS for the Keetac expansion project, and the conditions in the draft permits are reflective of those changes, as detailed the statements of basis.

Comment 12-2: The draft permits do not explain how the effluent limitations that have been set will be protective of water quality following the proposed mining expansion.

Response: It is not common practice to include the specific details for setting effluent limitations within the text of NPDES/SDS permits, but rather to document this information in the associated statement of basis documents. The effluent limitations that have been included in the draft permits have been calculated in consideration of water quality impacts, consistent with state and federal requirements, as well as MPCA policy for all point source discharge permits in Minnesota.

The effluent limitations have been calculated using the methodology developed from the EPA "Technical Support Document for Water Quality-based Toxics Control," based on consideration of effluent data from the Keetac facility, the applicable ambient water quality standards for the water bodies receiving the Keetac discharges, and expected changes resulting from the Keetac expansion. The water quality considerations documented in the EIS and the statements of basis illustrate how the permits will be protective of water quality. Additionally, these documents address the basis for not including effluent limitations and monitoring requirements for the mining-related pollutants listed in your comments, based on site-specific data for the Keetac facility.

Comment 12-3: Comments were made relating to legislative action associated with the ambient water quality standard for total sulfate applicable to waters used for the production of wild rice.

Response: The MPCA wishes to clarify that the bill referenced in your comments did not result in any changes to the applicability of the current ambient water quality standards. Therefore, the draft permits do include the appropriate final effluent limitations for total sulfate based on all current state and federal regulations, and do require the Permittee to comply with the final effluent limitations based on the existing standard as soon as possible in accordance with the regulations governing compliance schedules in NPDES/SDS permits.

Comment 12-4: The commenter requested additional time to comment on the draft permits.

Response: The MPCA extended the public comment period to end on August 19, 2011, in order to allow for review of the information contained in this response. Please note that much of the information related to your comments has previously been available for public review during the public notice of intent to major modify NPDES/SDS Permit MN0031879, which was open from May 14, 2010, to June 14, 2010; the public comment period for the EIS scoping process, which was open from September 8, 2008, to October 8, 2008; the public comment period for the draft EIS, which was open for 45 days, ending on January 26, 2010; the public comment period for the final EIS, which was open from November 12, 2010, to December 20, 2010; and public meetings regarding the EIS on October 1, 2008, and January 11, 2010.

13. Comments from Group of Concerned Citizens. Letters received electronically August 15, 2011 to September 8, 2011.

Comment 13-1: The comments indicate that the draft permits does not explain how the effluent limitations that have been set will be protective of water quality following the proposed mining expansion.

Response: It is not common practice to include the specific details for setting effluent limitations within the text of NPDES/SDS permits, but rather to document this information in the associated statement of basis documents. As detailed in the statement of basis documents, the effluent limitations that have been included in the draft permits have been calculated in consideration of water quality impacts, consistent with state and federal requirements, as well as the MPCA policy for all point source discharge permits in Minnesota. The effluent limitations have been calculated using the methodology developed from the EPA "Technical Support Document for Water Quality-based Toxics Control," based on consideration of effluent data from the Keetac facility, the applicable ambient water quality standards for the water bodies receiving the Keetac discharges, and expected changes resulting from the Keetac expansion. The water quality considerations documented in the EIS and

the statements of basis illustrate how the permits will be protective of water quality. Additionally, these documents address the basis for not including effluent limitations and monitoring requirements for the mining-related pollutants listed in the comments, based on site-specific data for the Keetac facility. Additionally, the comments indicate that the draft permits do not set limits on the total amount of pollutants that will be discharged from the Keetac facility. This is incorrect, as both the water quality and technology-based effluent limitations contained in the permits restrict the concentrations for specific pollutants that can be discharged. These limitations on effluent concentration work in conjunction with Minnesota Rules regarding nondegradation, which are included by reference in the permits, ensure that the total loading of pollutants in the discharges authorized by the permits meets all applicable state and federal regulations.

Comment 13-2: The Keetac Air Emissions permit will allow more than 75 pounds of additional mercury to be emitted into the air.

Response: Comments have been noted by the MPCA, however, please note that these comments have no bearing on the Keetac Mine and Keetac Tailings Basin permits identified in your e-mail, and the comments were received following completion of the public comment period for the air emissions permit. As for mercury discharges associated with the discharges in the permits, please note that the mercury concentrations in the Keetac facility's wastewater discharges have not been shown to exhibit reasonable potential to cause or contribute to excursions above the ambient water quality standard for this pollutant.

Comment 13-3: The permits do not set any limits on the amount of sulfate allowed to be discharged as the Keetac facility expands.

Response: This is incorrect, due to the fact that the rules governing nondegradation incorporated in the permits require the Permittee to maintain discharge loading consistent the baseline quality authorized under the current Permits given that the Permits do not authorize expansion of discharge beyond this level. The Permittee is required to restrict sulfate loading in accordance with nondegradation requirements. Additionally, the permits require further reductions of sulfate loads in the permitted discharges in accordance with schedules of compliance, which specifically require the Permittee to make reductions in sulfate discharge concentrations to the extent practical prior to attaining compliance with final effluent limitations. It is important to note that the compliance schedules are not limited to studies, but require implementation of a Sulfate Reduction Plan, which is specifically required to result in compliance with final effluent limitations for total sulfate as soon as possible. The language in the permits has been updated to more clearly reflect the means by which the compliance schedules will lead to compliance with final effluent limitations.

APPENDIX C

Permit	Location	Original Permit Condition	Change	Comment
MN0031879	Compliance Schedule	Pilot studies use the same schedule	Two distinct schedules with requirements for attainment of compliance written into MN0031879	Performed upon request of USEPA
MN0031879	Compliance Schedule	Proposes treatment evaluation of multiple outfalls	Require full-scale treatment evaluation for outfalls representative of wastewater type	Performed upon request of USEPA
MN0031879	Compliance Schedule	No interim effluent limits	Addition of interim effluent limits within 36 months of approval of the Sulfate Reduction Plan for non-tailings basin discharges	Performed upon request of USEPA
MN0031879	Compliance Schedule	No interim effluent limits	Addition of interim effluent limits within 42 months of approval of the Sulfate Reduction Plan for representative tailings basin discharges	Performed upon request of USEPA
MN0031879	Compliance Schedule	No interim effluent limits	Interim sulfate limit for total sulfate of 14 mg/L as a calendar quarter average for outfalls where full scale treatment evaluation is approved	Performed upon request of USEPA
MN0031879	Compliance Schedule	Sulfate effluent limits to be attained as soon as possible but no later than August 17, 2019	Sulfate effluent limits to be attained as soon as possible but no later than August 17, 2018 for non-tailings basin discharges	Performed upon request of USEPA
MN0055948	Compliance Schedule	Compliance schedule only in MN0031879	Include compliance schedule from MN0031879 by reference in to MN0055948	Performed upon request of USEPA
MN0055948	Compliance Schedule	Pilot studies use the same schedule	Two distinct schedules with requirements for attainment of compliance written into MN0031879	Performed upon request of USEPA
MN0055948	Compliance Schedule	Proposes treatment evaluation of multiple outfalls	Require full-scale treatment evaluation for outfalls representative of wastewater type	Performed upon request of USEPA
MN0055948	Compliance Schedule	No interim effluent limits	Addition of interim effluent limits within 36 months of approval of the Sulfate Reduction Plan for non-tailings basin discharges	Performed upon request of USEPA
MN0055948	Compliance Schedule	No interim effluent limits	Addition of interim effluent limits within 42 months of approval of the Sulfate Reduction Plan for representative tailings basin discharges	Performed upon request of USEPA

MN0055948	Compliance Schedule	No interim effluent limits	Interim sulfate limit for total sulfate of 14 mg/L as a calendar quarter average for outfalls where full scale treatment evaluation is approved	Performed upon request of USEPA
MN0055948	Compliance Schedule	Sulfate effluent limits to be attained as soon as possible but no later than August 17, 2019	Sulfate effluent limits to be attained as soon as possible but no later than August 17, 2018 for non-tailings basin discharges	Performed upon request of USEPA
MN0055948 MN0031879	Monitoring		Additional Monitoring for selenium	

STATE OF MINNESOTA

Minnesota Pollution Control Agency

Industrial Division

National Pollutant Discharge Elimination System (NPDES)/
State Disposal System (SDS) Permit MN0031879

PERMITTEE:	United States Steel Corporation
FACILITY NAME:	Minnesota Ore Operations – Keetac – Mining
RECEIVING WATER:	Welcome Lake; Welcome Creek to Reservoir 2 North; Unnamed wetlands and creeks tributary to O'Brien Reservoir

CITY OR TOWNSHIP:	Keewatin	**COUNTY:**	Itasca
ISSUANCE DATE:		**EXPIRATION DATE:**	

The state of Minnesota, on behalf of its citizens through the Minnesota Pollution Control Agency (MPCA), authorizes the Permittee to construct, install and operate a disposal system at the facility named above and to discharge from this facility to the receiving water named above, in accordance with the requirements of this permit.

The goal of this permit is to reduce pollutant levels in point source discharges and protect water quality in accordance with Minnesota and U.S. statutes and rules, including Minn. Stat. chs. 115 and 116, Minn. R. chs. 7001, 7050, 7053, 7060, 7090.3000 through 7090.3080, and the U.S. Clean Water Act.

This permit is effective on the issuance date identified above, and supersedes the previous permit that was issued for this facility on June 15, 2006. This permit expires at midnight on the expiration date identified above.

Signature: _____

Jeff Udd, P.E. *for* The Minnesota Pollution Control Agency
Acting Supervisor, Water Quality Permits Unit
Land and Water Quality Permits Section
Industrial Division

Submit DMRs to:
Attention: Discharge Monitoring Reports
Minnesota Pollution Control Agency
520 Lafayette Rd N
St Paul, MN 55155-4194

Submit Other WQ Reports to:
Attention: WQ Submittals Center
Minnesota Pollution Control Agency
520 Lafayette Rd N
St Paul, MN 55155-4194

Questions on this permit?

- For DMR and other permit reporting issues, contact: Belinda Nicholas, 651-757-2613.
- For specific permit requirements or permit compliance status, contact: John Thomas, 218-302-6616.
- General permit or NPDES program questions, contact: MPCA, 651-282-6143 or 1-800-657-3938.

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Facility Description

The principal activity at this facility is the open pit mining of taconite (Biwabik Iron Formation) for processing into taconite pellets. The facility consists of the United States Steel Corporation, Minnesota Ore Operations – Keetac plant area, all mine excavations, mining waste disposal areas, plant areas, materials and equipment storage areas, and wastewater disposal facilities. The facility has proposed an expansion to their mining and pellet production operations, which will increase production from 6.0 million short tons of pellets per year to 9.6 million short tons per year. The conditions of this permit reflect the changes associated with that expansion.

The plant area includes the above-mentioned shops as well as several equipment storage buildings, the general office building, the water supply treatment plant, fuel storage area, crude ore storage building, concentrator, pellet plant, various processing thickeners, laboratory, power substation, coal, concentrate and pellet stockpile areas, and the pellet rail load-out area. Yard and roof run-off from the plant area is routed either to the Bennett Pit, Welcome Lake, or to the Diversion Ditch System. The water supply treatment plant, located just north of Welcome Lake, uses potassium permanganate and potassium hydroxide for iron removal. The water treatment plant backwash wastewater from the sand filters currently discharges on a periodic basis through culvert outfall SD001, at a rate of less than 0.010 MGD, to Welcome Lake (class 2B, 3B, 4A, 4B, 5 and 6 waters). Filter backwash solids from the water treatment plant are land applied on a site within the inactive Bennett tailings basin (SW ¼ of Section 17, T57N, R21W).

Most surface drainage from mining waste disposal and excavation areas in the facility is collected in mine pit sumps and then pumped to Reservoir 5. The Bennett Pit water overflows to the Russell Pit, which is pumped at an average rate of 4.0 million gallons per day (MGD) to Reservoir 5. This treatment basin also receives surface flow from inactive stockpiles and tailings basins. Reservoir 5 also provides some make-up water for processing in the Keewatin Taconite plant. Reservoir 5 outflows through a decant control structure to the Diversion Ditch System, constructed as a series of sedimentation basins and a conveyance channel. These basins help to treat run-off from the Keewatin Taconite plant area, as well as some active and inactive stockpile areas. The ditch system discharges through weir outfall SD002 at an average rate of 2.3 MGD to Welcome Creek (class 2C, 3C, 4A, 4B, 5 and 6 waters).

Mine pit dewatering from the Mesabi Chief Pit may be pumped and discharged through pipe outfall SD003, at an average rate of 5.85 MGD, to O'Brien Creek (2C, 3C, 4A, 4B, 5 and 6 water) which flows to the O'Brien Reservoir (class 2B, 3B, 4A, 4B, 5 and 6 water). Some mining waste stockpile drainage from the northwestern side of the facility flows to unnamed wetlands and creeks tributary to O'Brien Reservoir.

Stormwater from stripping and stockpiling activities west of the Mesabi Chief mining area flows into the Perry Pit. This permit authorizes discharges of mine pit dewatering from the Perry Pit through pipe outfall SD012 at rate of up to 4.32 MGD to O'Brien Creek.

Wastewater drainage is collected in the bottom of the two coarse crushers located in the Section 18 Pit. Crusher #1 wastewater is pumped at an average rate of 2.6 MGD to Sump #1, then to Reservoir 5. Crusher #2 wastewater is pumped to the Section 18 Pit, then to Reservoir 5. A septic tank/drainfield system handles the sanitary wastewater generated at the two coarse crushers, at a rate of less than 10,000 gallons per day (gpd). Dry storage buildings, which generate no process or sanitary wastewaters, are located at the facility north of Reservoir 5, south of the coarse crushers and east of the main plant area. A shovel repair area located on the northwest side of the Russell Pit, in the NW ¼, Section 13, T57N, R22W, also generates no process or sanitary wastewaters.

The combined floor drain overflow from the concentrator and the pellet plant is routed to the Bennett Pit. This overflow may include emergency overflow process wastewater from the concentrator if a power failure occurs. All steam cleaning and floor drain wastewater from the truck shops and the plant/machine/welding shops is treated by an oil/water separator and sedimentation tank before overflowing to a drainage pipe to the Bennett Pit. Sludge from the shop areas are taken off-site for treatment or disposal. Oils removed by the oil/water separator are reclaimed for reuse.

Two recirculating wet scrubbers treat waste gas from the Phase II indurating grate-kiln. Blowdown water from these wet scrubbers is sent to a wastewater treatment system. The treatment system is used when the indurating grate-kiln is using coal as a fuel source. The wastewater treatment system includes lime addition to promote calcium sulfate (gypsum) precipitation and solids settling in an existing thickener (old indurating thickener). Solids from the thickener are dewatered using two filter presses and disposed off-site. Overflow from the thickener and filtrate from the filter presses are sent to the tailings basin. Waste station WS011 is located at the plant water make-up to the scrubber system and waste station WS012 is located on the overflow from the indurating thickener prior to being sent to the tailings basin.

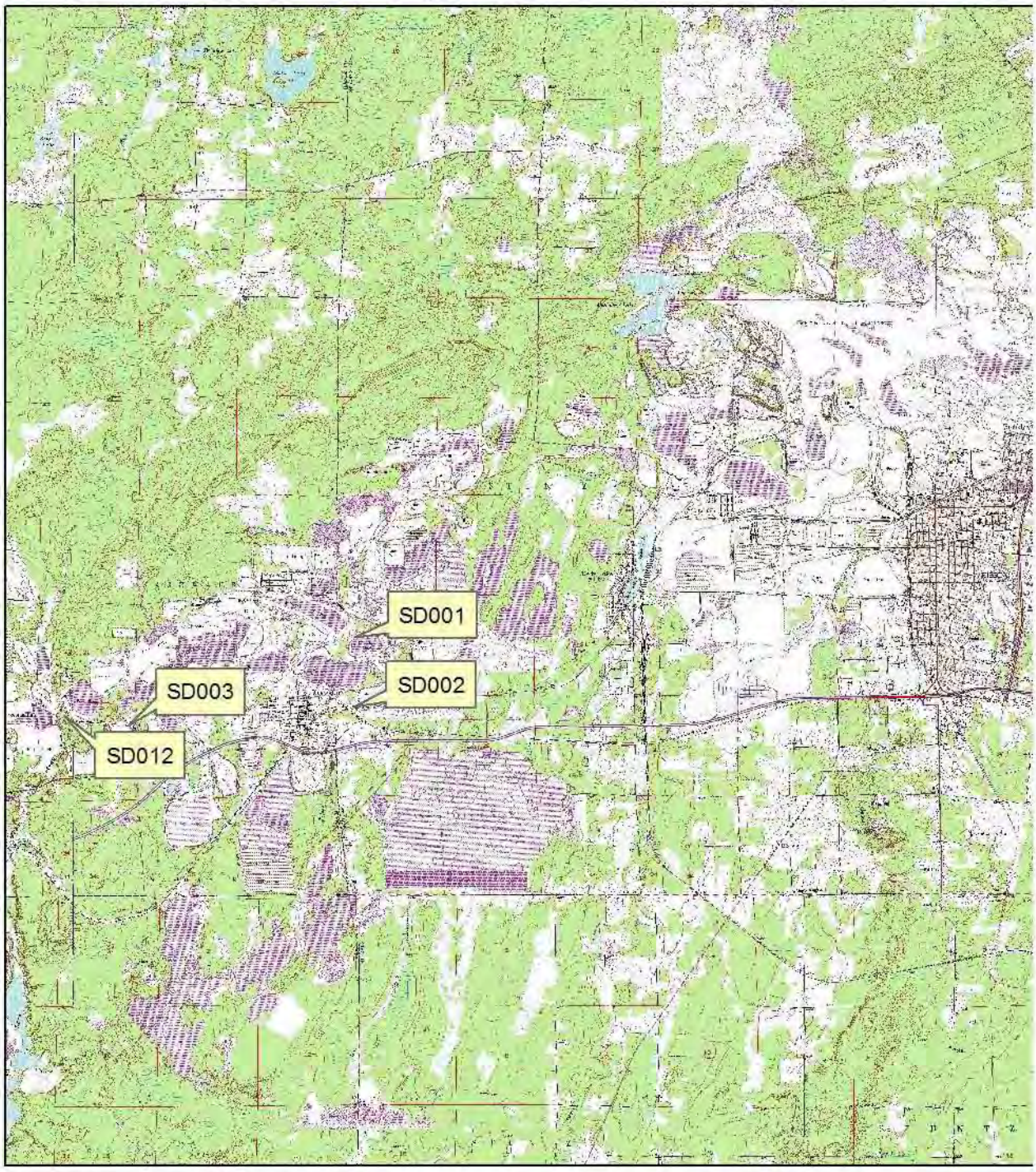
An activated sludge package plant consisting of a bar screen, comminutor, diffused aeration tank, sludge holding tank, and chlorination contact tank is used for the treatment of domestic wastewater. The sewage plant is designed to treat an average flow of 0.040 MGD with five-day carbonaceous biochemical oxygen demand (CBOD5) strength of 140 milligrams per liter (mg/l). No active dechlorination treatment is provided. The treated sanitary wastewater effluent is routed through weir station WS005 to Reservoir 5. The biosolids are transferred off-site to a permitted wastewater treatment facility.

Parallel tailings pipelines exit the north side of the concentrator and approximately follow the Diversion Ditch System east and south before crossing Highway 169 toward the Keewatin Taconite Tailings Basin Area. Segments of these pipelines do not have spill containment berms, and some leaks from pipelines north of Highway 169 may flow toward the Diversion Ditch. The tailings are pumped through the pipelines, which include three dump valve drainage points north of Highway 169. These dump valve points include detention basins and ponds used to contain tailings and process wastewater that is drained during normal maintenance and emergency shutdown situations. Dump Points 1 and 2 overflow to the Diversion Ditch System, while Dump Point 3 drains to a non-discharging infiltration basin. The tailings that do accumulate in these detention basins and ponds are typically removed every two years and hauled by truck for disposal in the Keewatin Taconite Tailings Basin, which is covered by permit MN0055948.

Chemical dust suppressants are occasionally applied on roads in the immediate plant area. Currently, magnesium chloride and lignosulfanate are used at a maximum rate of 11,000 gallons per year. This does not restrict the use of other acceptable dust suppressants at the facility.

Topographic Map of Permitted Facility

MN003189, US Steel - Keewatin Taconite Operations, Mining
St. Louis County & Itasca County, Minnesota



Map produced by: MPCA Staff, 4/15/2010
Source: USGS Nashwauk, Keewatin, Hibbing, Pengilly, Silica, Riley Quads
Scale: 1:24,000

0 0.5 1 2 Miles

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Waste Stream Stations

Station	Type of Station	Local Name	PLS Location
WS302	Solids to Land Treatment/Application	Shop wastewater treatment sludges	
WS303	Solids to Land Treatment/Application	WTP filter backwash treatment sludges	SW Quarter of the NW Quarter of the Section 19, Township 57 North, Range 21 West

Surface Discharge Stations

Station	Type of Station	Local Name	PLS Location
SD001	Effluent To Surface Water	WTP Backwash Outfall 040	SE Quarter of the SW Quarter of the NW Quarter of Section 19, Township 57 North, Range 21 West
SD002	Effluent To Surface Water	Weir Outfall 050	NE Quarter of the NW Quarter of the NW Quarter of Section 30, Township 57 North, Range 21 West
SD003	Effluent To Surface Water	Pipe Outfall 080	SW Quarter of the NE Quarter of the NE Quarter of Section 27, Township 57 North, Range 22 West
SD012	Effluent To Surface Water	Perry Pit Dewatering	

Waste Stream Stations

Station	Type of Station	Local Name	PLS Location
WS005	Internal Waste Stream	Station 901	NW Quarter of the NW Quarter of Section 19, Township 57 North, Range 21 West
WS011	Internal Waste Stream	Plant water to scrubber system	NW Quarter of Section 19, Township 57 North, Range 21 West
WS012	Internal Waste Stream	Scrubber blowdown after treatment	NW Quarter of Section 19, Township 57 North, Range 21 West

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The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Interim Period

SD 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Quarter Average	Jan-Dec	Measurement, Instantaneous	1 x Quarter	1
Flow	Monitor Only	MG	Calendar Quarter Total	Jan-Dec	Measurement, Instantaneous	1 x Quarter	1
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Quarter	1
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Quarter	1
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1

SD 002

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	2 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	2 x Month	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
Nitrogen, Ammonia, Un-ionized (as N)	0.04	mg/L	Calendar Month Average	Mar-Oct	Calculation	1 x Month	
Nitrogen, Ammonia, Un-ionized (as N)	Monitor Only	mg/L	Daily Maximum	Mar-Oct	Calculation	1 x Month	
Oil & Grease, Total Recoverable (Hexane Extraction)	0.5	mg/L	Calendar Quarter Average	Jan-Dec	Grab	1 x Quarter	1
Oil & Grease, Total Recoverable (Hexane Extraction)	5.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1
pH	8.5	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.5	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Quarter	1
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	
Temperature, Water (F)	Monitor Only	Deg F	Calendar Month Average	Mar-Oct	Estimate, Instantaneous	1 x Month	
Temperature, Water (F)	Monitor Only	Deg F	Daily Maximum	Mar-Oct	Estimate, Instantaneous	1 x Month	
Turbidity	25	NTU	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Turbidity	Monitor Only	NTU	Daily Maximum	Jan-Dec	Grab	2 x Month	

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The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Interim Period

SD 003

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
Oil & Grease, Total Recoverable (Hexane Extraction)	0.5	mg/L	Calendar Quarter Average	Jan-Dec	Grab	1 x Quarter	1
Oil & Grease, Total Recoverable (Hexane Extraction)	5.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1
pH	8.5	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.5	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	20	mg/L	Calendar Quarter Average	Jan-Dec	Grab	1 x Quarter	1
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Quarter	1
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Year Maximum	Jan-Dec	Grab	2 x Month	
Turbidity	25	NTU	Calendar Month Average	Jan-Dec	Grab	1 x Month	

SD 012

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	3
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	3
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	

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The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Interim Period

SD 012

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	3
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	

WS 005

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
BOD, Carbonaceous 05 Day (20 Deg C)	3.8	kg/day	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
BOD, Carbonaceous 05 Day (20 Deg C)	25	mg/L	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
BOD, Carbonaceous 05 Day (20 Deg C)	6.0	kg/day	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
BOD, Carbonaceous 05 Day (20 Deg C)	40	mg/L	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Fecal Coliform, MPN or Membrane Filter 44.5C	200	#100ml	Calendar Month Geometric Mean	Apr-Oct	Grab	2 x Month	
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement, Continuous	1 x Day	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement, Continuous	1 x Day	
Flow	Monitor Only	mgd	Maximum Calendar Week Average	Jan-Dec	Measurement, Continuous	1 x Day	
Nitrogen, Total (as N)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	2 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	2 x Month	
Phosphorus, Total (as P)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Phosphorus, Total (as P)	Monitor Only	mg/L	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	4.5	kg/day	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	6.8	kg/day	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	45	mg/L	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	

WS 011

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Calcium, Total (as Ca)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	

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The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Interim Period

WS 011

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Fluoride, Total (as F)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	
pH	Monitor Only	SU	Single Value	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	

WS 012

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Calcium, Total (as Ca)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Fluoride, Total (as F)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
pH	Monitor Only	SU	Single Value	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	

Period: Limits Applicable in the Final Period

SD 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Quarter Average	Jan-Dec	Measurement, Instantaneous	1 x Quarter	1
Flow	Monitor Only	MG	Calendar Quarter Total	Jan-Dec	Measurement, Instantaneous	1 x Quarter	1
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Quarter	1
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Quarter	1
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1

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The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Final Period

SD 002

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	2 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	2 x Month	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
Nitrogen, Ammonia, Un-ionized (as N)	0.04	mg/L	Calendar Month Average	Mar-Oct	Calculation	1 x Month	
Nitrogen, Ammonia, Un-ionized (as N)	Monitor Only	mg/L	Daily Maximum	Mar-Oct	Calculation	1 x Month	
Oil & Grease, Total Recoverable (Hexane Extraction)	0.5	mg/L	Calendar Quarter Average	Jan-Dec	Grab	1 x Quarter	1
Oil & Grease, Total Recoverable (Hexane Extraction)	5.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1
pH	8.5	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.5	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Quarter	1
Sulfate, Total (as SO4)	14	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	24	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	
Temperature, Water (F)	Monitor Only	Deg F	Calendar Month Average	Mar-Oct	Estimate, Instantaneous	1 x Month	
Temperature, Water (F)	Monitor Only	Deg F	Daily Maximum	Mar-Oct	Estimate, Instantaneous	1 x Month	
Turbidity	25	NTU	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Turbidity	Monitor Only	NTU	Daily Maximum	Jan-Dec	Grab	2 x Month	

SD 003

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2

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The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Final Period

SD 003

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Oil & Grease, Total Recoverable (Hexane Extraction)	0.5	mg/L	Calendar Quarter Average	Jan-Dec	Grab	1 x Quarter	1
Oil & Grease, Total Recoverable (Hexane Extraction)	5.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1
pH	8.5	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.5	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	20	mg/L	Calendar Quarter Average	Jan-Dec	Grab	1 x Quarter	1
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Quarter	1
Sulfate, Total (as SO4)	14	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	24	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	
Turbidity	25	NTU	Calendar Month Average	Jan-Dec	Grab	1 x Month	

SD 012

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	3
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	3
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	3
Sulfate, Total (as SO4)	14	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	24	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	

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The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Final Period

WS 005

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
BOD, Carbonaceous 05 Day (20 Deg C)	3.8	kg/day	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
BOD, Carbonaceous 05 Day (20 Deg C)	25	mg/L	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
BOD, Carbonaceous 05 Day (20 Deg C)	6.0	kg/day	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
BOD, Carbonaceous 05 Day (20 Deg C)	40	mg/L	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Fecal Coliform, MPN or Membrane Filter 44.5C	200	#100ml	Calendar Month Geometric Mean	Apr-Oct	Grab	2 x Month	
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement, Continuous	1 x Day	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement, Continuous	1 x Day	
Flow	Monitor Only	mgd	Maximum Calendar Week Average	Jan-Dec	Measurement, Continuous	1 x Day	
Nitrogen, Total (as N)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	2 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	2 x Month	
Phosphorus, Total (as P)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Phosphorus, Total (as P)	Monitor Only	mg/L	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	4.5	kg/day	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	6.8	kg/day	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	45	mg/L	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	

WS 011

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Calcium, Total (as Ca)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Fluoride, Total (as F)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	
pH	Monitor Only	SU	Single Value	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	

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The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Final Period

WS 012

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Calcium, Total (as Ca)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Fluoride, Total (as F)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
pH	Monitor Only	SU	Single Value	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	

Notes:
1 -- Samples may be taken any time during each calendar quarter but must be reported on the DMR for the last month of each quarter (e.g. the sample for the first calendar quarter of Jan - Mar should be reported on the March DMR).
2 -- Samples may be taken any time during each calendar quarter but must be reported on the DMR for the last month of each quarter (e.g. the sample for the first calendar quarter of Jan - Mar should be reported on the March DMR). Use EPA method 1631, with clean techniques method 1669, and any revisionsto this methods.
3 -- Samples may be taken any time during each calendar quarter but must be reported on the DMR for the last month of each quarter (e.g. the sample for the first calendar quarter of Jan - Mar should be reported on the March DMR). The permittee may request to modify this permit after 12 months of monitoring data have been submitted to MPCA, in order to remove or modify limits or monitoring requirements.

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Chapter 1. Special Requirements

1. Compliance Schedule

Compliance Schedule for Sulfate

1.1 The Permittee shall meet the terms of the compliance schedule detailed below in order to attain compliance with the final effluent limitations contained in this permit and NPDES/SDS Permit MN0055948 for total sulfate.

The Permittee shall continue to work toward minimizing sulfate in the discharges to the extent practical prior to the compliance date. Compliance with the final effluent limitations shall be attained as soon as possible, and in no case shall compliance be attained later than August 17, 2018 for non-tailings basin discharges, and August 17, 2019 for tailings basin discharges, unless the permit is modified pursuant to 40 CFR 122.62.

Water Management Study

1.2 The Permittee has submitted a Water Management Study Plan to refine the water mass balance, and evaluate water discharge and water consumption alternatives that may lead to compliance. The Water Management Study Plan was approved by the MPCA on October 6, 2010.

1.3 The Water Management Study shall be completed within 18 months of MPCA approval of the Water Management Study Plan. The Permittee, upon approval from the MPCA, may make revisions to the Water Management Study Plan as new alternatives and information emerge and as deemed appropriate. The Permittee shall notify the MPCA within 14 days of completion of the Water Management Study.

1.4 The Permittee shall provide written progress updates on the Water Management Study to the MPCA every six months, at minimum, following MPCA approval of the Water Management Study Plan. Additional updates can be provided in the form of electronic transmittals, conference calls or meetings.

1.5 The Permittee shall provide the results of the Water Management Study to the MPCA within three months of completion of the Water Management Study.

Sulfate Reduction Strategy Study

1.6 The Permittee has submitted a Sulfate Reduction Strategy Study Plan for water quantity and quality data review, and evaluation of source control strategies and sulfate treatment technologies that may lead to compliance. The Sulfate Reduction Strategy Study Plan was approved by the MPCA on October 6, 2010.

1.7 The Sulfate Reduction Strategy Study shall be completed within 18 months of MPCA approval of the Sulfate Reduction Strategy Study Plan. The Permittee, upon approval from the MPCA, may make revisions to the Sulfate Reduction Strategy Study Plan as new alternatives and information emerge and as deemed appropriate. The Permittee shall notify the MPCA within 14 days of completion of the Sulfate Reduction Strategy Study.

1.8 The Permittee shall provide written progress updates on the Sulfate Reduction Strategy Study to the MPCA every six months, at minimum, following MPCA approval of the Sulfate Reduction Strategy Study Plan. Additional updates can be provided in the form of electronic transmittals, conference calls or meetings.

1.9 The Permittee shall provide the results of the Sulfate Reduction Strategy Study to the MPCA within three months of completion of the study.

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Chapter 1. Special Requirements

1. Compliance Schedule

Sulfate Reduction Plan

1.10 Based on the results of the Water Management Study and the Sulfate Reduction Strategy Study, and within three months of submittal of the results of both studies, the Permittee shall provide a Sulfate Reduction Plan for MPCA review and approval. The Sulfate Reduction Plan shall, at minimum, detail the actions the Permittee proposes to take in order to comply with the final effluent limitations for total sulfate at each outfall under this permit and NPDES/SDS Permit MN0055948. The actions proposed in the Sulfate Reduction Plan must lead to compliance with final effluent limitations as soon as possible, and the plan must include a schedule for implementation of the proposed actions, as well as a justification for the proposed schedule that addresses the timing associated with each of the specific actions proposed in the plan. If treatment technology for sulfate is proposed in the Sulfate Reduction Plan, applications for any necessary permit modifications, as well as plans and specifications for the proposed treatment technology shall be submitted to the MPCA along with the Plan.

1.11 The Sulfate Reduction Plan may include a request for evaluation of treatment effectiveness at full scale on representative outfalls prior to installation of the same technology on similar outfalls if the following conditions are met:
1. The request categorizes all permitted outfalls into groups based on similar wastewater chemistry and physical conditions.
2. The results of the Water Management Study and Sulfate Reduction Strategy Study indicate that additional evaluation is necessary to determine treatment effectiveness at full scale for one or more of the outfall groups.
3. The treatment technology proposed in the Sulfate Reduction Plan is the same for the representative outfalls selected as the technology proposed for the other outfalls in the same waste group, and the results of the Sulfate Reduction Strategy Study do not show a significant difference in treatment effectiveness between the representative waste stream and the other waste streams of its type.
4. The representative outfall for each waste group has the highest volume and/or highest frequency of discharge of all outfalls in that group, and is therefore the most beneficial for evaluation.

1.12 Following approval of the Sulfate Reduction Plan by the MPCA, the Permittee shall complete the actions proposed in the Sulfate Reduction Plan and attain compliance with the final effluent limitations as detailed in Parts 1.13 and 1.14 of this Chapter, whichever is applicable.

1.13 If the approved Sulfate Reduction Plan includes approval of a request for full scale treatment evaluation pursuant to Part 1.11 of this Chapter, the Permittee shall attain compliance with final effluent limitations according to the following schedule:
1. The permitting, installation of equipment, and evaluation of treatment effectiveness on representative outfalls shall be completed within 36 months of MPCA approval of the Sulfate Reduction Plan for representative non-tailings basin discharges. The Permittee shall notify the MPCA within 14 days of completing this evaluation.
2. The permitting, installation of equipment, and evaluation of treatment effectiveness on representative outfalls shall be completed within 42 months of MPCA approval of the Sulfate Reduction Plan for representative tailings basin discharges. The Permittee shall notify the MPCA within 14 days of completing this evaluation.
3. Following completion of the full-scale treatment evaluation on the approved representative outfalls, the Permittee shall comply with an interim calendar quarter average effluent limitation of 14 mg/L total sulfate for all of the representative outfalls to ensure continued progress toward compliance with final effluent limitations.
4. The Permittee shall attain compliance with final effluent limitations for total sulfate on all non-tailings basin outfalls within 30 months of completing treatment evaluations on the representative outfalls for those waste types.
5. The Permittee shall attain compliance with final effluent limitations for total sulfate on all tailings basin outfalls within 36 months of completing treatment evaluations on the representative outfalls for those waste types.

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Chapter 1. Special Requirements

1. Compliance Schedule

1.14 If the approved Sulfate Reduction Plan does not include approval of a request for full scale treatment evaluation pursuant to Part 1.11 of this Chapter, the Permittee shall attain compliance with final effluent limitations according to the following schedule:
1. The Permittee shall attain compliance with final effluent limitations for total sulfate on all non-tailings basin outfalls within 30 months of MPCA approval of the Sulfate Reduction Plan.
2. The Permittee shall attain compliance with final effluent limitations for total sulfate on all tailings basin outfalls within 36 months of MPCA approval of the Sulfate Reduction Plan.

1.15 The Permittee shall provide written progress reports on the implementation of the Sulfate Reduction Plan to the MPCA every six months, at minimum, following MPCA approval of the Sulfate Reduction Plan. Additional updates can be provided in the form of electronic transmittals, conference calls or meetings.

1.16 The Permittee shall submit written notification of compliance to the MPCA within 14 days of completing all of the actions required for the attainment of compliance with final effluent limitations. The notification of compliance shall include a notification that installation and startup of treatment equipment has been completed, or shall include a submission of a representative effluent monitoring data set if equipment is not determined to be necessary. The MPCA will submit notification to the Permittee that final effluent limitations apply.

2. Special Requirements

Effluent Limit Study

2.1 The Permittee may opt to conduct a study to gather data and information that would support a total sulfate limit other than the final limitations included in this permit.

2.2 When cause exists according to state and federal law regarding modification of permits, this permit may be reopened for modification of effluent limitations, discharge restrictions, monitoring requirements, and or conditions of a schedule of compliance. Any modified permit conditions shall be consistent with all applicable state and federal requirements. MPCA shall comply with all procedural requirements under state and federal law prior to reopening and modifying this permit.

Chapter 2. Industrial Process Wastewater

1. Prohibited Discharges

1.1 This permit does not authorize the discharge of sewage, wash water, scrubber water, spills, oil, hazardous substances, or equipment/vehicle cleaning and maintenance wastewaters to ditches, wetlands or other surface waters of the state.

1.2 The Permittee shall prevent the routing of pollutants from the facility to a municipal wastewater treatment system in any manner unless authorized by the pretreatment standards of the MPCA and the municipal authority.

1.3 The Permittee shall not transport pollutants to a municipal wastewater treatment system that will interfere with the operation of the treatment system or cause pass-through violations of effluent limits or water quality standards.

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Chapter 2. Industrial Process Wastewater

2. Toxic Substance Reporting

2.1 The Permittee shall notify the MPCA immediately of any knowledge or reason to believe that an activity has occurred that would result in the discharge of a toxic pollutant listed in Minnesota Rules, pt. 7001.1060, subp. 4 to 10 or listed below that is not limited in the permit, if the discharge of this toxic pollutant has exceeded or is expected to exceed the following levels:

a. for acrolein and acrylonitrile, 200 ug/L;

b. for 2,4-dinitrophenol and 2-methyl-4,6-dinitrophenol, 500 ug/L;

c. for antimony, 1mg/L;

d. for any other toxic pollutant listed in Minnesota Rules, pt. 7001.1060, subp. 4 to 10, 100 ug/L; or

e. five times the maximum concentration value identified and reported for that pollutant in the permit application. (Minnesota Rules, pt. 7001.1090, subp. 2.A)

2.2 The Permittee shall notify the MPCA immediately if the Permittee has begun or expects to begin to use or manufacture as an intermediate or final by-product a toxic pollutant that was not reported in the permit application under Minnesota Rules, pt. 7001.1050, subp. 2.J. (Minnesota Rules, pt. 7001.1090, subp. 2.B)

3. Hydrotest Discharges

3.1 The Permittee shall notify the MPCA prior to discharging hydrostatic test waters. The Permittee shall provide information necessary to evaluate the potential impact of this discharge and to ensure compliance with this permit. This information shall include:

a. the proposed discharge dates;

b. the name and location of receiving waters, including city or township, county, and township/range location;

c. an evaluation of the impact of the discharge on the receiving waters in relation to the water quality standards;

d. a map identifying discharge location(s) and monitoring point(s);

e. the estimated average and maximum discharge rates;

f. the estimated total flow volume of discharge;

g. the water supply for the test water, with a copy of the appropriate Minnesota Department of Natural Resources (DNR) water appropriation permit;

h. water quality data for the water supply;

i. proposed treatment method(s) before discharge; and

j. methods to be used to prevent scouring and erosion due to the discharge.

3.2 This permit does not authorize the construction or installation of pipeline facilities.

4. Polychlorinated Biphenyls (PCBs)

4.1 PCBs, including but not limited to those used in electrical transformers and capacitors, shall not be discharged or released to the environment.

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Chapter 2. Industrial Process Wastewater

5. New Proposed Dewatering

5.1 The Permittee shall obtain a permit modification before discharging from a new dewatering outfall.

5.2 In addition to the requirements in the Permit Modifications section of this permit, the Permittee shall submit to the MPCA detailed plans and specifications for the proposed methods of achieving discharge limits for turbidity and total suspended solids, based in part upon representative water quality data for untreated wastewater and a detailed map and diagram description of the proposed design for the flow control structures, and route of the discharge to receiving waters.

6. Application for Permit Reissuance

6.1 The permit application shall include analytical data as part of the application for reissuance of this permit. These analyses shall be done on individual samples taken during the twelve-month period before the reissuance application is submitted.

6.2 The permit application shall include analytical data for at least the following parameters at monitoring station SD002:

a. biochemical oxygen demand, chemical oxygen demand, total organic carbon, gasoline range organics, diesel range organics, fecal coliform, ammonia, temperature;

b. color, fluoride, nitrate-nitrite (as nitrogen), total organic nitrogen, oil and grease, total phosphorus, chloride, sulfate, sulfide (as sulfur), surfactants, bicarbonates, alkalinity, total salinity, total dissolved solids, specific conductance;

c. aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, strontium, thallium, tin, titanium, vanadium, zinc (all in total form) using atomic absorption (AA) furnace methods according to 40 CFR Part 136.3;

d. total mercury using EPA Method 1631;

e. gross alpha particles, radium-226, radium-228, radon-222, uranium;

f. PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254, PCB-1260; and

g. a scan of constituents using EPA Methods 624 and 625, in 40 CFR Part 136.

The Permittee shall identify, in addition to those pollutants noted in Methods 624 and 625 (Appendix D, Table II), the concentrations of at least ten of the most abundant constituents of the acid and base/neutral organic fractions shown to be present by peaks on the total ion plots (reconstructed gas chromatograms) within ten percent of the nearest internal standard. Identification shall be through the use of U.S. EPA/NIH computerized library of mass spectra, with visual confirmation and potential quantification.

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Chapter 3. Domestic Wastewater (non-POTW)

1. Authorization

1.1 The sanitary wastewater generated at the facility shall be disposed of:

a. Through the activated sludge sewage treatment plant at the facility monitored by station WS005;

b. To portable units, and then transported from the facility for proper disposal; and/or

c. To permitted septic tank-drainfield systems that treat sanitary wastewater only, at a rate of less than 10,000 gallons/day each.

1.2 The Permittee shall prevent the introduction of the following to its domestic wastewater treatment system:

a. pollutants which create a fire or explosion hazard, including any discharge with a flash point less than 60 degrees C (140 degrees F);

b. pollutants which would cause corrosive structural damage, including any waste stream with a pH of less than 5.0;

c. solid or viscous pollutants which would obstruct flow;

d. heat that would inhibit biological activity, including any introduction of wastewater that would cause the temperature of the waste stream at the domestic wastewater treatment system to exceed 40 degrees C (104 degrees F);

e. pollutants which produce toxic gases, vapors, or fumes that may endanger the health or safety of workers;

f. non-contact cooling waters, unless there are no cost-effective alternatives; and

g. hazardous wastes.

The flushing or disposal of solvents and petroleum products is prohibited. Employee training shall be provided on the proper disposal of solvents and petroleum products.

2. Operator Certification

2.1 The Permittee shall provide a Class C state certified operator who is in direct responsible charge of the operation, maintenance and testing functions required to ensure compliance with the terms and conditions of this permit.

2.2 If applicable, the Permittee shall provide the appropriate number of operators with a Type IV certification to be responsible for the land application of the biosolids generated by the facility.

2.3 If the Permittee chooses to meet operator certification requirements through a contractual agreement, the Permittee shall provide a copy of the contract to the MPCA. The contract shall include the certified operator's name, certificate number, company name if appropriate, and evidence that the operation is being adequately supervised by a properly certified operator.

2.4 The Permittee shall notify the MPCA within 30 days of a change in operator certification or contract status.

3. Sanitary Sewer Extension Permit

3.1 The Permittee is required to obtain a Sanitary Sewer Extension Permit from the MPCA before the start of construction of any addition, extension or replacement to the sanitary sewer.

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Chapter 3. Domestic Wastewater (non-POTW)

4. Solids Management

Septage

4.1 Any accumulation of solids in pump stations, distribution devices, valve boxes or drop boxes shall be considered septage.

4.2 Septage shall be disposed of according to state, federal and local requirements.

Domestic Biosolids

4.3 The Permittee shall provide the information needed to comply with the biosolids requirements of Minn. R. ch. 7041 to others who treat, store, prepare or use the biosolids.

4.4 The Permittee shall keep records of the information necessary to show compliance with pollutant concentrations and loadings, pathogen reduction requirements, vector attraction reduction requirements and management practices as specified in Minn. R. 7041.1600, subp. 3.

Chapter 4. Metallic Mining

1. Mobile and Rail Equipment Service Areas

1.1 Mobile equipment and rail equipment service areas in the facility shall be operated in compliance with the following:

a. The Permittee shall collect and dispose of locomotive traction sand, degreasing wastes, motor oil, oil filters, oil sorbent pads and booms, transmission fluids, power steering fluids, brake fluids, coolant/antifreeze, radiator flush wastewater and spent solvents in accordance with applicable solid and hazardous waste management rules. These materials shall not be discharged to surface or ground waters of the state.

b. The steam-cleaning of mobile equipment and rail equipment, except for limited outdoor cleaning of large drills and shovels, shall be conducted in wash bays that drain to wastewater treatment systems that include the removal of suspended solids and flammable liquids. The only washing of mobile equipment done in outside areas shall be to remove mud and dirt that has accumulated during outside work.

c. The Permittee shall not use solvent-based cleaners, such as those available for brake cleaning and degreasing, to wash mobile and rail equipment unless the cleaning fluids are completely contained and not allowed to flow to surface or ground waters of the state. Soaps and detergents used in washing shall be biodegradable.

d. Mobile and rail equipment maintenance and repairs shall not be conducted in wash bays.

e. Hazardous materials shall not be stored or handled in wash bays.

f. The Permittee shall inspect wastewater containment systems regularly, and repair any leaks that are detected immediately.

g. If the Permittee discovers that recoverable amounts of petroleum products have entered wastewater containment systems, they shall be recovered immediately and reported to the MPCA.

h. Spill cleanup procedures shall be posted in mobile and rail equipment maintenance and repair areas.

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Chapter 5. Water Treatment

1. Residual Solids Management

1.1 The Permittee shall provide for the effective management and/or disposal of residual solids, or other substances resulting from treatment of potable water.

1.2 The Permittee shall dispose of residual solids in such a manner and at such locations that disposal practices shall not result in unlawful pollution of the air, surface water or ground water, or create nuisance conditions.

2. Waste Materials - Stockpiling

2.1 Stockpiling residual solids is prohibited unless authorized by the MPCA. If the Permittee proposes to stockpile residual solids, the Permittee shall submit a description of the type and amount of solids to be stockpiled and the proposed location of the stockpiles for review and approval.

3. Waste Materials - Nuisance Conditions

3.1 The Permittee shall notify the MPCA of any nuisance conditions, such as wind blown lime residual solids dust, immediately and take necessary actions to control and abate these conditions. (Minnesota Statutes, section 115.061)

4. Waste Materials - Land Application Restrictions

4.1 The Permittee shall not apply residual solids within 200 feet of any place of habitation or recreational area or within 100 feet of intermittent streams.

4.2 The Permittee shall apply residual solids uniformly over the entire site.

4.3 The Permittee shall regulate surface application rates to prevent surface runoff from the land application site.

4.4 The residual solids application rate shall be based on the University of Minnesota, College of Agriculture recommended application rates for Agricultural Liming Material (ALM).

4.5 Land application is not allowed when radium concentration in the waste product exceeds 50 pci per gram on a dry weight basis. Wastes with radium concentrations not exceeding 50 pci per gram may be land applied if the resulting radium concentration of the soil can be shown to not exceed 5 pci per gram. Testing shall be done according to nationally accepted laboratory procedures, such as the U.S. Department of Energy procedures manual.

4.6 Residual solids shall not be applied on any land without the owner's permission.

Chapter 6. Stormwater Management

1. Authorization

1.1 This chapter authorizes the Permittee to discharge stormwater associated with industrial activity in accordance with the terms and conditions of this chapter. The MPCA may initiate modification of this chapter in accordance with Minn. R. 7001.0170 and Minn. R. 7001.0190 Subp. 1 to incorporate revised requirements in response to the reissuance or modification of the General Stormwater Permit for Industrial Activity (MNG611000).

2. Prohibited Discharges

2.1 This permit, unless specifically authorized by another chapter, does not authorize the discharge of sewage, wash water, scrubber water, spills, oil, hazardous substances, or equipment/vehicle cleaning and maintenance wastewaters to ditches, wetlands or other surface waters of the state.

2.2 This permit does not authorize discharges from sites for which Environmental Assessment Worksheets or Environmental Impact Statements are required, in accordance with Minn. R. ch. 4410, until that environmental review is completed.

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Chapter 6. Stormwater Management

3. Water Quality Standards

3.1 The Permittee shall operate and maintain the facility and shall control runoff, including stormwater, from the facility to prevent the exceedance of water quality standards specified in Minnesota Rules, chs. 7050 and 7060.

3.2 The Permittee shall limit and control the use of materials at the facility that may cause exceedances of ground water standards specified in Minnesota Rules, ch. 7060. These materials include, but are not limited to, detergents and cleaning agents, solvents, chemical dust suppressants, lubricants, fuels, drilling fluids, oils, fertilizers, explosives and blasting agents.

4. Stormwater Pollution Prevention Plan

4.1 The Permittee shall develop and implement a Stormwater Pollution Prevention Plan (Plan) to address the specific conditions at the industrial facility. The goal of the Plan is to eliminate or minimize contact of stormwater with significant materials that may result in pollution of the runoff. If contact cannot be eliminated or reduced, stormwater that has contacted significant material should be treated before it is discharged from the site. The Plan shall apply to those areas of the facility where industrial activities occur or significant materials are stored, and stormwater runoff does not receive treatment prior to discharge via a permitted surface discharge station. In addition, the Plan should indentify all areas of the facility where the necessary treatment of stormwater is addressed by a permitted surface discharge station.

4.2 The Plan shall be implemented at the site before the Permittee is covered under this permit.

4.3 The Stormwater Pollution Prevention Plan shall include a description of appropriate Best Management Practices for protection of surface and ground water quality at the facility, and a schedule for implementing the practices. The Plan shall also include the procedures to be followed by designated staff employed by the Permittee to implement the plan.

4.4 The Permittee shall comply with its Stormwater Pollution Prevention Plan.

4.5 The Permittee shall submit the Stormwater Pollution Prevention Plan to MPCA upon request.

Plan Contents

4.6 Complete a drainage map. The map should indicate the following items at or adjacent to the facility:

a. drainage areas and directions of stormwater runoff (indicated by arrows);

b. discharge outfalls from the site (structures that carry stormwater runoff from the facility such as ditches or storm sewers);

c. the name and location of waters of the state that receive facility stormwater runoff (if waters of the state are too distant from the facility to be indicated on the site map, indicate the name, direction and shortest distance to the lake, river, stream or wetland that receives runoff from your site);

d. areas where significant materials are exposed to stormwater;

e. locations of storm sewer inlets and an indication of which, if any, structures have floor drains or loading dock drains that are connected to storm sewers; and

f. locations and types of Best Management Practices (BMPs) currently installed at the facility to reduce or eliminate pollutants to stormwater.

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Chapter 6. Stormwater Management

4. Stormwater Pollution Prevention Plan

4.7 Complete an inventory of exposed significant materials. Indicate the types of significant materials handled or stored at the site that may potentially contact stormwater. The following are examples of materials that, if exposed to stormwater, must be included in the inventory:

a. raw materials, such as fuels; solvents; petroleum products; detergents; plastic pellets; materials used in food processing or production; stockpiled sand, salt or coal;

b. by-products or intermediate products, such as wood dust, chips or bark; screened limestone, taconite or gravel by-product, recycled blacktop;

c. finished materials, such as metallic products, including scrap metal and recycled or scrap motor vehicle parts, old process equipment/machinery, taconite pellets;

d. waste products, such as ashes, sludge, solid and liquid waste, slag;

e. hazardous substances designated under section 101(14) of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA);

f. any chemical the facility is required to report under section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA).

4.8 Evaluate facility areas for exposure of significant materials to stormwater. In creating the inventory of exposed significant materials, the Permittee must, at a minimum, evaluate the following areas at the industrial site (as well as other areas where appropriate) to determine whether or not significant materials are exposed in these areas:

a. vehicle and equipment maintenance, parking and storage areas including fueling and washing/cleaning areas, to determine if there is discolored soil in these areas as a result of fuel and lubricant leaks and spills;

b. liquid storage tanks and other bulk material stockpile areas;

c. loading and unloading areas;

d. outdoor manufacturing, processing or storage areas and industrial plant yards, to determine if there is discolored soil in these areas as a result of leaked or spilled solvents, fuels, or lubricants;

e. dust or particulate generating areas including dust collection devices that may release dust;

f. rooftops contaminated by industrial activity or operation of a pollution control device;

g. on-site waste disposal areas, such as waste ponds, dumpsters, solid waste storage or management areas; and

h. exposed (non-vegetated) soil areas where there is a potential for erosion to occur.

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Chapter 6. Stormwater Management

4. Stormwater Pollution Prevention Plan

4.9 Describe appropriate BMPs, including structural and non-structural BMPs, that will be used at the facility to minimize or eliminate pollution of stormwater at the site. The description must include an objective for each BMP, as well as a description of how to evaluate proper functioning of the BMP and any maintenance requirements of the BMP. BMPs should target significant materials and areas identified in subparts 7 and 8 of this part. The following general categories of BMPs shall be considered and one or more shall be incorporated into the facility's Plan if significant materials are exposed to stormwater on-site:

a. Source reduction: reduce or eliminate the significant materials that are exposed to stormwater. Materials management practices should be evaluated to determine whether inventories of exposed materials can be reduced or eliminated. This can include clean-up of equipment yards, periodic checking of dust control equipment to ensure minimal accumulation of dust in the area of control equipment, removal and treatment of petroleum contaminated soil, consolidation of materials from multiple areas into one area, and training employees regarding proper handling and disposal of materials. Significant materials may also be moved indoors or covered with a tarp or structure to eliminate contact with precipitation.

b. Diversion: divert stormwater drainage away from exposed significant materials through use of curbing, berms, sewers or other forms of drainage control or elevate exposed significant material above surrounding drainage.

c. Treatment: where contact of stormwater with significant materials is unavoidable, use treatment devices to reduce the concentration and amount of pollutants in the discharge. Such devices include oil/water separators, stormwater detention/retention ponds, and vegetative swales.

4.10 Evaluate all discharge conveyances from the site (storm sewers, pipes, tile lines, ditches, etc.) to determine if liquids other than stormwater are being discharged from these devices. This should be done during dry weather when stormwater discharge is not occurring. The evaluation should cover sewer inlets and floor drains to determine which inlets/drains are connected to sanitary sewer lines, storm sewer lines, or septic tanks/drainage fields; appropriate methods such as dye or smoke testing or video imaging should be used to determine the source of discharges.

The Plan must certify that discharges from the site have been evaluated for the presence of non-stormwater discharges. The certification shall indicate the date of testing, location of testing, describe the method used to determine the source of discharges and the results of testing. Discharge of non-stormwater (such as sanitary sewer or floor drain connections to storm sewers) is not authorized by this permit; before such discharge may continue, authorization under an appropriate NPDES permit must be obtained.

4.11 Develop a preventive maintenance program. The program must require regular inspection and maintenance of stormwater management devices (e.g. cleaning oil/water separators and catch basins), as well as inspecting and testing plant equipment and systems to uncover conditions that could cause breakdowns or failures resulting in discharges of pollutants (e.g. hydraulic leaks, torn bag-house filters) to surface waters.

4.12 Develop a spill prevention and response procedure. In order to develop this procedure, Permittees should evaluate where spills have occurred and where they have the potential to occur. Determine drainage points for potential spill areas and develop appropriate spill prevention and containment measures, should a spill occur. Detailed procedures for cleaning-up spills shall be identified and made available to appropriate personnel. If your facility has any other spill contingency plan that satisfies the above requirements, that plan may be incorporated by reference into this Plan to satisfy this requirement.

4.13 Develop and implement an employee training program to inform appropriate personnel of the components and goals of the Plan. Training shall address spill response, good housekeeping and materials management practices. The Plan shall identify periodic dates for such training.

4.14 Identify personnel responsible for managing and implementing the Plan as well as those responsible for the reporting requirements of this permit. This should include the facility contact person as indicated on the permit application. Identified personnel must be available at reasonable times of operation.

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Chapter 6. Stormwater Management

5. Temporary Protection and Permanent Cover

5.1 The Permittee shall provide and maintain temporary protection or permanent cover for the exposed areas at the facility.

5.2 Temporary protection methods are used to prevent erosion on a short-term basis, such as the placement of mulching straw, wood fiber blankets, wood chips, erosion control netting, or temporary seeding.

5.3 Permanent cover or final stabilization methods are used to prevent erosion, such as the placement of rip rap, sodding, or permanent seeding or planting. Permanent seeding and planting must have a uniform perennial vegetation cover of at least 70 percent density to constitute final stabilization.

6. Inspection and Maintenance

6.1 Site inspections shall be conducted at least once every two months throughout the calendar year. During winter months, the inspections shall be conducted during non-frozen conditions. Inspections shall be conducted by an appropriately trained personnel at the facility site, as identified in part 4.13 of this chapter. The purpose of inspections is to: 1) determine whether structural and non-structural BMPs require maintenance or changes, and 2) evaluate the completeness and accuracy of the Plan.

At least one inspection during a reporting period shall be conducted while stormwater is discharging from the facility. Inspections may be documented using an inspection form provided by the MPCA. A Storm Water Site Inspection Form is provided in the appendices section of this permit.

6.2 Inspections shall be documented and a copy of all documentation shall remain on the permitted site whenever Permittee staff are availbale on the site, and be available upon request. The inspection form developed for the General Storm Water Permit for Industrial Activity may be used for recording inspection results, and is included in the appendices section of this permit.

6.3 The following compliance items will be inspected, and documented where appropriate:

a. evaluate the facility to determine that the Plan accurately reflects site conditions as described in subpart 6 of this part, and document any inaccuracies;

b. evaluate the facility to determine whether new exposed materials have been added to the site since completion of the Plan, and document any new significant materials;

c. during the inspection conducted during the runoff event, observe the runoff to determine if it is discolored or otherwise visibly contaminated, and document observations; and,

d. determine if the non-structural and structural BMPs as indicated in the Plan are installed and functioning properly.

6.4 The Permittee shall ensure that temporary protection and permanent cover for the exposed areas at the site are maintained.

6.5 Indicate the date and time of the inspection as well as the name of the inspector on the inspection form.

6.6 When the depth of sediment collected in the final sedimentation basin above the outfall reaches one-half of the riser height, or one-half of the basin design hydraulic storage volume, the Permittee shall drain the basin and remove the sediment within sixty (60) days of discovery. No outflow from the sedimentation basin shall occur while sediment is being removed from that basin. The sediment removed from the basin shall be disposed of at a site which drains to sedimentation basin(s) at the facility.

6.7 If conditions are observed at the site that require changes in the Plan, such changes shall be made to the Plan prior to submission of the annual report for that calendar year.

6.8 The Permittee shall minimize vehicle tracking of gravel, soil or mud onto paved surfaces at the facility.

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Chapter 6. Stormwater Management

6. Inspection and Maintenance

6.9 If the findings of a site inspection indicate that BMPs are not meeting the objectives as identified in subpart 9 of this part, corrective actions must be initiated within 30 days and the BMP restored to full operation as soon as field conditions allow.

6.10 The Permittee shall remove tracked material from the road surface and return it to the facility within one (1) day of discovery so that the materials drain to sedimentation basin(s) at the facility.

7. Sedimentation Basin Design and Construction

New Sedimentation Basins

7.1 Sedimentation basins shall be designed by a registered professional engineer, and installed under the direct supervision of a registered professional engineer.

7.2 The basin shall provide at least 1800 cubic feet, per acre drained, of hydraulic storage volume below the top of the outlet riser pipe.

7.3 Inlet(s) and outlet(s) shall be designed to prevent short circuiting and the discharge of floating debris.

7.4 The inlet(s) shall be placed at an elevation at least above one-half of the basin design hydraulic storage volume.

7.5 The outlet(s) shall consist of a perforated riser pipe wrapped with filter fabric and covered with crushed gravel. The perforated riser pipe shall be designed to allow complete drawdown of the basin(s).

7.6 Permanent erosion control, such as rip rap, splash pads or gabions shall be installed at the outlet(s) to prevent downstream erosion.

7.7 The basins shall be designed to allow for regular removal of accumulated sediment by a backhoe or other suitable equipment.

8. Application of Chemical Dust Suppressants

8.1 If chemical dust suppressants are applied, the Permittee shall submit a Chemical Dust Suppressant Annual Report due 31 days after the end of each calendar year following the application of a chemical dust suppressant.

8.2 The Chemical Dust Suppressant Annual Report shall include:

a. a record of the dates, methods, locations and amounts by volume of chemical application at the facility;

b. whether the product was applied in the preceding year; and,

c. the results of a chemical analysis of the materials applied each year.

8.3 If a material applied is mixed with water or another solvent before application, the chemical analysis shall be done on the aqueous or other mixture that is representative of the solution applied. This analysis shall be conducted during the same calendar year of application. This analysis shall include the parameters that may be determined by U.S. Environmental Protection Agency (EPA) Methods 624 and 625 which are described in 40 CFR Part 136.

8.4 Chemical dust suppressants, if used, shall not be applied within 100 feet of the surface receiving waters identified in the 'Facility Description' section of this permit. These materials also shall not be applied within 100 feet of ditches that conduct surface flow to the surface receiving waters identified on Page 1 of this permit.

9. Reporting

9.1 Submit a Stormwater Annual Report by March 31 of each year following permit issuance. A copy of the Stormwater Annual Report Form is provided in the appendices section of this permit.

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Chapter 6. Stormwater Management

9. Reporting

9.2 The Permittee shall, upon request of the Agency, submit within a reasonable time the information and reports that are relevant to compliance with this Chapter, including the Plan, inspection reports, annual reports, original laboratory sheets from analyses conducted on the waste stream, and BMP plans and specifications.

10. Records

10.1 The Plan shall be retained for the duration of the permit. A copy of the Plan shall remain on the permitted site whenever Permittee staff are available on the site, and be available upon request. The Permittee shall maintain the following records for the period of permit coverage:

a. dates of inspections;

b. findings of inspections;

c. corrective actions taken;

d. documentation of all changes to the Plan; and,

e. a copy of annual reports.

11. Notification

11.1 If the Permittee discharges stormwater into a municipal storm sewer, the Permittee shall notify the operator of the municipal storm sewer of the existence of this permit.

12. Request for Termination of Stormwater Permit Coverage

12.1 All Permittees regulated by 40 CFR 122.26(b)(14)(i) through (ix) and (xi) may request termination of permit coverage by applying for the no exposure exclusion from permitting. The Permittee must submit (form provided by the Agency) a written certification that a condition of no exposure exists at the facility and that the facility meets the definition of no exposure of industrial activities and materials to storm water.

The application for the no exposure exclusion must be completed by the Permittee and sent to: MPCA, Industrial Storm Water Program, 520 Lafayette Rd N, St Paul, MN 55155-4194.

Failure to complete an accurate application will result in the facility being denied the no exposure exclusion from permitting. The facility must submit the application to the Agency once every five years.

12.2 The no exposure exclusion is conditional. The Permittee must maintain a condition of no exposure at the facility in order for the no exposure exclusion to remain applicable. In the event of any change or circumstance that causes exposure of industrial activities or materials to stormwater, the Permittee must comply with the stormwater requirements of this chapter.

12.3 The no exposure certification is non-transferrable. In the event that the facility operator changes, then the new operator must submit a new no exposure certification to the MPCA, Industrial Stormwater Program, 520 Lafayette Rd N, St Paul, MN 55155-4194.

12.4 The MPCA retains the authority to require the facility operator to comply with the requirements of this chapter, even when an industrial operator certifies no exposure, if the MPCA has determined that the discharge is contributing to the violation of, or interfering with the attainment or maintenance of water quality standards, including designated uses.

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Chapter 6. Stormwater Management

13. Definitions

13.1 "No exposure" means all industrial materials and activities are protected by a storm resistant shelter to prevent exposure to rain, snow, snow melt, and/or runoff. Industrial activities or materials include, but are not limited to, material handling equipment or activities, industrial machinery, raw materials, intermediate products, by-products, final products, or waste products.

13.2 "Non-stormwater discharge" means any discharge not comprised entirely of stormwater discharges authorized by a NPDES permit.

13.3 "Runoff" means any liquid that drains over land from any part of a facility.

Chapter 7. Surface Discharge Stations

1. Requirements for Specific Stations

1.1 SD 001: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

1.2 SD 002: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

1.3 SD 003: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

1.4 SD 012: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

2. Special Requirements

Elimination of SD001

2.1 The Permittee currently discharges filter backwash from the Potable Water Plant via SD001. The filter backwash flows west through a ditch alongside the north side of the railroad tracks and ultimately into Welcome Lake, located on the south side of the railroad tracks, via a culvert. It is the Permittee's intent to re-route the filter backwash so that it does not discharge into Welcome Lake, if possible, by directing the waste stream to an alternative location within the facility's water system.

The Permittee shall notify the MPCA within 14 days of completing any rerouting the filter backwash stream currently discharged via SD001. The notification shall include a description of the new route for the backwash wastewater, and the final point of discharge for this wastewater. Following this notification, the MPCA may minor modify the permit to eliminate SD001 from the regulated outfalls.

During the interim period between completing the rerouting of SD001 wastewater and minor modification of the permit, the Permittee shall report No Discharge for SD001.

3. Sampling Location

3.1 Samples for Station SD001 shall be taken at the culvert flowing south under the railroad tracks towards Welcome Lake during a period of discharge. If a discharge from the culvert occurs at any time during the sampling quarter, a sample must be obtained for analysis.

3.2 Samples for Station SD002 shall be taken at the weir outfall at the old Highway 169 road crossing in the NW 1/4 of the NW 1/4 of Section 30, T57N, R21W.

3.3 Samples for Station SD003 shall be taken at the pipe outfall southwest of the Mesabi Chief Mine Pit.

3.4 Samples for SD012 shall be taken at the outfall of Perry Pit dewatering to O'Brien Creek.

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Chapter 7. Surface Discharge Stations

3. Sampling Location

3.5 Samples and measurements required by this permit shall be representative of the monitored activity.

4. Surface Discharges

4.1 Floating solids or visible foam shall not be discharged in other than trace amounts.

4.2 Oil or other substances shall not be discharged in amounts that create a visible color film.

4.3 The Permittee shall install and maintain outlet protection measures at the discharge stations to prevent erosion.

5. Winter Sampling Conditions

5.1 The Permittee shall sample flows at the designated monitoring stations including when this requires removing ice to sample the water. If the station is completely frozen throughout a designated sampling month, the Permittee shall check the "No Discharge" box on the Discharge Monitoring Report (DMR) and note the ice conditions in Comments on the DMR.

6. Discharge Monitoring Reports

6.1 The Permittee shall submit monitoring results for discharges in accordance with the limits and monitoring requirements for this station. If no discharge occurred during the reporting period, the Permittee shall check the "No Discharge" box on the Discharge Monitoring Report (DMR).

Chapter 8. Waste Stream Stations

1. Requirements for Specific Stations

1.1 WS 005: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

1.2 WS 011: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

1.3 WS 012: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

2. Sampling Location

2.1 Samples for Stations WS005 shall be taken at weir station 901 following the chlorination tank.

2.2 Samples for Station WS011 shall be representative of the plant water to the scrubber system. Samples for Station WS012 shall be taken at a point representative of the treated scrubber blowdown flow to the tailings basin.

3. Sampling Frequency

3.1 Monitoring frequency for WS011 and WS012 shall be taken in accordance with the limits and montioring requirements of this permit, including when coal is not being used as a fuel source in the Phase II indurating grate-kiln.

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Chapter 9. Total Facility Requirements

1. General Requirements

General Requirements

1.1 Incorporation by Reference. The following applicable federal and state laws are incorporated by reference in this permit, are applicable to the Permittee, and are enforceable parts of this permit: 40 CFR pts. 122.41, 122.42, 136, 403 and 503; Minn. R. pts. 7001, 7041, 7045, 7050, 7052, 7053, 7060, and 7080; and Minn. Stat. Sec. 115 and 116.

1.2 Permittee Responsibility. The Permittee shall perform the actions or conduct the activity authorized by the permit in compliance with the conditions of the permit and, if required, in accordance with the plans and specifications approved by the Agency. (Minn. R. 7001.0150, subp. 3, item E)

1.3 Toxic Discharges Prohibited. Whether or not this permit includes effluent limitations for toxic pollutants, the Permittee shall not discharge a toxic pollutant except according to Code of Federal Regulations, Title 40, sections 400 to 460 and Minnesota Rules 7050, 7052, 7053 and any other applicable MPCA rules. (Minn. R. 7001.1090, subp.1, item A)

1.4 Nuisance Conditions Prohibited. The Permittee's discharge shall not cause any nuisance conditions including, but not limited to: floating solids, scum and visible oil film, acutely toxic conditions to aquatic life, or other adverse impact on the receiving water. (Minn. R. 7050.0210 subp. 2)

1.5 Property Rights. This permit does not convey a property right or an exclusive privilege. (Minn. R. 7001.0150, subp. 3, item C)

1.6 Liability Exemption. In issuing this permit, the state and the MPCA assume no responsibility for damage to persons, property, or the environment caused by the activities of the Permittee in the conduct of its actions, including those activities authorized, directed, or undertaken under this permit. To the extent the state and the MPCA may be liable for the activities of its employees, that liability is explicitly limited to that provided in the Tort Claims Act. (Minn. R. 7001.0150, subp. 3, item O)

1.7 The MPCA's issuance of this permit does not obligate the MPCA to enforce local laws, rules, or plans beyond what is authorized by Minnesota Statutes. (Minn. R. 7001.0150, subp.3, item D)

1.8 Liabilities. The MPCA's issuance of this permit does not release the Permittee from any liability, penalty or duty imposed by Minnesota or federal statutes or rules or local ordinances, except the obligation to obtain the permit. (Minn. R. 7001.0150, subp.3, item A)

1.9 The issuance of this permit does not prevent the future adoption by the MPCA of pollution control rules, standards, or orders more stringent than those now in existence and does not prevent the enforcement of these rules, standards, or orders against the Permittee. (Minn. R. 7001.0150, subp.3, item B)

1.10 Severability. The provisions of this permit are severable and, if any provisions of this permit or the application of any provision of this permit to any circumstance are held invalid, the application of such provision to other circumstances and the remainder of this permit shall not be affected thereby.

1.11 Compliance with Other Rules and Statutes. The Permittee shall comply with all applicable air quality, solid waste, and hazardous waste statutes and rules in the operation and maintenance of the facility.

1.12 Inspection and Entry. When authorized by Minn. Stat. Sec. 115.04; 115B.17, subd. 4; and 116.091, and upon presentation of proper credentials, the agency, or an authorized employee or agent of the agency, shall be allowed by the Permittee to enter at reasonable times upon the property of the Permittee to examine and copy books, papers, records, or memoranda pertaining to the construction, modification, or operation of the facility covered by the permit or pertaining to the activity covered by the permit; and to conduct surveys and investigations, including sampling or monitoring, pertaining to the construction, modification, or operation of the facility covered by the permit or pertaining to the activity covered by the permit. (Minn. R. 7001.0150, subp.3, item I)

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Chapter 9. Total Facility Requirements

1. General Requirements

1.13 Control Users. The Permittee shall regulate the users of its wastewater treatment facility so as to prevent the introduction of pollutants or materials that may result in the inhibition or disruption of the conveyance system, treatment facility or processes, or disposal system that would contribute to the violation of the conditions of this permit or any federal, state or local law or regulation.

Sampling

1.14 Representative Sampling. Samples and measurements required by this permit shall be conducted as specified in this permit and shall be representative of the discharge or monitored activity. (40 CFR 122.41 (j)(1))

1.15 Additional Sampling. If the Permittee monitors more frequently than required, the results and the frequency of monitoring shall be reported on the Discharge Monitoring Report (DMR) or another MPCA-approved form for that reporting period. (Minn. R. 7001.1090, subp. 1, item E)

1.16 Certified Laboratory. A laboratory certified by the Minnesota Department of Health shall conduct analyses required by this permit. Analyses of dissolved oxygen, pH, temperature and total residual oxidants (chlorine, bromine) do not need to be completed by a certified laboratory but shall comply with manufacturers specifications for equipment calibration and use. (Minn. Stat. Sec. 144.97 through 144.98 and Minn. R. 4740.2010 and 4740.2050 through 4740.2120) (Minn. R. 4740.2010 and 4740.2050 through 2120)

1.17 Sample Preservation and Procedure. Sample preservation and test procedures for the analysis of pollutants shall conform to 40 CFR Part 136 and Minn. R. 7041.3200.

1.18 Equipment Calibration: Flow meters, pumps, flumes, lift stations or other flow monitoring equipment used for purposes of determining compliance with permit shall be checked and/or calibrated for accuracy at least twice annually. (Minn. R. 7001.0150, subp. 2, items B and C)

1.19 Maintain Records. The Permittee shall keep the records required by this permit for at least three years, including any calculations, original recordings from automatic monitoring instruments, and laboratory sheets. The Permittee shall extend these record retention periods upon request of the MPCA. The Permittee shall maintain records for each sample and measurement. The records shall include the following information (Minn. R. 7001.0150, subp. 2, item C):

a. The exact place, date, and time of the sample or measurement;

b. The date of analysis;

c. The name of the person who performed the sample collection, measurement, analysis, or calculation; and

d. The analytical techniques, procedures and methods used; and

e. The results of the analysis.

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Chapter 9. Total Facility Requirements

1. General Requirements

1.20 Completing Reports. The Permittee shall submit the results of the required sampling and monitoring activities on the forms provided, specified, or approved by the MPCA. The information shall be recorded in the specified areas on those forms and in the units specified. (Minn. R. 7001.1090, subp. 1, item D; Minn. R. 7001.0150, subp. 2, item B)

Required forms may include:

DMR Supplemental Form
Individual values for each sample and measurement must be recorded on the DMR Supplemental Form which, if required, will be provided by the MPCA. DMR Supplemental Forms shall be submitted with the appropriate DMRs. You may design and use your own supplemental form; however it must be approved by the MPCA. Note: Required summary information MUST also be recorded on the DMR. Summary information that is submitted ONLY on the DMR Supplemental Form does not comply with the reporting requirements.

1.21 Submitting Reports. DMRs and DMR Supplemental Forms shall be submitted to:

MPCA
Attn: Discharge Monitoring Reports
520 Lafayette Road North
St. Paul, Minnesota 55155-4194.

DMRs and DMR Supplemental Forms shall be postmarked by the 21st day of the month following the sampling period or as otherwise specified in this permit. A DMR shall be submitted for each required station even if no discharge occurred during the reporting period. (Minn. R. 7001.0150, subps. 2.B and 3.H)

Other reports required by this permit shall be postmarked by the date specified in the permit to:

MPCA
Attn: WQ Submittals Center
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

1.22 Incomplete or Incorrect Reports. The Permittee shall immediately submit an amended report or DMR to the MPCA upon discovery by the Permittee or notification by the MPCA that it has submitted an incomplete or incorrect report or DMR. The amended report or DMR shall contain the missing or corrected data along with a cover letter explaining the circumstances of the incomplete or incorrect report. (Minn. R. 7001.0150 subp. 3, item G)

1.23 Required Signatures. All DMRs, forms, reports, and other documents submitted to the MPCA shall be signed by the Permittee or the duly authorized representative of the Permittee. Minn. R. 7001.0150, subp. 2, item D. The person or persons that sign the DMRs, forms, reports or other documents must certify that he or she understands and complies with the certification requirements of Minn. R. 7001.0070 and 7001.0540, including the penalties for submitting false information. Technical documents, such as design drawings and specifications and engineering studies required to be submitted as part of a permit application or by permit conditions, must be certified by a registered professional engineer. (Minn. R. 7001.0540)

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Chapter 9. Total Facility Requirements

1. General Requirements

1.24 Detection Level. The Permittee shall report monitoring results below the reporting limit (RL) of a particular instrument as "<" the value of the RL. For example, if an instrument has a RL of 0.1 mg/L and a parameter is not detected at a value of 0.1 mg/L or greater, the concentration shall be reported as "<0.1 mg/L." "Non-detected," "undetected," "below detection limit," and "zero" are unacceptable reporting results, and are permit reporting violations. (Minn. R. 7001.0150, subp. 2, item B)

Where sample values are less than the level of detection and the permit requires reporting of an average, the Permittee shall calculate the average as follows:

a. If one or more values are greater than the level of detection, substitute zero for all nondetectable values to use in the average calculation.

b. If all values are below the level of detection, report the averages as "<" the corresponding level of detection.

c. Where one or more sample values are less than the level of detection, and the permit requires reporting of a mass, usually expressed as kg/day, the Permittee shall substitute zero for all nondetectable values. (Minn. R. 7001.0150, subp. 2, item B)

1.25 Records. The Permittee shall, when requested by the Agency, submit within a reasonable time the information and reports that are relevant to the control of pollution regarding the construction, modification, or operation of the facility covered by the permit or regarding the conduct of the activity covered by the permit. (Minn. R. 7001.0150, subp. 3, item H)

1.26 Confidential Information. Except for data determined to be confidential according to Minn. Stat. Sec. 116.075, subd. 2, all reports required by this permit shall be available for public inspection. Effluent data shall not be considered confidential. To request the Agency maintain data as confidential, the Permittee must follow Minn. R. 7000.1300.

Noncompliance and Enforcement

1.27 Subject to Enforcement Action and Penalties. Noncompliance with a term or condition of this permit subjects the Permittee to penalties provided by federal and state law set forth in section 309 of the Clean Water Act; United States Code, title 33, section 1319, as amended; and in Minn. Stat. Sec. 115.071 and 116.072, including monetary penalties, imprisonment, or both. (Minn. R. 7001.1090, subp. 1, item B)

1.28 Criminal Activity. The Permittee may not knowingly make a false statement, representation, or certification in a record or other document submitted to the Agency. A person who falsifies a report or document submitted to the Agency, or tampers with, or knowingly renders inaccurate a monitoring device or method required to be maintained under this permit is subject to criminal and civil penalties provided by federal and state law. (Minn. R. 7001.0150, subp.3, item G., 7001.1090, subps. 1, items G and H and Minn. Stat. Sec. 609.671)

1.29 Noncompliance Defense. It shall not be a defense for the Permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit. (40 CFR 122.41(c))

1.30 Effluent Violations. If sampling by the Permittee indicates a violation of any discharge limitation specified in this permit, the Permittee shall immediately make every effort to verify the violation by collecting additional samples, if appropriate, investigate the cause of the violation, and take action to prevent future violations. Violations that are determined to pose a threat to human health or a drinking water supply, or represent a significant risk to the environment shall be immediately reported to the Minnesota Department of Public Safety Duty Officer at 1(800)422-0798 (toll free) or (651)649-5451 (metro area). In addition, you may also contact the MPCA during business hours. Otherwise the violations and the results of any additional sampling shall be recorded on the next appropriate DMR or report.

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Chapter 9. Total Facility Requirements

1. General Requirements

1.31 Unauthorized Releases of Wastewater Prohibited. Except for conditions specifically described in Minn. R. 7001.1090, subp. 1, items J and K, all unauthorized bypasses, overflows, discharges, spills, or other releases of wastewater or materials to the environment, whether intentional or not, are prohibited. However, the MPCA will consider the Permittee's compliance with permit requirements, frequency of release, quantity, type, location, and other relevant factors when determining appropriate action. (40 CFR 122.41 and Minn. Stat. Sec 115.061)

1.32 Discovery of a release. Upon discovery of a release, the Permittee shall:

a. Take all reasonable steps to immediately end the release.

b. Notify the Minnesota Department of Public Safety Duty Officer at 1(800)422-0798 or (651)649-5451 (metro area) immediately upon discovery of the release. You may contact the MPCA during business hours at 1(800)657-3864 or (651)296-6300 (metro area).

c. Recover as rapidly and as thoroughly as possible all substances and materials released or immediately take other action as may be reasonably possible to minimize or abate pollution to waters of the state or potential impacts to human health caused thereby. If the released materials or substances cannot be immediately or completely recovered, the Permittee shall contact the MPCA. If directed by the MPCA, the Permittee shall consult with other local, state or federal agencies (such as the Minnesota Department of Natural Resources and/or the Wetland Conservation Act authority) for implementation of additional clean-up or remediation activities in wetland or other sensitive areas.

d. Collect representative samples of the release. The Permittee shall sample the release for parameters of concern immediately following discovery of the release. The Permittee may contact the MPCA during business hours to discuss the sampling parameters and protocol. In addition, Fecal Coliform Bacteria samples shall be collected where it is determined by the Permittee that the release contains or may contain sewage. If the release cannot be immediately stopped, the Permittee shall consult with MPCA regarding additional sampling requirements. Samples shall be collected at least, but not limited to, two times per week for as long as the release continues.

e. Submit the sampling results as directed by the MPCA. At a minimum, the results shall be submitted to the MPCA with the next DMR.

1.33 Upset Defense. In the event of temporary noncompliance by the Permittee with an applicable effluent limitation resulting from an upset at the Permittee's facility due to factors beyond the control of the Permittee, the Permittee has an affirmative defense to an enforcement action brought by the Agency as a result of the noncompliance if the Permittee demonstrates by a preponderance of competent evidence:

a. The specific cause of the upset;

b. That the upset was unintentional;

c. That the upset resulted from factors beyond the reasonable control of the Permittee and did not result from operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or increases in production which are beyond the design capability of the treatment facilities;

d. That at the time of the upset the facility was being properly operated;

e. That the Permittee properly notified the Commissioner of the upset in accordance with Minn. R. 7001.1090, subp. 1, item I; and

f. That the Permittee implemented the remedial measures required by Minn. R. 7001.0150, subp. 3, item J.

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Chapter 9. Total Facility Requirements

1. General Requirements

Operation and Maintenance

1.34 The Permittee shall at all times properly operate and maintain the facilities and systems of treatment and control, and the appurtenances related to them which are installed or used by the Permittee to achieve compliance with the conditions of the permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. The Permittee shall install and maintain appropriate backup or auxiliary facilities if they are necessary to achieve compliance with the conditions of the permit and, for all permits other than hazardous waste facility permits, if these backup or auxiliary facilities are technically and economically feasible Minn. R. 7001.0150. subp. 3, item F.

1.35 In the event of a reduction or loss of effective treatment of wastewater at the facility, the Permittee shall control production or curtail its discharges to the extent necessary to maintain compliance with the terms and conditions of this permit. The Permittee shall continue this control or curtailment until the wastewater treatment facility has been restored or until an alternative method of treatment is provided. (Minn. R. 7001.1090, subp. 1, item C)

1.36 Solids Management. The Permittee shall properly store, transport, and dispose of biosolids, septage, sediments, residual solids, filter backwash, screenings, oil, grease, and other substances so that pollutants do not enter surface waters or ground waters of the state. Solids should be disposed of in accordance with local, state and federal requirements. (40 CFR 503 and Minn. R. 7041 and applicable federal and state solid waste rules)

1.37 Scheduled Maintenance. The Permittee shall schedule maintenance of the treatment works during non-critical water quality periods to prevent degradation of water quality, except where emergency maintenance is required to prevent a condition that would be detrimental to water quality or human health. (Minn. R. 7001.0150. subp. 3, item F and Minn. R. 7001.0150. subp. 2, item B)

1.38 Control Tests. In-plant control tests shall be conducted at a frequency adequate to ensure compliance with the conditions of this permit. (Minn. R. 7001.0150. subp. 3, item F and Minn. R. 7001.0150. subp. 2, item B)

Changes to the Facility or Permit

1.39 Permit Modifications. No person required by statute or rule to obtain a permit may construct, install, modify, or operate the facility to be permitted, nor shall a person commence an activity for which a permit is required by statute or rule until the Agency has issued a written permit for the facility or activity. (Minn. R. 7001.0030)

Permittees that propose to make a change to the facility or discharge that requires a permit modification must follow Minn. R. 7001.0190. If the Permittee cannot determine whether a permit modification is needed, the Permittee must contact the MPCA prior to any action. It is recommended that the application for permit modification be submitted to the MPCA at least 180 days prior to the planned change.

1.40 Construction. No construction shall begin until the Permittee receives written approval of plans and specifications from the MPCA (Minn. Stat. Sec. 115.03(f)).

Plans, specifications and MPCA approval are not necessary when maintenance dictates the need for installation of new equipment, provided the equipment is the same design size and has the same design intent. For instance, a broken pipe, lift station pump, aerator, or blower can be replaced with the same design-sized equipment without MPCA approval.

If the proposed construction is not expressly authorized by this permit, it may require a permit modification. If the construction project requires an Environmental Assessment Worksheet under Minn. R. 4410, no construction shall begin until a negative declaration is issued and all approvals are received or implemented.

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Chapter 9. Total Facility Requirements

1. General Requirements

1.41 Report Changes. The Permittee shall give advance notice as soon as possible to the MPCA of any substantial changes in operational procedures, activities that may alter the nature or frequency of the discharge, and/or material factors that may affect compliance with the conditions of this permit. (Minn. R. 7001.0150, subp. 3, item M)

1.42 Chemical Additives. The Permittee shall receive prior written approval from the MPCA before increasing the use of a chemical additive authorized by this permit, or using a chemical additive not authorized by this permit, in quantities or concentrations that have the potential to change the characteristics, nature and/or quality of the discharge.

The Permittee shall request approval for an increased or new use of a chemical additive at least 60 days, or as soon as possible, before the proposed increased or new use.

This written request shall include at least the following information for the proposed additive:

a. The process for which the additive will be used;
b. Material Safety Data Sheet (MSDS) which shall include aquatic toxicity, human health, and environmental fate information for the proposed additive;
c. A complete product use and instruction label;
d. The commercial and chemical names and Chemical Abstract Survey (CAS) number for all ingredients in the additive (If the MSDS does not include information on chemical composition, including percentages for each ingredient totaling to 100%, the Permittee shall contact the supplier to have this information provided); and
e. The proposed method of application, application frequency, concentration, and daily average and maximum rates of use.

Upon review of the information submitted regarding the proposed chemical additive, the MPCA may require additional information be submitted for consideration. This permit may be modified to restrict the use or discharge of a chemical additive and include additional influent and effluent monitoring requirements.

Approval for the use of an additive shall not justify the exceedance of any effluent limitation nor shall it be used as a defense against pollutant levels in the discharge causing or contributing to the violation of a water quality standard. (Minn. R. 7001.0170)

1.43 MPCA Initiated Permit Modification, Suspension, or Revocation. The MPCA may modify or revoke and reissue this permit pursuant to Minn. R. 7001.0170. The MPCA may revoke without reissuance this permit pursuant to Minn. R. 7001.0180.

1.44 TMDL Impacts. Facilities that discharge to an impaired surface water, watershed or drainage basin may be required to comply with additional permits or permit requirements, including additional restriction or relaxation of limits and monitoring as authorized by the CWA 303(d)(4)(A) and 40 CFR 122.44.l.2.i., necessary to ensure consistency with the assumptions and requirements of any applicable US EPA approved wasteload allocations resulting from Total Maximum Daily Load (TMDL) studies.

1.45 Permit Transfer. The permit is not transferable to any person without the express written approval of the Agency after compliance with the requirements of Minn. R. 7001.0190. A person to whom the permit has been transferred shall comply with the conditions of the permit. (Minn. R., 7001.0150, subp. 3, item N)

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Chapter 9. Total Facility Requirements

1. General Requirements

1.46 Facility Closure. The Permittee is responsible for closure and postclosure care of the facility. The Permittee shall notify the MPCA of a significant reduction or cessation of the activities described in this permit at least 180 days before the reduction or cessation. The MPCA may require the Permittee to provide to the MPCA a facility Closure Plan for approval.

Facility closure that could result in a potential long-term water quality concern, such as the ongoing discharge of wastewater to surface or ground water, may require a permit modification or reissuance.

The MPCA may require the Permittee to establish and maintain financial assurance to ensure performance of certain obligations under this permit, including closure, postclosure care and remedial action at the facility. If financial assurance is required, the amount and type of financial assurance, and proposed modifications to previously MPCA-approved financial assurance, shall be approved by the MPCA. (Minn. Stat. Sec. 116.07, subd. 4)

1.47 Permit Reissuance. If the Permittee desires to continue permit coverage beyond the date of permit expiration, the Permittee shall submit an application for reissuance at least 180 days before permit expiration. If the Permittee does not intend to continue the activities authorized by this permit after the expiration date of this permit, the Permittee shall notify the MPCA in writing at least 180 days before permit expiration.

If the Permittee has submitted a timely application for permit reissuance, the Permittee may continue to conduct the activities authorized by this permit, in compliance with the requirements of this permit, until the MPCA takes final action on the application, unless the MPCA determines any of the following (Minn. R. 7001.0040 and 7001.0160):

a. The Permittee is not in substantial compliance with the requirements of this permit, or with a stipulation agreement or compliance schedule designed to bring the Permittee into compliance with this permit;

b. The MPCA, as a result of an action or failure to act by the Permittee, has been unable to take final action on the application on or before the expiration date of the permit;

c. The Permittee has submitted an application with major deficiencies or has failed to properly supplement the application in a timely manner after being informed of deficiencies.

STATE OF MINNESOTA

Minnesota Pollution Control Agency

Industrial Division

National Pollutant Discharge Elimination System (NPDES)/
State Disposal System (SDS) Permit MN0055948

PERMITTEE:	United States Steel Corporation
FACILITY NAME:	Minnesota Ore Operations – Keetac – Tailings Basin
RECEIVING WATER:	Reservoir 2, Welcome Creek

CITY OR TOWNSHIP:	Keewatin	**COUNTY:**	Itasca
ISSUANCE DATE:		**EXPIRATION DATE:**	

The state of Minnesota, on behalf of its citizens through the Minnesota Pollution Control Agency (MPCA), authorizes the Permittee to construct, install and operate a disposal system at the facility named above and to discharge from this facility to the receiving water named above, in accordance with the requirements of this permit.

The goal of this permit is to reduce pollutant levels in point source discharges and protect water quality in accordance with Minnesota and U.S. statutes and rules, including Minn. Stat. chs. 115 and 116, Minn. R. chs. 7001, 7050, 7053, 7060, 7090.3000 through 7090.3080, and the U.S. Clean Water Act.

This permit is effective on the issuance date identified above, and supersedes the previous permit that was issued for this facility on March 10, 2006. This permit expires at midnight on the expiration date identified above.

Signature: _____

Jeff Udd, P.E. *for* The Minnesota Pollution Control Agency
Acting Supervisor, Water Quality Permits Unit
Land and Water Quality Permits Section
Industrial Division

Submit DMRs to:
Attention: Discharge Monitoring Reports
Minnesota Pollution Control Agency
520 Lafayette Rd N
St Paul, MN 55155-4194

Submit Other WQ Reports to:
Attention: WQ Submittals Center
Minnesota Pollution Control Agency
520 Lafayette Rd N
St Paul, MN 55155-4194

Questions on this permit?

- For DMR and other permit reporting issues, contact: Belinda Nicholas, 651-757-2613.
- For specific permit requirements or permit compliance status, contact: John Thomas, 218-302-6616.
- General permit or NPDES program questions, contact: MPCA, 651-282-6143 or 1-800-657-3938.

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Facility Description

The principal activity at this facility is the disposal of taconite tailings and related wastewater from the U.S. Steel Corporation – Keewatin Taconite Operations plant. The facility consists of the Keewatin Taconite tailings basin, the drainage area contributing surface run-off to the basin, and all non-sewage wastewater disposal systems within the permitted area. The facility has proposed an expansion of the mining and taconite pellet manufacturing operations at the processing plant associated with this tailings basin. The conditions of this permit reflect the changes associated with this expansion.

The tailings and related wastewater that are disposed of in the tailings basin are generated by the Keewatin Taconite plant, which is located north of Highway 169. The plant consists of a series of crushers and screens, a concentrator, and an agglomerator. The concentrator consists of a series of mills, magnetic separators, hydroseparators, hydroclones, screens, and thickeners. A flocculant is added to the concentrator tailings slurry before the thickening stage, at a maximum rate of 250,000 lbs/yr. The agglomerator receives the concentrate, which is mixed with limestone then dewatered by disc filters. The filter cake is then mixed with bentonite and formed into pellets in balling drums. The agglomerator wastewater, as well as wet scrubber, recirculating non-contact cooling water, and normal floor drain wastewater that is generated at the plant, is recirculated as process water within the plant. The make-up water for the recirculating non-contact cooling water system in the plant is treated with softening, along with chemical additives, such as corrosion inhibitors, descalers, and microbiocides are also added. Chemicals used in the wet scrubber system are added for pH control, clarification, and coagulation aid. Corrosion inhibitor/descaler chemicals are used in the vacuum seal water system. A kiln slag inhibitor chemical is used at approximately 1,175 pounds per day or 430,000 pounds per year.

The wastewater flow to the tailings basin consists only of the tailings slurry, associated concentrator process wastewater, and wet scrubber blowdown water for a total average flow rate of 20 MGD. The tailings slurry and plant process wastewater is piped under pressure from the plant across Highway 169 and is spigotted into the tailings basin. The dual tailings pipelines have several gravity flow drainage points along their route that are used during routine maintenance, winter operations, and emergency situations, such as pump failure. Dump valve drainage points 4, 5, 6W, 6E, 7, and 8 flow by gravity directly to the tailings basin. An average of 13 million long tons of dry tailings are disposed of each year in the basin. The tailings are generated from the plant thickeners. The basin is divided into several parts, principally the older Stage 1 and the active Stage 2 basins. Much of the Stage 1 basin has undergone re-vegetation. Water is occasionally pumped from Reservoir 2 to Reservoir 6 for water level maintenance, at an average rate of 814 million gallons per year. The tailings basin is principally underlain by glacial till and glaciofluvial deposits.

The interior tailings basin dikes are constructed of coarse tailings which are spigotted from the tailings pipelines. The exterior basin dikes are constructed of clay starter dikes with a coarser sand and gravel chimney drain. A decant tower on the south side of the second stage interior tailings basin drains basin wastewater to the second stage exterior pond for additional sedimentation. A decant tower on the west side of the basin area drains water from the second stage exterior to Reservoir 6 for reuse. Return water for the plant water supply is pumped from a

station on Reservoir 6. This reservoir discharges through siphon outfall SD001, at a combined maximum rate of 9.4 MGD, to Reservoir 2. Outfall SD005 was established to discharge to Reservoir 2 North and Welcome Creek, to Reservoir 2, at a maximum flow of approximately 23 MGD. The proposed expansion to the mining and pellet manufacturing process will result in a vertical expansion of the tailings basin, and changes to the volumes discharged to and from the tailings basin. Discharges to surface water from the tailings basin following the expansion will not exceed the pre-expansion volumes.

Due to the proposed discharge location, direct discharge of mine pit dewatering from the Sargent Pit to an unnamed ditch is authorized under this permit. This activity is similar to other mine pit dewatering operations authorized in NPDES/SDS Permit MN0031879.

Surface drainage from the tailings basin area, in the form of surface run-off from the exterior dikes, flows to the West Swan River, unnamed wetlands, Hay Creek to Swan Lake, Reservoir 2, Reservoir 2 North, and Welcome Creek. These are all class 2B, 3B, 4A, 4B, 5, and 6 waters, except for Welcome Creek, which is class 2C, 3C, 4A, 4B, 5, and 6 waters.

Surface water station SW001 is located at the weir outlet of Reservoir 2 and was established at the request of the Permittee. No limits are associated with this monitoring station.

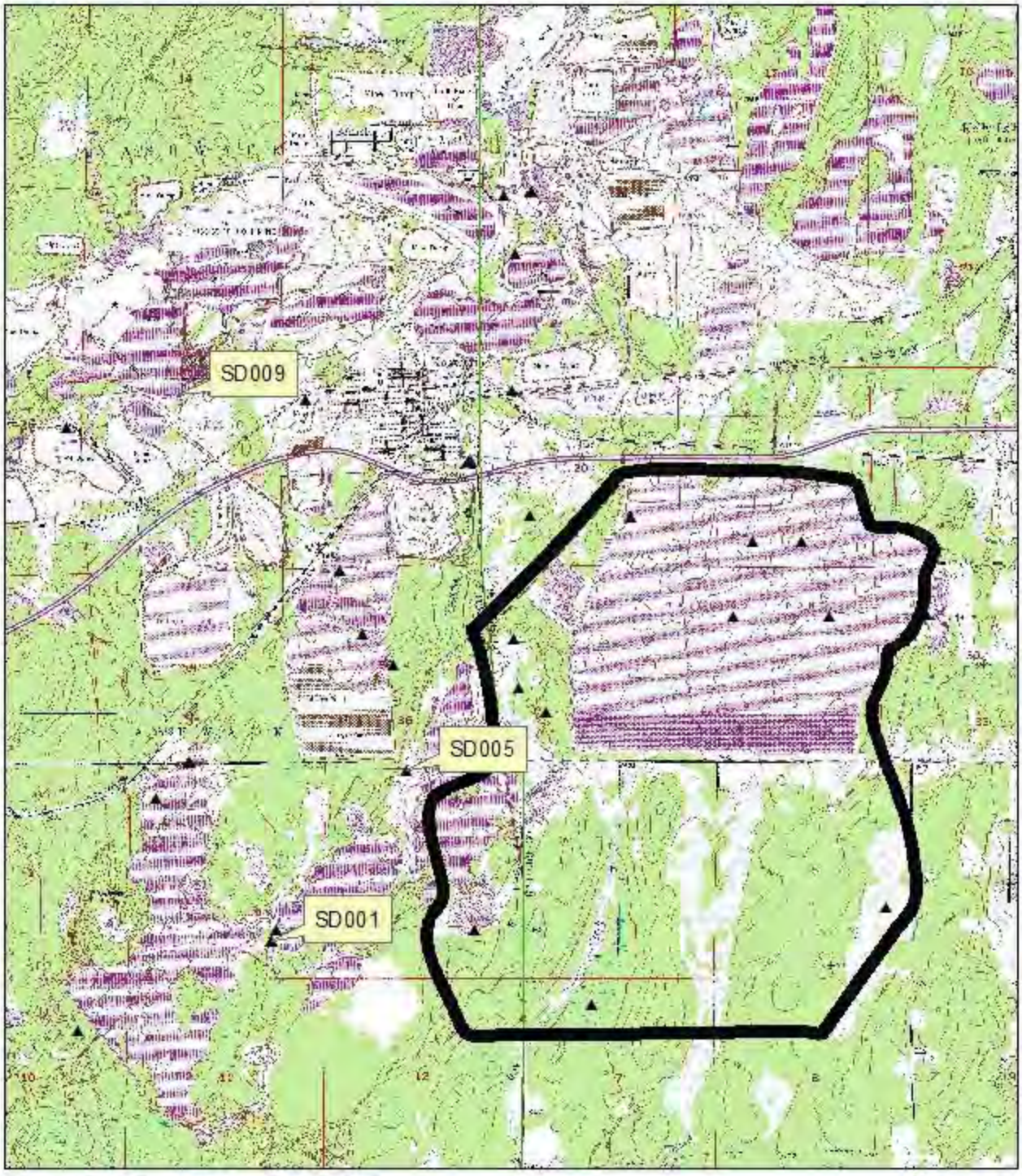
Chemical dust suppressants are occasionally used at the facility in accordance with MPCA approvals.

Repair shops and a garage are located in the Southwest ¼ of the Southeast ¼ of Section 36. Sewage generated at this site is contained in portable units and disposed of in a nearby municipal wastewater treatment facility.

The locations of the facility’s tailings basin discharge sites are shown on the following page.

Topographic Map of Permitted Facility

MN0055948, United States Steel Corporation - Keetac Tailings Basin
St. Louis & Itasca County, Minnesota



Map produced by: MPCA Staff, 6/23/2011
Source: USGS Keewatin, Silica Quad
Scale: 1:50,000

Keewatin Taconite Operations - Tailings
Summary of Stations

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Surface Discharge Stations

Station	Type of Station	Local Name	PLS Location
SD001	Effluent To Surface Water	Siphon Outfalls 011, 012, 013	SE Quarter of Section 2, Township 56 North, Range 22 West
SD005	Effluent To Surface Water	Culvert Outfall from Reservoir 6	NE Quarter of the NE Quarter of the NW Quarter of Section 1, Township 56 North, Range 22 West
SD008	Effluent To Surface Water	Sum of outfalls 011-013, 015	SE Quarter of Section 2, Township 56 North, Range 22 West
SD009	Effluent To Surface Water	Sargent Pit Dewatering to Unnamed Ditch	

Surface Water Stations

Station	Type of Station	Local Name	PLS Location
SW001	Lake/Reservoir	Reservoir 2	NE Quarter of Section 10, Township 56 North, Range 22 West

Waste Stream Stations

Station	Type of Station	Local Name	PLS Location
WS001	Water Intake	Non-pptn water inputs to the facility	SE Quarter of Section 2, Township 56 North, Range 22 West

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The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Interim Period

SD 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Estimate	1 x Month	4
Flow	Monitor Only	mgd	Calendar Month Maximum	Jan-Dec	Estimate	1 x Month	4
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Estimate	1 x Month	4
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	4
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	4
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Month	5
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	4
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	4
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	4
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	4
Specific Conductance	Monitor Only	umh/cm	Calendar Month Average	Jan-Dec	Grab	1 x Month	4
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	4
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	4

SD 005

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Estimate	1 x Week	
Flow	Monitor Only	mgd	Calendar Month Maximum	Jan-Dec	Estimate	1 x Week	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Estimate	1 x Week	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Selenium, Total (as Se)	Monitor Only	ug/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	7
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Average	Jan-Dec	Grab	1 x Month	

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The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Interim Period

SD 005

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	

SD 009

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Chloride, Total	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	Grab	1 x Month	
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	3
Nitrite Plus Nitrate, Total (as N)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
Nitrogen, Ammonia, Total (as N)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
Nitrogen, Kjeldahl, Total	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Selenium, Total (as Se)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	7
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Average	Jan-Dec	Grab	1 x Month	7
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	

Period: Limits Applicable in the Final Period

SD 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Estimate	1 x Month	4
Flow	Monitor Only	mgd	Calendar Month Maximum	Jan-Dec	Estimate	1 x Month	4

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The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Final Period

SD 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Estimate	1 x Month	4
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	4
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	4
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Month	5
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	4
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	4
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	4
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	4
Specific Conductance	Monitor Only	umh/cm	Calendar Month Average	Jan-Dec	Grab	1 x Month	4
Sulfate, Total (as SO4)	14	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	4
Sulfate, Total (as SO4)	24	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	4

SD 005

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Estimate	1 x Week	
Flow	Monitor Only	mgd	Calendar Month Maximum	Jan-Dec	Estimate	1 x Week	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Estimate	1 x Week	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Selenium, Total (as Se)	Monitor Only	ug/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	7
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Sulfate, Total (as SO4)	14	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	24	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	

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The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Final Period

SD 008

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Evaporation, Accumulated	Monitor Only	in	Calendar Month Total	Jan-Dec	Calculation	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Calculation	1 x Month	6
Precipitation	Monitor Only	in	Calendar Month Total	Jan-Dec	Measurement, Continuous	1 x Month	

SD 009

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Chloride, Total	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	Grab	1 x Month	
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	3
Nitrite Plus Nitrate, Total (as N)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
Nitrogen, Ammonia, Total (as N)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
Nitrogen, Kjeldahl, Total	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Selenium, Total (as Se)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	7
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Average	Jan-Dec	Grab	1 x Month	7
Sulfate, Total (as SO4)	14	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	24	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	

SW 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Estimate	1 x Month	

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The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Final Period

SW 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Estimate	1 x Month	
Solids, Total Suspended (TSS)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Turbidity	Monitor Only	NTU	Calendar Month Average	Jan-Dec	Grab	1 x Month	

WS 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	8

Notes:
1 -- At least one sample shall be collected in each April and September.
2 -- Samples may be taken any time during each calendar quarter but must be reported on the DMR for the last month of each quarter (e.g. the sample for the first calendar quarter of Jan - Mar should be reported on the March DMR). Use EPA method 1631, with clean techniques method 1669, and any revisions to those methods.
3 -- Samples may be taken any time during each calendar quarter but must be reported on the DMR for the last month of each quarter (e.g. the sample for the first calendar quarter of Jan - Mar should be reported on the March DMR). Use EPA method 1631, with clean techniques method 1669, and any revisionsto this methods.
4 -- Sampling shall be conducted in accordance with Chapter 5 of this permit.
5 -- Sampling shall be conducted in accordance with Chapter 5 of this permit. Use EPA method 1631, with clean techniques method 1669, and any revisions to those methods.
6 -- Sum of annual discharge from outfalls 010, 011, 012, 013 and 015 shall not exceed the annual net precipitation at the facility as calculated according to PART I, C.8.
7 -- The permittee may request to modify this requirement after 12 months of monitoring data have been submitted to MPCA.
8 -- Volume of non-precipitation water inputs to the facility (for example, from Reservoir 2 or from Reservoir 5).

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Chapter 1. Special Requirements

1. Compliance Schedule

Compliance Schedule for Sulfate

1.1 The Permittee is operating under a schedule of compliance pursuant to NPDES/SDS Permit MN0031879 to attain compliance with final effluent limitations for total sulfate. The Permittee shall comply with the schedule of compliance contained in Chapter 1 of NPDES/SDS Permit MN0031879. Pursuant to that schedule, the MPCA will submit notification to the Permittee that the final effluent limitations for total sulfate contained in this permit apply.

2. Special Requirements

Effluent Limit Study

2.1 The Permittee may opt to conduct a study to gather data and information that would support a total sulfate limit other than the final limitations included in this permit.

2.2 When cause exists according to state and federal law regarding modification of permits, this permit may be reopened for modification of effluent limitations, discharge restrictions, monitoring requirements, and or conditions of a schedule of compliance. Any modified permit conditions shall be consistent with all applicable state and federal requirements. MPCA shall comply with all procedural requirements under state and federal law prior to reopening and modifying this permit.

Chapter 2. Industrial Process Wastewater

1. Prohibited Discharges

1.1 This permit does not authorize the discharge of sewage, wash water, scrubber water, spills, oil, hazardous substances, or equipment/vehicle cleaning and maintenance wastewaters to ditches, wetlands or other surface waters of the state.

1.2 The Permittee shall prevent the routing of pollutants from the facility to a municipal wastewater treatment system in any manner unless authorized by the pretreatment standards of the MPCA and the municipal authority.

1.3 The Permittee shall not transport pollutants to a municipal wastewater treatment system that will interfere with the operation of the treatment system or cause pass-through violations of effluent limits or water quality standards.

2. Toxic Substance Reporting

2.1 The Permittee shall notify the MPCA immediately of any knowledge or reason to believe that an activity has occurred that would result in the discharge of a toxic pollutant listed in Minnesota Rules, pt. 7001.1060, subp. 4 to 10 or listed below that is not limited in the permit, if the discharge of this toxic pollutant has exceeded or is expected to exceed the following levels:

a. for acrolein and acrylonitrile, 200 ug/L;

b. for 2,4-dinitrophenol and 2-methyl-4,6-dinitrophenol, 500 ug/L;

c. for antimony, 1mg/L;

d. for any other toxic pollutant listed in Minnesota Rules, pt. 7001.1060, subp. 4 to 10, 100 ug/L; or

e. five times the maximum concentration value identified and reported for that pollutant in the permit application. (Minnesota Rules, pt. 7001.1090, subp. 2.A)

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Chapter 2. Industrial Process Wastewater

2. Toxic Substance Reporting

2.2 The Permittee shall notify the MPCA immediately if the Permittee has begun or expects to begin to use or manufacture as an intermediate or final by-product a toxic pollutant that was not reported in the permit application under Minnesota Rules, pt. 7001.1050, subp. 2.J. (Minnesota Rules, pt. 7001.1090, subp. 2.B)

3. Hydrotest Discharges

3.1 The Permittee shall notify the MPCA prior to discharging hydrostatic test waters. The Permittee shall provide information necessary to evaluate the potential impact of this discharge and to ensure compliance with this permit. This information shall include:

a. the proposed discharge dates;

b. the name and location of receiving waters, including city or township, county, and township/range location;

c. an evaluation of the impact of the discharge on the receiving waters in relation to the water quality standards;

d. a map identifying discharge location(s) and monitoring point(s);

e. the estimated average and maximum discharge rates;

f. the estimated total flow volume of discharge;

g. the water supply for the test water, with a copy of the appropriate Minnesota Department of Natural Resources (DNR) water appropriation permit;

h. water quality data for the water supply;

i. proposed treatment method(s) before discharge; and

j. methods to be used to prevent scouring and erosion due to the discharge.

3.2 This permit does not authorize the construction or installation of pipeline facilities.

4. Polychlorinated Biphenyls (PCBs)

4.1 PCBs, including but not limited to those used in electrical transformers and capacitors, shall not be discharged or released to the environment.

5. New Proposed Dewatering

5.1 The Permittee shall obtain a permit modification before discharging from a new dewatering outfall.

5.2 In addition to the requirements in the Permit Modifications section of this permit, the Permittee shall submit to the MPCA detailed plans and specifications for the proposed methods of achieving discharge limits for turbidity and total suspended solids, based in part upon representative water quality data for untreated wastewater and a detailed map and diagram description of the proposed design for the flow control structures, and route of the discharge to receiving waters.

6. Application for Permit Reissuance

6.1 The permit application shall include analytical data as part of the application for reissuance of this permit. These analyses shall be done on individual samples taken during the twelve-month period before the reissuance application is submitted.

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Chapter 2. Industrial Process Wastewater

6. Application for Permit Reissuance

6.2 The permit application shall include analytical data for at least the following parameters at monitoring station SD005:

a. biochemical oxygen demand, chemical oxygen demand, total organic carbon, gasoline range organics, diesel range organics, fecal coliform, ammonia, temperature;

b. color, fluoride, nitrate-nitrite (as nitrogen), total organic nitrogen, oil and grease, total phosphorus, chloride, sulfate, sulfide (as sulfur), surfactants, bicarbonates, alkalinity, total salinity, total dissolved solids, specific conductance;

c. aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, strontium, thallium, tin, titanium, vanadium, zinc (all in total form) using approved methods according to 40 CFR Part 136.3;

d. total mercury using EPA Method 1631;

e. gross alpha particles, radium-226, radium-228, radon-222, uranium;

f. PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254, PCB-1260; and

g. a scan of constituents using EPA Methods 624 and 625, in 40 CFR Part 136.

The Permittee shall identify, in addition to those pollutants noted in Methods 624 and 625 (Appendix D, Table II), the concentrations of at least ten of the most abundant constituents of the acid and base/neutral organic fractions shown to be present by peaks on the total ion plots (reconstructed gas chromatograms) within ten percent of the nearest internal standard. Identification shall be through the use of U.S. EPA/NIH computerized library of mass spectra, with visual confirmation and potential quantification.

6.3 The Permittee shall include, as part of the application for reissuance of this permit, and updated Operating Plan for the tailings basin for the next five (5) years.

Chapter 3. Metallic Mining

1. Mine Tailings Basin

1.1 To summarize the status of the tailings basin, the Permittee shall submit an Annual Report by January 31 of year following permit issuance.

1.2 The Annual Report shall include a current map of the tailings basin area that details the dikes, berms, dams, roads and cells, as well as the current topographic and water level elevations.

1.3 The Annual Report for the tailings basin shall also report the annual net precipitation determined from the previous calendar year and the annual flow volume discharged via outfalls SD001 and SD005.

1.4 The Permittee shall conduct a detailed field survey of seepage zones from the perimeter dikes of the tailings basin during October of each year.

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Chapter 3. Metallic Mining

1. Mine Tailings Basin

1.5 The Annual Report shall include a Dike Seepage Survey Report. The Dike Seepage Survey Report shall summarize the field survey and include the following information:

a. a clearly labeled map indicating the locations of the visible seepage zones;

b. the estimated flow rates for the seepage zones;

c. the specific conductance, pH and temperature values for the seepage zones;

d. a brief description of the changes in the nature of the seepage from previous observations; and

e. photographs as needed to document items a. - d.

1.6 The Permittee shall discharge through outfalls SD001 and SD005 no more than the annual net precipitation from the tailings basin during each calendar year. The annual net precipitation shall be determined as follows:

$Y = (Af * P) - (At * E)$

where:

Y = annual net precipitation
Af = area of the tailings basin plus the drainage area contributing surface runoff to the tailings basin
P = total annual precipitation
At = open water area of the tailings basin plus Reservoir 6, and
E = annual lake evaporation.

The total annual precipitation and the annual lake evaporation shall be based on the sum of the data reported through station SD008.

1.7 If the Permittee does not discharge through outfalls SD001 and SD005 the volume equivalent to the annual net precipitation in a given calendar year, then the Permittee may carry over the difference between the annual net precipitation and the actual volume discharged as a credit to the annual net precipitation for the following calendar year. Such credit may be carried over only to that calendar year immediately following the year in which not all of the allowable discharge volume was utilized.

1.8 The Permittee shall notify the Commissioner in writing at least 180 days in advance of any expansion of the area covered by mine tailings beyond the area enclosed by the perimeter basin dams on the date of issuance of this permit.

1.9 The Permittee shall notify the Commissioner in writing at least 30 days prior to the addition or modification of hydraulic relief features, such as granular blanket and filter drains, relief wells and relief trenches, other than those described in the Facility Description.

1.10 The Permittee shall make every effort to prevent and contain any breaks in or spills from the tailings pipeline which runs from the Keewatin Taconite plant to the tailings basin. In particular, the Permittee shall comply with the requirements of the Noncompliance, Upset Defense and Duty to Notify and Avoid Pollution requirements of the Total facility section of the permit, as well as the Tailings Spill Response Plan, should a pipeline break or spill occur.

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Chapter 3. Metallic Mining

2. Mobile and Rail Equipment Service Areas

2.1 Mobile equipment and rail equipment service areas in the facility shall be operated in compliance with the following:

a. The Permittee shall collect and dispose of locomotive traction sand, degreasing wastes, motor oil, oil filters, oil sorbent pads and booms, transmission fluids, power steering fluids, brake fluids, coolant/antifreeze, radiator flush wastewater and spent solvents in accordance with applicable solid and hazardous waste management rules. These materials shall not be discharged to surface or ground waters of the state.

b. The steam-cleaning of mobile equipment and rail equipment, except for limited outdoor cleaning of large drills and shovels, shall be conducted in wash bays that drain to wastewater treatment systems that include the removal of suspended solids and flammable liquids. The only washing of mobile equipment done in outside areas shall be to remove mud and dirt that has accumulated during outside work.

c. The Permittee shall not use solvent-based cleaners, such as those available for brake cleaning and degreasing, to wash mobile and rail equipment unless the cleaning fluids are completely contained and not allowed to flow to surface or ground waters of the state. Soaps and detergents used in washing shall be biodegradable.

d. Mobile and rail equipment maintenance and repairs shall not be conducted in wash bays.

e. Hazardous materials shall not be stored or handled in wash bays.

f. The Permittee shall inspect wastewater containment systems regularly, and repair any leaks that are detected immediately.

g. If the Permittee discovers that recoverable amounts of petroleum products have entered wastewater containment systems, they shall be recovered immediately and reported to the MPCA.

h. Spill cleanup procedures shall be posted in mobile and rail equipment maintenance and repair areas.

Chapter 4. Stormwater Management

1. Authorization

1.1 This chapter authorizes the Permittee to discharge stormwater associated with industrial activity in accordance with the terms and conditions of this chapter. The MPCA may initiate modification of this chapter in accordance with Minn. R. 7001.0170 and Minn. R. 7001.0190 Subp. 1 to incorporate revised requirements in response to the reissuance or modification of the General Stormwater Permit for Industrial Activity (MNG611000).

2. Prohibited Discharges

2.1 This permit, unless specifically authorized by another chapter, does not authorize the discharge of sewage, wash water, scrubber water, spills, oil, hazardous substances, or equipment/vehicle cleaning and maintenance wastewaters to ditches, wetlands or other surface waters of the state.

2.2 This permit does not authorize discharges from sites for which Environmental Assessment Worksheets or Environmental Impact Statements are required, in accordance with Minn. R. ch. 4410, until that environmental review is completed.

3. Water Quality Standards

3.1 The Permittee shall operate and maintain the facility and shall control runoff, including stormwater, from the facility to prevent the exceedance of water quality standards specified in Minnesota Rules, chs. 7050 and 7060.

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Chapter 4. Stormwater Management

3. Water Quality Standards

3.2 The Permittee shall limit and control the use of materials at the facility that may cause exceedances of ground water standards specified in Minnesota Rules, ch. 7060. These materials include, but are not limited to, detergents and cleaning agents, solvents, chemical dust suppressants, lubricants, fuels, drilling fluids, oils, fertilizers, explosives and blasting agents.

4. Stormwater Pollution Prevention Plan

4.1 The Permittee shall develop and implement a Stormwater Pollution Prevention Plan (Plan) to address the specific conditions at the industrial facility. The goal of the Plan is to eliminate or minimize contact of stormwater with significant materials that may result in pollution of the runoff. If contact cannot be eliminated or reduced, stormwater that has contacted significant material should be treated before it is discharged from the site. The Plan shall apply to those areas of the facility where industrial activities occur or significant materials are stored, and stormwater runoff does not receive treatment prior to discharge via a permitted surface discharge station. In addition, the Plan should indentify all areas of the facility where the necessary treatment of stormwater is addressed by a permitted surface discharge station.

4.2 The Plan shall be implemented at the site before the Permittee is covered under this permit.

4.3 The Stormwater Pollution Prevention Plan shall include a description of appropriate Best Management Practices for protection of surface and ground water quality at the facility, and a schedule for implementing the practices. The Plan shall also include the procedures to be followed by designated staff employed by the Permittee to implement the plan.

4.4 The Permittee shall comply with its Stormwater Pollution Prevention Plan.

4.5 The Permittee shall submit the Stormwater Pollution Prevention Plan to MPCA upon request.

Plan Contents

4.6 Complete a drainage map. The map should indicate the following items at or adjacent to the facility:

a. drainage areas and directions of stormwater runoff (indicated by arrows);

b. discharge outfalls from the site (structures that carry stormwater runoff from the facility such as ditches or storm sewers);

c. the name and location of waters of the state that receive facility stormwater runoff (if waters of the state are too distant from the facility to be indicated on the site map, indicate the name, direction and shortest distance to the lake, river, stream or wetland that receives runoff from your site);

d. areas where significant materials are exposed to stormwater;

e. locations of storm sewer inlets and an indication of which, if any, structures have floor drains or loading dock drains that are connected to storm sewers; and

f. locations and types of Best Management Practices (BMPs) currently installed at the facility to reduce or eliminate pollutants to stormwater.

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Chapter 4. Stormwater Management

4. Stormwater Pollution Prevention Plan

4.7 Complete an inventory of exposed significant materials. Indicate the types of significant materials handled or stored at the site that may potentially contact stormwater. The following are examples of materials that, if exposed to stormwater, must be included in the inventory:

a. raw materials, such as fuels; solvents; petroleum products; detergents; plastic pellets; materials used in food processing or production; stockpiled sand, salt or coal;

b. by-products or intermediate products, such as wood dust, chips or bark; screened limestone, taconite or gravel by-product, recycled blacktop;

c. finished materials, such as metallic products, including scrap metal and recycled or scrap motor vehicle parts, old process equipment/machinery, taconite pellets;

d. waste products, such as ashes, sludge, solid and liquid waste, slag;

e. hazardous substances designated under section 101(14) of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA);

f. any chemical the facility is required to report under section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA).

4.8 Evaluate facility areas for exposure of significant materials to stormwater. In creating the inventory of exposed significant materials, the Permittee must, at a minimum, evaluate the following areas at the industrial site (as well as other areas where appropriate) to determine whether or not significant materials are exposed in these areas:

a. vehicle and equipment maintenance, parking and storage areas including fueling and washing/cleaning areas, to determine if there is discolored soil in these areas as a result of fuel and lubricant leaks and spills;

b. liquid storage tanks and other bulk material stockpile areas;

c. loading and unloading areas;

d. outdoor manufacturing, processing or storage areas and industrial plant yards, to determine if there is discolored soil in these areas as a result of leaked or spilled solvents, fuels, or lubricants;

e. dust or particulate generating areas including dust collection devices that may release dust;

f. rooftops contaminated by industrial activity or operation of a pollution control device;

g. on-site waste disposal areas, such as waste ponds, dumpsters, solid waste storage or management areas; and

h. exposed (non-vegetated) soil areas where there is a potential for erosion to occur.

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Chapter 4. Stormwater Management

4. Stormwater Pollution Prevention Plan

4.9 Describe appropriate BMPs, including structural and non-structural BMPs, that will be used at the facility to minimize or eliminate pollution of stormwater at the site. The description must include an objective for each BMP, as well as a description of how to evaluate proper functioning of the BMP and any maintenance requirements of the BMP. BMPs should target significant materials and areas identified in subparts 7 and 8 of this part. The following general categories of BMPs shall be considered and one or more shall be incorporated into the facility's Plan if significant materials are exposed to stormwater on-site:

a. Source reduction: reduce or eliminate the significant materials that are exposed to stormwater. Materials management practices should be evaluated to determine whether inventories of exposed materials can be reduced or eliminated. This can include clean-up of equipment yards, periodic checking of dust control equipment to ensure minimal accumulation of dust in the area of control equipment, removal and treatment of petroleum contaminated soil, consolidation of materials from multiple areas into one area, and training employees regarding proper handling and disposal of materials. Significant materials may also be moved indoors or covered with a tarp or structure to eliminate contact with precipitation.

b. Diversion: divert stormwater drainage away from exposed significant materials through use of curbing, berms, sewers or other forms of drainage control or elevate exposed significant material above surrounding drainage.

c. Treatment: where contact of stormwater with significant materials is unavoidable, use treatment devices to reduce the concentration and amount of pollutants in the discharge. Such devices include oil/water separators, stormwater detention/retention ponds, and vegetative swales.

4.10 Evaluate all discharge conveyances from the site (storm sewers, pipes, tile lines, ditches, etc.) to determine if liquids other than stormwater are being discharged from these devices. This should be done during dry weather when stormwater discharge is not occurring. The evaluation should cover sewer inlets and floor drains to determine which inlets/drains are connected to sanitary sewer lines, storm sewer lines, or septic tanks/drainage fields; appropriate methods such as dye or smoke testing or video imaging should be used to determine the source of discharges.

The Plan must certify that discharges from the site have been evaluated for the presence of non-stormwater discharges. The certification shall indicate the date of testing, location of testing, describe the method used to determine the source of discharges and the results of testing. Discharge of non-stormwater (such as sanitary sewer or floor drain connections to storm sewers) is not authorized by this permit; before such discharge may continue, authorization under an appropriate NPDES permit must be obtained.

4.11 Develop a preventive maintenance program. The program must require regular inspection and maintenance of stormwater management devices (e.g. cleaning oil/water separators and catch basins), as well as inspecting and testing plant equipment and systems to uncover conditions that could cause breakdowns or failures resulting in discharges of pollutants (e.g. hydraulic leaks, torn bag-house filters) to surface waters.

4.12 Develop a spill prevention and response procedure. In order to develop this procedure, Permittees should evaluate where spills have occurred and where they have the potential to occur. Determine drainage points for potential spill areas and develop appropriate spill prevention and containment measures, should a spill occur. Detailed procedures for cleaning-up spills shall be identified and made available to appropriate personnel. If your facility has any other spill contingency plan that satisfies the above requirements, that plan may be incorporated by reference into this Plan to satisfy this requirement.

4.13 Develop and implement an employee training program to inform appropriate personnel of the components and goals of the Plan. Training shall address spill response, good housekeeping and materials management practices. The Plan shall identify periodic dates for such training.

4.14 Identify personnel responsible for managing and implementing the Plan as well as those responsible for the reporting requirements of this permit. This should include the facility contact person as indicated on the permit application. Identified personnel must be available at reasonable times of operation.

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Chapter 4. Stormwater Management

5. Temporary Protection and Permanent Cover

5.1 The Permittee shall provide and maintain temporary protection or permanent cover for the exposed areas at the facility.

5.2 Temporary protection methods are used to prevent erosion on a short-term basis, such as the placement of mulching straw, wood fiber blankets, wood chips, erosion control netting, or temporary seeding.

5.3 Permanent cover or final stabilization methods are used to prevent erosion, such as the placement of rip rap, sodding, or permanent seeding or planting. Permanent seeding and planting must have a uniform perennial vegetation cover of at least 70 percent density to constitute final stabilization.

6. Inspection and Maintenance

6.1 Site inspections shall be conducted at least once every two months throughout the calendar year. During winter months, the inspections shall be conducted during non-frozen conditions. Inspections shall be conducted by an appropriately trained personnel at the facility site, as identified in part 4.13 of this chapter. The purpose of inspections is to: 1) determine whether structural and non-structural BMPs require maintenance or changes, and 2) evaluate the completeness and accuracy of the Plan.

At least one inspection during a reporting period shall be conducted while stormwater is discharging from the facility. Inspections may be documented using an inspection form provided by the MPCA. A Storm Water Site Inspection Form is provided in the appendices section of this permit.

6.2 Inspections shall be documented and a copy of all documentation shall remain on the permitted site whenever Permittee staff are availbale on the site, and be available upon request. The inspection form developed for the General Storm Water Permit for Industrial Activity may be used for recording inspection results, and is included in the appendices section of this permit.

6.3 The following compliance items will be inspected, and documented where appropriate:

a. evaluate the facility to determine that the Plan accurately reflects site conditions as described in subpart 6 of this part, and document any inaccuracies;

b. evaluate the facility to determine whether new exposed materials have been added to the site since completion of the Plan, and document any new significant materials;

c. during the inspection conducted during the runoff event, observe the runoff to determine if it is discolored or otherwise visibly contaminated, and document observations; and,

d. determine if the non-structural and structural BMPs as indicated in the Plan are installed and functioning properly.

6.4 The Permittee shall ensure that temporary protection and permanent cover for the exposed areas at the site are maintained.

6.5 Indicate the date and time of the inspection as well as the name of the inspector on the inspection form.

6.6 When the depth of sediment collected in the final sedimentation basin above the outfall reaches one-half of the riser height, or one-half of the basin design hydraulic storage volume, the Permittee shall drain the basin and remove the sediment within sixty (60) days of discovery. No outflow from the sedimentation basin shall occur while sediment is being removed from that basin. The sediment removed from the basin shall be disposed of at a site which drains to sedimentation basin(s) at the facility.

6.7 If conditions are observed at the site that require changes in the Plan, such changes shall be made to the Plan prior to submission of the annual report for that calendar year.

6.8 The Permittee shall minimize vehicle tracking of gravel, soil or mud onto paved surfaces at the facility.

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Chapter 4. Stormwater Management

6. Inspection and Maintenance

6.9 If the findings of a site inspection indicate that BMPs are not meeting the objectives as identified in subpart 9 of this part, corrective actions must be initiated within 30 days and the BMP restored to full operation as soon as field conditions allow.

6.10 The Permittee shall remove tracked material from the road surface and return it to the facility within one (1) day of discovery so that the materials drain to sedimentation basin(s) at the facility.

7. Sedimentation Basin Design and Construction

New Sedimentation Basins

7.1 Sedimentation basins shall be designed by a registered professional engineer, and installed under the direct supervision of a registered professional engineer.

7.2 The basin shall provide at least 1800 cubic feet, per acre drained, of hydraulic storage volume below the top of the outlet riser pipe.

7.3 Inlet(s) and outlet(s) shall be designed to prevent short circuiting and the discharge of floating debris.

7.4 The inlet(s) shall be placed at an elevation at least above one-half of the basin design hydraulic storage volume.

7.5 The outlet(s) shall consist of a perforated riser pipe wrapped with filter fabric and covered with crushed gravel. The perforated riser pipe shall be designed to allow complete drawdown of the basin(s).

7.6 Permanent erosion control, such as rip rap, splash pads or gabions shall be installed at the outlet(s) to prevent downstream erosion.

7.7 The basins shall be designed to allow for regular removal of accumulated sediment by a backhoe or other suitable equipment.

8. Application of Chemical Dust Suppressants

8.1 If chemical dust suppressants are applied, the Permittee shall submit a Chemical Dust Suppressant Annual Report due 31 days after the end of each calendar year following the application of a chemical dust suppressant.

8.2 The Chemical Dust Suppressant Annual Report shall include:

a. a record of the dates, methods, locations and amounts by volume of chemical application at the facility;

b. whether the product was applied in the preceding year; and,

c. the results of a chemical analysis of the materials applied each year.

8.3 If a material applied is mixed with water or another solvent before application, the chemical analysis shall be done on the aqueous or other mixture that is representative of the solution applied. This analysis shall be conducted during the same calendar year of application. This analysis shall include the parameters that may be determined by U.S. Environmental Protection Agency (EPA) Methods 624 and 625 which are described in 40 CFR Part 136.

8.4 Chemical dust suppressants, if used, shall not be applied within 100 feet of the surface receiving waters identified in the 'Facility Description' section of this permit. These materials also shall not be applied within 100 feet of ditches that conduct surface flow to the surface receiving waters identified on Page 1 of this permit.

9. Reporting

9.1 Submit a Stormwater Annual Report by March 31 of each year following permit issuance. A copy of the Stormwater Annual Report Form is provided in the appendices section of this permit.

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Chapter 4. Stormwater Management

9. Reporting

9.2 The Permittee shall, upon request of the Agency, submit within a reasonable time the information and reports that are relevant to compliance with this Chapter, including the Plan, inspection reports, annual reports, original laboratory sheets from analyses conducted on the waste stream, and BMP plans and specifications.

10. Records

10.1 The Plan shall be retained for the duration of the permit. A copy of the Plan shall remain on the permitted site whenever Permittee staff are available on the site, and be available upon request. The Permittee shall maintain the following records for the period of permit coverage:

a. dates of inspections;

b. findings of inspections;

c. corrective actions taken;

d. documentation of all changes to the Plan; and,

e. a copy of annual reports.

11. Notification

11.1 If the Permittee discharges stormwater into a municipal storm sewer, the Permittee shall notify the operator of the municipal storm sewer of the existence of this permit.

12. Request for Termination of Stormwater Permit Coverage

12.1 All Permittees regulated by 40 CFR 122.26(b)(14)(i) through (ix) and (xi) may request termination of permit coverage by applying for the no exposure exclusion from permitting. The Permittee must submit (form provided by the Agency) a written certification that a condition of no exposure exists at the facility and that the facility meets the definition of no exposure of industrial activities and materials to storm water.

The application for the no exposure exclusion must be completed by the Permittee and sent to: MPCA, Industrial Storm Water Program, 520 Lafayette Rd N, St Paul, MN 55155-4194.

Failure to complete an accurate application will result in the facility being denied the no exposure exclusion from permitting. The facility must submit the application to the Agency once every five years.

12.2 The no exposure exclusion is conditional. The Permittee must maintain a condition of no exposure at the facility in order for the no exposure exclusion to remain applicable. In the event of any change or circumstance that causes exposure of industrial activities or materials to stormwater, the Permittee must comply with the stormwater requirements of this chapter.

12.3 The no exposure certification is non-transferrable. In the event that the facility operator changes, then the new operator must submit a new no exposure certification to the MPCA, Industrial Stormwater Program, 520 Lafayette Rd N, St Paul, MN 55155-4194.

12.4 The MPCA retains the authority to require the facility operator to comply with the requirements of this chapter, even when an industrial operator certifies no exposure, if the MPCA has determined that the discharge is contributing to the violation of, or interfering with the attainment or maintenance of water quality standards, including designated uses.

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Chapter 4. Stormwater Management

13. Definitions

13.1 "No exposure" means all industrial materials and activities are protected by a storm resistant shelter to prevent exposure to rain, snow, snow melt, and/or runoff. Industrial activities or materials include, but are not limited to, material handling equipment or activities, industrial machinery, raw materials, intermediate products, by-products, final products, or waste products.

13.2 "Non-stormwater discharge" means any discharge not comprised entirely of stormwater discharges authorized by a NPDES permit.

13.3 "Runoff" means any liquid that drains over land from any part of a facility.

Chapter 5. Surface Discharge Stations

1. Requirements for Specific Stations

1.1 SD 001, SD 005, SD 008, SD 009: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

2. Special Requirements

2.1 Samples shall be taken at SD001 during any and all discharge events. The time, date, and duration of each discharge event shall be submitted with the appropriate Discharge Monitoring Report.

3. Sampling Location

3.1 Samples for Station SD001 shall be taken at one of the four siphon outfall points which has the greatest flow at the time of sampling.

3.2 Samples for Station SD005 shall be taken at the culvert prior to combination with Reservoir 2 North waters, during a period of discharge from Reservoir 6. If a discharge from Reservoir 6 occurs at any time during the sampling month, a sample must be obtained for analysis.

3.3 Samples for SD009 shall be taken at a point representative of the discharge of dewatering effluent from Sargent Pit to the unnamed ditch.

3.4 Samples and measurements required by this permit shall be representative of the monitored activity.

4. Surface Discharges

4.1 Floating solids or visible foam shall not be discharged in other than trace amounts.

4.2 Oil or other substances shall not be discharged in amounts that create a visible color film.

4.3 The Permittee shall install and maintain outlet protection measures at the discharge stations to prevent erosion.

5. Winter Sampling Conditions

5.1 The Permittee shall sample flows at the designated monitoring stations including when this requires removing ice to sample the water. If the station is completely frozen throughout a designated sampling month, the Permittee shall check the "No Discharge" box on the Discharge Monitoring Report (DMR) and note the ice conditions in Comments on the DMR.

6. Discharge Monitoring Reports

6.1 The Permittee shall submit monitoring results for discharges in accordance with the limits and monitoring requirements for this station. If no discharge occurred during the reporting period, the Permittee shall check the "No Discharge" box on the Discharge Monitoring Report (DMR).

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Chapter 6. Surface Water Stations

1. Requirements for Specific Stations

1.1 SW 001: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

2. Special Requirements

2.1 Station SW001 was established at the request of the Permittee.

3. Discharge Monitoring Reports

3.1 The Permittee shall submit monitoring results in accordance with the limits and monitoring requirements for this station. If flow conditions are such that no sample could be acquired, the Permittee shall check the "No Flow" box and note the conditions on the Discharge Monitoring Report (DMR).

4. Sampling Location

4.1 Samples for Station SW001 shall be taken at the weir outlet on Reservoir 2.

5. Sampling Protocol

5.1 All instruments used for field measurements shall be maintained and calibrated to insure accuracy of measurements.

5.2 Sample water shall be preserved according to lab instructions and delivered to a certified lab within the minimum holding times.

6. Winter Sampling Conditions

6.1 The Permittee shall sample flows at the designated monitoring stations including when this requires removing ice to sample the water. If the station is completely frozen throughout a designated sampling month, the Permittee shall check the "No Flow" box on the Discharge Monitoring Report (DMR) and note the ice conditions in Comments on the DMR.

Chapter 7. Waste Stream Stations

1. Requirements for Specific Stations

1.1 WS 001: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

2. Sampling Location

2.1 Flow measurements for Station WS001 shall be representative of the non-precipitation inputs to the facility (for example, from Reservoir 2 and/or from Reservoir 6).

Chapter 8. Total Facility Requirements

1. General Requirements

General Requirements

1.1 Incorporation by Reference. The following applicable federal and state laws are incorporated by reference in this permit, are applicable to the Permittee, and are enforceable parts of this permit: 40 CFR pts. 122.41, 122.42, 136, 403 and 503; Minn. R. pts. 7001, 7041, 7045, 7050, 7052, 7053, 7060, and 7080; and Minn. Stat. Sec. 115 and 116.

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Chapter 8. Total Facility Requirements

1. General Requirements

1.2 Permittee Responsibility. The Permittee shall perform the actions or conduct the activity authorized by the permit in compliance with the conditions of the permit and, if required, in accordance with the plans and specifications approved by the Agency. (Minn. R. 7001.0150, subp. 3, item E)

1.3 Toxic Discharges Prohibited. Whether or not this permit includes effluent limitations for toxic pollutants, the Permittee shall not discharge a toxic pollutant except according to Code of Federal Regulations, Title 40, sections 400 to 460 and Minnesota Rules 7050, 7052, 7053 and any other applicable MPCA rules. (Minn. R. 7001.1090, subp.1, item A)

1.4 Nuisance Conditions Prohibited. The Permittee's discharge shall not cause any nuisance conditions including, but not limited to: floating solids, scum and visible oil film, acutely toxic conditions to aquatic life, or other adverse impact on the receiving water. (Minn. R. 7050.0210 subp. 2)

1.5 Property Rights. This permit does not convey a property right or an exclusive privilege. (Minn. R. 7001.0150, subp. 3, item C)

1.6 Liability Exemption. In issuing this permit, the state and the MPCA assume no responsibility for damage to persons, property, or the environment caused by the activities of the Permittee in the conduct of its actions, including those activities authorized, directed, or undertaken under this permit. To the extent the state and the MPCA may be liable for the activities of its employees, that liability is explicitly limited to that provided in the Tort Claims Act. (Minn. R. 7001.0150, subp. 3, item O)

1.7 The MPCA's issuance of this permit does not obligate the MPCA to enforce local laws, rules, or plans beyond what is authorized by Minnesota Statutes. (Minn. R. 7001.0150, subp.3, item D)

1.8 Liabilities. The MPCA's issuance of this permit does not release the Permittee from any liability, penalty or duty imposed by Minnesota or federal statutes or rules or local ordinances, except the obligation to obtain the permit. (Minn. R. 7001.0150, subp.3, item A)

1.9 The issuance of this permit does not prevent the future adoption by the MPCA of pollution control rules, standards, or orders more stringent than those now in existence and does not prevent the enforcement of these rules, standards, or orders against the Permittee. (Minn. R. 7001.0150, subp.3, item B)

1.10 Severability. The provisions of this permit are severable and, if any provisions of this permit or the application of any provision of this permit to any circumstance are held invalid, the application of such provision to other circumstances and the remainder of this permit shall not be affected thereby.

1.11 Compliance with Other Rules and Statutes. The Permittee shall comply with all applicable air quality, solid waste, and hazardous waste statutes and rules in the operation and maintenance of the facility.

1.12 Inspection and Entry. When authorized by Minn. Stat. Sec. 115.04; 115B.17, subd. 4; and 116.091, and upon presentation of proper credentials, the agency, or an authorized employee or agent of the agency, shall be allowed by the Permittee to enter at reasonable times upon the property of the Permittee to examine and copy books, papers, records, or memoranda pertaining to the construction, modification, or operation of the facility covered by the permit or pertaining to the activity covered by the permit; and to conduct surveys and investigations, including sampling or monitoring, pertaining to the construction, modification, or operation of the facility covered by the permit or pertaining to the activity covered by the permit. (Minn. R. 7001.0150, subp.3, item I)

1.13 Control Users. The Permittee shall regulate the users of its wastewater treatment facility so as to prevent the introduction of pollutants or materials that may result in the inhibition or disruption of the conveyance system, treatment facility or processes, or disposal system that would contribute to the violation of the conditions of this permit or any federal, state or local law or regulation.

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Chapter 8. Total Facility Requirements

1. General Requirements

Sampling

1.14 Representative Sampling. Samples and measurements required by this permit shall be conducted as specified in this permit and shall be representative of the discharge or monitored activity. (40 CFR 122.41 (j)(1))

1.15 Additional Sampling. If the Permittee monitors more frequently than required, the results and the frequency of monitoring shall be reported on the Discharge Monitoring Report (DMR) or another MPCA-approved form for that reporting period. (Minn. R. 7001.1090, subp. 1, item E)

1.16 Certified Laboratory. A laboratory certified by the Minnesota Department of Health shall conduct analyses required by this permit. Analyses of dissolved oxygen, pH, temperature and total residual oxidants (chlorine, bromine) do not need to be completed by a certified laboratory but shall comply with manufacturers specifications for equipment calibration and use. (Minn. Stat. Sec. 144.97 through 144.98 and Minn. R. 4740.2010 and 4740.2050 through 4740.2120) (Minn. R. 4740.2010 and 4740.2050 through 2120)

1.17 Sample Preservation and Procedure. Sample preservation and test procedures for the analysis of pollutants shall conform to 40 CFR Part 136 and Minn. R. 7041.3200.

1.18 Equipment Calibration: Flow meters, pumps, flumes, lift stations or other flow monitoring equipment used for purposes of determining compliance with permit shall be checked and/or calibrated for accuracy at least twice annually. (Minn. R. 7001.0150, subp. 2, items B and C)

1.19 Maintain Records. The Permittee shall keep the records required by this permit for at least three years, including any calculations, original recordings from automatic monitoring instruments, and laboratory sheets. The Permittee shall extend these record retention periods upon request of the MPCA. The Permittee shall maintain records for each sample and measurement. The records shall include the following information (Minn. R. 7001.0150, subp. 2, item C):

a. The exact place, date, and time of the sample or measurement;

b. The date of analysis;

c. The name of the person who performed the sample collection, measurement, analysis, or calculation; and

d. The analytical techniques, procedures and methods used; and

e. The results of the analysis.

1.20 Completing Reports. The Permittee shall submit the results of the required sampling and monitoring activities on the forms provided, specified, or approved by the MPCA. The information shall be recorded in the specified areas on those forms and in the units specified. (Minn. R. 7001.1090, subp. 1, item D; Minn. R. 7001.0150, subp. 2, item B)

Required forms may include:

DMR Supplemental Form
Individual values for each sample and measurement must be recorded on the DMR Supplemental Form which, if required, will be provided by the MPCA. DMR Supplemental Forms shall be submitted with the appropriate DMRs. You may design and use your own supplemental form; however it must be approved by the MPCA. Note: Required summary information MUST also be recorded on the DMR. Summary information that is submitted ONLY on the DMR Supplemental Form does not comply with the reporting requirements.

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Chapter 8. Total Facility Requirements

1. General Requirements

1.21 Submitting Reports. DMRs and DMR Supplemental Forms shall be submitted to:

MPCA
Attn: Discharge Monitoring Reports
520 Lafayette Road North
St. Paul, Minnesota 55155-4194.

DMRs and DMR Supplemental Forms shall be postmarked by the 21st day of the month following the sampling period or as otherwise specified in this permit. A DMR shall be submitted for each required station even if no discharge occurred during the reporting period. (Minn. R. 7001.0150, subps. 2.B and 3.H)

Other reports required by this permit shall be postmarked by the date specified in the permit to:

MPCA
Attn: WQ Submittals Center
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

1.22 Incomplete or Incorrect Reports. The Permittee shall immediately submit an amended report or DMR to the MPCA upon discovery by the Permittee or notification by the MPCA that it has submitted an incomplete or incorrect report or DMR. The amended report or DMR shall contain the missing or corrected data along with a cover letter explaining the circumstances of the incomplete or incorrect report. (Minn. R. 7001.0150 subp. 3, item G)

1.23 Required Signatures. All DMRs, forms, reports, and other documents submitted to the MPCA shall be signed by the Permittee or the duly authorized representative of the Permittee. Minn. R. 7001.0150, subp. 2, item D. The person or persons that sign the DMRs, forms, reports or other documents must certify that he or she understands and complies with the certification requirements of Minn. R. 7001.0070 and 7001.0540, including the penalties for submitting false information. Technical documents, such as design drawings and specifications and engineering studies required to be submitted as part of a permit application or by permit conditions, must be certified by a registered professional engineer. (Minn. R. 7001.0540)

1.24 Detection Level. The Permittee shall report monitoring results below the reporting limit (RL) of a particular instrument as "<" the value of the RL. For example, if an instrument has a RL of 0.1 mg/L and a parameter is not detected at a value of 0.1 mg/L or greater, the concentration shall be reported as "<0.1 mg/L." "Non-detected," "undetected," "below detection limit," and "zero" are unacceptable reporting results, and are permit reporting violations. (Minn. R. 7001.0150, subp. 2, item B)

Where sample values are less than the level of detection and the permit requires reporting of an average, the Permittee shall calculate the average as follows:

a. If one or more values are greater than the level of detection, substitute zero for all nondetectable values to use in the average calculation.

b. If all values are below the level of detection, report the averages as "<" the corresponding level of detection.

c. Where one or more sample values are less than the level of detection, and the permit requires reporting of a mass, usually expressed as kg/day, the Permittee shall substitute zero for all nondetectable values.
(Minn. R. 7001.0150, subp. 2, item B)

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Chapter 8. Total Facility Requirements

1. General Requirements

1.25 Records. The Permittee shall, when requested by the Agency, submit within a reasonable time the information and reports that are relevant to the control of pollution regarding the construction, modification, or operation of the facility covered by the permit or regarding the conduct of the activity covered by the permit. (Minn. R. 7001.0150, subp. 3, item H)

1.26 Confidential Information. Except for data determined to be confidential according to Minn. Stat. Sec. 116.075, subd. 2, all reports required by this permit shall be available for public inspection. Effluent data shall not be considered confidential. To request the Agency maintain data as confidential, the Permittee must follow Minn. R. 7000.1300.

Noncompliance and Enforcement

1.27 Subject to Enforcement Action and Penalties. Noncompliance with a term or condition of this permit subjects the Permittee to penalties provided by federal and state law set forth in section 309 of the Clean Water Act; United States Code, title 33, section 1319, as amended; and in Minn. Stat. Sec. 115.071 and 116.072, including monetary penalties, imprisonment, or both. (Minn. R. 7001.1090, subp. 1, item B)

1.28 Criminal Activity. The Permittee may not knowingly make a false statement, representation, or certification in a record or other document submitted to the Agency. A person who falsifies a report or document submitted to the Agency, or tampers with, or knowingly renders inaccurate a monitoring device or method required to be maintained under this permit is subject to criminal and civil penalties provided by federal and state law. (Minn. R. 7001.0150, subp.3, item G., 7001.1090, subps. 1, items G and H and Minn. Stat. Sec. 609.671)

1.29 Noncompliance Defense. It shall not be a defense for the Permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit. (40 CFR 122.41(c))

1.30 Effluent Violations. If sampling by the Permittee indicates a violation of any discharge limitation specified in this permit, the Permittee shall immediately make every effort to verify the violation by collecting additional samples, if appropriate, investigate the cause of the violation, and take action to prevent future violations. Violations that are determined to pose a threat to human health or a drinking water supply, or represent a significant risk to the environment shall be immediately reported to the Minnesota Department of Public Safety Duty Officer at 1(800)422-0798 (toll free) or (651)649-5451 (metro area). In addition, you may also contact the MPCA during business hours. Otherwise the violations and the results of any additional sampling shall be recorded on the next appropriate DMR or report.

1.31 Unauthorized Releases of Wastewater Prohibited. Except for conditions specifically described in Minn. R. 7001.1090, subp. 1, items J and K, all unauthorized bypasses, overflows, discharges, spills, or other releases of wastewater or materials to the environment, whether intentional or not, are prohibited. However, the MPCA will consider the Permittee's compliance with permit requirements, frequency of release, quantity, type, location, and other relevant factors when determining appropriate action. (40 CFR 122.41 and Minn. Stat. Sec 115.061)

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Chapter 8. Total Facility Requirements

1. General Requirements

1.32 Discovery of a release. Upon discovery of a release, the Permittee shall:

a. Take all reasonable steps to immediately end the release.

b. Notify the Minnesota Department of Public Safety Duty Officer at 1(800)422-0798 or (651)649-5451 (metro area) immediately upon discovery of the release. You may contact the MPCA during business hours at 1(800)657-3864 or (651)296-6300 (metro area).

c. Recover as rapidly and as thoroughly as possible all substances and materials released or immediately take other action as may be reasonably possible to minimize or abate pollution to waters of the state or potential impacts to human health caused thereby. If the released materials or substances cannot be immediately or completely recovered, the Permittee shall contact the MPCA. If directed by the MPCA, the Permittee shall consult with other local, state or federal agencies (such as the Minnesota Department of Natural Resources and/or the Wetland Conservation Act authority) for implementation of additional clean-up or remediation activities in wetland or other sensitive areas.

d. Collect representative samples of the release. The Permittee shall sample the release for parameters of concern immediately following discovery of the release. The Permittee may contact the MPCA during business hours to discuss the sampling parameters and protocol. In addition, Fecal Coliform Bacteria samples shall be collected where it is determined by the Permittee that the release contains or may contain sewage. If the release cannot be immediately stopped, the Permittee shall consult with MPCA regarding additional sampling requirements. Samples shall be collected at least, but not limited to, two times per week for as long as the release continues.

e. Submit the sampling results as directed by the MPCA. At a minimum, the results shall be submitted to the MPCA with the next DMR.

1.33 Upset Defense. In the event of temporary noncompliance by the Permittee with an applicable effluent limitation resulting from an upset at the Permittee's facility due to factors beyond the control of the Permittee, the Permittee has an affirmative defense to an enforcement action brought by the Agency as a result of the noncompliance if the Permittee demonstrates by a preponderance of competent evidence:

a. The specific cause of the upset;

b. That the upset was unintentional;

c. That the upset resulted from factors beyond the reasonable control of the Permittee and did not result from operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or increases in production which are beyond the design capability of the treatment facilities;

d. That at the time of the upset the facility was being properly operated;

e. That the Permittee properly notified the Commissioner of the upset in accordance with Minn. R. 7001.1090, subp. 1, item I; and

f. That the Permittee implemented the remedial measures required by Minn. R. 7001.0150, subp. 3, item J.

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Chapter 8. Total Facility Requirements

1. General Requirements

Operation and Maintenance

1.34 The Permittee shall at all times properly operate and maintain the facilities and systems of treatment and control, and the appurtenances related to them which are installed or used by the Permittee to achieve compliance with the conditions of the permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. The Permittee shall install and maintain appropriate backup or auxiliary facilities if they are necessary to achieve compliance with the conditions of the permit and, for all permits other than hazardous waste facility permits, if these backup or auxiliary facilities are technically and economically feasible Minn. R. 7001.0150. subp. 3, item F.

1.35 In the event of a reduction or loss of effective treatment of wastewater at the facility, the Permittee shall control production or curtail its discharges to the extent necessary to maintain compliance with the terms and conditions of this permit. The Permittee shall continue this control or curtailment until the wastewater treatment facility has been restored or until an alternative method of treatment is provided. (Minn. R. 7001.1090, subp. 1, item C)

1.36 Solids Management. The Permittee shall properly store, transport, and dispose of biosolids, septage, sediments, residual solids, filter backwash, screenings, oil, grease, and other substances so that pollutants do not enter surface waters or ground waters of the state. Solids should be disposed of in accordance with local, state and federal requirements. (40 CFR 503 and Minn. R. 7041 and applicable federal and state solid waste rules)

1.37 Scheduled Maintenance. The Permittee shall schedule maintenance of the treatment works during non-critical water quality periods to prevent degradation of water quality, except where emergency maintenance is required to prevent a condition that would be detrimental to water quality or human health. (Minn. R. 7001.0150. subp. 3, item F and Minn. R. 7001.0150. subp. 2, item B)

1.38 Control Tests. In-plant control tests shall be conducted at a frequency adequate to ensure compliance with the conditions of this permit. (Minn. R. 7001.0150. subp. 3, item F and Minn. R. 7001.0150. subp. 2, item B)

Changes to the Facility or Permit

1.39 Permit Modifications. No person required by statute or rule to obtain a permit may construct, install, modify, or operate the facility to be permitted, nor shall a person commence an activity for which a permit is required by statute or rule until the Agency has issued a written permit for the facility or activity. (Minn. R. 7001.0030)

Permittees that propose to make a change to the facility or discharge that requires a permit modification must follow Minn. R. 7001.0190. If the Permittee cannot determine whether a permit modification is needed, the Permittee must contact the MPCA prior to any action. It is recommended that the application for permit modification be submitted to the MPCA at least 180 days prior to the planned change.

1.40 Construction. No construction shall begin until the Permittee receives written approval of plans and specifications from the MPCA (Minn. Stat. Sec. 115.03(f)).

Plans, specifications and MPCA approval are not necessary when maintenance dictates the need for installation of new equipment, provided the equipment is the same design size and has the same design intent. For instance, a broken pipe, lift station pump, aerator, or blower can be replaced with the same design-sized equipment without MPCA approval.

If the proposed construction is not expressly authorized by this permit, it may require a permit modification. If the construction project requires an Environmental Assessment Worksheet under Minn. R. 4410, no construction shall begin until a negative declaration is issued and all approvals are received or implemented.

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Chapter 8. Total Facility Requirements

1. General Requirements

1.41 Report Changes. The Permittee shall give advance notice as soon as possible to the MPCA of any substantial changes in operational procedures, activities that may alter the nature or frequency of the discharge, and/or material factors that may affect compliance with the conditions of this permit. (Minn. R. 7001.0150, subp. 3, item M)

1.42 Chemical Additives. The Permittee shall receive prior written approval from the MPCA before increasing the use of a chemical additive authorized by this permit, or using a chemical additive not authorized by this permit, in quantities or concentrations that have the potential to change the characteristics, nature and/or quality of the discharge.

The Permittee shall request approval for an increased or new use of a chemical additive at least 60 days, or as soon as possible, before the proposed increased or new use.

This written request shall include at least the following information for the proposed additive:

a. The process for which the additive will be used;
b. Material Safety Data Sheet (MSDS) which shall include aquatic toxicity, human health, and environmental fate information for the proposed additive;
c. A complete product use and instruction label;
d. The commercial and chemical names and Chemical Abstract Survey (CAS) number for all ingredients in the additive (If the MSDS does not include information on chemical composition, including percentages for each ingredient totaling to 100%, the Permittee shall contact the supplier to have this information provided); and
e. The proposed method of application, application frequency, concentration, and daily average and maximum rates of use.

Upon review of the information submitted regarding the proposed chemical additive, the MPCA may require additional information be submitted for consideration. This permit may be modified to restrict the use or discharge of a chemical additive and include additional influent and effluent monitoring requirements.

Approval for the use of an additive shall not justify the exceedance of any effluent limitation nor shall it be used as a defense against pollutant levels in the discharge causing or contributing to the violation of a water quality standard. (Minn. R. 7001.0170)

1.43 MPCA Initiated Permit Modification, Suspension, or Revocation. The MPCA may modify or revoke and reissue this permit pursuant to Minn. R. 7001.0170. The MPCA may revoke without reissuance this permit pursuant to Minn. R. 7001.0180.

1.44 TMDL Impacts. Facilities that discharge to an impaired surface water, watershed or drainage basin may be required to comply with additional permits or permit requirements, including additional restriction or relaxation of limits and monitoring as authorized by the CWA 303(d)(4)(A) and 40 CFR 122.44.l.2.i., necessary to ensure consistency with the assumptions and requirements of any applicable US EPA approved wasteload allocations resulting from Total Maximum Daily Load (TMDL) studies.

1.45 Permit Transfer. The permit is not transferable to any person without the express written approval of the Agency after compliance with the requirements of Minn. R. 7001.0190. A person to whom the permit has been transferred shall comply with the conditions of the permit. (Minn. R., 7001.0150, subp. 3, item N)

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Chapter 8. Total Facility Requirements

1. General Requirements

1.46 Facility Closure. The Permittee is responsible for closure and postclosure care of the facility. The Permittee shall notify the MPCA of a significant reduction or cessation of the activities described in this permit at least 180 days before the reduction or cessation. The MPCA may require the Permittee to provide to the MPCA a facility Closure Plan for approval.

Facility closure that could result in a potential long-term water quality concern, such as the ongoing discharge of wastewater to surface or ground water, may require a permit modification or reissuance.

The MPCA may require the Permittee to establish and maintain financial assurance to ensure performance of certain obligations under this permit, including closure, postclosure care and remedial action at the facility. If financial assurance is required, the amount and type of financial assurance, and proposed modifications to previously MPCA-approved financial assurance, shall be approved by the MPCA. (Minn. Stat. Sec. 116.07, subd. 4)

1.47 Permit Reissuance. If the Permittee desires to continue permit coverage beyond the date of permit expiration, the Permittee shall submit an application for reissuance at least 180 days before permit expiration. If the Permittee does not intend to continue the activities authorized by this permit after the expiration date of this permit, the Permittee shall notify the MPCA in writing at least 180 days before permit expiration.

If the Permittee has submitted a timely application for permit reissuance, the Permittee may continue to conduct the activities authorized by this permit, in compliance with the requirements of this permit, until the MPCA takes final action on the application, unless the MPCA determines any of the following (Minn. R. 7001.0040 and 7001.0160):

a. The Permittee is not in substantial compliance with the requirements of this permit, or with a stipulation agreement or compliance schedule designed to bring the Permittee into compliance with this permit;

b. The MPCA, as a result of an action or failure to act by the Permittee, has been unable to take final action on the application on or before the expiration date of the permit;

c. The Permittee has submitted an application with major deficiencies or has failed to properly supplement the application in a timely manner after being informed of deficiencies.

Minnesota Pollution Control Agency

National Pollutant Discharge Elimination System /State Disposal System (NPDES/SDS) Permit Program Statement of Basis

Permittee: United States Steel, Minnesota Ore Operations
Name: Keetac – Mining Operations
Permit Number: MN0031879

Current Permit Expiration: May 31, 2011

Public Comment Period Begins: June 27, 2011
Period Ends: August 19, 2011

Receiving Water: Welcome Lake; Welcome Creek to Reservoir 2 North; Unnamed wetlands and creeks tributary to O'Brien Reservoir

Proposed Action: Permit Reissuance

Permitting Contact
Brandon Smith
520 Lafayette Road N.
St. Paul, MN 55155
Phone: 651-757-2740
Fax: 651-296-8717

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Purpose and Participation

Purpose
This Statement of Basis outlines the principal issues related to the preparation of this permit reissuance and documents the decisions that were made in the determination of the effluent limitations and conditions of this permit.

The permit will be reissued if the Minnesota Pollution Control Agency (MPCA) determines that the proposed Permittee or Permittees will, with respect to the facility or activity to be permitted, comply or undertake a schedule to achieve compliance with all applicable state and federal pollution control statutes and rules administered by the MPCA and the conditions of the permit and that all applicable requirements of Minn. Stat. ch. 116D and the rules promulgated thereunder have been fulfilled.

More detail on all requirements placed on the facility may be found in the Permit document.

Facility Description

Background Information
Facility Location
The permitted facility includes the mining and processing operations for the U. S. Steel – Keetac facility, located to the north of Keewatin, Minnesota.

Outfall Locations
SD001: This outfall represents the discharge of filter backwash water from the potable water system to Welcome Lake. PLS coordinates are T57N, R21W, Section 19b.

SD002: The overflow discharge from Reservoir 5 treatment basin and diversion ditch treatment system is to Welcome Creek, south of Welcome Lake. PLS coordinates are T 57 N, R 21 W, Section 30b.

SD003: The Mesabi Chief dewatering outfall is located off the southwestern edge of the Mesabi Chief pit, PLS coordinates are T 57 N, R 22 W, Section 27a.

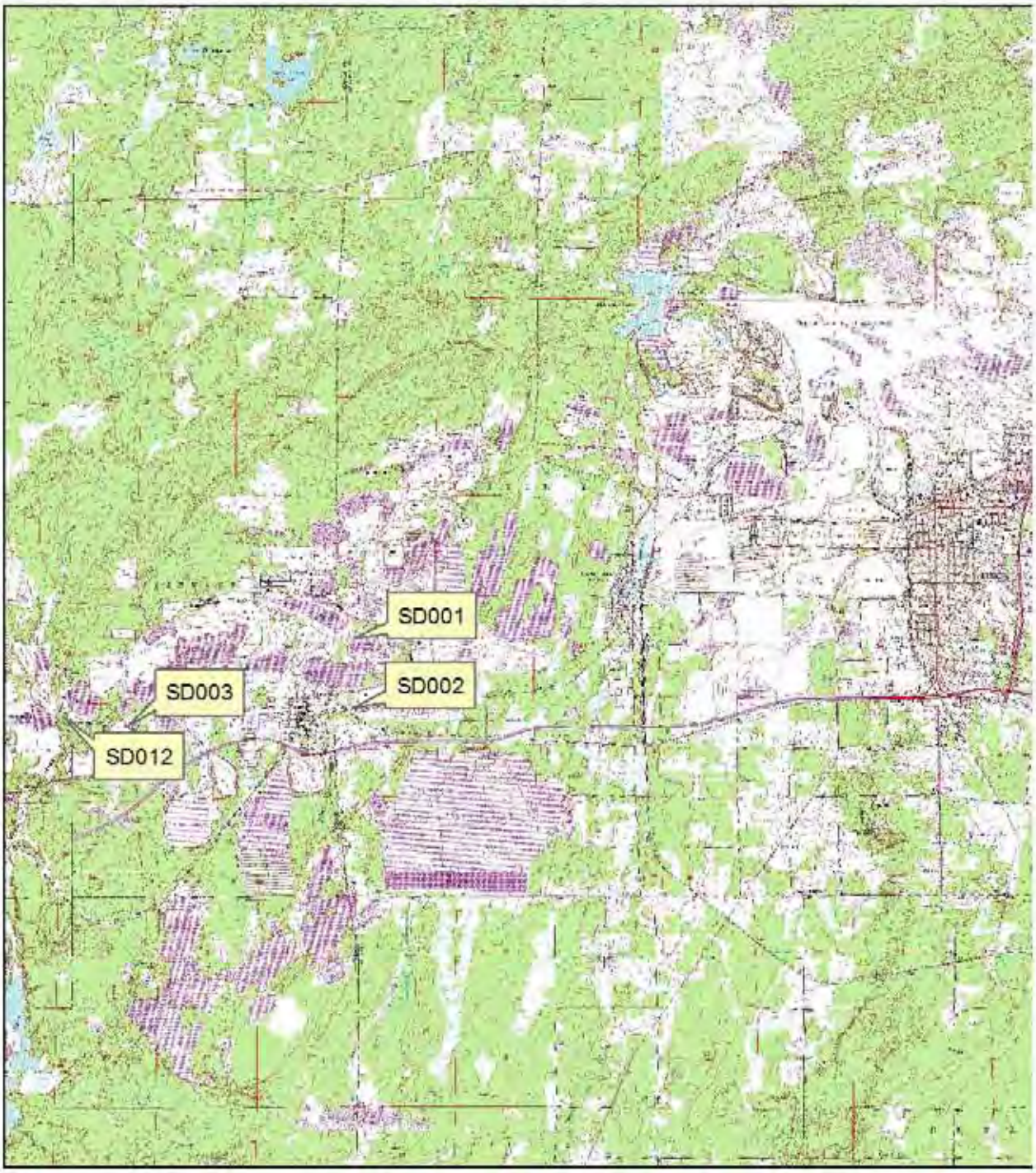
SD012: The Perry Pit dewatering outfall is located off the southwest side of the Perry Pit. PLS coordinates are T 57 N, R 22 W, Section 27b.

Changes to Facility or Operation
The facility has proposed an expansion of the taconite processing plant with which the permitted operations are associated.

Recent Compliance History
The Facility was inspected on May 10, 2010. No significant compliance issues were found that would affect modification of this permit.

Topographic Map of Permitted Facility

MN003189, US Steel - Keewatin Taconite Operations, Mining
St. Louis County & Itasca County, Minnesota



Map produced by: MPCA Staff, 4/15/2010
Source: USGS Nashwauk, Keewatin, Hibbing, Pengilly, Silica, Riley Quads
Scale: 1:24,000

0 0.5 1 2 Miles

N

Receiving Waters

Use Classification
The receiving waters affected by this permit reissuance include Welcome Lake, Welcome Creek, O'Brien Creek, and the O'Brien Reservoir.

All waters of the state of Minnesota must be classified based on considerations of best usage in the interest of the public and in conformance with the requirements of the applicable statutes, as described in Minn. R. 7050.0140. Based on these considerations, Welcome Creek and O'Brien Creek are classified as Class 2C waters as listed in Minn. R. 7050.0470 subp. 4.A. items (127) and (236), respectively. According to Minn. R.7050.0410, any listed water in Minn. R. 7050.0470 is also classified as a Class 3C, 4A, 4B, 5, and 6 water.

Welcome Lake and O'Brien Reservoir are not listed waters in Minn. R. 7050.0470. As detailed in Minn. R. 7050.0430, all surface waters of the state that are not listed in Minn. R. 7050.0470 and that are not wetlands as defined in Minn. R. 7050.0186, subp. 1a, are classified as Class 2B, 3C, 4A, 4B, 5, and 6 waters.

Based on the applicable classifications, the receiving waters named above are designated for use in the forms of aquatic life and recreation, industrial consumption, agriculture and wildlife, aesthetic enjoyment and navigation, and other uses.

Impairments
Minnesota is required to maintain a list of impaired waters, pursuant to Section 303(d) of the Federal Clean Water Act. Impairments have been identified in the receiving waters affected by this permit modification for mercury. Permit conditions with regard to mercury for this permit modification are discussed later in this statement of basis.

Proposed Permit Effluent Limits

The MPCA may develop effluent limitations based on Minnesota state water quality standards for the receiving water use classification, federal categorical standards applicable to specific industrial categories, or combination of these standards to regulate discharge of industrial wastewater. In addition, the MPCA may derive standards that are specific to a particular discharge. These standards may be based on toxicity studies, best professional judgment analysis, technology based standards, and in some instances standards developed by other U.S. states or regulatory agencies. Minnesota Rules and the U.S. Code of Federal Regulations (CFR) require that the MPCA categorize industrial dischargers consistent with the U.S. Environmental Protection Agency federal categorical standards, and state standards if appropriate.

Technology Based Effluent Limits
Minn. R. 7053.0225 subp. 1.A requires that all point source dischargers of industrial or other wastes shall comply with applicable federal standards, including those listed in 40 CFR pt. 401 through 469. The MPCA has determined that the specific industrial category and federal effluent limitation guidelines (Categorical Standards) applicable to this facility are those described in 40 CFR pt. 440 subp. A, for the iron ore mining and dressing point source category. The facility constitutes an existing source, and is therefore not subject to the New Source Performance Standards for this industry. The Categorical Standards for Best Practicable Control Technology currently available (BPT) and Best Available Technology economically achievable (BAT) have been applied for the conditions in this permit. These standards, along with Minnesota State Water Discharge Restrictions, have been used to develop the effluent limitations for discharge via permitted outfalls as summarized in the tables below.

Table – Technology-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0031879, Surface Discharge Station SD001: Water Treatment Plant Backwash

Effluent Characteristic	*Effluent Limitation*	*Basis*
pH	6.0 Standard Units (SU) Instantaneous Minimum; 9.0 SU Instantaneous Maximum	Minn. R. 7053.0225 subp. 1.B.
Total Suspended Solids	30 mg/L Daily Maximum	Minn. R. 7053.0225 subp. 1.B.

Pursuant to Minn. R. 7053.0225, given that effluent limitations have not been promulgated for treatment plant backwash under 40 CFR 440, Minnesota State Water Discharge Restrictions are applied to ensure adequate treatment is achieved prior to discharge via SD001.

Table – Technology-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0031879, Surface Discharge Stations SD002 and SD003

Effluent Characteristic	*Effluent Limitation*	*Basis*
Iron, dissolved (as Fe)	1.0 mg/L Calendar Month Average, 2.0 mg/L Daily Maximum	40 CFR § 440.12(a), 40 CFR § 440.13(a)
Total Suspended Solids	20 mg/L Calendar Month Average, 30 mg/L Daily Maximum	40 CFR § 440.12(a)

Effluent from SD002 and SD003 consists primarily of industrial stormwater and mine drainage as described in 40 CFR pt. 440. Effluent limitations have been included for total dissolved iron and total suspended solids to ensure that treatment requirements based on BAT and BPT considerations are achieved. Effluent limitations for pH based on water quality considerations have been determined to be more restrictive than the applicable limitations based on BAT and BPT.

Table – Technology-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0031879, Surface Discharge Station SD012: Perry Pit Dewatering

Effluent Characteristic	*Effluent Limitation*	*Basis*
pH	6.0 Standard Units (SU) Instantaneous Minimum; 9.0 SU Instantaneous Maximum	40 CFR § 440.12(a)
Iron, dissolved (as Fe)	1.0 mg/L Calendar Month Average, 2.0 mg/L Daily Maximum	40 CFR § 440.12(a), 40 CFR § 440.13(a)
Total Suspended Solids	20 mg/L Calendar Month Average, 30 mg/L Daily Maximum	40 CFR § 440.12(a)

Effluent from SD012 consists of mine drainage from Perry Pit, which receives surface runoff from stripping and stockpiling activities associated with mining from Keetac operations. Therefore, effluent limitations have been included to reflect BAT and BPT for this waste stream.

Table – Technology-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0031879, Waste Stream Station WS005: Internal Waste Stream

Effluent Characteristic	*Effluent Limitation*	*Basis*
Carbonaceous Biochemical Oxygen Demand, 5 Day	25 mg/L, 3.8 kg/day Calendar Month Average; 40 mg/L, 6.0 kg/day Daily Maximum	Minn. R. 7053.0215 subp. 1
Fecal Coliform	200 Organisms/100 mL Geometric Mean	Minn. R. 7053.0215
pH	6.0 Standard Units (SU) Instantaneous Minimum; 9.0 SU Instantaneous Maximum	Minn. R. 7053.0215
Total Suspended Solids	30 mg/L, 4.5 kg/day Calendar Month Average; 45 mg/L, 6.8 kg/day Daily Maximum	Minn. R. 7053.0215

WS005 consists of treated effluent from an activated sludge package plant that commingles with pit drainage effluent prior to discharge. To ensure adequate treatment is applied prior to discharge as required by Minn. R. 7053.0215, the permit requires that effluent limitations for discharges of sewage are met prior to commingling with other waste sources.

Water Quality Based Limits
Effluent limitations based on Minnesota state water quality standards for the receiving water use classifications previously discussed have been included in the permit for surface discharge stations SD002, SD003, and SD012.

The MPCA has made the determination that, based on the information available at the time of this permit modification, sulfate from the facility's discharges via SD002, SD003, and SD012 reaches waters that are used for the production of wild rice. Pursuant to Minn. R. 7050.0224 subp. 2, the available information at the time of this permit modification, and currently established permitting policies, the MPCA is including final effluent limitations for total sulfate based on a water quality standard of 10 mg/L total sulfate for these outfalls. The effluent limitations and associated reasonable potential calculations are detailed for each outfall in this section. The calculations are based on a zero-dilution factor, due to the fact that the receiving waters are above the currently supported water quality standard of 10 mg/L sulfate.

Table – Water Quality-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0031879, Surface Discharge Station SD002: Weir Outfall

Effluent Characteristic	*Effluent Limitation*	*Basis*
Ammonia, Unionized	0.04 mg/L Calendar Month Average	Minn. R. 7050.0222 subp. 5
Oil and Grease	0.5 mg/L Calendar Quarter Average; 5.0 mg/L Daily Maximum	Minn. R. 7050.0222 Subp. 5
pH	6.5 Standard Units (SU) Instantaneous Minimum; 8.5 SU Instantaneous Maximum	Minn. R. 7050.0222 subp. 5, Minn. R. 7050.0224 subp. 2
Total Sulfate	14 mg/L Calendar Month Average, 24 mg/L Daily Maximum	Minn. R. 7050.0224 subp. 2, in combination with currently available information
Turbidity	25 Nephelometric Turbidity Units Calendar Month Average	Minn. R. 7050.0222 subp. 5

Effluent limitations are included for the parameters listed in the table above based on reasonable potential analyses completed during previous permit actions. Reasonable potential analysis completed utilizing data collected for mercury and specific conductance indicated that effluent limitations were not necessary for those parameters, as detailed in the following table.

Table – Reasonable Potential Calculations for SD002

PARAMETER	Hg (ng/l)	Sp. Conductance (µmhos/cm)
Maximum measured effluent value	1.9	784
Projected effluent quality (PEQ)	2.66	784
@ n data points	(18)	(38)
Plant design flow (mgd)	15.1	15.1
Receiving water design flow (mgd)	0	0
Background concentration	0	0
Continuous standard (cs)	6.9	700
Maximum standard (ms)	2400	
Final acute value (FAV)	4900	
Mass Balance - cs	6.9	700
Mass Balance - ms	2400	
Coefficient Of Variation (CV)	0.64	0.19
Long Term Average: LTA cs	5.31	924.78
LTA ms	732.48	
Preliminary Effluent Limit (PEL):	17.4	1395
Daily Maximum		
Monthly Average	10	1137
Reasonable Potential PEQ>PEL (Dmax/FAV)	No	No

Table – Water Quality-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0031879, Surface Discharge Station SD003: Mesabi Chief Pit Dewatering

Effluent Characteristic	***Effluent Limitation***	***Basis***
Oil and Grease	0.5 mg/L Calendar Quarter Average; 5.0 mg/L Daily Maximum	Minn. R. 7050.0222 subp. 5
pH	6.5 Standard Units (SU) Instantaneous Minimum; 8.5 SU Instantaneous Maximum	Minn. R. 7050.0222 subp. 5, Minn. R. 7050.0224 subp. 2
Total Sulfate	14 mg/L Calendar Month Average, 24 mg/L Daily Maximum	Minn. R. 7050.0224 subp. 2, in combination with currently available information

Effluent limitations are included for the parameters listed in the table above based on reasonable potential analyses completed during previous permit actions. Reasonable potential analysis completed utilizing data collected for mercury and specific conductance indicated that effluent limitations were not necessary for those parameters, as detailed in the following table.

Table – Reasonable Potential Calculations for SD003

PARAMETER	Hg (ng/l)	Sp. Conductance (µmhos/cm)
Maximum measured effluent value	5.2	702
Projected effluent quality (PEQ)	7.28	702
@ n data points	(18)	(39)
Plant design flow (mgd)	5.85	5.85
Receiving water design flow (mgd)	0	0
Background concentration	0	0
Continuous standard (cs)	6.9	700
Maximum standard (ms)	2400	
Final acute value (FAV)	4900	
Mass Balance - cs	6.9	700
Mass Balance - ms	2400	
Coefficient Of Variation (CV)	0.62	0.15
Long Term Average: LTA cs	5.34	939.41
LTA ms	746.94	
Preliminary Effluent Limit (PEL):	17.1	1309
Daily Maximum		
Monthly Average	10	1109
Reasonable Potential PEQ>PEL (Dmax/FAV)	No	No

Table – Water Quality-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0031879, Surface Discharge Station SD012: Perry Pit Dewatering

Effluent Characteristic	***Effluent Limitation***	***Basis***
Total Sulfate	14 mg/L Calendar Month Average, 24 mg/L Daily Maximum	Minn. R. 7050.0224 subp. 2, in combination with currently available information

With the exception of bicarbonate alkalinity, reasonable potential analyses completed during a permit modification in 2010 were used to determine the need for water quality-based effluent limitations due to the fact that the data are still representative of Perry Pit effluent quality. Effluent limitations are included for total sulfate based on those reasonable potential calculations.

As described in the previous permit, reasonable potential for bicarbonate alkalinity was recalculated following representative monitoring by the Permittee. Based on the new information collected, an effluent limitation for bicarbonates is not warranted in this permit reissuance, as indicated in the table below.

Table – Reasonable Potential Calculations for SD012

PARAMETER	Hardness (mg/L)	TDS (mg/L)	Bicarb (meq/L)	Sp. Cond. (µmhos/cm)	Hg (ng/L)	Sulfate (mg/l)
Maximum measured effluent value	256	345	3.86	702	1.7	23.4
Projected effluent quality (PEQ)	780	1035	5.404	842.4	4.42	60.84
@ n data points	(3)	(3)	(14)	(38)	(4)	(4)
Plant design flow (mgd)	4.32	4.32	4.32	4.32	4.32	4.32
Receiving water design flow (mgd)	0	0	0	0	0	0
Background concentration	0	0	0	0	0	0
Continuous standard (cs)	500	700	5	1000	6.9	10
Maximum standard (ms)					2400	-
Final acute value (FAV)					4900	-
Mass Balance - cs	500	700	5	1000	6.9	10
Mass Balance - ms					2400	-
Coefficient Of Variation (CV)	0.6	0.6	0.45	0.6	0.6	0.6
Long Term Average: LTA cs	390	546	4.15	780	5.4	7.8
LTA ms					771	-
Preliminary Effluent Limit (PEL):	1215	1701	10.21	2430	17	
Daily Maximum						24
Monthly Average	701	982	6.57	1403	10	14
Reasonable Potential PEQ>PEL (Dmax/FAV)	No	No	No	No	No	Yes

Additional Requirements

Compliance Schedule
The permit reissuance includes a schedule for attaining compliance with the final effluent limitations for total sulfate. The schedule requires attainment of compliance as soon as possible and in no case later than August 17, 2019. The term of the compliance schedule is based on the time required for completion of evaluations by the Permittee, as well as time for implementation of any final plans for attaining compliance, including time for obtaining various regulatory approvals. The compliance schedule has been developed in accordance with the requirements of 40 CFR § 122.47.

Nondegredation and Anti-Backsliding

Anti-Backsliding
The effluent limitations contained in this permit modification are not less stringent than the effluent limitations in the existing permit, in accordance with the antibacksliding requirements found in 40 CFR § 122.44(l) and Minn. R. 7053.0275.

Nondegradation
In accordance with the MPCA rules regarding nondegradation for all waters, the design flow of the facility as of January 1, 1988, and associated mass loading are the baseline design flow and mass loading. This baseline flow and mass loading are used to determine whether nondegradation review is required for any change in the discharge. Additional volume and pollutant loading associated with the discharge of Perry Pit dewatering effluent was reviewed in accordance with Minn. R. 7050.0185 as part of a permit modification completed on June 17, 2010, including consideration of the quantity and quality of the proposed discharge and the potential for violating water quality standards in the receiving water.

The Permittee has not proposed expansion of any permitted discharges above the volumes and mass loadings authorized under previous permit actions.

Minnesota Pollution Control Agency

National Pollutant Discharge Elimination System /State Disposal System (NPDES/SDS) Permit Program Statement of Basis

Permittee: United States Steel, Minnesota Ore Operations
Name: Keetac – Tailings Basin
Permit Number: MN0055948

Current Permit Expiration: February 28, 2011

Public Comment Period Begins: June 27, 2011
Period Ends: August 19, 2011

Receiving Water: Reservoir 2; Welcome Creek

Proposed Action: Permit Reissuance

Permitting Contact
Brandon Smith
520 Lafayette Road N.
St. Paul, MN 55155
Phone: 651-757-2740
Fax: 651-296-8717

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Purpose and Participation

Purpose
This Statement of Basis outlines the principal issues related to the preparation of this permit reissuance and documents the decisions that were made in the determination of the effluent limitations and conditions of this permit.

The permit will be reissued if the Minnesota Pollution Control Agency (MPCA) determines that the proposed Permittee or Permittees will, with respect to the facility or activity to be permitted, comply or undertake a schedule to achieve compliance with all applicable state and federal pollution control statutes and rules administered by the MPCA and the conditions of the permit and that all applicable requirements of Minn. Stat. ch. 116D and the rules promulgated thereunder have been fulfilled.

More detail on all requirements placed on the facility may be found in the Permit document.

Facility Description

Background Information
Facility Location
The permitted facility includes the tailings basin and Sargent Pit dewatering operations for the U. S. Steel – Keetac facility, located to the north of Keewatin, Minnesota.

Outfall Locations
SD001: Four siphon outfalls to Reservoir 2. This outfall is used as an emergency discharge to maintain the integrity of the dike system. The outfalls are located at the southwestern edge of Reservoir 6, at PLS coordinates T 56 N, R 22 W, Section 2.

SD005: Weir outfall to Reservoir 2 North/Welcome Creek. This is the primary outfall for discharges from the tailings basin system. The outfall is located at the northeastern edge of Reservoir 6, at PLS coordinates T 56 N, R 22 W, Section 1.

SD008: Combination of discharges from SD001 and SD005. This station is for compliance reporting purposes only.

SD009: Sargent Pit dewatering outfall to unnamed ditch, leading to Welcome Creek. This will be a new outfall constructed to facilitate direct discharge of Sargent Pit dewatering, which is currently directed to other outfalls that are covered under NPDES/SDS Permit MN0031879. The outfall will be located at the edge of the Sargent Pit, at PLS coordinates T 57 N, R 22 W, Section 26.

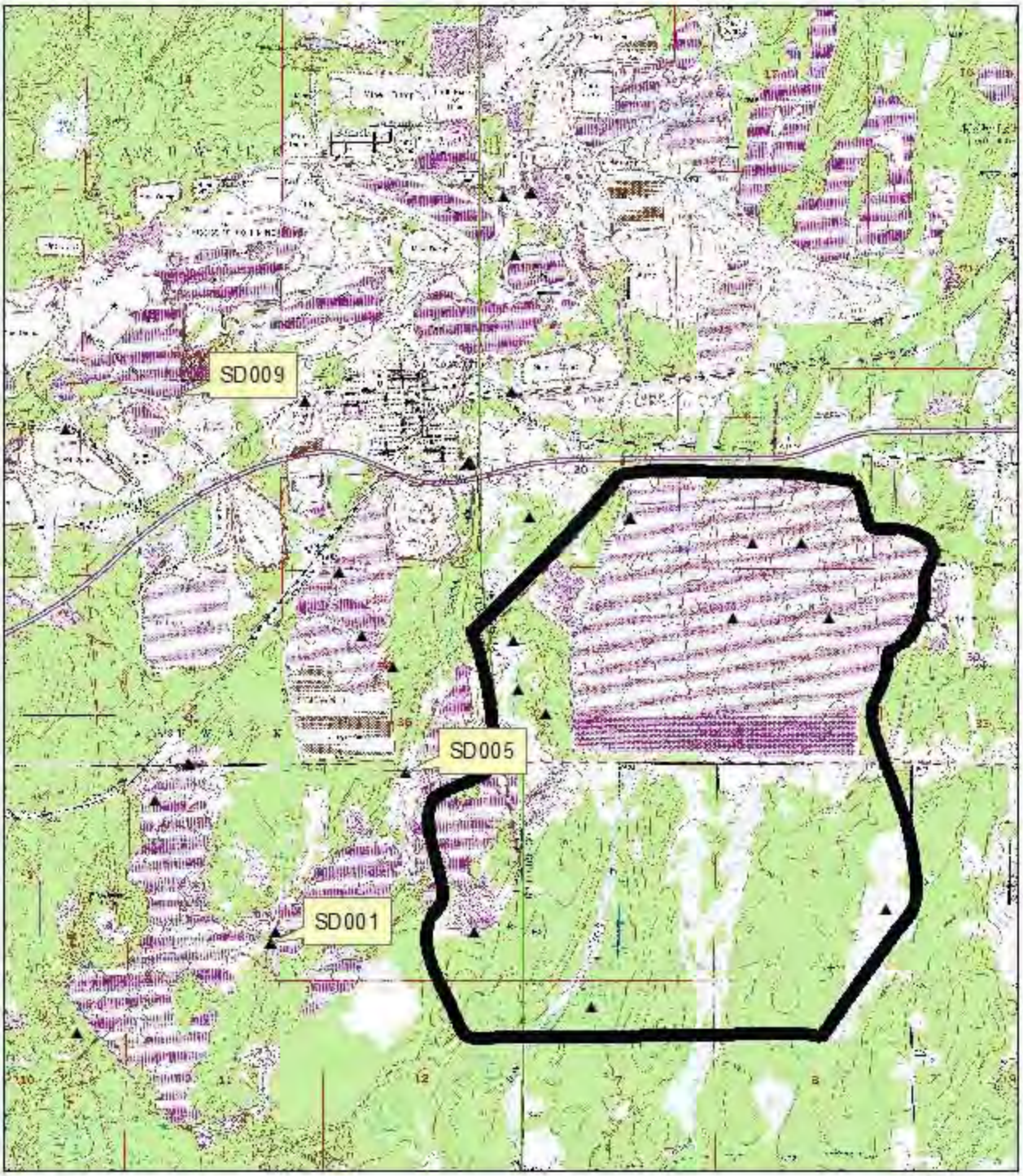
Changes to Facility or Operation
The facility has proposed an expansion of the taconite processing plant with which the permitted operations are associated. As a result, the rate of tailings deposition to the tailings basin will be increased. An increase in the discharge rate of process wastewaters from the tailings basin is not expected to exceed the volumes already permitted.

The facility is proposing to discharge dewatering effluent from the Sargent Pit directly to surface water. This discharge is discussed later in this statement of basis.

Recent Compliance History
The Facility was inspected on May 10, 2010. No significant compliance issues were found that would affect reissuance of this permit.

Topographic Map of Permitted Facility

MN0055948, United States Steel Corporation - Keetac Tailings Basin
St. Louis & Itasca County, Minnesota



Map produced by: MPCA Staff, 6/23/2011
Source: USGS Keewatin, Silica Quad
Scale: 1:50,000

0 0.25 0.5 1 Miles

N

Receiving Waters

Use Classification
The receiving waters affected by this permit reissuance include Reservoir 2, Reservoir 2 North, Welcome Creek, and an unnamed ditch, which discharges to Welcome Creek.

All waters of the state of Minnesota must be classified based on considerations of best usage in the interest of the public and in conformance with the requirements of the applicable statutes, as described in Minn. R. 7050.0140. Based on these considerations, Welcome Creek is classified as Class 2C waters as listed in Minn R. 7050.0470 subp. 4.A. item (236). According to Minn. R. 7050.0410, any listed water in part 7050.0470 is also classified as a Class 3C, 4A, 4B, 5, and 6 water.

Reservoir 2, Reservoir 2 North, and the unnamed ditch leading to Welcome Creek are not listed waters in Minn. R. 7050.0470. As detailed in Minn. R. 7050.0430, all surface waters of the state that are not listed in part 7050.0470 and that are not wetlands as defined in part Minn. R. 7050.0186, subp. 1a, are classified as Class 2B, 3C, 4A, 4B, 5, and 6 waters.

Based on the applicable classifications, the receiving waters named above are designated for use in the forms of aquatic life and recreation, industrial consumption, agriculture and wildlife, aesthetic enjoyment and navigation, and other uses.

Impairments
Minnesota is required to maintain a list of impaired waters, pursuant to Section 303(d) of the Federal Clean Water Act. Impairments have been identified in the receiving waters affected by this permit reissuance for mercury. Permit conditions with regard to mercury for this permit modification are discussed later in this statement of basis.

Proposed Permit Effluent Limits

The MPCA may develop effluent limitations based on Minnesota state water quality standards for the receiving water use classification, federal categorical standards applicable to specific industrial categories, or combination of these standards to regulate discharge of industrial wastewater. In addition, the MPCA may derive standards that are specific to a particular discharge. These standards may be based on toxicity studies, best professional judgment analysis, technology based standards, and in some instances standards developed by other U.S. states or regulatory agencies. Minnesota Rules and the U.S. Code of Federal Regulations (CFR) require that the MPCA categorize industrial dischargers consistent with the U.S. Environmental Protection Agency federal categorical standards, and state standards if appropriate.

Technology Based Effluent Limits
Minn. R. 7053.0225 subp. 1.A requires that all point source dischargers of industrial or other wastes shall comply with applicable federal standards, including those listed in 40 CFR pt. 401 through 469. The MPCA has determined that the specific industrial category and federal effluent limitation guidelines (Categorical Standards) applicable to this facility are those described in 40 CFR pt. 440 subp. A, for the iron ore mining and dressing point source category. The facility constitutes an existing source, and is therefore not subject to the New Source Performance Standards for this industry. The Categorical Standards for Best Practicable Control Technology currently available (BPT) and Best Available Technology economically achievable (BAT) have been applied for the conditions in this permit. These standards have been used to develop the effluent limitations for discharge of process wastewaters and dewatering effluent summarized in the tables below.

Table – Technology-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0055948, Surface Discharge Stations SD001: Siphon Outfalls to Reservoir 2 and SD005: Weir Outfall to Reservoir 2 North

Effluent Characteristic	*Effluent Limitation*	*Basis*
pH	6.0 Standard Units (SU) Instantaneous Minimum; 9.0 SU Instantaneous Maximum	40 CFR § 440.12(c)(2)
Iron, dissolved (as Fe)	1.0 mg/L Calendar Month Average, 2.0 mg/L Daily Maximum	40 CFR § 440.12(c)(2), 40 CFR § 440.13(c)(2)
Total Suspended Solids	20 mg/L Calendar Month Average, 30 mg/L Daily Maximum	40 CFR § 440.12(c)(2)

Stations SD001 and SD005 are both discharges of process wastewater from Reservoir 6 to surface water. Both constitute discharges of process wastewaters from a mill that employs magnetic and physical methods to beneficiate iron ore in the Mesabi Range. Therefore, pursuant to 40 CFR §§ 440.12(c) and 440.13(c), the allowable discharges from these outfalls are limited to the volume associated with the net accumulation of annual precipitation when annual precipitation exceeds evaporation. Compliance with this requirement is monitored for the combination of flows from SD001 and SD005 and reported via station SD008, along with the annual precipitation and annual evaporation.

Table – Technology-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0055948, Surface Discharge Station SD009: Sargent Pit Dewatering to Unnamed Ditch

Effluent Characteristic	*Effluent Limitation*	*Basis*
pH	6.0 Standard Units (SU) Instantaneous Minimum; 9.0 SU Instantaneous Maximum	40 CFR § 440.12(a)
Iron, dissolved (as Fe)	1.0 mg/L Calendar Month Average, 2.0 mg/L Daily Maximum	40 CFR § 440.12(a), 40 CFR § 440.13(a)
Total Suspended Solids	20 mg/L Calendar Month Average, 30 mg/L Daily Maximum	40 CFR § 440.12(a)

Water Quality Based Effluent Limits

Stations SD001, SD005, and SD009 have been evaluated to determine the need for effluent limitations to protect the receiving waters for the use classifications previously discussed. Water quality-based effluent limitations have been included for the permit reissuance as discussed below.

The MPCA has made the determination that, based on the information available at the time of this permit reissuance, sulfate from the facility's discharges via SD001, SD005, and SD009 reaches waters that are used for the production of wild rice. Pursuant to Minn. R. 7050.0224 subp. 2, the available information at the time of this permit reissuance, and currently established permitting policies, the MPCA is including final effluent limitations for total sulfate based on a water quality standard of 10 mg/L total sulfate for these outfalls. The effluent limitations and associated reasonable potential calculations are detailed in the two tables below. The calculations are based on a zero-dilution factor, due to the fact that the receiving waters are above the currently supported water quality standard of 10 mg/L sulfate.

Discharges from the tailings basin were evaluated for reasonable potential for water quality parameters as directed by MPCA permitting policy. The discharge indicates reasonable potential for sulfate as previously discussed. None of the additional parameters evaluated indicated reasonable potential to exceed water quality standards in the receiving waters.

Table – Reasonable Potential Calculations for SD001 and SD005

PARAMETER	SO4 AQ. LIFE (mg/l)	SO4 WILD RICE (mg/l)	SPEC. COND. (umohms/cm)	HG (ng/l)	CL- AQ. LIFE (mg/l)	CL- CLASS 3 (mg/l)
Maximum measured effluent value	137	137	958	2.4	24.8	24.8
Projected effluent quality (PEQ) @ n data points	1 (47)	1 (47)	1 (47)	4 (10)	154 (1)	154 (1)
Plant design flow (mgd)	23	23	23	23	23	23
Receiving water design flow (mgd)	0	0	0	0	0	0
Background concentration	0	0	0	6.9	0	0
Continuous standard (cs) @302 Hd	1210	10	1000	6.9	230	250
Maximum standard (ms) @ 302 Hd	1452	Na	Na	2400	860	Na
Final acute value (FAV) @ 302 Hd	2904	Na	Na	4900	1720	Na
Mass Balance – cs	1210	10	1000	6.9	230	250
Mass Balance - ms	1452	-	-	2400	860	-
Coefficient Of Variation (CV)	0.6	0.6	0.1763	0.6	0.6	0.6
Long Term Average: LTA cs	638.2	7.8029	928.3732	5.3840	121.3	195.0737
LTAms	466	-	-	771	276	-
Preliminary Effluent Limit (PEL): Daily Maximum	1452	24.3	1373.3	16.8	378	1607.5
Monthly Average	838	14.0	1130	9.7	218	350.7
Reasonable Potential PEQ>PEL (Dmax/FAV)	No	**Yes**	No	No	No	No

The proposed discharge of Sargent Pit dewatering effluent to an unnamed ditch was evaluated for the potential to exceed water quality standards. The reasonable potential calculations for this discharge are summarized in the table below.

Table – Reasonable Potential Calculations for SD009

PARAMETER	BA (ug/l)	SE (ug/l)	CL-AQ. LIFE (mg/l))	CL-CLASS 3 (mg/l))	SO4 AQ. LIFE (mg/l)	SO4 WILD RICE (mg/l)	AS (ug/l)	HG (ng/l)	SP. COND (umhos/cm)
Maximum measured effluent value	35.6	2.9	8.84	8.84	113	113	12.6	1.2	660
Projected effluent quality (PEQ) @ n data points	220.7 (1)	17.98 (1)	55 (1)	55 (1)	700.6 (1)	700.6 (1)	32.8 (1)	7 (1)	4092 (1)
Plant design flow (mgd)	4.75	4.75	4.75	4.75	4.75	4.75	4.75	4.75	4.75
Receiving water design flow (mgd)	0	0	0	0	0	0	0	0	0
Background concentration	0	0	0	0	0	0	0	0	0
Continuous standard (cs) @331 Hd	683	5	230	250	908	10	53	6.9	1000
Maximum standard (ms) @ 331 Hd	2758	20	860	Na	1090	Na	360	2400	Na
Final acute value (FAV) @ 331 Hd	5516	40	1720	Na	2179	Na	720	4900	Na
Mass Balance – cs	683	5	230	250	908	10	53	6.9	1000
Mass Balance - ms	2758	20	860	-	1090	-	360	2400	-
Coefficient Of Variation (CV)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Long Term Average: LTA cs	360.2	2.64	121.31	195.07	478.9	7.803	28	5.384	780.295
LTAms	885.6	6.42	276.14	-	350.0	-	115.6	771	-
Preliminary Effluent Limit (PEL): Daily Maximum	1122	8.2	378	607.5	1090	24.3	87	16.8	2430.1
Monthly Average	647.6	5	218	350.7	629	14.0	50	9.7	1403
Reasonable Potential PEQ>PEL (Dmax/FAV)	No	**Yes**	No	No	No	**Yes**	No	No	**Yes**

The discharge of Sargent Pit dewatering effluent indicated reasonable potential for sulfate as previously discussed. In addition, reasonable potential to exceed water quality standards for selenium and specific conductance was identified; however this indication is based on a limited data set. Therefore, effluent limitations have not been included for the reissuance of this permit; however monitoring requirements have been included to provide additional detail regarding these pollutants as discussed in greater detail later in this statement of basis.

Additional Requirements

Compliance Schedule

The permit reissuance includes a schedule for attaining compliance with the final effluent limitations for total sulfate. The schedule requires attainment of compliance as soon as possible and in no case later than August 17, 2020. The term of the compliance schedule is based on the time required for completion of evaluations by the Permittee, as well as time for implementation of any final plans for attaining compliance, including time for obtaining various regulatory approvals. The compliance schedule has been developed in accordance with the requirements of 40 CFR § 122.47.

Monitoring for Selenium and Specific Conductance
The permit contains effluent limitations for selenium and specific conductance and previously discussed. However, these effluent limitations have been calculated based on a single data point, which may or may not be representative of the actual discharge conditions. The permit includes a requirement to monitor the discharge from Sargent Pit monthly for selenium and specific conductance, and discharges from the tailings basin monthly for selenium. After accumulating a data set that represents at least 12 data points, and characterizes the seasonal variability of these discharges, the Permittee has the option of requesting reduction or elimination of monitoring for these parameters based on a revised reasonable potential analysis.

Nondegredation and Anti-Backsliding

Anti-Backsliding
The effluent limitations contained in this permit modification are not less stringent than the effluent limitations in the existing permit, in accordance with the antibacksliding requirements found in 40 CFR § 122.44(l) and Minn. R. 7053.0275.

Nondegradation
In accordance with the MPCA rules regarding nondegradation for all waters, the design flow of the facility as of January 1, 1988, and associated mass loading are the baseline design flow and mass loading. This baseline flow and mass loading are used to determine whether nondegradation review is required for any change in the discharge.

Given that the new discharge location for Sargent Pit dewatering to the unnamed ditch represents an expansion of the facility's permitted discharge to this receiving water by more than 0.2 mgd, and an increased loading of one or more pollutants over the baseline quality in the receiving water, the discharge of dewatering effluent has been reviewed in accordance with Minn. R. 7050.0185. The review includes consideration of the quantity and quality of the proposed discharge and the potential for violating water quality standards in the receiving water. The statistical reasonable potential analysis discussed previously in this Statement of Basis shows that the proposed project will not impair the designated beneficial uses of the receiving waters. The results of the analysis, including the water quality-based effluent limits for sulfate, selenium, and specific conductance have been included in this modified permit to ensure continued protection of existing beneficial uses.

The permit contains conditions for installation of treatment technology to ensure that sulfate loading associated with inputs to the tailings basin complies with nondegradation requirements following expansion of the facility's taconite processing operations.

The Permittee has provided information for the proposed Sargent Pit dewatering as required under the provisions of the nondegradation rule. Using the information provided and all available data, the MPCA is required to determine appropriate effluent limitations protective of existing beneficial uses and determine whether additional controls can reasonably be taken to minimize the potential for impact on receiving waters. The discharge restrictions and monitoring requirements included in this permit have been designed to maintain water quality and preserve designated beneficial uses of the receiving waters. Additional controls beyond these measures are not warranted. Effluent monitoring and reporting requirements ensure ongoing compliance with the discharge permit conditions. Monitoring without numerical effluent limits is included for those parameters that do not have a reasonable potential to exceed water quality standards.

ATTACHMENT 7

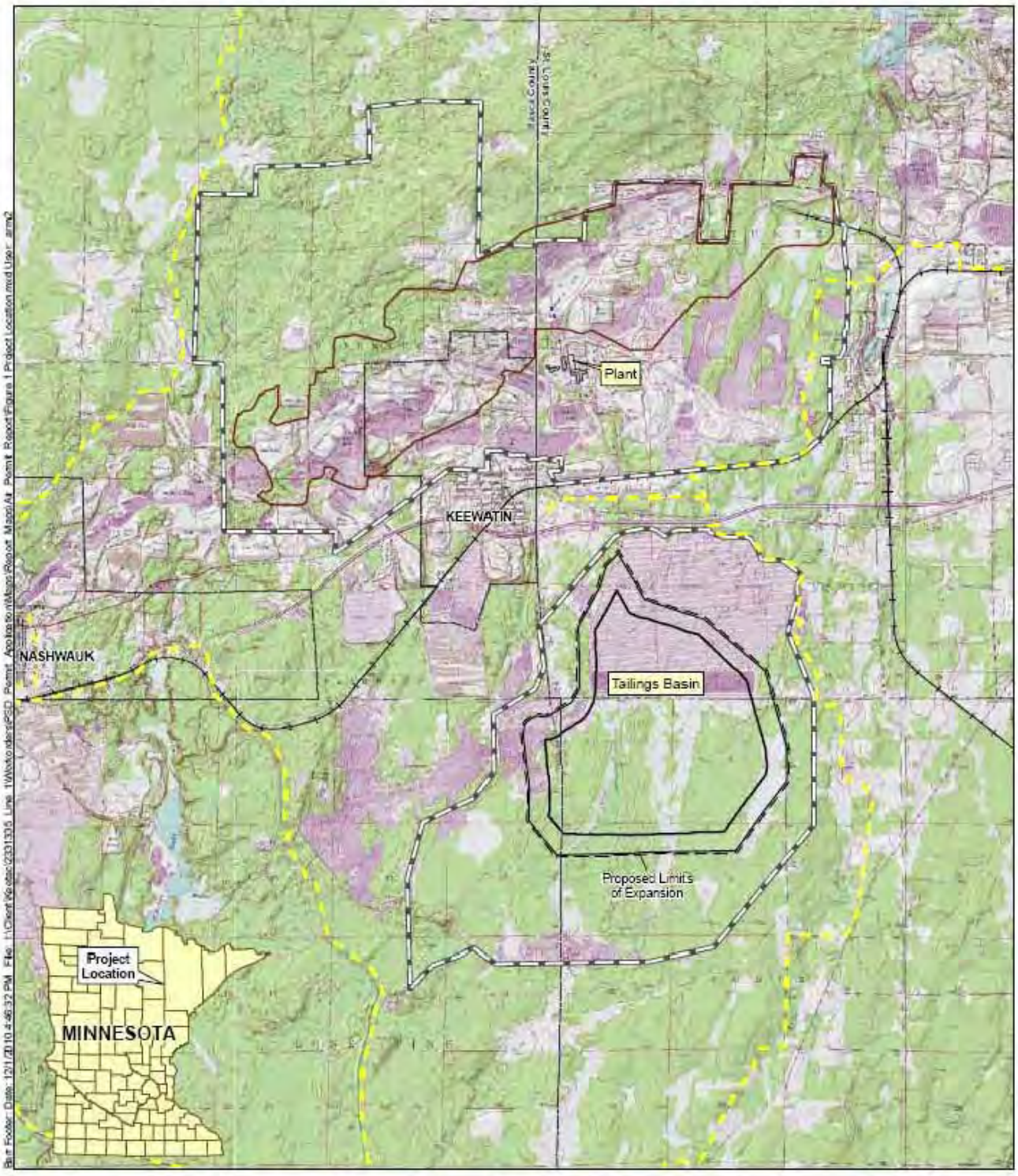


Figure 1
PROJECT LOCATION
Keetac Project
U. S. Steel
Keewatin, Minnesota

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 3

Discharge Monitoring Reports, Bulk Exports for Keetac Permits MN0031879, MN0055948 Sulfate and Specific Conductance, 2018-2024.

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	Facility	Preferred Id	Permit Action	Station	Station Description	Year	Month of M	Mon End Da	Parameter	Limit	Non- detect	Rpt Va	Units	Limit Typ	Nc	Watershed	Huc8 Cod	Huc12 Nai	Longitude	Latitude	Mon End Date	
2	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	March	03/31/2018	Specific Conductance			750	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2018	
3	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	June	06/30/2018	Specific Conductance			721	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2018	
4	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	September	09/30/2018	Specific Conductance			716	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2018	
5	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	December	12/31/2018	Specific Conductance			729	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2018	
6	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	March	03/31/2019	Specific Conductance			755	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2019	
7	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	June	06/30/2019	Specific Conductance			767	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2019	
8	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	September	09/30/2019	Specific Conductance			713	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2019	
9	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	December	12/31/2019	Specific Conductance			731	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2019	
10	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	March	03/31/2020	Specific Conductance			786	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2020	
11	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	June	06/30/2020	Specific Conductance			818	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2020	
12	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	September	09/30/2020	Specific Conductance			781	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2020	
13	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	December	12/31/2020	Specific Conductance			733	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2020	
14	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	March	03/31/2021	Specific Conductance			767	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2021	
15	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	June	06/30/2021	Specific Conductance			762	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2021	
16	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	September	09/30/2021	Specific Conductance			780	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2021	
17	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	December	12/31/2021	Specific Conductance			810	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2021	
18	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	March	03/31/2022	Specific Conductance			783	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2022	
19	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	June	06/30/2022	Specific Conductance			826	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2022	
20	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	September	09/30/2022	Specific Conductance			792	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2022	
21	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	December	12/31/2022	Specific Conductance			811	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2022	
22	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	March	03/31/2023	Specific Conductance			844	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2023	
23	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	June	06/30/2023	Specific Conductance			881	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2023	
24	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	September	09/30/2023	Specific Conductance			823	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2023	
25	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	December	12/31/2023	Specific Conductance			820	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2023	
26	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	March	03/31/2024	Specific Conductance			810	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2024	
27	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	June	06/30/2024	Specific Conductance			831	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2024	
28	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	September	09/30/2024	Specific Conductance			932	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2024	
29	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	December	12/31/2024	Specific Conductance			812	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2024	
30											Average	789										
31	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	March	03/31/2018	Specific Conductance			554	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2018	
32	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	June	06/30/2018	Specific Conductance			577	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2018	
33	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	September	09/30/2018	Specific Conductance			611	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2018	
34	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	December	12/31/2018	Specific Conductance			625	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2018	
35	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	March	03/31/2019	Specific Conductance			533	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2019	
36	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	June	06/30/2019	Specific Conductance			665	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2019	
37	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	September	09/30/2019	Specific Conductance			642	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2019	
38	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	December	12/31/2019	Specific Conductance			653	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2019	
39	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	March	03/31/2020	Specific Conductance			578	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2020	
40	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	June	06/30/2020	Specific Conductance			626	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2020	
41	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	September	09/30/2020	Specific Conductance			703	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2020	
42	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	December	12/31/2020	Specific Conductance			588	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2020	
43	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	March	03/31/2021	Specific Conductance			585	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2021	
44	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	June	06/30/2021	Specific Conductance			709	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2021	
45	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	September	09/30/2021	Specific Conductance			589	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2021	
46	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	December	12/31/2021	Specific Conductance			652	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2021	
47	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	March	03/31/2022	Specific Conductance			778	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2022	
48	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	June	06/30/2022	Specific Conductance			721	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2022	
49	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	September	09/30/2022	Specific Conductance			668	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2022	
50	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	December	12/31/2022	Specific Conductance			625	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2022	
51	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	March	03/31/2023	Specific Conductance			643	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2023	
52	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	June	06/30/2023	Specific Conductance			697	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2023	
53	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	September	09/30/2023	Specific Conductance			639	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2023	
54	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	December	12/31/2023	Specific Conductance			811	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2023	
55	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	March	03/31/2024	Specific Conductance			671	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2024	

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
56	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	June	06/30/2024	Specific Conductance			732	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2024	
57	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	September	09/30/2024	Specific Conductance			775	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2024	
58	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	December	12/31/2024	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2024	
59	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	March	03/31/2018	Specific Conductance			492	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2018	
60	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	June	06/30/2018	Specific Conductance			484	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2018	
61	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	September	09/30/2018	Specific Conductance			481	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2018	
62	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	December	12/31/2018	Specific Conductance			444	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2018	
63	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	March	03/31/2019	Specific Conductance			483	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2019	
64	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	June	06/30/2019	Specific Conductance			481	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2019	
65	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	September	09/30/2019	Specific Conductance			480	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2019	
66	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	December	12/31/2019	Specific Conductance			453	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2019	
67	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	March	03/31/2020	Specific Conductance			489	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2020	
68	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	June	06/30/2020	Specific Conductance			480	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2020	
69	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	September	09/30/2020	Specific Conductance			489	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2020	
70	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	December	12/31/2020	Specific Conductance			455	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2020	
71	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	March	03/31/2021	Specific Conductance			486	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2021	
72	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	June	06/30/2021	Specific Conductance			472	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2021	
73	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	September	09/30/2021	Specific Conductance			460	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2021	
74	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	December	12/31/2021	Specific Conductance			459	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2021	
75	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	March	03/31/2022	Specific Conductance			481	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2022	
76	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	June	06/30/2022	Specific Conductance			501	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2022	
77	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	September	09/30/2022	Specific Conductance			493	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2022	
78	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	December	12/31/2022	Specific Conductance			482	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2022	
79	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	March	03/31/2023	Specific Conductance			517	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2023	
80	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	June	06/30/2023	Specific Conductance			512	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2023	
81	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	September	09/30/2023	Specific Conductance			515	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2023	
82	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	December	12/31/2023	Specific Conductance			506	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2023	
83	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	March	03/31/2024	Specific Conductance			517	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2024	
84	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	June	06/30/2024	Specific Conductance			497	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2024	
85	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	September	09/30/2024	Specific Conductance			482	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2024	
86	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	December	12/31/2024	Specific Conductance			486	umhos/cm	CalQtrMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2024	
87	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	January	01/31/2018	Specific Conductance			833	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2018	
88	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	February	02/28/2018	Specific Conductance			794	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2018	
89	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	March	03/31/2018	Specific Conductance			869	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2018	
90	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	April	04/30/2018	Specific Conductance			883	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2018	
91	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	May	05/31/2018	Specific Conductance			806	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2018	
92	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	June	06/30/2018	Specific Conductance			751	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2018	
93	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	July	07/31/2018	Specific Conductance			757	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2018	
94	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	August	08/31/2018	Specific Conductance			725	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2018	
95	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	September	09/30/2018	Specific Conductance			714	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2018	
96	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	October	10/31/2018	Specific Conductance			706	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2018	
97	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	November	11/30/2018	Specific Conductance			750	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2018	
98	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	December	12/31/2018	Specific Conductance			825	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2018	
99	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	January	01/31/2019	Specific Conductance			788	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2019	
100	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	February	02/28/2019	Specific Conductance			850	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2019	
101	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	March	03/31/2019	Specific Conductance			862	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2019	
102	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	April	04/30/2019	Specific Conductance			886	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2019	
103	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	May	05/31/2019	Specific Conductance			786	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2019	
104	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	June	06/30/2019	Specific Conductance			824	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2019	
105	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	July	07/31/2019	Specific Conductance			777	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2019	
106	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	August	08/31/2019	Specific Conductance			734	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2019	
107	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	September	09/30/2019	Specific Conductance			819	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2019	
108	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	October	10/31/2019	Specific Conductance			723	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2019	
109	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	November	11/30/2019	Specific Conductance			843	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2019	
110	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	December	12/31/2019	Specific Conductance			850	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2019	

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
111	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	January	01/31/2020	Specific Conductance			879	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2020	
112	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	February	02/29/2020	Specific Conductance			920	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/29/2020	
113	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	March	03/31/2020	Specific Conductance			926	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2020	
114	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	April	04/30/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2020	
115	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	May	05/31/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2020	
116	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	June	06/30/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2020	
117	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	July	07/31/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2020	
118	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	August	08/31/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2020	
119	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	September	09/30/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2020	
120	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	October	10/31/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2020	
121	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	November	11/30/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2020	
122	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	December	12/31/2020	Specific Conductance			870	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2020	
123	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	January	01/31/2021	Specific Conductance			870	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2021	
124	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	February	02/28/2021	Specific Conductance			837	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2021	
125	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	March	03/31/2021	Specific Conductance			920	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2021	
126	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	April	04/30/2021	Specific Conductance			842	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2021	
127	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	May	05/31/2021	Specific Conductance			806	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2021	
128	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	June	06/30/2021	Specific Conductance			794	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2021	
129	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	July	07/31/2021	Specific Conductance			843	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2021	
130	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	August	08/31/2021	Specific Conductance			880	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2021	
131	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	September	09/30/2021	Specific Conductance			789	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2021	
132	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	October	10/31/2021	Specific Conductance			850	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2021	
133	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	November	11/30/2021	Specific Conductance			846	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2021	
134	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	December	12/31/2021	Specific Conductance			948	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2021	
135	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	January	01/31/2022	Specific Conductance			926	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2022	
136	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	February	02/28/2022	Specific Conductance			997	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2022	
137	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	March	03/31/2022	Specific Conductance			981	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2022	
138	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	April	04/30/2022	Specific Conductance			916	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2022	
139	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	May	05/31/2022	Specific Conductance			845	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2022	
140	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	June	06/30/2022	Specific Conductance			789	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2022	
141	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	July	07/31/2022	Specific Conductance			757	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2022	
142	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	August	08/31/2022	Specific Conductance			630	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2022	
143	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	September	09/30/2022	Specific Conductance			774	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2022	
144	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	October	10/31/2022	Specific Conductance			749	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2022	
145	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	November	11/30/2022	Specific Conductance			758	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2022	
146	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	December	12/31/2022	Specific Conductance			809	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2022	
147	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	January	01/31/2023	Specific Conductance			882	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2023	
148	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	February	02/28/2023	Specific Conductance			440	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2023	
149	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	March	03/31/2023	Specific Conductance			1022	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2023	
150	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	April	04/30/2023	Specific Conductance			1009	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2023	
151	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	May	05/31/2023	Specific Conductance			885	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2023	
152	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	June	06/30/2023	Specific Conductance			784	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2023	
153	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	July	07/31/2023	Specific Conductance			750	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2023	
154	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	August	08/31/2023	Specific Conductance			763	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2023	
155	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	September	09/30/2023	Specific Conductance			779	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2023	
156	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	October	10/31/2023	Specific Conductance			845	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2023	
157	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	November	11/30/2023	Specific Conductance			809	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2023	
158	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	December	12/31/2023	Specific Conductance			891	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2023	
159	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	January	01/31/2024	Specific Conductance			985	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2024	
160	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	February	02/29/2024	Specific Conductance			987	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/29/2024	
161	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	March	03/31/2024	Specific Conductance			976	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2024	
162	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	April	04/30/2024	Specific Conductance			946	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2024	
163	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	May	05/31/2024	Specific Conductance			904	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2024	
164	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	June	06/30/2024	Specific Conductance			894	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2024	
165	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	July	07/31/2024	Specific Conductance			897	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2024	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
166	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	August	08/31/2024	Specific Conductance			866	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2024	
167	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	September	09/30/2024	Specific Conductance			817	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2024	
168	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	October	10/31/2024	Specific Conductance			888	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2024	
169	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	November	11/30/2024	Specific Conductance			888	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2024	
170	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	December	12/31/2024	Specific Conductance			965	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2024	
171	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	January	01/31/2018	Specific Conductance			2171	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2018	
172	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	February	02/28/2018	Specific Conductance			2202	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2018	
173	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	March	03/31/2018	Specific Conductance			2044	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2018	
174	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	April	04/30/2018	Specific Conductance			2234	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2018	
175	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	May	05/31/2018	Specific Conductance			2085	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2018	
176	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	June	06/30/2018	Specific Conductance			2662	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2018	
177	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	July	07/31/2018	Specific Conductance			2188	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2018	
178	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	August	08/31/2018	Specific Conductance			2058	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2018	
179	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	September	09/30/2018	Specific Conductance			2134	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2018	
180	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	October	10/31/2018	Specific Conductance			2219	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2018	
181	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	November	11/30/2018	Specific Conductance			2070	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2018	
182	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	December	12/31/2018	Specific Conductance			2241	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2018	
183	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	January	01/31/2019	Specific Conductance			2241	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2019	
184	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	February	02/28/2019	Specific Conductance			1685	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2019	
185	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	March	03/31/2019	Specific Conductance			2163	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2019	
186	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	April	04/30/2019	Specific Conductance			2230	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2019	
187	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	May	05/31/2019	Specific Conductance			2268	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2019	
188	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	June	06/30/2019	Specific Conductance			2027	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2019	
189	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	July	07/31/2019	Specific Conductance			2369	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2019	
190	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	August	08/31/2019	Specific Conductance			1412	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2019	
191	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	September	09/30/2019	Specific Conductance			2715	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2019	
192	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	October	10/31/2019	Specific Conductance			1722	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2019	
193	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	November	11/30/2019	Specific Conductance			2771	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2019	
194	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	December	12/31/2019	Specific Conductance			2011	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2019	
195	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	January	01/31/2020	Specific Conductance			3292	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2020	
196	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	February	02/29/2020	Specific Conductance			2859	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/29/2020	
197	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	March	03/31/2020	Specific Conductance			2988	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2020	
198	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	April	04/30/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2020	
199	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	May	05/31/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2020	
200	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	June	06/30/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2020	
201	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	July	07/31/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2020	
202	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	August	08/31/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2020	
203	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	September	09/30/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2020	
204	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	October	10/31/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2020	
205	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	November	11/30/2020	Specific Conductance				umhos/cm	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2020	
206	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	December	12/31/2020	Specific Conductance			2207	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2020	
207	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	January	01/31/2021	Specific Conductance			2109	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2021	
208	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	February	02/28/2021	Specific Conductance			1181	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2021	
209	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	March	03/31/2021	Specific Conductance			2150	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2021	
210	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	April	04/30/2021	Specific Conductance			2125	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2021	
211	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	May	05/31/2021	Specific Conductance			2518	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2021	
212	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	June	06/30/2021	Specific Conductance			2759	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2021	
213	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	July	07/31/2021	Specific Conductance			3383	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2021	
214	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	August	08/31/2021	Specific Conductance			3234	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2021	
215	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	September	09/30/2021	Specific Conductance			2293	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2021	
216	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	October	10/31/2021	Specific Conductance			3567	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2021	
217	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	November	11/30/2021	Specific Conductance			3275	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2021	
218	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	December	12/31/2021	Specific Conductance			1980	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2021	
219	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	January	01/31/2022	Specific Conductance			3935	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2022	
220	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	February	02/28/2022	Specific Conductance			4060	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2022	

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
221	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	March	03/31/2022	Specific Conductance			3830	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2022	
222	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	April	04/30/2022	Specific Conductance			2800	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2022	
223	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	May	05/31/2022	Specific Conductance			3280	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2022	
224	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	June	06/30/2022	Specific Conductance			3049	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2022	
225	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	July	07/31/2022	Specific Conductance			3676	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2022	
226	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	August	08/31/2022	Specific Conductance			3873	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2022	
227	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	September	09/30/2022	Specific Conductance			3608	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2022	
228	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	October	10/31/2022	Specific Conductance			2455	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2022	
229	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	November	11/30/2022	Specific Conductance			1500	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2022	
230	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	December	12/31/2022	Specific Conductance			2987	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2022	
231	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	January	01/31/2023	Specific Conductance			2945	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2023	
232	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	February	02/28/2023	Specific Conductance			4312	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2023	
233	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	March	03/31/2023	Specific Conductance			3747	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2023	
234	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	April	04/30/2023	Specific Conductance			2618	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2023	
235	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	May	05/31/2023	Specific Conductance			2861	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2023	
236	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	June	06/30/2023	Specific Conductance			2710	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2023	
237	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	July	07/31/2023	Specific Conductance			2845	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2023	
238	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	August	08/31/2023	Specific Conductance			3239	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2023	
239	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	September	09/30/2023	Specific Conductance			3273	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2023	
240	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	October	10/31/2023	Specific Conductance			2736	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2023	
241	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	November	11/30/2023	Specific Conductance			2856	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2023	
242	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	December	12/31/2023	Specific Conductance			2552	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2023	
243	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	January	01/31/2024	Specific Conductance			2215	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2024	
244	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	February	02/29/2024	Specific Conductance			2439	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/29/2024	
245	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	March	03/31/2024	Specific Conductance			2223	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2024	
246	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	April	04/30/2024	Specific Conductance			2856	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2024	
247	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	May	05/31/2024	Specific Conductance			1795	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2024	
248	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	June	06/30/2024	Specific Conductance			2890	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2024	
249	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	July	07/31/2024	Specific Conductance			3318	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2024	
250	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	August	08/31/2024	Specific Conductance			3536	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2024	
251	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	September	09/30/2024	Specific Conductance			2711	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2024	
252	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	October	10/31/2024	Specific Conductance			2673	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2024	
253	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	November	11/30/2024	Specific Conductance			2966	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2024	
254	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	December	12/31/2024	Specific Conductance			2966	umhos/cm	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2024	
255	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	January	01/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2018	
256	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	February	02/28/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/28/2018	
257	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	March	03/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2018	
258	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	April	04/30/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2018	
259	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	May	05/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2018	
260	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	June	06/30/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2018	
261	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	July	07/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2018	
262	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	August	08/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2018	
263	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	September	09/30/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2018	
264	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	October	10/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2018	
265	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	November	11/30/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2018	
266	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	December	12/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2018	
267	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	January	01/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2019	
268	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	February	02/28/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/28/2019	
269	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	March	03/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2019	
270	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	April	04/30/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2019	
271	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	May	05/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2019	
272	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	June	06/30/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2019	
273	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	July	07/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2019	
274	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	August	08/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2019	
275	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	September	09/30/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2019	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
276	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	October	10/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2019	
277	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	November	11/30/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2019	
278	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	December	12/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2019	
279	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	January	01/31/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2020	
280	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	February	02/29/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/29/2020	
281	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	March	03/31/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2020	
282	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	April	04/30/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2020	
283	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	May	05/31/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2020	
284	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	June	06/30/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2020	
285	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	July	07/31/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2020	
286	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	August	08/31/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2020	
287	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	September	09/30/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2020	
288	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	October	10/31/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2020	
289	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	November	11/30/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2020	
290	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	December	12/31/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2020	
291	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	January	01/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2021	
292	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	February	02/28/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/28/2021	
293	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	March	03/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2021	
294	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	April	04/30/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2021	
295	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	May	05/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2021	
296	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	June	06/30/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2021	
297	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	July	07/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2021	
298	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	August	08/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2021	
299	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	September	09/30/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2021	
300	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	October	10/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2021	
301	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	November	11/30/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2021	
302	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	December	12/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2021	
303	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	January	01/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2022	
304	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	February	02/28/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/28/2022	
305	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	March	03/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2022	
306	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	April	04/30/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2022	
307	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	May	05/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2022	
308	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	June	06/30/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2022	
309	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	July	07/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2022	
310	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	August	08/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2022	
311	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	September	09/30/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2022	
312	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	October	10/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2022	
313	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	November	11/30/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2022	
314	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	December	12/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2022	
315	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	January	01/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2023	
316	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	February	02/28/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/28/2023	
317	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	March	03/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2023	
318	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	April	04/30/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2023	
319	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	May	05/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2023	
320	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	June	06/30/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2023	
321	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	July	07/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2023	
322	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	August	08/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2023	
323	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	September	09/30/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2023	
324	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	October	10/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2023	
325	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	November	11/30/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2023	
326	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	December	12/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2023	
327	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	January	01/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2024	
328	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	February	02/29/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/29/2024	
329	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	March	03/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2024	
330	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	April	04/30/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2024	

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
331	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	May	05/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2024	
332	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	June	06/30/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2024	
333	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	July	07/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2024	
334	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	August	08/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2024	
335	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	September	09/30/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2024	
336	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	October	10/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2024	
337	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	November	11/30/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2024	
338	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	December	12/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2024	
339	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	January	01/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2018	
340	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	February	02/28/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/28/2018	
341	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	March	03/31/2018	Specific Conductance			779	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2018	
342	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	April	04/30/2018	Specific Conductance			837	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2018	
343	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	May	05/31/2018	Specific Conductance			585	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2018	
344	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	June	06/30/2018	Specific Conductance			716	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2018	
345	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	July	07/31/2018	Specific Conductance			707	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2018	
346	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	August	08/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2018	
347	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	September	09/30/2018	Specific Conductance			772	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2018	
348	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	October	10/31/2018	Specific Conductance			684	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2018	
349	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	November	11/30/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2018	
350	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	December	12/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2018	
351	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	January	01/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2019	
352	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	February	02/28/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/28/2019	
353	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	March	03/31/2019	Specific Conductance			749	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2019	
354	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	April	04/30/2019	Specific Conductance			861	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2019	
355	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	May	05/31/2019	Specific Conductance			749	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2019	
356	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	June	06/30/2019	Specific Conductance			739	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2019	
357	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	July	07/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2019	
358	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	August	08/31/2019	Specific Conductance			718	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2019	
359	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	September	09/30/2019	Specific Conductance			722	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2019	
360	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	October	10/31/2019	Specific Conductance			731	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2019	
361	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	November	11/30/2019	Specific Conductance			766	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2019	
362	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	December	12/31/2019	Specific Conductance			795	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2019	
363	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	January	01/31/2020	Specific Conductance			799	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2020	
364	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	February	02/29/2020	Specific Conductance			837	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/29/2020	
365	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	March	03/31/2020	Specific Conductance			913	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2020	
366	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	April	04/30/2020	Specific Conductance			793	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2020	
367	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	May	05/31/2020	Specific Conductance			749	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2020	
368	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	June	06/30/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2020	
369	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	July	07/31/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2020	
370	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	August	08/31/2020	Specific Conductance			787	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2020	
371	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	September	09/30/2020	Specific Conductance			781	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2020	
372	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	October	10/31/2020	Specific Conductance			759	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2020	
373	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	November	11/30/2020	Specific Conductance			771	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2020	
374	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	December	12/31/2020	Specific Conductance			813	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2020	
375	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	January	01/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2021	
376	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	February	02/28/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/28/2021	
377	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	March	03/31/2021	Specific Conductance			873	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2021	
378	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	April	04/30/2021	Specific Conductance			762	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2021	
379	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	May	05/31/2021	Specific Conductance			785	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2021	
380	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	June	06/30/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2021	
381	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	July	07/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2021	
382	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	August	08/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2021	
383	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	September	09/30/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2021	
384	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	October	10/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2021	
385	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	November	11/30/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2021	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
386	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	December	12/31/2021	Specific Conductance			859	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2021	
387	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	January	01/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2022	
388	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	February	02/28/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/28/2022	
389	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	March	03/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2022	
390	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	April	04/30/2022	Specific Conductance			678	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2022	
391	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	May	05/31/2022	Specific Conductance			765	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2022	
392	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	June	06/30/2022	Specific Conductance			731	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2022	
393	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	July	07/31/2022	Specific Conductance			722	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2022	
394	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	August	08/31/2022	Specific Conductance				mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2022	
395	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	September	09/30/2022	Specific Conductance			728	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2022	
396	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	October	10/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2022	
397	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	November	11/30/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2022	
398	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	December	12/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2022	
399	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	January	01/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2023	
400	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	February	02/28/2023	Specific Conductance			854	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/28/2023	
401	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	March	03/31/2023	Specific Conductance			954	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2023	
402	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	April	04/30/2023	Specific Conductance			1028	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2023	
403	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	May	05/31/2023	Specific Conductance			745	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2023	
404	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	June	06/30/2023	Specific Conductance			725	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2023	
405	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	July	07/31/2023	Specific Conductance			736	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2023	
406	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	August	08/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2023	
407	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	September	09/30/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2023	
408	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	October	10/31/2023	Specific Conductance			808	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2023	
409	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	November	11/30/2023	Specific Conductance			823	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2023	
410	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	December	12/31/2023	Specific Conductance			866	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2023	
411	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	January	01/31/2024	Specific Conductance			890	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2024	
412	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	February	02/29/2024	Specific Conductance			922	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/29/2024	
413	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	March	03/31/2024	Specific Conductance			957	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2024	
414	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	April	04/30/2024	Specific Conductance			882	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2024	
415	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	May	05/31/2024	Specific Conductance			922	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2024	
416	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	June	06/30/2024	Specific Conductance			883	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2024	
417	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	July	07/31/2024	Specific Conductance			828	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2024	
418	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	August	08/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2024	
419	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	September	09/30/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2024	
420	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	October	10/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2024	
421	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	November	11/30/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2024	
422	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	December	12/31/2024	Specific Conductance			797	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2024	
423																						
424	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	January	01/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2018	
425	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	February	02/28/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/28/2018	
426	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	March	03/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2018	
427	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	April	04/30/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2018	
428	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	May	05/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2018	
429	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	June	06/30/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2018	
430	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	July	07/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2018	
431	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	August	08/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2018	
432	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	September	09/30/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2018	
433	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	October	10/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2018	
434	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	November	11/30/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2018	
435	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	December	12/31/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2018	
436	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	January	01/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2019	
437	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	February	02/28/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/28/2019	
438	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	March	03/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2019	
439	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	April	04/30/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2019	
440	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	May	05/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2019	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
441	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	June	06/30/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2019	
442	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	July	07/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2019	
443	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	August	08/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2019	
444	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	September	09/30/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2019	
445	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	October	10/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2019	
446	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	November	11/30/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2019	
447	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	December	12/31/2019	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2019	
448	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	January	01/31/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2020	
449	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	February	02/29/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/29/2020	
450	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	March	03/31/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2020	
451	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	April	04/30/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2020	
452	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	May	05/31/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2020	
453	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	June	06/30/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2020	
454	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	July	07/31/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2020	
455	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	August	08/31/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2020	
456	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	September	09/30/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2020	
457	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	October	10/31/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2020	
458	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	November	11/30/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2020	
459	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	December	12/31/2020	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2020	
460	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	January	01/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2021	
461	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	February	02/28/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/28/2021	
462	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	March	03/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2021	
463	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	April	04/30/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2021	
464	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	May	05/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2021	
465	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	June	06/30/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2021	
466	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	July	07/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2021	
467	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	August	08/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2021	
468	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	September	09/30/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2021	
469	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	October	10/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2021	
470	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	November	11/30/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2021	
471	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	December	12/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2021	
472	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	January	01/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2022	
473	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	February	02/28/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/28/2022	
474	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	March	03/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2022	
475	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	April	04/30/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2022	
476	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	May	05/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2022	
477	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	June	06/30/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2022	
478	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	July	07/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2022	
479	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	August	08/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2022	
480	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	September	09/30/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2022	
481	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	October	10/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2022	
482	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	November	11/30/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2022	
483	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	December	12/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2022	
484	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	January	01/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2023	
485	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	February	02/28/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/28/2023	
486	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	March	03/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2023	
487	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	April	04/30/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2023	
488	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	May	05/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2023	
489	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	June	06/30/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2023	
490	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	July	07/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2023	
491	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	August	08/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2023	
492	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	September	09/30/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2023	
493	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	October	10/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2023	
494	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	November	11/30/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2023	
495	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	December	12/31/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2023	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
496	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	January	01/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2024	
497	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	February	02/29/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/29/2024	
498	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	March	03/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2024	
499	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	April	04/30/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2024	
500	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	May	05/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2024	
501	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	June	06/30/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2024	
502	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	July	07/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2024	
503	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	August	08/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2024	
504	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	September	09/30/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2024	
505	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	October	10/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2024	
506	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	November	11/30/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2024	
507	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	December	12/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2024	
508	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2018	January	01/31/2018	Specific Conductance			743	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	01/31/2018	
509	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2018	February	02/28/2018	Specific Conductance			649	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	02/28/2018	
510	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2018	March	03/31/2018	Specific Conductance			649	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	03/31/2018	
511	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2018	April	04/30/2018	Specific Conductance			653	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	04/30/2018	
512	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2018	May	05/31/2018	Specific Conductance			563	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	05/31/2018	
513	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2018	June	06/30/2018	Specific Conductance			576	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	06/30/2018	
514	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2018	July	07/31/2018	Specific Conductance			565	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	07/31/2018	
515	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2018	August	08/31/2018	Specific Conductance			585	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	08/31/2018	
516	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2018	September	09/30/2018	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	09/30/2018	
517	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2018	October	10/31/2018	Specific Conductance			540	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	10/31/2018	
518	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2018	November	11/30/2018	Specific Conductance			580	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	11/30/2018	
519	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2018	December	12/31/2018	Specific Conductance			845	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	12/31/2018	
520	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2019	January	01/31/2019	Specific Conductance			712	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	01/31/2019	
521	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2019	February	02/28/2019	Specific Conductance			730	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	02/28/2019	
522	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2019	March	03/31/2019	Specific Conductance			658	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	03/31/2019	
523	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2019	April	04/30/2019	Specific Conductance			679	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	04/30/2019	
524	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2019	May	05/31/2019	Specific Conductance			625	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	05/31/2019	
525	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2019	June	06/30/2019	Specific Conductance			655	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	06/30/2019	
526	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2019	July	07/31/2019	Specific Conductance			633	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	07/31/2019	
527	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2019	August	08/31/2019	Specific Conductance			594	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	08/31/2019	
528	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2019	September	09/30/2019	Specific Conductance			559	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	09/30/2019	
529	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2019	October	10/31/2019	Specific Conductance			605	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	10/31/2019	
530	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2019	November	11/30/2019	Specific Conductance			665	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	11/30/2019	
531	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2019	December	12/31/2019	Specific Conductance			687	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	12/31/2019	
532	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2020	January	01/31/2020	Specific Conductance			675	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	01/31/2020	
533	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2020	February	02/29/2020	Specific Conductance			710	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	02/29/2020	
534	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2020	March	03/31/2020	Specific Conductance			736	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	03/31/2020	
535	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2020	April	04/30/2020	Specific Conductance			696	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	04/30/2020	
536	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2020	May	05/31/2020	Specific Conductance			671	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	05/31/2020	
537	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2020	June	06/30/2020	Specific Conductance			715	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	06/30/2020	
538	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2020	July	07/31/2020	Specific Conductance			667	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	07/31/2020	
539	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2020	August	08/31/2020	Specific Conductance			660	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	08/31/2020	
540	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2020	September	09/30/2020	Specific Conductance			781	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	09/30/2020	
541	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2020	October	10/31/2020	Specific Conductance			676	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	10/31/2020	
542	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2020	November	11/30/2020	Specific Conductance			661	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	11/30/2020	
543	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2020	December	12/31/2020	Specific Conductance			743	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	12/31/2020	
544	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2021	January	01/31/2021	Specific Conductance			764	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	01/31/2021	
545	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2021	February	02/28/2021	Specific Conductance			815	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	02/28/2021	
546	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2021	March	03/31/2021	Specific Conductance			813	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	03/31/2021	
547	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2021	April	04/30/2021	Specific Conductance			625	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	04/30/2021	
548	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2021	May	05/31/2021	Specific Conductance			658	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	05/31/2021	
549	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2021	June	06/30/2021	Specific Conductance			661	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	06/30/2021	
550	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2021	July	07/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	07/31/2021	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
551	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2021	August	08/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	08/31/2021	
552	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2021	September	09/30/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	09/30/2021	
553	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2021	October	10/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	10/31/2021	
554	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2021	November	11/30/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	11/30/2021	
555	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2021	December	12/31/2021	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	12/31/2021	
556	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2022	January	01/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	01/31/2022	
557	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2022	February	02/28/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	02/28/2022	
558	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2022	March	03/31/2022	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	03/31/2022	
559	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2022	April	04/30/2022	Specific Conductance			525	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	04/30/2022	
560	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2022	May	05/31/2022	Specific Conductance			613	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	05/31/2022	
561	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2022	June	06/30/2022	Specific Conductance			590	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	06/30/2022	
562	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2022	July	07/31/2022	Specific Conductance			600	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	07/31/2022	
563	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2022	August	08/31/2022	Specific Conductance			591	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	08/31/2022	
564	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2022	September	09/30/2022	Specific Conductance			572	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	09/30/2022	
565	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2022	October	10/31/2022	Specific Conductance			579	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	10/31/2022	
566	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2022	November	11/30/2022	Specific Conductance			428	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	11/30/2022	
567	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2022	December	12/31/2022	Specific Conductance			466	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	12/31/2022	
568	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2023	January	01/31/2023	Specific Conductance			729	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	01/31/2023	
569	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2023	February	02/28/2023	Specific Conductance			803	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	02/28/2023	
570	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2023	March	03/31/2023	Specific Conductance			724	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	03/31/2023	
571	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2023	April	04/30/2023	Specific Conductance			716	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	04/30/2023	
572	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2023	May	05/31/2023	Specific Conductance			628	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	05/31/2023	
573	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2023	June	06/30/2023	Specific Conductance			683	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	06/30/2023	
574	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2023	July	07/31/2023	Specific Conductance			673	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	07/31/2023	
575	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2023	August	08/31/2023	Specific Conductance			667	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	08/31/2023	
576	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2023	September	09/30/2023	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	09/30/2023	
577	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2023	October	10/31/2023	Specific Conductance			971	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	10/31/2023	
578	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2023	November	11/30/2023	Specific Conductance			838	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	11/30/2023	
579	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2023	December	12/31/2023	Specific Conductance			838	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	12/31/2023	
580	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2024	January	01/31/2024	Specific Conductance			671	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	01/31/2024	
581	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2024	February	02/29/2024	Specific Conductance			705	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	02/29/2024	
582	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2024	March	03/31/2024	Specific Conductance			724	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	03/31/2024	
583	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2024	April	04/30/2024	Specific Conductance			706	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	04/30/2024	
584	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2024	May	05/31/2024	Specific Conductance			715	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	05/31/2024	
585	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2024	June	06/30/2024	Specific Conductance			783	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	06/30/2024	
586	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2024	July	07/31/2024	Specific Conductance			680	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	07/31/2024	
587	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2024	August	08/31/2024	Specific Conductance			649	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	08/31/2024	
588	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2024	September	09/30/2024	Specific Conductance			721	mmh/cm	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	09/30/2024	
589	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2024	October	10/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	10/31/2024	
590	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2024	November	11/30/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	11/30/2024	
591	US Steel Corp - Tailings	MN0055948	IND20110001	SW 001	Reservoir 2	2024	December	12/31/2024	Specific Conductance				mmh/cm	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1050029	47.3457354	12/31/2024	
592	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	January	01/31/2018	Sulfate, Total (as SO4)			118	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	01/31/2018	
593	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	January	01/31/2018	Sulfate, Total (as SO4)			124	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	01/31/2018	
594	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	February	02/28/2018	Sulfate, Total (as SO4)			126	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	02/28/2018	
595	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	February	02/28/2018	Sulfate, Total (as SO4)			128	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	02/28/2018	
596	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	March	03/31/2018	Sulfate, Total (as SO4)			119	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2018	
597	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	March	03/31/2018	Sulfate, Total (as SO4)			124	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2018	
598	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	April	04/30/2018	Sulfate, Total (as SO4)			99.4	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	04/30/2018	
599	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	April	04/30/2018	Sulfate, Total (as SO4)			117	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	04/30/2018	
600	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	May	05/31/2018	Sulfate, Total (as SO4)			124	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	05/31/2018	
601	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	May	05/31/2018	Sulfate, Total (as SO4)			128	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	05/31/2018	
602	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	June	06/30/2018	Sulfate, Total (as SO4)			127	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2018	
603	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	June	06/30/2018	Sulfate, Total (as SO4)			130	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2018	
604	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	July	07/31/2018	Sulfate, Total (as SO4)			127	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	07/31/2018	
605	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	July	07/31/2018	Sulfate, Total (as SO4)			135	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	07/31/2018	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
606	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	August	08/31/2018	Sulfate, Total (as SO4)			120	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	08/31/2018	
607	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	August	08/31/2018	Sulfate, Total (as SO4)			128	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	08/31/2018	
608	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	September	09/30/2018	Sulfate, Total (as SO4)			123	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2018	
609	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	September	09/30/2018	Sulfate, Total (as SO4)			124	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2018	
610	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	October	10/31/2018	Sulfate, Total (as SO4)			117	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	10/31/2018	
611	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	October	10/31/2018	Sulfate, Total (as SO4)			125	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	10/31/2018	
612	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	November	11/30/2018	Sulfate, Total (as SO4)			124	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	11/30/2018	
613	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	November	11/30/2018	Sulfate, Total (as SO4)			125	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	11/30/2018	
614	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	December	12/31/2018	Sulfate, Total (as SO4)			120	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2018	
615	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	December	12/31/2018	Sulfate, Total (as SO4)			125	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2018	
616	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	January	01/31/2019	Sulfate, Total (as SO4)			132	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	01/31/2019	
617	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	January	01/31/2019	Sulfate, Total (as SO4)			137	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	01/31/2019	
618	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	February	02/28/2019	Sulfate, Total (as SO4)			129	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	02/28/2019	
619	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	February	02/28/2019	Sulfate, Total (as SO4)			132	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	02/28/2019	
620	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	March	03/31/2019	Sulfate, Total (as SO4)			114	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2019	
621	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	March	03/31/2019	Sulfate, Total (as SO4)			130	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2019	
622	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	April	04/30/2019	Sulfate, Total (as SO4)			123	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	04/30/2019	
623	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	April	04/30/2019	Sulfate, Total (as SO4)			134	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	04/30/2019	
624	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	May	05/31/2019	Sulfate, Total (as SO4)			133	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	05/31/2019	
625	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	May	05/31/2019	Sulfate, Total (as SO4)			136	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	05/31/2019	
626	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	June	06/30/2019	Sulfate, Total (as SO4)			135	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2019	
627	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	June	06/30/2019	Sulfate, Total (as SO4)			137	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2019	
628	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	July	07/31/2019	Sulfate, Total (as SO4)			132	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	07/31/2019	
629	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	July	07/31/2019	Sulfate, Total (as SO4)			134	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	07/31/2019	
630	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	August	08/31/2019	Sulfate, Total (as SO4)			124	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	08/31/2019	
631	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	August	08/31/2019	Sulfate, Total (as SO4)			125	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	08/31/2019	
632	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	September	09/30/2019	Sulfate, Total (as SO4)			114	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2019	
633	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	September	09/30/2019	Sulfate, Total (as SO4)			117	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2019	
634	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	October	10/31/2019	Sulfate, Total (as SO4)			115	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	10/31/2019	
635	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	October	10/31/2019	Sulfate, Total (as SO4)			117	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	10/31/2019	
636	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	November	11/30/2019	Sulfate, Total (as SO4)			130	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	11/30/2019	
637	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	November	11/30/2019	Sulfate, Total (as SO4)			132	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	11/30/2019	
638	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	December	12/31/2019	Sulfate, Total (as SO4)			126	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2019	
639	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	December	12/31/2019	Sulfate, Total (as SO4)			129	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2019	
640	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	January	01/31/2020	Sulfate, Total (as SO4)			131	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	01/31/2020	
641	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	January	01/31/2020	Sulfate, Total (as SO4)			132	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	01/31/2020	
642	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	February	02/29/2020	Sulfate, Total (as SO4)			136	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	02/29/2020	
643	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	February	02/29/2020	Sulfate, Total (as SO4)			136	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	02/29/2020	
644	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	March	03/31/2020	Sulfate, Total (as SO4)			133	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2020	
645	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	March	03/31/2020	Sulfate, Total (as SO4)			140	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2020	
646	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	April	04/30/2020	Sulfate, Total (as SO4)			126	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	04/30/2020	
647	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	April	04/30/2020	Sulfate, Total (as SO4)			135	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	04/30/2020	
648	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	May	05/31/2020	Sulfate, Total (as SO4)			148	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	05/31/2020	
649	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	May	05/31/2020	Sulfate, Total (as SO4)			150	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	05/31/2020	
650	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	June	06/30/2020	Sulfate, Total (as SO4)			136	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2020	
651	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	June	06/30/2020	Sulfate, Total (as SO4)			140	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2020	
652	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	July	07/31/2020	Sulfate, Total (as SO4)			142	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	07/31/2020	
653	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	July	07/31/2020	Sulfate, Total (as SO4)			146	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	07/31/2020	
654	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	August	08/31/2020	Sulfate, Total (as SO4)			132	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	08/31/2020	
655	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	August	08/31/2020	Sulfate, Total (as SO4)			136	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	08/31/2020	
656	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	September	09/30/2020	Sulfate, Total (as SO4)			144	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2020	
657	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	September	09/30/2020	Sulfate, Total (as SO4)			148	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2020	
658	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	October	10/31/2020	Sulfate, Total (as SO4)			143	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	10/31/2020	
659	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	October	10/31/2020	Sulfate, Total (as SO4)			145	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	10/31/2020	
660	**United States Steel Corp - Keetac**	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	November	11/30/2020	Sulfate, Total (as SO4)			140	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	11/30/2020	

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Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
661	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	November	11/30/2020	Sulfate, Total (as SO4)			141	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	11/30/2020	
662	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	December	12/31/2020	Sulfate, Total (as SO4)			132	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2020	
663	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	December	12/31/2020	Sulfate, Total (as SO4)			135	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2020	
664	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	January	01/31/2021	Sulfate, Total (as SO4)			141	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	01/31/2021	
665	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	January	01/31/2021	Sulfate, Total (as SO4)			145	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	01/31/2021	
666	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	February	02/28/2021	Sulfate, Total (as SO4)			141	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	02/28/2021	
667	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	February	02/28/2021	Sulfate, Total (as SO4)			146	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	02/28/2021	
668	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	March	03/31/2021	Sulfate, Total (as SO4)			135	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2021	
669	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	March	03/31/2021	Sulfate, Total (as SO4)			139	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2021	
670	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	April	04/30/2021	Sulfate, Total (as SO4)			134	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	04/30/2021	
671	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	April	04/30/2021	Sulfate, Total (as SO4)			134	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	04/30/2021	
672	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	May	05/31/2021	Sulfate, Total (as SO4)			147	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	05/31/2021	
673	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	May	05/31/2021	Sulfate, Total (as SO4)			147	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	05/31/2021	
674	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	June	06/30/2021	Sulfate, Total (as SO4)			146	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2021	
675	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	June	06/30/2021	Sulfate, Total (as SO4)			148	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2021	
676	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	July	07/31/2021	Sulfate, Total (as SO4)			151	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	07/31/2021	
677	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	July	07/31/2021	Sulfate, Total (as SO4)			157	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	07/31/2021	
678	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	August	08/31/2021	Sulfate, Total (as SO4)			144	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	08/31/2021	
679	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	August	08/31/2021	Sulfate, Total (as SO4)			144	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	08/31/2021	
680	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	September	09/30/2021	Sulfate, Total (as SO4)			135	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2021	
681	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	September	09/30/2021	Sulfate, Total (as SO4)			142	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2021	
682	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	October	10/31/2021	Sulfate, Total (as SO4)			135	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	10/31/2021	
683	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	October	10/31/2021	Sulfate, Total (as SO4)			140	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	10/31/2021	
684	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	November	11/30/2021	Sulfate, Total (as SO4)			143	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	11/30/2021	
685	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	November	11/30/2021	Sulfate, Total (as SO4)			148	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	11/30/2021	
686	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	December	12/31/2021	Sulfate, Total (as SO4)			146	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2021	
687	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	December	12/31/2021	Sulfate, Total (as SO4)			146	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2021	
688	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	January	01/31/2022	Sulfate, Total (as SO4)			145	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	01/31/2022	
689	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	January	01/31/2022	Sulfate, Total (as SO4)			146	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	01/31/2022	
690	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	February	02/28/2022	Sulfate, Total (as SO4)			146	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	02/28/2022	
691	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	February	02/28/2022	Sulfate, Total (as SO4)			146	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	02/28/2022	
692	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	March	03/31/2022	Sulfate, Total (as SO4)			141	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2022	
693	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	March	03/31/2022	Sulfate, Total (as SO4)			145	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2022	
694	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	April	04/30/2022	Sulfate, Total (as SO4)			152	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	04/30/2022	
695	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	April	04/30/2022	Sulfate, Total (as SO4)			158	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	04/30/2022	
696	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	May	05/31/2022	Sulfate, Total (as SO4)			155	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	05/31/2022	
697	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	May	05/31/2022	Sulfate, Total (as SO4)			167	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	05/31/2022	
698	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	June	06/30/2022	Sulfate, Total (as SO4)			154	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2022	
699	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	June	06/30/2022	Sulfate, Total (as SO4)			155	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2022	
700	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	July	07/31/2022	Sulfate, Total (as SO4)			151	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	07/31/2022	
701	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	July	07/31/2022	Sulfate, Total (as SO4)			151	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	07/31/2022	
702	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	August	08/31/2022	Sulfate, Total (as SO4)			153	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	08/31/2022	
703	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	August	08/31/2022	Sulfate, Total (as SO4)			153	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	08/31/2022	
704	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	September	09/30/2022	Sulfate, Total (as SO4)			149	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2022	
705	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	September	09/30/2022	Sulfate, Total (as SO4)			149	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2022	
706	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	October	10/31/2022	Sulfate, Total (as SO4)			147	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	10/31/2022	
707	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	October	10/31/2022	Sulfate, Total (as SO4)			150	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	10/31/2022	
708	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	November	11/30/2022	Sulfate, Total (as SO4)			132	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	11/30/2022	
709	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	November	11/30/2022	Sulfate, Total (as SO4)			139	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	11/30/2022	
710	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	December	12/31/2022	Sulfate, Total (as SO4)			129	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2022	
711	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	December	12/31/2022	Sulfate, Total (as SO4)			136	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2022	
712	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	January	01/31/2023	Sulfate, Total (as SO4)			130	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	01/31/2023	
713	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	January	01/31/2023	Sulfate, Total (as SO4)			134	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	01/31/2023	
714	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	February	02/28/2023	Sulfate, Total (as SO4)			130	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	02/28/2023	
715	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	February	02/28/2023	Sulfate, Total (as SO4)			132	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	02/28/2023	

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
716	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	March	03/31/2023	Sulfate, Total (as SO4)			132	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2023	
717	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	March	03/31/2023	Sulfate, Total (as SO4)			138	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2023	
718	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	April	04/30/2023	Sulfate, Total (as SO4)			149	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	04/30/2023	
719	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	April	04/30/2023	Sulfate, Total (as SO4)			165	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	04/30/2023	
720	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	May	05/31/2023	Sulfate, Total (as SO4)			151	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	05/31/2023	
721	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	May	05/31/2023	Sulfate, Total (as SO4)			156	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	05/31/2023	
722	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	June	06/30/2023	Sulfate, Total (as SO4)			139	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2023	
723	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	June	06/30/2023	Sulfate, Total (as SO4)			148	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2023	
724	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	July	07/31/2023	Sulfate, Total (as SO4)			142	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	07/31/2023	
725	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	July	07/31/2023	Sulfate, Total (as SO4)			144	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	07/31/2023	
726	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	August	08/31/2023	Sulfate, Total (as SO4)			147	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	08/31/2023	
727	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	August	08/31/2023	Sulfate, Total (as SO4)			157	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	08/31/2023	
728	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	September	09/30/2023	Sulfate, Total (as SO4)			126	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2023	
729	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	September	09/30/2023	Sulfate, Total (as SO4)			130	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2023	
730	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	October	10/31/2023	Sulfate, Total (as SO4)			133	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	10/31/2023	
731	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	October	10/31/2023	Sulfate, Total (as SO4)			134	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	10/31/2023	
732	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	November	11/30/2023	Sulfate, Total (as SO4)			151	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	11/30/2023	
733	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	November	11/30/2023	Sulfate, Total (as SO4)			159	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	11/30/2023	
734	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	December	12/31/2023	Sulfate, Total (as SO4)			139	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2023	
735	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	December	12/31/2023	Sulfate, Total (as SO4)			140	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2023	
736	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	January	01/31/2024	Sulfate, Total (as SO4)			156	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	01/31/2024	
737	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	January	01/31/2024	Sulfate, Total (as SO4)			160	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	01/31/2024	
738	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	February	02/29/2024	Sulfate, Total (as SO4)			149	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	02/29/2024	
739	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	February	02/29/2024	Sulfate, Total (as SO4)			149	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	02/29/2024	
740	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	March	03/31/2024	Sulfate, Total (as SO4)			142	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2024	
741	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	March	03/31/2024	Sulfate, Total (as SO4)			144	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	03/31/2024	
742	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	April	04/30/2024	Sulfate, Total (as SO4)			149	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	04/30/2024	
743	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	April	04/30/2024	Sulfate, Total (as SO4)			151	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	04/30/2024	
744	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	May	05/31/2024	Sulfate, Total (as SO4)			160	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	05/31/2024	
745	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	May	05/31/2024	Sulfate, Total (as SO4)			161	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	05/31/2024	
746	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	June	06/30/2024	Sulfate, Total (as SO4)			180	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2024	
747	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	June	06/30/2024	Sulfate, Total (as SO4)			182	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	06/30/2024	
748	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	July	07/31/2024	Sulfate, Total (as SO4)			191	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	07/31/2024	
749	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	July	07/31/2024	Sulfate, Total (as SO4)			202	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	07/31/2024	
750	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	August	08/31/2024	Sulfate, Total (as SO4)			168	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	08/31/2024	
751	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	August	08/31/2024	Sulfate, Total (as SO4)			174	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	08/31/2024	
752	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	September	09/30/2024	Sulfate, Total (as SO4)			168	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2024	
753	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	September	09/30/2024	Sulfate, Total (as SO4)			171	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	09/30/2024	
754	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	October	10/31/2024	Sulfate, Total (as SO4)			167	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	10/31/2024	
755	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	October	10/31/2024	Sulfate, Total (as SO4)			169	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	10/31/2024	
756	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	November	11/30/2024	Sulfate, Total (as SO4)			166	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	11/30/2024	
757	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	November	11/30/2024	Sulfate, Total (as SO4)			166	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	11/30/2024	
758	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	December	12/31/2024	Sulfate, Total (as SO4)			169	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2024	
759	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2024	December	12/31/2024	Sulfate, Total (as SO4)			172	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0669907	47.3989872	12/31/2024	
760												141										
761	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	January	01/31/2018	Sulfate, Total (as SO4)			49.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	01/31/2018	
762	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	January	01/31/2018	Sulfate, Total (as SO4)			49.7	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	01/31/2018	
763	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	February	02/28/2018	Sulfate, Total (as SO4)			51.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	02/28/2018	
764	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	February	02/28/2018	Sulfate, Total (as SO4)			54.6	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	02/28/2018	
765	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	March	03/31/2018	Sulfate, Total (as SO4)			50.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2018	
766	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	March	03/31/2018	Sulfate, Total (as SO4)			52.2	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2018	
767	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	April	04/30/2018	Sulfate, Total (as SO4)			47.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	04/30/2018	
768	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	April	04/30/2018	Sulfate, Total (as SO4)			48.6	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	04/30/2018	
769	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	May	05/31/2018	Sulfate, Total (as SO4)			52.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	05/31/2018	
770	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	May	05/31/2018	Sulfate, Total (as SO4)			57.4	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	05/31/2018	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
771	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	June	06/30/2018	Sulfate, Total (as SO4)			57	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2018	
772	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	June	06/30/2018	Sulfate, Total (as SO4)			59.1	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2018	
773	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	July	07/31/2018	Sulfate, Total (as SO4)			56.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	07/31/2018	
774	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	July	07/31/2018	Sulfate, Total (as SO4)			59.5	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	07/31/2018	
775	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	August	08/31/2018	Sulfate, Total (as SO4)			55.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	08/31/2018	
776	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	August	08/31/2018	Sulfate, Total (as SO4)			55.5	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	08/31/2018	
777	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	September	09/30/2018	Sulfate, Total (as SO4)			55.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2018	
778	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	September	09/30/2018	Sulfate, Total (as SO4)			56.7	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2018	
779	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	October	10/31/2018	Sulfate, Total (as SO4)			61.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	10/31/2018	
780	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	October	10/31/2018	Sulfate, Total (as SO4)			61.6	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	10/31/2018	
781	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	November	11/30/2018	Sulfate, Total (as SO4)			62.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	11/30/2018	
782	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	November	11/30/2018	Sulfate, Total (as SO4)			62.3	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	11/30/2018	
783	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	December	12/31/2018	Sulfate, Total (as SO4)			53.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2018	
784	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	December	12/31/2018	Sulfate, Total (as SO4)			55.5	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2018	
785	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	January	01/31/2019	Sulfate, Total (as SO4)			51.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	01/31/2019	
786	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	January	01/31/2019	Sulfate, Total (as SO4)			52	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	01/31/2019	
787	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	February	02/28/2019	Sulfate, Total (as SO4)			51.4	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	02/28/2019	
788	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	February	02/28/2019	Sulfate, Total (as SO4)			53.5	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	02/28/2019	
789	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	March	03/31/2019	Sulfate, Total (as SO4)			52.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2019	
790	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	March	03/31/2019	Sulfate, Total (as SO4)			55.9	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2019	
791	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	April	04/30/2019	Sulfate, Total (as SO4)			63.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	04/30/2019	
792	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	April	04/30/2019	Sulfate, Total (as SO4)			70.3	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	04/30/2019	
793	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	May	05/31/2019	Sulfate, Total (as SO4)			71.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	05/31/2019	
794	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	May	05/31/2019	Sulfate, Total (as SO4)			77.3	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	05/31/2019	
795	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	June	06/30/2019	Sulfate, Total (as SO4)			59.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2019	
796	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	June	06/30/2019	Sulfate, Total (as SO4)			59.3	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2019	
797	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	July	07/31/2019	Sulfate, Total (as SO4)			55	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	07/31/2019	
798	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	July	07/31/2019	Sulfate, Total (as SO4)			55	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	07/31/2019	
799	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	August	08/31/2019	Sulfate, Total (as SO4)			59.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	08/31/2019	
800	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	August	08/31/2019	Sulfate, Total (as SO4)			63.5	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	08/31/2019	
801	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	September	09/30/2019	Sulfate, Total (as SO4)			62.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2019	
802	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	September	09/30/2019	Sulfate, Total (as SO4)			64.6	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2019	
803	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	October	10/31/2019	Sulfate, Total (as SO4)			68.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	10/31/2019	
804	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	October	10/31/2019	Sulfate, Total (as SO4)			73.1	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	10/31/2019	
805	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	November	11/30/2019	Sulfate, Total (as SO4)			62.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	11/30/2019	
806	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	November	11/30/2019	Sulfate, Total (as SO4)			67.9	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	11/30/2019	
807	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	December	12/31/2019	Sulfate, Total (as SO4)			51.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2019	
808	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	December	12/31/2019	Sulfate, Total (as SO4)			53.3	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2019	
809	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	January	01/31/2020	Sulfate, Total (as SO4)			56.4	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	01/31/2020	
810	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	January	01/31/2020	Sulfate, Total (as SO4)			58.8	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	01/31/2020	
811	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	February	02/29/2020	Sulfate, Total (as SO4)			56.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	02/29/2020	
812	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	February	02/29/2020	Sulfate, Total (as SO4)			56.3	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	02/29/2020	
813	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	March	03/31/2020	Sulfate, Total (as SO4)			56.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2020	
814	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	March	03/31/2020	Sulfate, Total (as SO4)			57.6	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2020	
815	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	April	04/30/2020	Sulfate, Total (as SO4)			61.4	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	04/30/2020	
816	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	April	04/30/2020	Sulfate, Total (as SO4)			64.9	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	04/30/2020	
817	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	May	05/31/2020	Sulfate, Total (as SO4)			59.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	05/31/2020	
818	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	May	05/31/2020	Sulfate, Total (as SO4)			59.6	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	05/31/2020	
819	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	June	06/30/2020	Sulfate, Total (as SO4)			62.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2020	
820	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	June	06/30/2020	Sulfate, Total (as SO4)			69.4	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2020	
821	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	July	07/31/2020	Sulfate, Total (as SO4)			66.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	07/31/2020	
822	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	July	07/31/2020	Sulfate, Total (as SO4)			72.7	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	07/31/2020	
823	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	August	08/31/2020	Sulfate, Total (as SO4)			68.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	08/31/2020	
824	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	August	08/31/2020	Sulfate, Total (as SO4)			69.7	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	08/31/2020	
825	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	September	09/30/2020	Sulfate, Total (as SO4)			61.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2020	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
826	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	September	09/30/2020	Sulfate, Total (as SO4)			62.8	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2020	
827	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	October	10/31/2020	Sulfate, Total (as SO4)			63.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	10/31/2020	
828	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	October	10/31/2020	Sulfate, Total (as SO4)			66.1	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	10/31/2020	
829	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	November	11/30/2020	Sulfate, Total (as SO4)			62.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	11/30/2020	
830	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	November	11/30/2020	Sulfate, Total (as SO4)			63.1	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	11/30/2020	
831	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	December	12/31/2020	Sulfate, Total (as SO4)			59.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2020	
832	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2020	December	12/31/2020	Sulfate, Total (as SO4)			59.4	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2020	
833	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	January	01/31/2021	Sulfate, Total (as SO4)			60.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	01/31/2021	
834	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	January	01/31/2021	Sulfate, Total (as SO4)			61.6	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	01/31/2021	
835	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	February	02/28/2021	Sulfate, Total (as SO4)			60.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	02/28/2021	
836	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	February	02/28/2021	Sulfate, Total (as SO4)			61.4	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	02/28/2021	
837	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	March	03/31/2021	Sulfate, Total (as SO4)			62.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2021	
838	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	March	03/31/2021	Sulfate, Total (as SO4)			64.7	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2021	
839	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	April	04/30/2021	Sulfate, Total (as SO4)			69.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	04/30/2021	
840	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	April	04/30/2021	Sulfate, Total (as SO4)			74.3	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	04/30/2021	
841	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	May	05/31/2021	Sulfate, Total (as SO4)			66.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	05/31/2021	
842	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	May	05/31/2021	Sulfate, Total (as SO4)			70	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	05/31/2021	
843	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	June	06/30/2021	Sulfate, Total (as SO4)			66.4	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2021	
844	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	June	06/30/2021	Sulfate, Total (as SO4)			70	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2021	
845	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	July	07/31/2021	Sulfate, Total (as SO4)			68.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	07/31/2021	
846	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	July	07/31/2021	Sulfate, Total (as SO4)			70.7	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	07/31/2021	
847	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	August	08/31/2021	Sulfate, Total (as SO4)			65.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	08/31/2021	
848	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	August	08/31/2021	Sulfate, Total (as SO4)			67	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	08/31/2021	
849	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	September	09/30/2021	Sulfate, Total (as SO4)			74.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2021	
850	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	September	09/30/2021	Sulfate, Total (as SO4)			84.3	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2021	
851	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	October	10/31/2021	Sulfate, Total (as SO4)			69.5	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	10/31/2021	
852	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	October	10/31/2021	Sulfate, Total (as SO4)			72.3	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	10/31/2021	
853	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	November	11/30/2021	Sulfate, Total (as SO4)			69.4	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	11/30/2021	
854	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	November	11/30/2021	Sulfate, Total (as SO4)			73.3	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	11/30/2021	
855	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	December	12/31/2021	Sulfate, Total (as SO4)			65.5	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2021	
856	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2021	December	12/31/2021	Sulfate, Total (as SO4)			68.8	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2021	
857	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	January	01/31/2022	Sulfate, Total (as SO4)			65.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	01/31/2022	
858	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	January	01/31/2022	Sulfate, Total (as SO4)			66	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	01/31/2022	
859	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	February	02/28/2022	Sulfate, Total (as SO4)			63.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	02/28/2022	
860	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	February	02/28/2022	Sulfate, Total (as SO4)			64	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	02/28/2022	
861	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	March	03/31/2022	Sulfate, Total (as SO4)			66.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2022	
862	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	March	03/31/2022	Sulfate, Total (as SO4)			68	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2022	
863	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	April	04/30/2022	Sulfate, Total (as SO4)			73.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	04/30/2022	
864	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	April	04/30/2022	Sulfate, Total (as SO4)			76.5	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	04/30/2022	
865	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	May	05/31/2022	Sulfate, Total (as SO4)			61.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	05/31/2022	
866	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	May	05/31/2022	Sulfate, Total (as SO4)			72.6	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	05/31/2022	
867	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	June	06/30/2022	Sulfate, Total (as SO4)			71.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2022	
868	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	June	06/30/2022	Sulfate, Total (as SO4)			72.2	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2022	
869	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	July	07/31/2022	Sulfate, Total (as SO4)			71.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	07/31/2022	
870	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	July	07/31/2022	Sulfate, Total (as SO4)			72.2	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	07/31/2022	
871	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	August	08/31/2022	Sulfate, Total (as SO4)			73.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	08/31/2022	
872	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	August	08/31/2022	Sulfate, Total (as SO4)			76	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	08/31/2022	
873	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	September	09/30/2022	Sulfate, Total (as SO4)			66.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2022	
874	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	September	09/30/2022	Sulfate, Total (as SO4)			66.5	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2022	
875	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	October	10/31/2022	Sulfate, Total (as SO4)			61.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	10/31/2022	
876	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	October	10/31/2022	Sulfate, Total (as SO4)			61.8	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	10/31/2022	
877	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	November	11/30/2022	Sulfate, Total (as SO4)			62.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	11/30/2022	
878	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	November	11/30/2022	Sulfate, Total (as SO4)			63.4	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	11/30/2022	
879	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	December	12/31/2022	Sulfate, Total (as SO4)			59.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2022	
880	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2022	December	12/31/2022	Sulfate, Total (as SO4)			61.7	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2022	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
881	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	January	01/31/2023	Sulfate, Total (as SO4)			62.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	01/31/2023	
882	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	January	01/31/2023	Sulfate, Total (as SO4)			65	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	01/31/2023	
883	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	February	02/28/2023	Sulfate, Total (as SO4)			60.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	02/28/2023	
884	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	February	02/28/2023	Sulfate, Total (as SO4)			61.1	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	02/28/2023	
885	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	March	03/31/2023	Sulfate, Total (as SO4)			64.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2023	
886	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	March	03/31/2023	Sulfate, Total (as SO4)			67.1	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2023	
887	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	April	04/30/2023	Sulfate, Total (as SO4)			66.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	04/30/2023	
888	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	April	04/30/2023	Sulfate, Total (as SO4)			73.4	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	04/30/2023	
889	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	May	05/31/2023	Sulfate, Total (as SO4)			69.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	05/31/2023	
890	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	May	05/31/2023	Sulfate, Total (as SO4)			69.8	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	05/31/2023	
891	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	June	06/30/2023	Sulfate, Total (as SO4)			67.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2023	
892	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	June	06/30/2023	Sulfate, Total (as SO4)			68.3	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2023	
893	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	July	07/31/2023	Sulfate, Total (as SO4)			66.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	07/31/2023	
894	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	July	07/31/2023	Sulfate, Total (as SO4)			68.8	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	07/31/2023	
895	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	August	08/31/2023	Sulfate, Total (as SO4)			63.5	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	08/31/2023	
896	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	August	08/31/2023	Sulfate, Total (as SO4)			63.5	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	08/31/2023	
897	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	September	09/30/2023	Sulfate, Total (as SO4)			62.4	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2023	
898	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	September	09/30/2023	Sulfate, Total (as SO4)			64.9	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2023	
899	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	October	10/31/2023	Sulfate, Total (as SO4)			67.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	10/31/2023	
900	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	October	10/31/2023	Sulfate, Total (as SO4)			72.5	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	10/31/2023	
901	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	November	11/30/2023	Sulfate, Total (as SO4)			70.5	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	11/30/2023	
902	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	November	11/30/2023	Sulfate, Total (as SO4)			72.9	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	11/30/2023	
903	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	December	12/31/2023	Sulfate, Total (as SO4)			56.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2023	
904	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	December	12/31/2023	Sulfate, Total (as SO4)			60	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2023	
905	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	January	01/31/2024	Sulfate, Total (as SO4)			66.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	01/31/2024	
906	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	January	01/31/2024	Sulfate, Total (as SO4)			70.1	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	01/31/2024	
907	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	February	02/29/2024	Sulfate, Total (as SO4)			64	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	02/29/2024	
908	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	February	02/29/2024	Sulfate, Total (as SO4)			66.5	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	02/29/2024	
909	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	March	03/31/2024	Sulfate, Total (as SO4)			59.5	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2024	
910	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	March	03/31/2024	Sulfate, Total (as SO4)			60.6	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	03/31/2024	
911	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	April	04/30/2024	Sulfate, Total (as SO4)			65.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	04/30/2024	
912	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	April	04/30/2024	Sulfate, Total (as SO4)			65.6	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	04/30/2024	
913	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	May	05/31/2024	Sulfate, Total (as SO4)			71.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	05/31/2024	
914	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	May	05/31/2024	Sulfate, Total (as SO4)			71.9	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	05/31/2024	
915	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	June	06/30/2024	Sulfate, Total (as SO4)			80.5	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2024	
916	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	June	06/30/2024	Sulfate, Total (as SO4)			80.8	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	06/30/2024	
917	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	July	07/31/2024	Sulfate, Total (as SO4)			73.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	07/31/2024	
918	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	July	07/31/2024	Sulfate, Total (as SO4)			75.9	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	07/31/2024	
919	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	August	08/31/2024	Sulfate, Total (as SO4)			80	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	08/31/2024	
920	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	August	08/31/2024	Sulfate, Total (as SO4)			81	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	08/31/2024	
921	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	September	09/30/2024	Sulfate, Total (as SO4)			74.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2024	
922	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	September	09/30/2024	Sulfate, Total (as SO4)			75.8	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	09/30/2024	
923	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	October	10/31/2024	Sulfate, Total (as SO4)			62	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	10/31/2024	
924	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	October	10/31/2024	Sulfate, Total (as SO4)			63.3	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	10/31/2024	
925	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	November	11/30/2024	Sulfate, Total (as SO4)			63.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	11/30/2024	
926	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	November	11/30/2024	Sulfate, Total (as SO4)			63.1	mg/L	CalYrMax	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	11/30/2024	
927	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	December	12/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2024	
928	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2024	December	12/31/2024	Sulfate, Total (as SO4)				mg/L	CalYrMax	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1179698	47.3960788	12/31/2024	
929	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	January	01/31/2018	Sulfate, Total (as SO4)			27.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	01/31/2018	
930	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	January	01/31/2018	Sulfate, Total (as SO4)			28.2	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	01/31/2018	
931	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	February	02/28/2018	Sulfate, Total (as SO4)			27.4	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	02/28/2018	
932	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	February	02/28/2018	Sulfate, Total (as SO4)			28.1	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	02/28/2018	
933	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	March	03/31/2018	Sulfate, Total (as SO4)			26.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2018	
934	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	March	03/31/2018	Sulfate, Total (as SO4)			26.8	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2018	
935	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	April	04/30/2018	Sulfate, Total (as SO4)			26.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	04/30/2018	

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
936	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	April	04/30/2018	Sulfate, Total (as SO4)			26.6	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	04/30/2018	
937	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	May	05/31/2018	Sulfate, Total (as SO4)			26.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	05/31/2018	
938	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	May	05/31/2018	Sulfate, Total (as SO4)			26.3	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	05/31/2018	
939	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	June	06/30/2018	Sulfate, Total (as SO4)			25.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2018	
940	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	June	06/30/2018	Sulfate, Total (as SO4)			25.7	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2018	
941	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	July	07/31/2018	Sulfate, Total (as SO4)			24.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	07/31/2018	
942	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	July	07/31/2018	Sulfate, Total (as SO4)			24.5	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	07/31/2018	
943	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	August	08/31/2018	Sulfate, Total (as SO4)			23	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	08/31/2018	
944	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	August	08/31/2018	Sulfate, Total (as SO4)			24.8	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	08/31/2018	
945	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	September	09/30/2018	Sulfate, Total (as SO4)			21.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2018	
946	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	September	09/30/2018	Sulfate, Total (as SO4)			21.7	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2018	
947	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	October	10/31/2018	Sulfate, Total (as SO4)			22.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	10/31/2018	
948	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	October	10/31/2018	Sulfate, Total (as SO4)			23	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	10/31/2018	
949	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	November	11/30/2018	Sulfate, Total (as SO4)			22.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	11/30/2018	
950	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	November	11/30/2018	Sulfate, Total (as SO4)			22.8	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	11/30/2018	
951	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	December	12/31/2018	Sulfate, Total (as SO4)			21.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2018	
952	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	December	12/31/2018	Sulfate, Total (as SO4)			21.4	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2018	
953	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	January	01/31/2019	Sulfate, Total (as SO4)			24.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	01/31/2019	
954	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	January	01/31/2019	Sulfate, Total (as SO4)			25.2	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	01/31/2019	
955	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	February	02/28/2019	Sulfate, Total (as SO4)			25.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	02/28/2019	
956	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	February	02/28/2019	Sulfate, Total (as SO4)			25.3	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	02/28/2019	
957	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	March	03/31/2019	Sulfate, Total (as SO4)			25.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2019	
958	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	March	03/31/2019	Sulfate, Total (as SO4)			26.2	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2019	
959	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	April	04/30/2019	Sulfate, Total (as SO4)			25.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	04/30/2019	
960	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	April	04/30/2019	Sulfate, Total (as SO4)			26.5	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	04/30/2019	
961	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	May	05/31/2019	Sulfate, Total (as SO4)			23.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	05/31/2019	
962	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	May	05/31/2019	Sulfate, Total (as SO4)			24.1	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	05/31/2019	
963	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	June	06/30/2019	Sulfate, Total (as SO4)			24.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2019	
964	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	June	06/30/2019	Sulfate, Total (as SO4)			24.2	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2019	
965	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	July	07/31/2019	Sulfate, Total (as SO4)			22.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	07/31/2019	
966	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	July	07/31/2019	Sulfate, Total (as SO4)			22.6	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	07/31/2019	
967	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	August	08/31/2019	Sulfate, Total (as SO4)			22.5	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	08/31/2019	
968	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	August	08/31/2019	Sulfate, Total (as SO4)			22.8	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	08/31/2019	
969	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	September	09/30/2019	Sulfate, Total (as SO4)			20.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2019	
970	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	September	09/30/2019	Sulfate, Total (as SO4)			20.8	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2019	
971	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	October	10/31/2019	Sulfate, Total (as SO4)			19.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	10/31/2019	
972	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	October	10/31/2019	Sulfate, Total (as SO4)			20.1	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	10/31/2019	
973	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	November	11/30/2019	Sulfate, Total (as SO4)			20.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	11/30/2019	
974	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	November	11/30/2019	Sulfate, Total (as SO4)			21.5	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	11/30/2019	
975	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	December	12/31/2019	Sulfate, Total (as SO4)			20.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2019	
976	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	December	12/31/2019	Sulfate, Total (as SO4)			20.9	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2019	
977	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	January	01/31/2020	Sulfate, Total (as SO4)			24.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	01/31/2020	
978	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	January	01/31/2020	Sulfate, Total (as SO4)			25.2	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	01/31/2020	
979	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	February	02/29/2020	Sulfate, Total (as SO4)			25.4	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	02/29/2020	
980	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	February	02/29/2020	Sulfate, Total (as SO4)			25.5	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	02/29/2020	
981	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	March	03/31/2020	Sulfate, Total (as SO4)			25.4	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2020	
982	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	March	03/31/2020	Sulfate, Total (as SO4)			25.8	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2020	
983	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	April	04/30/2020	Sulfate, Total (as SO4)			27.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	04/30/2020	
984	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	April	04/30/2020	Sulfate, Total (as SO4)			28.1	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	04/30/2020	
985	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	May	05/31/2020	Sulfate, Total (as SO4)			24.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	05/31/2020	
986	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	May	05/31/2020	Sulfate, Total (as SO4)			24.7	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	05/31/2020	
987	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	June	06/30/2020	Sulfate, Total (as SO4)			24.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2020	
988	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	June	06/30/2020	Sulfate, Total (as SO4)			25.2	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2020	
989	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	July	07/31/2020	Sulfate, Total (as SO4)			25.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	07/31/2020	
990	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	July	07/31/2020	Sulfate, Total (as SO4)			25.2	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	07/31/2020	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
991	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	August	08/31/2020	Sulfate, Total (as SO4)			23.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	08/31/2020	
992	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	August	08/31/2020	Sulfate, Total (as SO4)			23.9	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	08/31/2020	
993	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	September	09/30/2020	Sulfate, Total (as SO4)			21.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2020	
994	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	September	09/30/2020	Sulfate, Total (as SO4)			21.5	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2020	
995	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	October	10/31/2020	Sulfate, Total (as SO4)			21.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	10/31/2020	
996	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	October	10/31/2020	Sulfate, Total (as SO4)			22.2	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	10/31/2020	
997	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	November	11/30/2020	Sulfate, Total (as SO4)			21.5	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	11/30/2020	
998	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	November	11/30/2020	Sulfate, Total (as SO4)			21.6	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	11/30/2020	
999	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	December	12/31/2020	Sulfate, Total (as SO4)			22.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2020	
1000	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	December	12/31/2020	Sulfate, Total (as SO4)			24	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2020	
1001	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	January	01/31/2021	Sulfate, Total (as SO4)			26.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	01/31/2021	
1002	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	January	01/31/2021	Sulfate, Total (as SO4)			26.5	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	01/31/2021	
1003	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	February	02/28/2021	Sulfate, Total (as SO4)			26.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	02/28/2021	
1004	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	February	02/28/2021	Sulfate, Total (as SO4)			26.3	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	02/28/2021	
1005	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	March	03/31/2021	Sulfate, Total (as SO4)			26	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2021	
1006	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	March	03/31/2021	Sulfate, Total (as SO4)			26	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2021	
1007	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	April	04/30/2021	Sulfate, Total (as SO4)			24.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	04/30/2021	
1008	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	April	04/30/2021	Sulfate, Total (as SO4)			25.3	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	04/30/2021	
1009	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	May	05/31/2021	Sulfate, Total (as SO4)			21.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	05/31/2021	
1010	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	May	05/31/2021	Sulfate, Total (as SO4)			22.1	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	05/31/2021	
1011	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	June	06/30/2021	Sulfate, Total (as SO4)			22.5	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2021	
1012	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	June	06/30/2021	Sulfate, Total (as SO4)			22.8	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2021	
1013	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	July	07/31/2021	Sulfate, Total (as SO4)			24.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	07/31/2021	
1014	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	July	07/31/2021	Sulfate, Total (as SO4)			24.5	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	07/31/2021	
1015	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	August	08/31/2021	Sulfate, Total (as SO4)			23.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	08/31/2021	
1016	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	August	08/31/2021	Sulfate, Total (as SO4)			24.2	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	08/31/2021	
1017	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	September	09/30/2021	Sulfate, Total (as SO4)			22	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2021	
1018	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	September	09/30/2021	Sulfate, Total (as SO4)			22	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2021	
1019	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	October	10/31/2021	Sulfate, Total (as SO4)			23.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	10/31/2021	
1020	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	October	10/31/2021	Sulfate, Total (as SO4)			23.3	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	10/31/2021	
1021	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	November	11/30/2021	Sulfate, Total (as SO4)			22.5	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	11/30/2021	
1022	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	November	11/30/2021	Sulfate, Total (as SO4)			23	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	11/30/2021	
1023	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	December	12/31/2021	Sulfate, Total (as SO4)			22.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2021	
1024	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2021	December	12/31/2021	Sulfate, Total (as SO4)			22.8	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2021	
1025	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	January	01/31/2022	Sulfate, Total (as SO4)			24.5	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	01/31/2022	
1026	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	January	01/31/2022	Sulfate, Total (as SO4)			24.8	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	01/31/2022	
1027	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	February	02/28/2022	Sulfate, Total (as SO4)			24.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	02/28/2022	
1028	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	February	02/28/2022	Sulfate, Total (as SO4)			24.8	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	02/28/2022	
1029	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	March	03/31/2022	Sulfate, Total (as SO4)			25.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2022	
1030	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	March	03/31/2022	Sulfate, Total (as SO4)			26.1	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2022	
1031	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	April	04/30/2022	Sulfate, Total (as SO4)			26.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	04/30/2022	
1032	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	April	04/30/2022	Sulfate, Total (as SO4)			26.5	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	04/30/2022	
1033	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	May	05/31/2022	Sulfate, Total (as SO4)			27.5	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	05/31/2022	
1034	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	May	05/31/2022	Sulfate, Total (as SO4)			27.9	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	05/31/2022	
1035	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	June	06/30/2022	Sulfate, Total (as SO4)			26.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2022	
1036	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	June	06/30/2022	Sulfate, Total (as SO4)			26.7	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2022	
1037	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	July	07/31/2022	Sulfate, Total (as SO4)			26	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	07/31/2022	
1038	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	July	07/31/2022	Sulfate, Total (as SO4)			26	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	07/31/2022	
1039	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	August	08/31/2022	Sulfate, Total (as SO4)			26.5	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	08/31/2022	
1040	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	August	08/31/2022	Sulfate, Total (as SO4)			26.5	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	08/31/2022	
1041	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	September	09/30/2022	Sulfate, Total (as SO4)			23.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2022	
1042	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	September	09/30/2022	Sulfate, Total (as SO4)			25.2	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2022	
1043	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	October	10/31/2022	Sulfate, Total (as SO4)			23	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	10/31/2022	
1044	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	October	10/31/2022	Sulfate, Total (as SO4)			24.7	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	10/31/2022	
1045	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	November	11/30/2022	Sulfate, Total (as SO4)			24.4	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	11/30/2022	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1046	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	November	11/30/2022	Sulfate, Total (as SO4)			24.8	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	11/30/2022	
1047	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	December	12/31/2022	Sulfate, Total (as SO4)			24.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2022	
1048	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	December	12/31/2022	Sulfate, Total (as SO4)			25	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2022	
1049	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	January	01/31/2023	Sulfate, Total (as SO4)			25.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	01/31/2023	
1050	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	January	01/31/2023	Sulfate, Total (as SO4)			25.6	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	01/31/2023	
1051	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	February	02/28/2023	Sulfate, Total (as SO4)			24.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	02/28/2023	
1052	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	February	02/28/2023	Sulfate, Total (as SO4)			24.9	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	02/28/2023	
1053	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	March	03/31/2023	Sulfate, Total (as SO4)			25.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2023	
1054	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	March	03/31/2023	Sulfate, Total (as SO4)			25.9	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2023	
1055	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	April	04/30/2023	Sulfate, Total (as SO4)			26.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	04/30/2023	
1056	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	April	04/30/2023	Sulfate, Total (as SO4)			26.6	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	04/30/2023	
1057	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	May	05/31/2023	Sulfate, Total (as SO4)			25.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	05/31/2023	
1058	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	May	05/31/2023	Sulfate, Total (as SO4)			26.8	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	05/31/2023	
1059	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	June	06/30/2023	Sulfate, Total (as SO4)			26	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2023	
1060	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	June	06/30/2023	Sulfate, Total (as SO4)			26.5	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2023	
1061	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	July	07/31/2023	Sulfate, Total (as SO4)			27.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	07/31/2023	
1062	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	July	07/31/2023	Sulfate, Total (as SO4)			28.4	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	07/31/2023	
1063	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	August	08/31/2023	Sulfate, Total (as SO4)			26.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	08/31/2023	
1064	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	August	08/31/2023	Sulfate, Total (as SO4)			26.2	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	08/31/2023	
1065	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	September	09/30/2023	Sulfate, Total (as SO4)			23.4	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2023	
1066	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	September	09/30/2023	Sulfate, Total (as SO4)			23.6	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2023	
1067	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	October	10/31/2023	Sulfate, Total (as SO4)			22.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	10/31/2023	
1068	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	October	10/31/2023	Sulfate, Total (as SO4)			23	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	10/31/2023	
1069	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	November	11/30/2023	Sulfate, Total (as SO4)			24.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	11/30/2023	
1070	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	November	11/30/2023	Sulfate, Total (as SO4)			24.3	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	11/30/2023	
1071	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	December	12/31/2023	Sulfate, Total (as SO4)			23	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2023	
1072	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	December	12/31/2023	Sulfate, Total (as SO4)			23	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2023	
1073	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	January	01/31/2024	Sulfate, Total (as SO4)			25	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	01/31/2024	
1074	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	January	01/31/2024	Sulfate, Total (as SO4)			26.6	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	01/31/2024	
1075	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	February	02/29/2024	Sulfate, Total (as SO4)			24.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	02/29/2024	
1076	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	February	02/29/2024	Sulfate, Total (as SO4)			25.2	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	02/29/2024	
1077	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	March	03/31/2024	Sulfate, Total (as SO4)			23.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2024	
1078	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	March	03/31/2024	Sulfate, Total (as SO4)			24.7	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	03/31/2024	
1079	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	April	04/30/2024	Sulfate, Total (as SO4)			23	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	04/30/2024	
1080	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	April	04/30/2024	Sulfate, Total (as SO4)			23	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	04/30/2024	
1081	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	May	05/31/2024	Sulfate, Total (as SO4)			21.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	05/31/2024	
1082	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	May	05/31/2024	Sulfate, Total (as SO4)			22	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	05/31/2024	
1083	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	June	06/30/2024	Sulfate, Total (as SO4)			24.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2024	
1084	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	June	06/30/2024	Sulfate, Total (as SO4)			25.1	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	06/30/2024	
1085	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	July	07/31/2024	Sulfate, Total (as SO4)			22.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	07/31/2024	
1086	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	July	07/31/2024	Sulfate, Total (as SO4)			22.8	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	07/31/2024	
1087	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	August	08/31/2024	Sulfate, Total (as SO4)			22	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	08/31/2024	
1088	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	August	08/31/2024	Sulfate, Total (as SO4)			22	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	08/31/2024	
1089	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	September	09/30/2024	Sulfate, Total (as SO4)			20.4	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2024	
1090	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	September	09/30/2024	Sulfate, Total (as SO4)			20.9	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	09/30/2024	
1091	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	October	10/31/2024	Sulfate, Total (as SO4)			21.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	10/31/2024	
1092	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	October	10/31/2024	Sulfate, Total (as SO4)			22.1	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	10/31/2024	
1093	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	November	11/30/2024	Sulfate, Total (as SO4)			22.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	11/30/2024	
1094	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	November	11/30/2024	Sulfate, Total (as SO4)			24.3	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	11/30/2024	
1095	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	December	12/31/2024	Sulfate, Total (as SO4)			24.8	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2024	
1096	United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2024	December	12/31/2024	Sulfate, Total (as SO4)			24.8	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1278287	47.3980353	12/31/2024	
1097	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	January	01/31/2018	Sulfate, Total (as SO4)			100	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2018	
1098	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	February	02/28/2018	Sulfate, Total (as SO4)			96.4	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2018	
1099	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	March	03/31/2018	Sulfate, Total (as SO4)			110	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2018	
1100	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	April	04/30/2018	Sulfate, Total (as SO4)			111	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2018	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1101	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	May	05/31/2018	Sulfate, Total (as SO4)			103	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2018	
1102	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	June	06/30/2018	Sulfate, Total (as SO4)			94.6	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2018	
1103	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	July	07/31/2018	Sulfate, Total (as SO4)			94.8	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2018	
1104	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	August	08/31/2018	Sulfate, Total (as SO4)			91.3	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2018	
1105	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	September	09/30/2018	Sulfate, Total (as SO4)			91.4	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2018	
1106	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	October	10/31/2018	Sulfate, Total (as SO4)			94.1	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2018	
1107	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	November	11/30/2018	Sulfate, Total (as SO4)			102	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2018	
1108	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2018	December	12/31/2018	Sulfate, Total (as SO4)			101	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2018	
1109	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	January	01/31/2019	Sulfate, Total (as SO4)			109	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2019	
1110	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	February	02/28/2019	Sulfate, Total (as SO4)			120	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2019	
1111	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	March	03/31/2019	Sulfate, Total (as SO4)			118	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2019	
1112	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	April	04/30/2019	Sulfate, Total (as SO4)			126	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2019	
1113	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	May	05/31/2019	Sulfate, Total (as SO4)			102	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2019	
1114	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	June	06/30/2019	Sulfate, Total (as SO4)			110	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2019	
1115	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	July	07/31/2019	Sulfate, Total (as SO4)			102	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2019	
1116	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	August	08/31/2019	Sulfate, Total (as SO4)			97.2	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2019	
1117	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	September	09/30/2019	Sulfate, Total (as SO4)			111	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2019	
1118	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	October	10/31/2019	Sulfate, Total (as SO4)			95.9	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2019	
1119	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	November	11/30/2019	Sulfate, Total (as SO4)			106	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2019	
1120	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2019	December	12/31/2019	Sulfate, Total (as SO4)			106	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2019	
1121	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	January	01/31/2020	Sulfate, Total (as SO4)			112	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2020	
1122	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	February	02/29/2020	Sulfate, Total (as SO4)			120	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/29/2020	
1123	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	March	03/31/2020	Sulfate, Total (as SO4)			128	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2020	
1124	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	April	04/30/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2020	
1125	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	May	05/31/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2020	
1126	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	June	06/30/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2020	
1127	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	July	07/31/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2020	
1128	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	August	08/31/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2020	
1129	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	September	09/30/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2020	
1130	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	October	10/31/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2020	
1131	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	November	11/30/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2020	
1132	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2020	December	12/31/2020	Sulfate, Total (as SO4)			110	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2020	
1133	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	January	01/31/2021	Sulfate, Total (as SO4)			105	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2021	
1134	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	February	02/28/2021	Sulfate, Total (as SO4)			109	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2021	
1135	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	March	03/31/2021	Sulfate, Total (as SO4)			120	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2021	
1136	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	April	04/30/2021	Sulfate, Total (as SO4)			109	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2021	
1137	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	May	05/31/2021	Sulfate, Total (as SO4)			108	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2021	
1138	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	June	06/30/2021	Sulfate, Total (as SO4)			114	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2021	
1139	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	July	07/31/2021	Sulfate, Total (as SO4)			114	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2021	
1140	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	August	08/31/2021	Sulfate, Total (as SO4)			122	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2021	
1141	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	September	09/30/2021	Sulfate, Total (as SO4)			119	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2021	
1142	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	October	10/31/2021	Sulfate, Total (as SO4)			128	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2021	
1143	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	November	11/30/2021	Sulfate, Total (as SO4)			126	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2021	
1144	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2021	December	12/31/2021	Sulfate, Total (as SO4)			128	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2021	
1145	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	January	01/31/2022	Sulfate, Total (as SO4)			142	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2022	
1146	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	February	02/28/2022	Sulfate, Total (as SO4)			134	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2022	
1147	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	March	03/31/2022	Sulfate, Total (as SO4)			140	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2022	
1148	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	April	04/30/2022	Sulfate, Total (as SO4)			133	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2022	
1149	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	May	05/31/2022	Sulfate, Total (as SO4)			108	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2022	
1150	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	June	06/30/2022	Sulfate, Total (as SO4)			102	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2022	
1151	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	July	07/31/2022	Sulfate, Total (as SO4)			98.3	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2022	
1152	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	August	08/31/2022	Sulfate, Total (as SO4)			102	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2022	
1153	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	September	09/30/2022	Sulfate, Total (as SO4)			94	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2022	
1154	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	October	10/31/2022	Sulfate, Total (as SO4)			97.5	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2022	
1155	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	November	11/30/2022	Sulfate, Total (as SO4)			95	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2022	

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1156	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2022	December	12/31/2022	Sulfate, Total (as SO4)			98	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2022	
1157	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	January	01/31/2023	Sulfate, Total (as SO4)			108	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2023	
1158	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	February	02/28/2023	Sulfate, Total (as SO4)			116	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2023	
1159	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	March	03/31/2023	Sulfate, Total (as SO4)			127	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2023	
1160	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	April	04/30/2023	Sulfate, Total (as SO4)			132	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2023	
1161	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	May	05/31/2023	Sulfate, Total (as SO4)			111	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2023	
1162	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	June	06/30/2023	Sulfate, Total (as SO4)			94.6	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2023	
1163	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	July	07/31/2023	Sulfate, Total (as SO4)			97.5	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2023	
1164	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	August	08/31/2023	Sulfate, Total (as SO4)			92.8	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2023	
1165	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	September	09/30/2023	Sulfate, Total (as SO4)			94	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2023	
1166	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	October	10/31/2023	Sulfate, Total (as SO4)			102	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2023	
1167	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	November	11/30/2023	Sulfate, Total (as SO4)			108	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2023	
1168	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2023	December	12/31/2023	Sulfate, Total (as SO4)			106	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2023	
1169	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	January	01/31/2024	Sulfate, Total (as SO4)			118	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2024	
1170	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	February	02/29/2024	Sulfate, Total (as SO4)			124	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/29/2024	
1171	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	March	03/31/2024	Sulfate, Total (as SO4)			120	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2024	
1172	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	April	04/30/2024	Sulfate, Total (as SO4)			125	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2024	
1173	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	May	05/31/2024	Sulfate, Total (as SO4)			117	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2024	
1174	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	June	06/30/2024	Sulfate, Total (as SO4)			129	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2024	
1175	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	July	07/31/2024	Sulfate, Total (as SO4)			122	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2024	
1176	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	August	08/31/2024	Sulfate, Total (as SO4)			117	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2024	
1177	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	September	09/30/2024	Sulfate, Total (as SO4)			110	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2024	
1178	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	October	10/31/2024	Sulfate, Total (as SO4)			120	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2024	
1179	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	November	11/30/2024	Sulfate, Total (as SO4)			121	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2024	
1180	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 011	Plant water to scrubber system	2024	December	12/31/2024	Sulfate, Total (as SO4)			124	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2024	
1181	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	January	01/31/2018	Sulfate, Total (as SO4)			1010	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2018	
1182	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	February	02/28/2018	Sulfate, Total (as SO4)			1030	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2018	
1183	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	March	03/31/2018	Sulfate, Total (as SO4)			939	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2018	
1184	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	April	04/30/2018	Sulfate, Total (as SO4)			982	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2018	
1185	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	May	05/31/2018	Sulfate, Total (as SO4)			919	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2018	
1186	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	June	06/30/2018	Sulfate, Total (as SO4)			1420	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2018	
1187	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	July	07/31/2018	Sulfate, Total (as SO4)			993	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2018	
1188	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	August	08/31/2018	Sulfate, Total (as SO4)			877	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2018	
1189	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	September	09/30/2018	Sulfate, Total (as SO4)			972	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2018	
1190	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	October	10/31/2018	Sulfate, Total (as SO4)			1070	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2018	
1191	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	November	11/30/2018	Sulfate, Total (as SO4)			938	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2018	
1192	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2018	December	12/31/2018	Sulfate, Total (as SO4)			1020	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2018	
1193	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	January	01/31/2019	Sulfate, Total (as SO4)			924	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2019	
1194	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	February	02/28/2019	Sulfate, Total (as SO4)			606	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2019	
1195	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	March	03/31/2019	Sulfate, Total (as SO4)			975	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2019	
1196	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	April	04/30/2019	Sulfate, Total (as SO4)			975	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2019	
1197	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	May	05/31/2019	Sulfate, Total (as SO4)			820	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2019	
1198	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	June	06/30/2019	Sulfate, Total (as SO4)			854	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2019	
1199	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	July	07/31/2019	Sulfate, Total (as SO4)			1110	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2019	
1200	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	August	08/31/2019	Sulfate, Total (as SO4)			561	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2019	
1201	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	September	09/30/2019	Sulfate, Total (as SO4)			1320	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2019	
1202	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	October	10/31/2019	Sulfate, Total (as SO4)			661	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2019	
1203	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	November	11/30/2019	Sulfate, Total (as SO4)			1290	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2019	
1204	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2019	December	12/31/2019	Sulfate, Total (as SO4)			810	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2019	
1205	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	January	01/31/2020	Sulfate, Total (as SO4)			1770	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2020	
1206	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	February	02/29/2020	Sulfate, Total (as SO4)			1320	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/29/2020	
1207	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	March	03/31/2020	Sulfate, Total (as SO4)			1490	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2020	
1208	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	April	04/30/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2020	
1209	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	May	05/31/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2020	
1210	United States Steel Corp - Keetac	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	June	06/30/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2020	

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1211	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	July	07/31/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2020	
1212	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	August	08/31/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2020	
1213	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	September	09/30/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2020	
1214	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	October	10/31/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2020	
1215	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	November	11/30/2020	Sulfate, Total (as SO4)				mg/L	SingleVal	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2020	
1216	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2020	December	12/31/2020	Sulfate, Total (as SO4)			1050	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2020	
1217	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	January	01/31/2021	Sulfate, Total (as SO4)			1040	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2021	
1218	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	February	02/28/2021	Sulfate, Total (as SO4)			324	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2021	
1219	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	March	03/31/2021	Sulfate, Total (as SO4)			977	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2021	
1220	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	April	04/30/2021	Sulfate, Total (as SO4)			1040	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2021	
1221	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	May	05/31/2021	Sulfate, Total (as SO4)			1240	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2021	
1222	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	June	06/30/2021	Sulfate, Total (as SO4)			1450	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2021	
1223	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	July	07/31/2021	Sulfate, Total (as SO4)			1950	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2021	
1224	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	August	08/31/2021	Sulfate, Total (as SO4)			1790	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2021	
1225	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	September	09/30/2021	Sulfate, Total (as SO4)			1040	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2021	
1226	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	October	10/31/2021	Sulfate, Total (as SO4)			1850	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2021	
1227	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	November	11/30/2021	Sulfate, Total (as SO4)			1540	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2021	
1228	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2021	December	12/31/2021	Sulfate, Total (as SO4)			839	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2021	
1229	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	January	01/31/2022	Sulfate, Total (as SO4)			2260	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2022	
1230	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	February	02/28/2022	Sulfate, Total (as SO4)			2220	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2022	
1231	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	March	03/31/2022	Sulfate, Total (as SO4)			2030	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2022	
1232	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	April	04/30/2022	Sulfate, Total (as SO4)			1340	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2022	
1233	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	May	05/31/2022	Sulfate, Total (as SO4)			1700	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2022	
1234	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	June	06/30/2022	Sulfate, Total (as SO4)			1370	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2022	
1235	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	July	07/31/2022	Sulfate, Total (as SO4)			1940	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2022	
1236	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	August	08/31/2022	Sulfate, Total (as SO4)			1700	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2022	
1237	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	September	09/30/2022	Sulfate, Total (as SO4)			1800	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2022	
1238	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	October	10/31/2022	Sulfate, Total (as SO4)			1100	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2022	
1239	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	November	11/30/2022	Sulfate, Total (as SO4)			1550	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2022	
1240	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2022	December	12/31/2022	Sulfate, Total (as SO4)			1370	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2022	
1241	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	January	01/31/2023	Sulfate, Total (as SO4)			1320	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2023	
1242	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	February	02/28/2023	Sulfate, Total (as SO4)			1982	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/28/2023	
1243	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	March	03/31/2023	Sulfate, Total (as SO4)			1420	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2023	
1244	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	April	04/30/2023	Sulfate, Total (as SO4)			1260	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2023	
1245	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	May	05/31/2023	Sulfate, Total (as SO4)			2200	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2023	
1246	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	June	06/30/2023	Sulfate, Total (as SO4)			1260	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2023	
1247	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	July	07/31/2023	Sulfate, Total (as SO4)			1400	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2023	
1248	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	August	08/31/2023	Sulfate, Total (as SO4)			1640	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2023	
1249	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	September	09/30/2023	Sulfate, Total (as SO4)			1480	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2023	
1250	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	October	10/31/2023	Sulfate, Total (as SO4)			1230	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2023	
1251	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	November	11/30/2023	Sulfate, Total (as SO4)			1550	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2023	
1252	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2023	December	12/31/2023	Sulfate, Total (as SO4)			1120	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2023	
1253	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	January	01/31/2024	Sulfate, Total (as SO4)			935	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	01/31/2024	
1254	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	February	02/29/2024	Sulfate, Total (as SO4)			1040	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	02/29/2024	
1255	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	March	03/31/2024	Sulfate, Total (as SO4)			1000	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	03/31/2024	
1256	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	April	04/30/2024	Sulfate, Total (as SO4)			1380	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	04/30/2024	
1257	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	May	05/31/2024	Sulfate, Total (as SO4)			698	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	05/31/2024	
1258	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	June	06/30/2024	Sulfate, Total (as SO4)			1050	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	06/30/2024	
1259	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	July	07/31/2024	Sulfate, Total (as SO4)			1470	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	07/31/2024	
1260	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	August	08/31/2024	Sulfate, Total (as SO4)			1770	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	08/31/2024	
1261	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	September	09/30/2024	Sulfate, Total (as SO4)			1320	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	09/30/2024	
1262	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	October	10/31/2024	Sulfate, Total (as SO4)			1160	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	10/31/2024	
1263	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	November	11/30/2024	Sulfate, Total (as SO4)			1020	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	11/30/2024	
1264	**United States Steel Corp - Keetac**	MN0031879	IND20120003	WS 012	Scrubber blowdown after treatment	2024	December	12/31/2024	Sulfate, Total (as SO4)			1340	mg/L	SingleVal	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0626719	47.4138827	12/31/2024	
1265	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	January	01/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2018	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1266	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	January	01/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2018	
1267	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	February	02/28/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/28/2018	
1268	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	February	02/28/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/28/2018	
1269	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	March	03/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2018	
1270	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	March	03/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2018	
1271	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	April	04/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2018	
1272	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	April	04/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2018	
1273	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	May	05/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2018	
1274	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	May	05/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2018	
1275	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	June	06/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2018	
1276	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	June	06/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2018	
1277	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	July	07/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2018	
1278	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	July	07/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2018	
1279	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	August	08/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2018	
1280	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	August	08/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2018	
1281	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	September	09/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2018	
1282	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	September	09/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2018	
1283	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	October	10/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2018	
1284	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	October	10/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2018	
1285	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	November	11/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2018	
1286	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	November	11/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2018	
1287	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	December	12/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2018	
1288	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2018	December	12/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2018	
1289	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	January	01/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2019	
1290	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	January	01/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2019	
1291	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	February	02/28/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/28/2019	
1292	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	February	02/28/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/28/2019	
1293	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	March	03/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2019	
1294	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	March	03/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2019	
1295	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	April	04/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2019	
1296	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	April	04/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2019	
1297	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	May	05/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2019	
1298	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	May	05/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2019	
1299	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	June	06/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2019	
1300	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	June	06/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2019	
1301	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	July	07/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2019	
1302	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	July	07/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2019	
1303	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	August	08/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2019	
1304	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	August	08/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2019	
1305	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	September	09/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2019	
1306	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	September	09/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2019	
1307	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	October	10/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2019	
1308	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	October	10/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2019	
1309	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	November	11/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2019	
1310	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	November	11/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2019	
1311	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	December	12/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2019	
1312	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2019	December	12/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2019	
1313	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	January	01/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2020	
1314	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	January	01/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2020	
1315	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	February	02/29/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/29/2020	
1316	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	February	02/29/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/29/2020	
1317	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	March	03/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2020	
1318	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	March	03/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2020	
1319	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	April	04/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2020	
1320	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	April	04/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2020	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1321	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	May	05/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2020	
1322	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	May	05/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2020	
1323	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	June	06/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2020	
1324	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	June	06/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2020	
1325	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	July	07/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2020	
1326	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	July	07/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2020	
1327	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	August	08/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2020	
1328	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	August	08/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2020	
1329	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	September	09/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2020	
1330	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	September	09/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2020	
1331	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	October	10/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2020	
1332	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	October	10/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2020	
1333	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	November	11/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2020	
1334	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	November	11/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2020	
1335	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	December	12/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2020	
1336	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2020	December	12/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2020	
1337	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	January	01/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2021	
1338	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	January	01/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2021	
1339	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	February	02/28/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/28/2021	
1340	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	February	02/28/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/28/2021	
1341	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	March	03/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2021	
1342	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	March	03/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2021	
1343	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	April	04/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2021	
1344	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	April	04/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2021	
1345	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	May	05/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2021	
1346	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	May	05/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2021	
1347	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	June	06/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2021	
1348	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	June	06/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2021	
1349	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	July	07/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2021	
1350	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	July	07/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2021	
1351	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	August	08/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2021	
1352	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	August	08/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2021	
1353	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	September	09/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2021	
1354	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	September	09/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2021	
1355	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	October	10/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2021	
1356	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	October	10/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2021	
1357	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	November	11/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2021	
1358	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	November	11/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2021	
1359	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	December	12/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2021	
1360	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2021	December	12/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2021	
1361	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	January	01/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2022	
1362	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	January	01/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2022	
1363	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	February	02/28/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/28/2022	
1364	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	February	02/28/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/28/2022	
1365	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	March	03/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2022	
1366	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	March	03/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2022	
1367	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	April	04/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2022	
1368	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	April	04/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2022	
1369	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	May	05/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2022	
1370	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	May	05/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2022	
1371	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	June	06/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2022	
1372	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	June	06/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2022	
1373	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	July	07/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2022	
1374	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	July	07/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2022	
1375	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	August	08/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2022	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1376	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	August	08/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2022	
1377	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	September	09/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2022	
1378	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	September	09/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2022	
1379	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	October	10/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2022	
1380	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	October	10/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2022	
1381	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	November	11/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2022	
1382	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	November	11/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2022	
1383	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	December	12/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2022	
1384	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2022	December	12/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2022	
1385	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	January	01/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2023	
1386	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	January	01/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2023	
1387	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	February	02/28/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/28/2023	
1388	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	February	02/28/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/28/2023	
1389	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	March	03/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2023	
1390	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	March	03/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2023	
1391	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	April	04/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2023	
1392	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	April	04/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2023	
1393	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	May	05/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2023	
1394	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	May	05/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2023	
1395	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	June	06/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2023	
1396	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	June	06/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2023	
1397	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	July	07/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2023	
1398	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	July	07/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2023	
1399	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	August	08/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2023	
1400	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	August	08/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2023	
1401	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	September	09/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2023	
1402	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	September	09/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2023	
1403	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	October	10/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2023	
1404	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	October	10/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2023	
1405	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	November	11/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2023	
1406	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	November	11/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2023	
1407	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	December	12/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2023	
1408	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2023	December	12/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2023	
1409	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	January	01/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2024	
1410	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	January	01/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	01/31/2024	
1411	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	February	02/29/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/29/2024	
1412	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	February	02/29/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	02/29/2024	
1413	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	March	03/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2024	
1414	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	March	03/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	03/31/2024	
1415	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	April	04/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2024	
1416	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	April	04/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	04/30/2024	
1417	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	May	05/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2024	
1418	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	May	05/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	05/31/2024	
1419	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	June	06/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2024	
1420	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	June	06/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	06/30/2024	
1421	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	July	07/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2024	
1422	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	July	07/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	07/31/2024	
1423	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	August	08/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2024	
1424	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	August	08/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	08/31/2024	
1425	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	September	09/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2024	
1426	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	September	09/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	09/30/2024	
1427	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	October	10/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2024	
1428	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	October	10/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	10/31/2024	
1429	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	November	11/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2024	
1430	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	November	11/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	11/30/2024	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1431	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	December	12/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2024	
1432	US Steel Corp - Tailings	MN0055948	IND20110001	SD 001	Siphon Outfalls 011, 012, 013	2024	December	12/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0916992	47.3598656	12/31/2024	
1433	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	January	01/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2018	
1434	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	January	01/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2018	
1435	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	February	02/28/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/28/2018	
1436	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	February	02/28/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/28/2018	
1437	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	March	03/31/2018	Sulfate, Total (as SO4)			97	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2018	
1438	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	March	03/31/2018	Sulfate, Total (as SO4)			100	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2018	
1439	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	April	04/30/2018	Sulfate, Total (as SO4)			105	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2018	
1440	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	April	04/30/2018	Sulfate, Total (as SO4)			106	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2018	
1441	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	May	05/31/2018	Sulfate, Total (as SO4)			73.5	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2018	
1442	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	May	05/31/2018	Sulfate, Total (as SO4)			73.5	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2018	
1443	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	June	06/30/2018	Sulfate, Total (as SO4)			90.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2018	
1444	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	June	06/30/2018	Sulfate, Total (as SO4)			90.9	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2018	
1445	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	July	07/31/2018	Sulfate, Total (as SO4)			87.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2018	
1446	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	July	07/31/2018	Sulfate, Total (as SO4)			87.6	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2018	
1447	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	August	08/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2018	
1448	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	August	08/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2018	
1449	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	September	09/30/2018	Sulfate, Total (as SO4)			77.4	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2018	
1450	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	September	09/30/2018	Sulfate, Total (as SO4)			77.4	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2018	
1451	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	October	10/31/2018	Sulfate, Total (as SO4)			89.2	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2018	
1452	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	October	10/31/2018	Sulfate, Total (as SO4)			89.2	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2018	
1453	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	November	11/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2018	
1454	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	November	11/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2018	
1455	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	December	12/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2018	
1456	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2018	December	12/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2018	
1457	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	January	01/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2019	
1458	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	January	01/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2019	
1459	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	February	02/28/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/28/2019	
1460	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	February	02/28/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/28/2019	
1461	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	March	03/31/2019	Sulfate, Total (as SO4)			122	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2019	
1462	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	March	03/31/2019	Sulfate, Total (as SO4)			124	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2019	
1463	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	April	04/30/2019	Sulfate, Total (as SO4)			113	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2019	
1464	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	April	04/30/2019	Sulfate, Total (as SO4)			121	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2019	
1465	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	May	05/31/2019	Sulfate, Total (as SO4)			97.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2019	
1466	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	May	05/31/2019	Sulfate, Total (as SO4)			97.1	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2019	
1467	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	June	06/30/2019	Sulfate, Total (as SO4)			100	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2019	
1468	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	June	06/30/2019	Sulfate, Total (as SO4)			100	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2019	
1469	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	July	07/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2019	
1470	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	July	07/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2019	
1471	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	August	08/31/2019	Sulfate, Total (as SO4)			96.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2019	
1472	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	August	08/31/2019	Sulfate, Total (as SO4)			96.1	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2019	
1473	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	September	09/30/2019	Sulfate, Total (as SO4)			95.5	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2019	
1474	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	September	09/30/2019	Sulfate, Total (as SO4)			95.6	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2019	
1475	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	October	10/31/2019	Sulfate, Total (as SO4)			92.3	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2019	
1476	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	October	10/31/2019	Sulfate, Total (as SO4)			97.5	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2019	
1477	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	November	11/30/2019	Sulfate, Total (as SO4)			104	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2019	
1478	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	November	11/30/2019	Sulfate, Total (as SO4)			104	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2019	
1479	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	December	12/31/2019	Sulfate, Total (as SO4)			102	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2019	
1480	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	December	12/31/2019	Sulfate, Total (as SO4)			105	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2019	
1481	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	January	01/31/2020	Sulfate, Total (as SO4)			112	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2020	
1482	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	January	01/31/2020	Sulfate, Total (as SO4)			115	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2020	
1483	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	February	02/29/2020	Sulfate, Total (as SO4)			123	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/29/2020	
1484	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	February	02/29/2020	Sulfate, Total (as SO4)			130	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/29/2020	
1485	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	March	03/31/2020	Sulfate, Total (as SO4)			125	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2020	

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1486	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	March	03/31/2020	Sulfate, Total (as SO4)			125	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2020	
1487	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	April	04/30/2020	Sulfate, Total (as SO4)			102	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2020	
1488	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	April	04/30/2020	Sulfate, Total (as SO4)			107	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2020	
1489	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	May	05/31/2020	Sulfate, Total (as SO4)			110	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2020	
1490	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	May	05/31/2020	Sulfate, Total (as SO4)			110	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2020	
1491	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	June	06/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2020	
1492	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	June	06/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2020	
1493	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	July	07/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2020	
1494	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	July	07/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2020	
1495	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	August	08/31/2020	Sulfate, Total (as SO4)			104	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2020	
1496	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	August	08/31/2020	Sulfate, Total (as SO4)			106	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2020	
1497	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	September	09/30/2020	Sulfate, Total (as SO4)			96	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2020	
1498	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	September	09/30/2020	Sulfate, Total (as SO4)			96.8	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2020	
1499	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	October	10/31/2020	Sulfate, Total (as SO4)			95.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2020	
1500	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	October	10/31/2020	Sulfate, Total (as SO4)			95.7	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2020	
1501	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	November	11/30/2020	Sulfate, Total (as SO4)			96.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2020	
1502	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	November	11/30/2020	Sulfate, Total (as SO4)			97.9	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2020	
1503	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	December	12/31/2020	Sulfate, Total (as SO4)			103	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2020	
1504	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	December	12/31/2020	Sulfate, Total (as SO4)			104	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2020	
1505	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	January	01/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2021	
1506	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	January	01/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2021	
1507	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	February	02/28/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/28/2021	
1508	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	February	02/28/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/28/2021	
1509	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	March	03/31/2021	Sulfate, Total (as SO4)			112	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2021	
1510	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	March	03/31/2021	Sulfate, Total (as SO4)			120	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2021	
1511	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	April	04/30/2021	Sulfate, Total (as SO4)			107	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2021	
1512	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	April	04/30/2021	Sulfate, Total (as SO4)			107	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2021	
1513	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	May	05/31/2021	Sulfate, Total (as SO4)			110	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2021	
1514	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	May	05/31/2021	Sulfate, Total (as SO4)			112	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2021	
1515	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	June	06/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2021	
1516	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	June	06/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2021	
1517	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	July	07/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2021	
1518	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	July	07/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2021	
1519	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	August	08/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2021	
1520	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	August	08/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2021	
1521	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	September	09/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2021	
1522	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	September	09/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2021	
1523	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	October	10/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2021	
1524	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	October	10/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2021	
1525	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	November	11/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2021	
1526	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	November	11/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2021	
1527	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	December	12/31/2021	Sulfate, Total (as SO4)			131	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2021	
1528	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2021	December	12/31/2021	Sulfate, Total (as SO4)			131	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2021	
1529	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	January	01/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2022	
1530	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	January	01/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2022	
1531	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	February	02/28/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/28/2022	
1532	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	February	02/28/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/28/2022	
1533	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	March	03/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2022	
1534	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	March	03/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2022	
1535	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	April	04/30/2022	Sulfate, Total (as SO4)			105	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2022	
1536	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	April	04/30/2022	Sulfate, Total (as SO4)			123	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2022	
1537	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	May	05/31/2022	Sulfate, Total (as SO4)			94.9	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2022	
1538	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	May	05/31/2022	Sulfate, Total (as SO4)			102	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2022	
1539	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	June	06/30/2022	Sulfate, Total (as SO4)			95.4	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2022	
1540	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	June	06/30/2022	Sulfate, Total (as SO4)			95.6	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2022	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1541	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	July	07/31/2022	Sulfate, Total (as SO4)			95.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2022	
1542	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	July	07/31/2022	Sulfate, Total (as SO4)			95.5	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2022	
1543	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	August	08/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2022	
1544	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	August	08/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2022	
1545	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	September	09/30/2022	Sulfate, Total (as SO4)			93.6	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2022	
1546	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	September	09/30/2022	Sulfate, Total (as SO4)			93.6	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2022	
1547	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	October	10/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2022	
1548	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	October	10/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2022	
1549	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	November	11/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2022	
1550	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	November	11/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2022	
1551	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	December	12/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2022	
1552	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	December	12/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2022	
1553	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	January	01/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2023	
1554	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	January	01/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2023	
1555	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	February	02/28/2023	Sulfate, Total (as SO4)			106	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/28/2023	
1556	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	February	02/28/2023	Sulfate, Total (as SO4)			106	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/28/2023	
1557	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	March	03/31/2023	Sulfate, Total (as SO4)			126	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2023	
1558	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	March	03/31/2023	Sulfate, Total (as SO4)			136	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2023	
1559	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	April	04/30/2023	Sulfate, Total (as SO4)			111	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2023	
1560	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	April	04/30/2023	Sulfate, Total (as SO4)			133	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2023	
1561	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	May	05/31/2023	Sulfate, Total (as SO4)			86.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2023	
1562	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	May	05/31/2023	Sulfate, Total (as SO4)			87.5	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2023	
1563	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	June	06/30/2023	Sulfate, Total (as SO4)			89	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2023	
1564	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	June	06/30/2023	Sulfate, Total (as SO4)			90.4	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2023	
1565	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	July	07/31/2023	Sulfate, Total (as SO4)			91.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2023	
1566	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	July	07/31/2023	Sulfate, Total (as SO4)			91.1	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2023	
1567	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	August	08/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2023	
1568	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	August	08/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2023	
1569	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	September	09/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2023	
1570	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	September	09/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2023	
1571	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	October	10/31/2023	Sulfate, Total (as SO4)			98.7	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2023	
1572	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	October	10/31/2023	Sulfate, Total (as SO4)			98.7	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2023	
1573	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	November	11/30/2023	Sulfate, Total (as SO4)			102	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2023	
1574	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	November	11/30/2023	Sulfate, Total (as SO4)			102	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2023	
1575	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	December	12/31/2023	Sulfate, Total (as SO4)			95.1	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2023	
1576	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	December	12/31/2023	Sulfate, Total (as SO4)			97.9	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2023	
1577	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	January	01/31/2024	Sulfate, Total (as SO4)			112	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2024	
1578	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	January	01/31/2024	Sulfate, Total (as SO4)			112	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	01/31/2024	
1579	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	February	02/29/2024	Sulfate, Total (as SO4)			118	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/29/2024	
1580	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	February	02/29/2024	Sulfate, Total (as SO4)			120	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	02/29/2024	
1581	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	March	03/31/2024	Sulfate, Total (as SO4)			117	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2024	
1582	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	March	03/31/2024	Sulfate, Total (as SO4)			117	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	03/31/2024	
1583	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	April	04/30/2024	Sulfate, Total (as SO4)			123	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2024	
1584	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	April	04/30/2024	Sulfate, Total (as SO4)			123	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	04/30/2024	
1585	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	May	05/31/2024	Sulfate, Total (as SO4)			122	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2024	
1586	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	May	05/31/2024	Sulfate, Total (as SO4)			123	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	05/31/2024	
1587	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	June	06/30/2024	Sulfate, Total (as SO4)			123	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2024	
1588	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	June	06/30/2024	Sulfate, Total (as SO4)			133	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	06/30/2024	
1589	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	July	07/31/2024	Sulfate, Total (as SO4)			111	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2024	
1590	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	July	07/31/2024	Sulfate, Total (as SO4)			112	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	07/31/2024	
1591	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	August	08/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2024	
1592	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	August	08/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	08/31/2024	
1593	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	September	09/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2024	
1594	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	September	09/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	09/30/2024	
1595	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	October	10/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2024	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1596	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	October	10/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	10/31/2024	
1597	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	November	11/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2024	
1598	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	November	11/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	11/30/2024	
1599	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	December	12/31/2024	Sulfate, Total (as SO4)			136	mg/L	CalMoAvg	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2024	
1600	US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2024	December	12/31/2024	Sulfate, Total (as SO4)			136	mg/L	CalMoMa	N	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.0773655	47.3710275	12/31/2024	
1601												105										
1602	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	January	01/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2018	
1603	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	January	01/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2018	
1604	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	February	02/28/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/28/2018	
1605	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	February	02/28/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/28/2018	
1606	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	March	03/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2018	
1607	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	March	03/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2018	
1608	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	April	04/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2018	
1609	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	April	04/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2018	
1610	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	May	05/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2018	
1611	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	May	05/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2018	
1612	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	June	06/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2018	
1613	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	June	06/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2018	
1614	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	July	07/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2018	
1615	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	July	07/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2018	
1616	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	August	08/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2018	
1617	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	August	08/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2018	
1618	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	September	09/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2018	
1619	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	September	09/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2018	
1620	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	October	10/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2018	
1621	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	October	10/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2018	
1622	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	November	11/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2018	
1623	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	November	11/30/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2018	
1624	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	December	12/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2018	
1625	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2018	December	12/31/2018	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2018	
1626	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	January	01/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2019	
1627	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	January	01/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2019	
1628	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	February	02/28/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/28/2019	
1629	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	February	02/28/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/28/2019	
1630	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	March	03/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2019	
1631	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	March	03/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2019	
1632	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	April	04/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2019	
1633	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	April	04/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2019	
1634	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	May	05/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2019	
1635	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	May	05/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2019	
1636	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	June	06/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2019	
1637	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	June	06/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2019	
1638	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	July	07/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2019	
1639	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	July	07/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2019	
1640	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	August	08/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2019	
1641	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	August	08/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2019	
1642	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	September	09/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2019	
1643	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	September	09/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2019	
1644	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	October	10/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2019	
1645	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	October	10/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2019	
1646	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	November	11/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2019	
1647	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	November	11/30/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2019	
1648	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	December	12/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2019	
1649	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2019	December	12/31/2019	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2019	
1650	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	January	01/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2020	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1651	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	January	01/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2020	
1652	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	February	02/29/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/29/2020	
1653	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	February	02/29/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/29/2020	
1654	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	March	03/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2020	
1655	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	March	03/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2020	
1656	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	April	04/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2020	
1657	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	April	04/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2020	
1658	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	May	05/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2020	
1659	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	May	05/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2020	
1660	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	June	06/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2020	
1661	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	June	06/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2020	
1662	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	July	07/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2020	
1663	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	July	07/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2020	
1664	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	August	08/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2020	
1665	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	August	08/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2020	
1666	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	September	09/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2020	
1667	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	September	09/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2020	
1668	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	October	10/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2020	
1669	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	October	10/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2020	
1670	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	November	11/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2020	
1671	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	November	11/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2020	
1672	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	December	12/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2020	
1673	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2020	December	12/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2020	
1674	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	January	01/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2021	
1675	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	January	01/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2021	
1676	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	February	02/28/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/28/2021	
1677	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	February	02/28/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/28/2021	
1678	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	March	03/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2021	
1679	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	March	03/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2021	
1680	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	April	04/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2021	
1681	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	April	04/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2021	
1682	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	May	05/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2021	
1683	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	May	05/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2021	
1684	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	June	06/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2021	
1685	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	June	06/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2021	
1686	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	July	07/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2021	
1687	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	July	07/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2021	
1688	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	August	08/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2021	
1689	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	August	08/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2021	
1690	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	September	09/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2021	
1691	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	September	09/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2021	
1692	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	October	10/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2021	
1693	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	October	10/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2021	
1694	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	November	11/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2021	
1695	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	November	11/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2021	
1696	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	December	12/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2021	
1697	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2021	December	12/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2021	
1698	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	January	01/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2022	
1699	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	January	01/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2022	
1700	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	February	02/28/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/28/2022	
1701	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	February	02/28/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/28/2022	
1702	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	March	03/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2022	
1703	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	March	03/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2022	
1704	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	April	04/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2022	
1705	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	April	04/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2022	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1706	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	May	05/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2022	
1707	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	May	05/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2022	
1708	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	June	06/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2022	
1709	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	June	06/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2022	
1710	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	July	07/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2022	
1711	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	July	07/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2022	
1712	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	August	08/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2022	
1713	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	August	08/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2022	
1714	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	September	09/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2022	
1715	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	September	09/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2022	
1716	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	October	10/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2022	
1717	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	October	10/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2022	
1718	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	November	11/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2022	
1719	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	November	11/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2022	
1720	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	December	12/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2022	
1721	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2022	December	12/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2022	
1722	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	January	01/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2023	
1723	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	January	01/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2023	
1724	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	February	02/28/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/28/2023	
1725	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	February	02/28/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/28/2023	
1726	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	March	03/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2023	
1727	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	March	03/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2023	
1728	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	April	04/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2023	
1729	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	April	04/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2023	
1730	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	May	05/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2023	
1731	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	May	05/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2023	
1732	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	June	06/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2023	
1733	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	June	06/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2023	
1734	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	July	07/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2023	
1735	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	July	07/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2023	
1736	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	August	08/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2023	
1737	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	August	08/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2023	
1738	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	September	09/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2023	
1739	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	September	09/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2023	
1740	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	October	10/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2023	
1741	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	October	10/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2023	
1742	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	November	11/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2023	
1743	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	November	11/30/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2023	
1744	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	December	12/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2023	
1745	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2023	December	12/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2023	
1746	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	January	01/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2024	
1747	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	January	01/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	01/31/2024	
1748	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	February	02/29/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/29/2024	
1749	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	February	02/29/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	02/29/2024	
1750	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	March	03/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2024	
1751	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	March	03/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	03/31/2024	
1752	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	April	04/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2024	
1753	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	April	04/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	04/30/2024	
1754	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	May	05/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2024	
1755	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	May	05/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	05/31/2024	
1756	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	June	06/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2024	
1757	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	June	06/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	06/30/2024	
1758	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	July	07/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2024	
1759	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	July	07/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	07/31/2024	
1760	US Steel Corp - Tailings	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	August	08/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2024	

MPCA Online Discharge Monitoring Reports (2025 Bulk Export of Data from 2018-2024)
U.S. Steel Corp - Keetac Permits MN0031879 and MN0055947
Specific Conductance and Sulfate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1761	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	August	08/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	08/31/2024	
1762	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	September	09/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2024	
1763	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	September	09/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	09/30/2024	
1764	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	October	10/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2024	
1765	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	October	10/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	10/31/2024	
1766	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	November	11/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2024	
1767	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	November	11/30/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	11/30/2024	
1768	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	December	12/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoAvg	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2024	
1769	**US Steel Corp - Tailings**	MN0055948	IND20110001	SD 009	Sargent Pit Dewatering to Unnamed I	2024	December	12/31/2024	Sulfate, Total (as SO4)				mg/L	CalMoMa	Y	Mississippi River - Grand Rapids (07010103)	7010103	Hay Creek	-93.1146999	47.3986848	12/31/2024	

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 4

EPA, NEIC Civil Investigation Report, U.S. Steel – Keetac, Keewatin, Minnesota, 55753, October 2022.

United States Environmental Protection Agency
Office of Enforcement and Compliance Assurance
Office of Criminal Enforcement, Forensics and Training

National Enforcement Investigations Center

NEIC

NEICVP1482E01

NEIC CIVIL INVESTIGATION REPORT

U.S. Steel - Keetac
Keewatin, Minnesota, 55753

Investigation Dates:
October 25-28, 2022

Solter, Michael
Digitally signed by Solter, Michael
Date: 2022.12.14 14:00:03 -07'00'
Mike Solter, Project Manager, NEIC

Authorized for Release by:

Linda TeKrony
Digitally signed by LINDA TEKRONY
DN: c=US, o=U.S. Government, ou=Environmental Protection Agency, cn=LINDA TEKRONY, 0.9.2342.19200300.100.1.1=68001003671918
Date: 2022.12.14 15:23:00 -07'00'
Linda TeKrony, Field Branch Chief (Acting), NEIC

Report Prepared for:
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Chicago, Illinois 60604

NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
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Building 25, Denver Federal Center
Denver, Colorado 80225

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A U.S. Steel - Keetac NPDES Permit MN0031879 – Mine Operations (41 pages)
B U.S. Steel - Keetac NPDES Permit MN0055948 – Tailings (34 pages)
C Minnesota Pollution Control Agency Inspection Report from June 15, 2017, Inspection (14 pages)
D Minnesota Pollution Control Agency June 2019 Stipulation agreement with Penalty (13 pages)
E Minnesota Pollution Control Agency June 5,2020 Administrative Penalty Order (8 pages)
F Facility Description from Mine NPDES Renewal Application MN0031879, March 4, 2016 (8 pages)
G NEIC Field Photographs - U.S. Steel - Keetac (19 pages) *
H Production Chemical Use Records, 2019-2021 (2 pages)
I Facility Description from Tailings Basin NPDES Renewal Application MN0055948 2016 (8 pages)
J U.S. Steel - Keetac Water Flow Schematic (1 page)
K Water Balance Diagram, 2011-2012 (1 page)
L Water Management Study Report FINAL, July 2012 (132 pages)
M Sulfate Reduction Strategy Study Report FINAL, July 2012 (123 pages)
N Final Sulfate Reduction Plan, October 5, 2012 (18 pages)
O March 2014 Keetac Sulfate Reduction Plan Revision FINAL (31 pages)
P FINAL BioteQ Technical Feasibility Evaluation, December 19, 2014 (24 pages)
Q BioteQ - USS Keetac Sulf-IX Pilot Report FINAL (23 pages)
R Keetac Site Specific Standard Application FINAL, December 2014 (71 pages)
S GE - Keetac Pilot Report FINAL (66 pages)
T Sulfate Site-Specific Standard Application-Hay Lake AUG2022 (1733 pages)
U Minnesota 2015 Session Law, Article 4, Section 136 (163 pages)
V Minnesota 2016 Session Law, Ch165 (1 page)
W Minnesota Attorney General Letter to EPA, August 12, 2016 (5 pages)

X Schedule of Compliance Termination Letter, January 12, 2017 (1 page)
Y February 16, 2022, Letter to MPCA Commissioner Regarding Minnesota Sulfate Laws (9 pages) *
Z Wastewater Treatment Plant Sampling Permit Modification Request (18 pages)
AA Permit Modification to Remove Selenium Monitoring from MN0055948 Outfall SD005 (16 pages)
BB Minnesota Pollution Control Agency Response to Permit Modification Requests, August 3, 2021 (1 page)
CC U.S. Steel - Keetac MN0031879 Discharge Monitoring Reports, January 2019-September 2022 (Sulfate Highlights) (434 pages) *
DD U.S. Steel - Keetac MN0055948 Discharge Monitoring Reports, January 2019-September 2022 (Sulfate Highlights) (330 pages) *
EE Email on Wastewater Treatment Plant Sampling Procedure (2 pages)
FF U.S. Steel - Keetac Storm Water Pollution Prevention Plan, Revision 14, October 7, 2019 (42 pages)
GG Diesel Exhaust Fluid Safety Data Sheet (12 pages)
HH Facility-Reported Permit Noncompliance Summary, 2017-2022 (2 pages)

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INVESTIGATION OVERVIEW

PROJECT OBJECTIVE

At the request of U.S. Environmental Protection Agency (EPA) Region 5 (Region), EPA's National Enforcement Investigations Center (NEIC) conducted a Clean Water Act (CWA) compliance investigation of the U.S. Steel - Keetac taconite mine located at 1 Mine Road in Keewatin, Minnesota. The investigation assessed U.S. Steel - Keetac's compliance with federal environmental statutes and permit requirements. The specific areas of focus for the inspection included:

- Sanitary wastewater and process wastewater generation, collection and treatment systems, sampling points, and outfalls.
- Stormwater pollution management controls, such as drainage and collection systems, treatment, sampling points, and outfalls.
- Evaluation of on-site sampling and testing procedures for wastewater.
- Operations under National Pollution Discharge Elimination System (NPDES/State Disposal System (SDS) permits MN0031879 and MN0055948.
- Site storm water pollution prevention plan (SWPPP).

NEIC personnel also documented activities and conditions that, although not specifically regulated, may have impacted, or could potentially impact, the environment. Investigation activities included the following:

- Interviewing mine personnel and management responsible for operations, maintenance, monitoring, and reporting for the facility.
- Reviewing documents relevant to the facility's operations and self-monitoring programs.
- Visually inspecting the physical control structures, discharge locations, and monitoring points of the facility systems.
- Observing and documenting operations of the mine including all site operations.

Table 1 lists the project team members.

Table 1. PROJECT TEAM MEMBERS

Team Member	Organization	Project Role
Mike Solter	NEIC	Project manager
Kristine Andersen	NEIC	Field team member

Table 1. PROJECT TEAM MEMBERS		
Team Member	**Organization**	**Project Role**
Trent Rainey	NEIC	Field team member
REGIONAL AND OTHER CONTACTS		
Jake Berger	EPA Region 5	Regional field team member
Matthew Schulte	EPA Region 5	Regional field team member

FACILITY CONTACT INFORMATION

Table 2 lists the primary facility contacts.

Table 2. FACILITY CONTACT INFORMATION		
Name, Title	**Title**	**Email Address**
Chrissy Bartovich	Environmental Director	clbartovich@uss.com
Tishie Woodwell	Vice President, Environmental	twoodwell@uss.com
Tom Moe	Environmental Engineer	tmoe@uss.com
Eric Williams	HQ Manager - Water	ewilliams@uss.com

FACILITY OVERVIEW

U.S. Steel - Keetac is a taconite (iron ore) mine (EPA Registry Identification No. 110008797864). The U.S. Steel - Keetac facility is one of two large-scale taconite mines owned by U.S. Steel located in Minnesota, with an approximate net annual production capability of 6 million net tons of pellets. The facility employs approximately 416 individuals (though some are shared with the other U.S. Steel location) and produces taconite pellets for steel manufacturing at locations throughout the United States.

The overall facility holds two minor NPDES/SDS permits, one for the taconite mining operations (MN0031879) and one for the tailings operations (MN0055948). Water covered by permit MN0031879 is either reused, directly discharged through permitted outfalls, or discharged to the tailings area operated under permit MN0055948. Permit MN0055048 covers water from the tailings area that is generally treated then sent back to the mining operations area for reuse in the areas covered under permit MN0031879 or discharged through the permitted outfalls. The respective NPDES/SDS permits describe the outfalls and water use in detail.

Permit MN0031879 (listed in the permit as “Keewatin Taconite Operations – Mining”) covers discharges from mine excavations, mining waste disposal areas, plant areas, materials and equipment storage areas, and wastewater disposal facilities (**Appendix A**). In addition to these areas, the operations areas include several equipment storage buildings; the general office building; the water supply treatment plant; fuel storage areas; the crude ore storage building; the concentrator; the pellet plant; various processing thickeners; the laboratory; the power substation; coal, concentrate, and pellet stockpile areas; and the pellet rail load-out area.

Permit MN0055948 (listed in the permit as "Keewatin Taconite Operations – Tailings") covers discharges from the taconite tailings basin, the drainage area contributing surface runoff to the basin, and all non-sewage wastewater disposal systems within the permitted area (**Appendix B**). The tailings operations include multiple water systems to either discharge water or reintroduce water to the mining operations portions of the facility.

U.S. Steel - Keetac was last inspected for compliance with the Clean Water Act (CWA) on June 15, 2017, by representatives of the State of Minnesota Pollution Control Agency (MPCA) (**Appendix C**). According to the EPA Enforcement and Compliance History Online (ECHO) database, the facility received two formal enforcement actions for violations of the Clean Water Act, one settled on June 21, 2019, with a penalty of $16,500, and one settled on June 5, 2020, with a penalty of $17,550. The June 21, 2019, settlement agreement specifically settles violations discovered during the June 15, 2017, inspection, and other unauthorized discharges of material (the settlement agreement appears to reference inspection date incorrectly as June 15, 2016, (**Appendix D**, page 3). The second penalty is related to unauthorized discharges from stockpile A reported on August 28, 2019, and September 18, 2019 (**Appendix E**).

According to the EPA Envirofacts database, this facility has the following North American Industry Classification System (NAICS) code (**Table 3**):

Table 3. APPLICABLE NAICS CODE

NAICS Code	Description
212210	Iron Ore Mining

FACILITY OPERATIONS SUMMARY

Mining Operations

The facility provided a full description of its mining activities in its mine permit renewal application (**Appendix F**). Following is a description of the mining operations based on observations and discussions with the facility representatives and the application. The facility is an active mine, and the actual operations are changed regularly based on the needs of U.S. Steel at the time of operation.

The Keetac mine and plant facility consists of mining excavation, mining waste rock disposal, a processing plant, materials and equipment storage areas, a water treatment facility, and wastewater treatment and disposal facilities. The principal activities at the facility are the open-pit mining of taconite (Biwabik Iron Formation) and the associated processing of mined taconite to produce taconite pellets.

Most surface drainage and groundwater dewatering from mining waste disposal and excavation areas in the eastern half of the facility are collected in mine pit sumps and then pumped to

Carlz Pit. These mine pit sumps include those from Bennett, Russell, Section 18, and Stevenson Pits.

Water from the Bennett, Russell, Section 18, and Stevenson Pit sumps (overflow) is routed to Carlz Pit via pump stations in Section 18 and Russell Pits (**Appendix G**, photos PA250003, PA250004, and PA250005).

Water from Carlz Pit may then be used as makeup water in the plant via a lift pump that carries water from Carlz Pit to the Wolf Hill head tank (**Appendix G**, photo PA250006).

Dewatering from Sargent Pit has the capability of routing to Russell Pit (**Appendix G**, photo PA250001), and Sargent Pit may also pump to Mesabi Chief Pit, which is directly linked to outfall SD-003, located at O'Brien Creek (**Appendix G**, photos PA250002 and PA250008).

On the west side of the pit operations, Perry Pit discharges directly through outfall SD-012 (**Appendix G**, photos PA250009 and PA250010).

Domestic sanitary wastewater is treated on-site by an activated sludge package plant. Treated effluent is discharged through outfall WS005 (treated domestic wastewater effluent) to Bennett Pit. The treatment system consists of a bar screen, comminutor, diffused aeration tank, sludge holding tank, and chlorination contact tank. The sewage plant is designed to treat 40,000 gallons per day (GPD) of sanitary wastewater with a 5-day carbonaceous biochemical oxygen demand (CBOD5) influent strength of 140 milligrams per liter (mg/L). Facility representatives stated that the flow rate currently averages 25,000 GPD (**Appendix G**, photos PA260025-PA260028). Bio-solids from this treatment process are transferred off-site by a licensed waste hauler to a permitted wastewater treatment facility.

Process wastewater is produced and collected in the bottom of two coarse crushers located in Section 18 Pit. Crusher #1 and crusher #2 process wastewater is pumped to sump #1 and then to the Section 18 Pit sump. A septic holding tank stores the sanitary wastewater generated in the pit areas. This sanitary wastewater is hauled to the on-site wastewater treatment facility.

The combined floor drain overflow from the concentrator and the pellet plant is routed to Bennett Pit, which discharges to Russell Pit, and then is pumped to Carlz Pit. The floor drain overflow may include emergency overflow process wastewater from the concentrator if a power failure occurs.

All steam-cleaning and floor drain wastewater from the truck shops and the plant/machine/welding shops is treated by an oil/water separator and sedimentation tank prior to overflowing to a drainage pipe to Bennett Pit. Sludge from the shop areas is taken off-site by a licensed

waste hauler for treatment or disposal. Oils removed from the oil/water separator are transported off-site for disposal or reuse.

A single fueling point located near the primary crushers in the mining pit area consists of twin 25,000-gallon diesel tanks (**Appendix G**, photo PA260032). This area is used for fueling heavy equipment used in the mine pit areas. An additional fueling point is located near the plant area and consists of a single 10,000-gallon diesel tank (**Appendix G**, photo PA260034). The final fueling location is next to the "new truck shop" and consists of an underground gasoline storage tank that is connected to the small vehicle fuel pumps (**Appendix G**, photo PA260038).

The concentrator plant on the mining operations side is the primary contributor of tailings and water to the tailings basin. Process water is introduced to the plant in part as makeup and clean water from the Wolf Hill head tank (**Appendix G**, photo PA270053). The remainder of the water used in processing is recirculated through the facility. The concentrator consists of a series of mills, magnetic separators, hydro separators, hydro clones, screens, and thickeners (**Appendix G**, photos PA270041-PA270047 and PA270049). A flocculent is added to the concentrator tailings slurry before the thickening stage. The agglomerator receives the concentrate, which is mixed with limestone/dolomite and then dewatered by disc filters. The filter cake is then mixed with bentonite and formed into pellets in balling drums. The agglomerator wastewater, as well as wet scrubber wastewater, recirculating non-contact cooling water, and normal floor drain wastewater that is generated at the plant, is recirculated as process water within the plant.

Two recirculating wet scrubbers treat waste gas from the existing indurating grate-kiln used to fire the concentrate and bentonite mixed pellets. Blowdown water from these wet scrubbers is sent to a wastewater treatment system. Chemicals used in the wet scrubber system include calcium hydroxide for pH control and as a clarification/coagulation aid. Diluted hydrochloric acid is used to clean pH probes. Two types of lime descaler are used to clean lime deposits. The wastewater from the scrubber system is mixed with the tailings slurry in the tailings sump (**Appendix G**, photo PA270051)

The majority of plant wastewater is combined with waste tailings and discharged to the tailings basin system as tailings slurry. Waters discharged in the slurry include treated blowdown water from two recirculating wet scrubbers. The wastewater treatment system includes lime addition (**Appendix G**, photo PA270056) to promote calcium sulfate (gypsum) precipitation and solids settling in an existing thickener (old indurating thickener). Solids from the thickener are dewatered using two filter presses (**Appendix G**, photo PA270057) and disposed of off-site. Overflow from the thickener and filtrate from the filter presses are sent to the tailings basin within the slurry. The discharges from the tailings basin system are subject to permit MN0055948. The surface water discharges associated with the tailings basin system ultimately flow into Reservoir 2.

Ten settling basins surround the production area and eventually discharge into Welcome Creek through outfall SD-002 (**Appendix G**, photo PA260015). Flows that enter the 10 settling basins are:

- Overflows from the Wolf Hill head tank.
- Runoff from the plant area, as well as some active and inactive waste rock stockpile areas, that are routed directly to the 10 settling basins.
- Water from the pellet dust control operations (**Appendix G**, photos PA260011 and PA260012).
- Ancillary tailings pipeline discharges. Two parallel tailings pipelines exit the north side of the concentrator and approximately follow the 10 settling basins prior to crossing Highway 169 toward the tailings basin. Segments of these pipelines do not have spill containment berms, and some leaks from pipelines north of Highway 169 may flow toward the 10 settling basins. The tailings are pumped through the pipelines, which include three dump valve drainage points north of Highway 169. These dump-valve points include detention basins and ponds used to contain tailings and process wastewater that is drained from the pipeline(s) during line change-over, normal maintenance, and emergency shutdowns. Dump points 1 and 2 overflow to the 10 settling basins, while dump point 3 drains into a non-discharging infiltration basin.

The potable water treatment plant is located just north of Welcome Lake. The water treatment plant backwash wastewater from the sand filters is periodically discharged through a culvert through outfall SD-001 to Welcome Lake (**Appendix G**, photos PA260030 and PA260031). The plant uses potassium permanganate for iron removal and sodium hydroxide for pH balancing.

Some additional discharge from mining waste rock stockpile drainage flows to unnamed wetlands and creeks.

The facility occasionally applies dust suppressants to roads in the plant and mine area. A usage report for 2019-2021 indicated that the facility used 4,306 gallons of magnesium chloride in the plant area in June 2019 and 4,306 gallons of calcium chloride in the mining area in July 2021 (**Appendix H**). No usage of dust suppressant chemicals was reported in 2020. Water trucks are also used for dust control on roads and within the plant area. These trucks are filled at water fill stations that utilize mine dewatering water as their source of water.

Dry storage buildings are located north and east of the processing facilities. A shovel repair area is located on the northwest side of Russell Pit. Neither of these areas generate process or sanitary wastewaters.

Tailings Management

The facility provided a full description of the tailings basin operational activities in its tailings basin permit renewal application (**Appendix I**). Following is a description of the tailings basin operation based on observations and discussions with the facility representatives and the application. There are significant overlaps with the previously described mine operations.

The tailings basin facility provides the primary method of process water treatment as well as most makeup water for the plant process. The system consists of the inner tailings basin, outer tailings basin, 2nd stage pond, Reservoir 6, a small maintenance building, the drainage areas contributing surface runoff to these basins/reservoirs, and all non-sewage wastewater disposal systems contributing flow to the tailings discharge.

The tailings and related process water treated in the tailings basin are generated by the mine operations permitted under permit MN0031879.

The process water flow to the tailings basin consists of the tailings slurry and the associated process water. The average tailings slurry flow rate is 20-25 million gallons per day (MGD). The tailings slurry and plant process water are pressurized using a series of inline pumps in the plant (**Appendix G**, photo PA270052) and then piped under pressure from the plant across Highway 169, where the slurry is sprayed into the tailings basin (**Appendix G**, photo PA260018). The dual tailings pipelines have several gravity flow drainage points along their route that are used during routine maintenance, winter operations, and emergency situations such as pump failure.

The tailings basin is divided into two parts, the inner tailings basin and the outer tailings basin. The tailings slurry is discharged into the inner tailings basin via a spigot system such that coarse tails are deposited near the outer areas (used to build the containment dike) and fine tails are deposited further from the outer edge and settle out within the tailings pond. The elevation of the inner tailings basin increases with time, as tailings settle within the pond and increase the pond bottom elevation.

Water discharges from the inner tailings basin via a decant structure (**Appendix G**, photo PA260017) into the outer tailings basin, where it flows to the 2nd stage pond for additional sedimentation. The outer tailings basin dikes are constructed of clay starter dikes with a coarser sand and gravel chimney drain. The tailings basin (outer and inner) is principally underlain by glacial till and glaciofluvial deposits.

Water from the 2nd stage pond is moved to Reservoir 6 via a structure located in the southwest corner. Most of the water routed into Reservoir 6 is re-circulated back to the plant as makeup water via a pump house to the Wolf Hill head tank (**Appendix G**, photos PA260020 and

PA250007). Surface water from Reservoir 6 discharges through outfall SD005 (**Appendix G**, photo PA260016) into a drainage swale and then into Reservoir 2.

Depending on water elevations, water can flow in reverse through the drainage swale, which will convey water from Reservoir 2 North into Reservoir 6. Reservoir 2 North also receives water from Welcome Creek.

At the time of the inspection, water was being pumped from Reservoir 2 to Reservoir 6 for water-level maintenance (**Appendix G**, photo PA260022).

Reservoir 6 is equipped with emergency overflow to Reservoir 2 via siphon outlet SD001 (**Appendix G**, photo PA260021). This discharge point is above the typical water elevation in Reservoir 6; discharge monitoring reports (DMRs) that the NEIC field team reviewed during the inspection indicate this location has not discharged in the last 3 years.

Surface water monitoring station SW001 is located at the weir outlet of Reservoir 2; no permit limits are associated with the SW001 monitoring station (**Appendix G**, photo PA260023).

Per the permit renewal application, precipitation that falls on the outer edge of the exterior tailings basin dike flows as surface runoff away from the basin and may discharge to various surface waters, including West Swan River, unnamed wetlands, Hay Creek, Reservoir 2, Reservoir 2 North, and Welcome Creek.

A usage report from 2019-2021 indicated that the facility used 8,337 gallons of magnesium chloride in the tailings basin area in July 2019 and 10,000 gallons of calcium chloride in the tailings area in July 2021; both the calcium chloride and magnesium chloride were used as dust suppressants (**Appendix H**).

Repair shops and a garage are located to the north of the main tailings basin, and vehicle and/or equipment maintenance is conducted indoors.

Portable toilets are used in the tailings basin operational area, and sewage is disposed of by properly licensed waste haulers.

A diagram showing the complete water flow under both permits MN0031879 and MN0055948 is included in **Appendix J**. The diagram shows the closely interrelated nature of the water management operations. **Appendix K** also shows a more detailed water balance diagram, but the information is from 2011/2012.

Closures

The facility has had several substantial shutdowns, primarily for economic reasons. During extended shutdowns, environmental staff continue monitoring operations required by the permit, and dewatering operations continue due to costs and time required to dewater flooded areas. Staff indicated the following closure time frames:

- December 7, 2008-December 27, 2009
- May 17, 2015-March 5, 2017
- April 19, 2020-December 14, 2020

Sulfate Reduction Operations

Per the permit requirements, the facility tested multiple strategies to reduce sulfate discharges from the operations per the compliance schedule contained in permit MN0031879. U.S. Steel - Keetac evaluated multiple technologies to determine the most effective strategies for sulfate reduction in its discharges.

The facility first performed a full water management study in July 2012 and used that study, in part, as the basis for the evaluation/development of sulfate reduction strategies (**Appendix L**). In addition to the water management study, the facility developed a report on possible strategies for sulfate reduction in July 2012 (**Appendix M**). The purpose of the combined reports was to develop the October 2012 sulfate reduction plan (**Appendix N**) that included the proposed actions that U.S. Steel - Keetac would take to comply with the final effluent limitations included in their permits.

In March 2014, U.S. Steel - Keetac submitted a revision to the October 2012 sulfate reduction plan (**Appendix O**). In the revision, U.S. Steel states:

> *In January 2013, approximately three months following submission of the SRP, MPCA informed U. S. Steel that the SRP could not be approved as written. The main reason for MPCA's rejection of the SRP was that wild rice was found to be present in various segments of Swan River downstream of Swan Lake, even though none of the Swan River downstream of Swan Lake had or has yet been officially designated as waters used for the production of wild rice. This same situation holds true for Hay Lake and Hay Creek, which have yet to be officially designated as waters used for the production of wild rice. U. S. Steel maintains that unless a specific water body/stream reach is officially designated as waters used for the production of wild rice, the Class 4A wild rice sulfate standard does not apply.*

U.S. Steel further stated that the goal of the revised submission, in part, was to provide an update to a November 2013 submission, which, in turn, was a revision of the original submission with changes requested by MPCA.

During the inspection, U.S. Steel - Keetac provided the inspection team with a technical feasibility study on the use of a pilot-scale BioteQ ion exchange technology combined with treatment of nanofiltration retentate using lime softening and Sulf-IX (**Appendices P** and **Q**).

In December 2014, U.S. Steel - Keetac applied to MPCA for site-specific standards for Hay Lake, Hay Creek, Swan Lake (including Swan Lake, southwest bay), and Swan River (Swan Lake outlet to confluence with Snowball Creek). This application did not specify the desired level for the site-specific criteria but asked for the current 10 mg/L standard to be withdrawn, and for a site-specific level to be established (**Appendix R**).

In 2016, U.S. Steel - Keetac conducted an on-site pilot study of a GE Water & Process Technologies ZeeWeed 1500 and nanofiltration system. The pilot system was operated from August to October 2016 and was set up to remove sulfate from Welcome Creek (**Appendix G**; photo PA260014 shows the location of the pilot study). The full report on the study is included as **Appendix S**.

In August 2022, the facility applied to MPCA for a sulfate site-specific standard at Hay Lake (located downstream from the Keetac mine operations). In its application letter (**Appendix T**), the facility stated that it had previously submitted requests to the MPCA for site-specific standards and that the current application is an update to:

> *The Application for Site-Specific Sulfate Standard(s) for Hay Lake, Hay Creek, Swan Lake (including Swan Lake Southwest Bay), and Swan River (Swan Lake outlet to confluence with Snowball Creek), submitted in December 2014 with MPCA acknowledgement of receipt on December 29, 2014. To date, the MPCA has not acted on this application for Keetac. U. S. Steel requests the MPCA approve and implement this revised request for a sulfate site-specific standard of 79 mg/L at Hay Lake, which will replace the existing Class 4A sulfate standard of 10 mg/L. The site-specific standard is being requested in accordance with Minn Rules, part 7050.0220, subpart 7.*

The facility does not currently use any sulfate reduction strategies but continues to monitor for sulfate in its discharges per the permit requirements. The facility removed the sulfate treatment systems that were installed on-site because MPCA and the Minnesota state legislature passed a series of rules and laws requiring additional evaluation of sulfate impacts on wild rice production and growth.

In 2015, the Minnesota state legislature passed a law, in part, prohibiting MPCA from requiring permitted facilities “to expend money for design or implementation of sulfate treatment technologies or other forms of sulfate mitigation.” **See Appendix U**, page 144.

In 2016, the state of Minnesota passed a law stating, in part, that the “final sulfate limits resulting from implementation of the wild rice water quality standard in Minnesota Rules, part

7050.0224, subpart 2, are no longer valid; and (2) any compliance schedule permit conditions related to those final limits are no longer valid." See **Appendix V**.

On August 12, 2016, the attorney general of the state of Minnesota sent a letter to the EPA stating their belief that the laws passed by the state did not interfere with MPCA's ability to implement the NPDES program (**Appendix W**).

Further, on January 12, 2017, the MPCA sent a letter to U.S. Steel stating, in part, that the facility had completed the requirements of its schedule of compliance and that the associated schedule of compliance was terminated (**Appendix X**).

On February 16, 2022, the EPA Region 5 Administrator sent a letter to the commissioner of MPCA stating, in part, "that the session laws (from 2015 and 2016) constitute a non-substantial change to Minnesota's NPDES program and are inconsistent with the Clean Water Act (CWA). EPA therefore disapproves the program revision affected by these laws as an improper modification to MPCA's authority to implement the NPDES program." See **Appendix Y**.

Permit Modification Requests

In September 2017, the facility requested a modification to permit MN0031879 to change the monitoring requirements at the wastewater treatment facility from an 8-hour-flow-based composite sample to a once-per-week grab sample (**Appendix Z**).

In March 2021, the facility applied to have selenium monitoring removed from the tailings basin permit because the original permit stated that "the permittee may request to modify this requirement after 12 months of monitoring data have been submitted to the MPCA." See **Appendix AA**.

In August 2021, MPCA responded to both requests for permit modifications: "Each of the modification requests were submitted after the permits expired. At this time, the MPCA cannot make modifications to expired permits without reissuing the entire permit. We will consider these change requests during the permit reissuance process." See **Appendix BB**. Facility representatives stated that MPCA has not provided the facility with an estimated timeline for reissuing the permits.

FIELD ACTIVITIES SUMMARY

NEIC conducted the field inspection from October 25-28, 2022. An opening conference was held on October 25, 2022, during which credentials were presented to facility contacts listed in Table 2 of this report. NEIC was joined on the inspection by Jake Berger and Matthew Schulte from EPA Region 5. During the inspection, the NEIC inspection team reviewed monitoring

reports, laboratory sampling data, training records, production records, process flow diagrams, and self-reported noncompliance notifications and interviewed personnel at the facility. In addition, NEIC conducted a walk-through inspection of the entire mining and tailings operations.

INVESTIGATION OBSERVATIONS

NEIC identified the following observations during the Clean Water Act compliance inspection. NEIC field team members discussed all observations with facility representatives during the closeout meeting, unless otherwise noted in the observation description.

These observations are not final compliance determinations. EPA Region 5 will make the final compliance determinations based on its review of this report and other technical, regulatory, and facility information.

Observation 1
Observation Summary: U.S. Steel - Keetac had multiple exceedances of permitted sulfate limits.
Citation: **NPDES/SDS Permit MN0031879, Chapter 1, Part 1.1 –** *The Permittee shall meet the terms of the compliance schedule detailed below in order to attain compliance with the final effluent limitations contained in this permit and NPDES/DES Permit MN055948 for total sulfate. The permittee shall continue to work toward minimizing sulfate in the discharges to the extent practical prior to the compliance date. Compliance with the final effluent limitations shall be attained as soon as possible, and in no case shall compliance be attained later that August 17, 2018, for non-tailings basin discharges, and August 17, 2019, for tailings basin discharges unless the permit is modified pursuant to 40 CFR 122.62.*
Evidence: **Appendix CC** – U.S. Steel - Keetac MN0031879 Discharge Monitoring Reports, January 2019-September 2022 (Sulfate Highlights) **Appendix DD** – U.S. Steel - Keetac MN0055948 Discharge Monitoring Reports, January 2019-September 2022 (Sulfate Highlights) **Appendix A** – U.S. Steel - Keetac NPDES Permit MN0031879 – Mine Operations **Appendix B** – U.S. Steel - Keetac NPDES Permit MN0055948 – Tailings
Description of Observation: NEIC review of DMRs (**Appendices CC** and **DD**) provided by the facility showed multiple exceedances of sulfate limits based on the final effluent limits provided in both permits for the facility. Permit MN0031879 (**Appendix A**) has final sulfate limits of 14 mg/L monthly average and 21 mg/L monthly maximum. A review of the monthly DMRs for permit MN0031879 from January 2019 through September 2022 showed the following total exceedances of sulfate limits under the permit: 1) 135 calendar month average exceedances 2) 118 calendar month maximum exceedances These exceedances do not show as violations in ECHO because the system identifies the sulfate limits as "REPORT." DMRs prior to January 2019 were not reviewed as part of this inspection. Note: **Appendix CC** includes some duplicate DMRs because the facility filed amended DMRs in some instances.

Observation 1

Permit MN0055948 (**Appendix B**) has final sulfate limits of 14 mg/L monthly average and 21 mg/L monthly maximum. A review of the monthly DMRs for permit MN0055948 from September 2019 through September 2022 showed the following total exceedances of sulfate limits under the permit:

1) 23 calendar month average exceedances
2) 23 calendar month maximum exceedances

These exceedances do not show as violations in ECHO because the system identifies the sulfate limits as "REPORT." Sulfate limits were not applicable until after August 17, 2019, for permit MN0055948.

Note: **Appendix DD** includes some duplicate DMRs because the facility filed amended DMRs in some instances.

Observation 2

Observation Summary: U.S. Steel - Keetac did not collect permit-required samples.

Citation:

NPDES/SDS Permit MN0055948, **Limits and Monitoring Requirements** – *The Permittee shall comply with the limits and monitoring requirements as specified below… Period: Limits applicable in the Final Period – SD 005, Sulfate, Total (as SO4)… 2 x Month*

Evidence:

Appendix B – U.S. Steel - Keetac NPDES Permit MN0055948 – Tailings
Appendix DD – U.S. Steel - Keetac MN0055948 Discharge Monitoring Reports, January 2019-September 2022 (Sulfate Highlights)

Description of Observation: NPDES/SDS permit MN0055948 (**Appendix B**) requires once-per-month sampling for iron dissolved (as Fe), pH, selenium total (as Se), total suspended solids (TSS), specific conductance, and twice-per-month sampling for sulfate, total (as SO_4).

In August 2022, no samples were collected from outfall SD-005 even though a discharge was occurring. The facility stated on the DMR, "Only limited discharge was observed through SD-005 during August 2022. Flow was observed and measured on 8/19/22 and a sampling event was planned for 8/23/22 but by then the discharge had gone to zero, as was the case for the balance of August. As a result, constituent monitoring was not possible." See **Appendix DD**, page 319.

In September 2022, only one sulfate sample was collected from outfall SD-005. The facility stated in the DMR, "Discharge through SD005 was limited to a portion of one week during September 2022. Therefore, it was not possible to collect a 2nd sulfate sample as required by permit." See **Appendix DD**, page 326.

Note: This observation is based on documents received from the facility and was reviewed following the on-site inspection and not discussed with the facility representatives during the closing conference.

Observation 3

Observation Summary: WS005 composite sampling is not flow-proportioned.

Observation 3

Citation:

NPDES/SDS Permit MN0031879, Limits and Monitoring Requirements – *The Permittee shall comply with the limits and monitoring requirements as specified below… Period: Limits applicable in the Final Period – WS 005: Treated Domestic Effluent,… 8-Hour Flow Composite*

Evidence:

Appendix A – U.S. Steel - Keetac NPDES Permit MN0031879 – Mine Operations
Appendix EE – Email on Wastewater Treatment Plant Sampling Procedure
Appendix C – Minnesota Pollution Control Agency Inspection Report from June 15, 2017, Inspection
Appendix Z – Wastewater Treatment Plant Sampling Permit Modification Request

Description of Observation: Permit MN0031879 (**Appendix A**) requires sampling from WS005, the treated domestic wastewater effluent. The permit specifies that biochemical oxygen demand (BOD), carbonaceous; phosphorus, total; and solids, total suspended are to be collected as 8-hour flow composite samples.

The facility currently collects these samples as 8-hour time composites, with facility representatives stating, "The flows from the facility are relatively stable so a time weighted sample is appropriate." See **Appendix EE**.

This same observation is in the report on the MPCA inspection conducted June 15, 2017 (**Appendix C**).

The facility requested a modification to the permit to allow for weekly grab samples, but the request occurred after the permit expired (**Appendix Z**).

Observation 4

Observation Summary: The SWPPP lacks a procedure for sheening management in secondary containment of aboveground storage tank and pit refueling areas.

Citation:

NPDES/SDS Permit MN0031879, Chapter 6, Section 4.9 – *Describe appropriate BMPs, including structural and non-structural BMPs, that will be used at the facility to minimize or eliminate pollution of stormwater at the site. The description must include an objective for each BMP, as well as a description of how to evaluate proper functioning of the BMP and any maintenance requirements of the BMP.*

Facility SWPPP, Section 7.2, Eliminating and Reducing Exposure, and **Section 7.8, Spill Prevention and Response**

Evidence:

Appendix A – U.S. Steel Keetac NPDES Permit MN0031879 – Mine Operations
Appendix FF – U.S. Steel - Keetac Storm Water Pollution Prevention Plan, Revision 14, October 7, 2019
Appendix G – NEIC Field Photographs - U.S. Steel - Keetac

Description of Observation: Permit MN0031879 (**Appendix A**) requires a description of all the best management practices (BMPs) that will be used to minimize or eliminate pollution at the site as part of the facility's SWPPP. Page 18 of the SWPPP includes a description of the

Observation 4

aboveground storage tanks, including statements that the secondary containment is drained after significant rainfalls after inspection for sheening (**Appendix FF**).

Discussions with facility representatives revealed that U.S. Steel- Keetac has no standard for determining the appropriate control in the event sheen is discovered in secondary containment. The facility further stated that if the sheen is "bad enough," a contractor will be called to remove the contaminated water, but if it is "not too bad," it will be discharged.

During the inspection, NEIC inspectors observed a sheen on the water in the secondary containment of both aboveground storage tank locations (**Appendix G**, photo PA260033 and PA260035), but did not observe a discharge of the secondary containment water during the inspection.

Observation 5

Observation Summary: Chemical containers were stored and exposed to potential stormwater runoff.

Citation:

NPDES/SDS Permit MN0031879, Chapter 6, Section 4.1 – *The Permittee shall develop and implement a Stormwater Pollution Prevention Plan (Plan) to address the specific conditions at the industrial facility. The goal of the Plan is to eliminate or minimize contact of stormwater with significant materials that may result in pollution of the runoff.*

NPDES/SDA Permit MN0055948, Chapter 4, Section 4.1 – *The Permittee shall develop and implement a Stormwater Pollution Prevention Plan (Plan) to address the specific conditions at the industrial facility. The goal of the Plan is to eliminate or minimize contact of stormwater with significant materials that may result in pollution of the runoff. If contact cannot be eliminated or reduced, stormwater that has contacted significant material should be treated before it is discharged from the site. The Plan shall apply to those areas of the facility where industrial activities occur or significant materials are stored, and stormwater runoff does not receive treatment prior to discharge via a permitted surface discharge station.*

Facility SWPPP, Section 7.2, Eliminating and Reducing Exposure

Facility SWPPP BMP 2 – *The hazardous / non-hazardous waste storage area is a curbed 3-sided building with a roof. The building is designated for the storage of properly labeled barrels containing waste oil, hazardous, and non-hazardous waste materials waiting to be removed from the site by vendors.*

Facility SWPPP BMP 14 – *Good housekeeping practices employed include: to the extent practical, significant materials shall be stored in areas not exposed to precipitation or runoff*.

Evidence:

Appendix A – U.S. Steel Keetac NPDES Permit MN0031879 – Mine Operations
Appendix B – U.S. Steel Keetac NPDES Permit MN0055948 – Tailings
Appendix G – NEIC Field Photographs - U.S. Steel - Keetac
Appendix GG – Diesel Exhaust Fluid Safety Data Sheet
Appendix FF – U.S. Steel - Keetac Storm Water Pollution Prevention Plan, Revision 14, October 7, 2019

Observation 5

Description of Observation: Both permits for the facility require the development of storm water pollution protection plans "to address the specific conditions at the industrial facility. The goal of the Plan is to eliminate or minimize contact of stormwater with significant materials that may result in pollution of the runoff." See **Appendices A** and **B**.

NEIC inspectors observed a container of diesel exhaust fluid (DEF) on an access road near the south side of the tailings basin, between the primary tailings basin and outer tailings basin/second stage pond (**Appendix G**, photo PA260019). At the time of the inspection, the container had no storm water protection or secondary containment. The safety data sheet for DEF states that the secondary containment is not specified, but to prevent entry to sewers and public waters (**Appendix GG**).

The facility SWPPP states that hazardous and non-hazardous materials shall be stored in the curbed three-sided building with roof pending removal by vendors (**Appendix FF**). During the inspection, NEIC inspectors observed an unprotected, unlabeled, partially full container stored with empty containers (**Appendix G**, photo PA260037).

Inspectors also observed oil/fluid totes stored outside of the "old truck shop" that were exposed to stormwater and had no secondary containment (**Appendix G**, photo PA260039).

Observation 6

Observation Summary: Spilled fuel was observed on the ground outside of secondary containment in the plant fueling area.

Citation:

NPDES/SDS Permit MN0031879, Chapter 6, Section 4.1 – *The Permittee shall develop and implement a Stormwater Pollution Prevention Plan (Plan) to address the specific conditions at the industrial facility. The goal of the Plan is to eliminate or minimize contact of stormwater with significant materials that may result in pollution of the runoff.*

Facility SWPPP, Section 7.8, Spill Prevention and Response

Evidence:

Appendix G – NEIC Field Photographs - U.S. Steel - Keetac

Description of Observation: NEIC inspectors observed significant evidence of un-remediated fuel spills on the ground outside of the secondary containment area for the fueling point. The spill evidence is in the area where vehicles would normally pull up to for fueling (**Appendix G**, photo PA260036).

Observation 7

Observation Summary: The facility provided a list of self-reported non-compliance events associated with the mine operations area. The facility did not report any non-compliance events associated with the tailings areas.

Citation: N/A

Evidence:

Appendix HH – Facility-Reported Permit Noncompliance Summary, 2017-2022

Observation 7
Description of Observation: The facility provided NEIC a summary of self-reported non-compliance events associated with the mining operations areas from 2017-2022 (**Appendix HH**). The facility did not submit any self-reported non-compliance events associated with the tailings areas.

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 5

EPA, *In re U.S. Steel Corp. Keetac Mining Operations and Tailings Basin*, Notice of Violation, May 15, 2024.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

IN THE MATTER OF:	)	
	)	
United States Steel Corporation	)	
Keetac Mining Operations and Tailings Basin	)	**NOTICE OF VIOLATION**
Keewatin, Minnesota	)	
	)	
	)	
	)	

NOTICE OF VIOLATION

The U.S. Environmental Protection Agency (EPA) is issuing this Notice of Violation (NOV) under Section 309(a)(1) of the Clean Water Act (CWA), 33 U.S.C. § 1319(a)(1). EPA finds that United States Steel Corporation (US Steel) has violated Section 301(a) of the CWA, 33 U.S.C. § 1311(a), at its Keetac iron ore mine, in Keewatin, Minnesota, as follows:

Statutory and Regulatory Background

The Clean Water Act and National Pollutant Discharge Elimination System (NPDES) Permits

1. The CWA is the primary federal statute regulating the protection of the nation's waters. The CWA aims to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." 33 U.S.C. § 1251(a).

2. Consistent with that objective, Section 301(a) of the CWA, 33 U.S.C. § 1311(a), prohibits the discharge of any pollutant into a water of the United States by any person except, *inter alia*, in compliance with a National Pollutant Discharge Elimination System (NPDES) permit issued pursuant to Section 402 of the CWA, 33 U.S.C. § 1342.

3. Section 402 of the CWA, 33 U.S.C. § 1342, authorizes states to request approval from EPA to administer their own NPDES permit programs for discharges into waters of the United States within their jurisdictions.

4. Either EPA or an approved State may initiate revision of the approved state's NPDES permit program. 40 C.F.R. § 123.62(a). A revision of a state's NPDES permit program becomes effective upon EPA's approval. *Id.* § 123.62(b)(4).

5. Pursuant to Section 402 of the CWA, 33 U.S.C. § 1342, the State of Minnesota requested approval from EPA to administer its own NPDES permit program for discharges into waters of the United States within Minnesota, and such approval was granted by EPA on June 30, 1974. *See* 39 Fed. Reg. 26,061 (July 16, 1974). Violation of an NPDES permit issued by Minnesota under the State's NPDES permit program is a violation of Section 301(a) of the CWA, 33 U.S.C. § 1311(a).

Minnesota's Water Quality Standards for NPDES Permits

6. Section 303 of the CWA requires states to adopt water quality standards, subject to EPA's approval. 33 U.S.C. § 1313. Water quality standards serve as the basis for determining NPDES permit effluent limitations for pollutants that are not specifically addressed in the effluent guidelines or for pollutants for which the effluent guidelines are not stringent enough to protect desired water uses. *See* 42 Fed. Reg. 56,786, 56,786-87 (Oct. 28, 1977).

7. Pursuant to Section 303 of the CWA, in 1973 Minnesota promulgated a sulfate water quality standard of 10 milligrams per liter (mg/L), which is applicable to waters used for the production of wild rice. *See* Minn. R. 7050.0224, subp. 2. EPA approved Minnesota's sulfate water quality standard in 1977. *See* 42 Fed. Reg. 56,786, 56,789 (Sept. 9, 1977).

8. Section 301(b)(1)(C) of the CWA and its implementing regulations require that NPDES permits include requirements necessary to achieve a state's approved water quality standards. 33 U.S.C. § 1311(b)(1)(C); 40 C.F.R. §§ 122.44(d)(1)-(5), 123.25(a)(15).

9. In 2011, the Minnesota state legislature passed a law directing the Minnesota Pollution Control Agency (MPCA) to update the sulfate wild rice water quality standard of 10 mg/L, as per Minn. Laws 2011, 1st Spec. Sess., Chapter 2, Article 4, Section 32. To date, MPCA has not updated the sulfate water quality standard.

10. In 2015, the Minnesota state legislature passed a law prohibiting MPCA from, among other things, requiring NPDES permittees "to expend money for design or implementation of sulfate treatment technologies or other forms of sulfate mitigation," and set 2018 as the deadline for MPCA to update the sulfate wild rice standard. Minn. Laws 2015, 1st Spec. Sess., Chapter 4, Article 4, Section 136(a)(1)(i), (c) (2015 Sulfate Law).

11. In 2016, the Minnesota state legislature passed another law declaring that "final sulfate limits resulting from implementation of the wild rice water quality standard . . . are no longer valid; and any compliance schedule permit conditions related to those final limits are no longer valid." Minn. Laws 2016, Chapter 165, Section 1 (a) (2016 Sulfate Law).

12. On February 16, 2022, EPA sent a letter to MPCA stating that the 2015 Sulfate Law and the 2016 Sulfate Law "are inconsistent with the Clean Water Act (CWA)," and therefore "EPA . . . disapproves the program revision affected by these laws as an improper modification to MPCA's authority to implement the NPDES program." EPA's letter further explained that, as a result, "the effluent limits and permit compliance schedules invalidated by the 2016 Sulfate Law remain subject to any federal enforcement and citizen action as provided for under the CWA."

13. To date, the State of Minnesota has not submitted any proposed revisions to its sulfate water quality standard for EPA's approval. Accordingly, the 10 mg/L sulfate standard remains in effect for CWA permitting and enforcement purposes.

Factual Allegations

14. US Steel owns and operates the Keetac taconite iron ore mining operations and tailings basin at 1 Mine Road in Keewatin, Minnesota (Facility), which began operating in 1967.

15. According to US Steel's website, the Facility can produce about 6 million tons of iron ore pellets each year. These iron-containing pellets are used to make steel.

16. MPCA issued NPDES Permit No. MN0031879 to US Steel for discharges from the Facility's mining operations (Mining Operations Permit) under Section 402 of the CWA, 33 U.S.C. § 1342. The Mining Operations Permit became effective on November 15, 2011, and was later modified on September 4, 2015. MPCA also issued US Steel NPDES Permit No. MN0055948 for discharges from the Facility's tailings basin (Tailings Basin Permit) under Section 402 of the CWA, 33 U.S.C. § 1342. The Tailings Basin Permit became effective on November 15, 2011.

17. The Mining Operations Permit and the Tailings Basin Permit both expired on October 31, 2016, but have been administratively continued by MPCA and continue to authorize and govern wastewater discharges from the Facility's mining operations and tailings basin.

18. The Mining Operations Permit authorizes discharges from Outfall SD 002 into Welcome Lake, from Outfall SD 003 into O'Brien Reservoir, and from Outfall SD 012 into O'Brien Creek. The Tailings Basin Permit authorizes discharges from Outfall SD 005 into Welcome Creek.

19. In 2010, before issuance of the Mining Operations Permit and Tailings Basin Permit, MPCA determined that discharges from US Steel's mining operations and tailings basin reach downstream waters "used for the production of wild rice" as stated in Minn. R. 7050.0224, subp. 2, including Hay Lake.

20. MPCA's Impaired Waters List includes waters in the State that fail to meet water quality standards under the CWA and is updated once every two years. MPCA's 2022 Impaired Waters List identifies Hay Lake as impaired due to sulfate.

21. At all times relevant to this NOV, US Steel was authorized to discharge pollutants from the Facility to waters of the United States only in compliance with the specific terms and conditions of the Mining Operations Permit and the Tailings Basin Permit.

22. The Mining Operations Permit and the Tailings Basin Permit both contain interim and final effluent requirements for total sulfate. During the "Interim Period," US Steel is required to monitor for sulfate concentration twice per month. During the "Final Period," US Steel is subject to total sulfate effluent limits of 14 mg/L as a calendar month average concentration, and 24 mg/L as a calendar month maximum concentration.

23. Chapter 1, Section 1.1 of the Mining Operations Permit states that "[t]he Permittee shall

meet the terms of the compliance schedule detailed below in order to attain compliance with the final effluent limitations contained in this permit and [the Tailings Basin Permit] for total sulfate. The Permittee shall continue to work toward minimizing sulfate in the discharges to the extent practical prior to the compliance date. Compliance with the final effluent limitations shall be attained as soon as possible, and in no case shall compliance be attained later than August 17, 2018 for non-tailings basin discharges, and August 17, 2019 for tailings basin discharges, unless the permit is modified pursuant to 40 CFR 122.62." Therefore, the "Final Period" of compliance began on August 17, 2018, for the mining operations discharges, and August 17, 2019, for the tailings basin discharges.

24. The Mining Operations Permit and the Tailings Basin Permit require US Steel to complete effluent sampling and analysis each month. These data are reported in monthly Discharge Monitoring Reports prepared by US Steel and submitted to MPCA.

25. From October 25, 2022, to October 28, 2022, EPA conducted a CWA inspection of the Facility.

26. During EPA's inspection, EPA requested US Steel's Discharge Monitoring Reports for the mining operations discharges and the tailings basin discharges from January 2019 to September 2022.

27. EPA's review of the Discharge Monitoring Reports for the mining operations discharges found 135 exceedances of the Mining Operations Permit's monthly average sulfate effluent limit of 14 mg/L between January 1, 2019, and September 30, 2022. EPA's review found 118 exceedances of the Mining Operation Permit's monthly maximum sulfate limit of 24 mg/L for this same period. These exceedances are listed in Appendix 1.

28. EPA's review of the Discharge Monitoring Reports for the tailings basin discharges found 23 exceedances of the Tailings Basin Permit's monthly average sulfate effluent limit of 14 mg/L between September 1, 2019, to September 30, 2022. EPA's review found 23 exceedances of the Tailings Basin Permit's monthly maximum sulfate concentration limit of 24 mg/L for this same period. These exceedances are listed in Appendix 2.

Violations

29. Each instance in which US Steel discharged sulfate in amounts exceeding the final sulfate effluent limits contained in the Mining Operations Permit or the Tailings Basin Permit is a violation of NPDES Permit No. MN0031879 or NPDES Permit No. MN0055948, respectively. Therefore, as described in Paragraph 27 and Paragraph 28 above, US Steel has violated the terms of these permits a total of 299 times.

30. US Steel's failure to comply with the final effluent limits in the Mining Operations and Tailings Basin Permits at the Facility is a violation of Section 301(a) of the CWA, 33 U.S.C. § 1311(a).

MICHAEL HARRIS

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Date: 2024.05.15 08:24:37 -05'00'

Michael D. Harris
Division Director
Enforcement and Compliance Assurance Division

Appendix 1: Exceedances of sulfate limits at the US Steel – Keetac Mining Operations (NPDES Permit No. MN0031879); January 1, 2019, to September 30, 2022. NPDES Permit No. MN0031879 has an average sulfate concentration limit of 14 mg/L and a maximum sulfate concentration limit of 24 mg/L.

Monitoring Period End Date	Parameter	Outfall	Average Concentration (mg/L)	Maximum Concentration (mg/L)
1/31/2019	Sulfate, Total (as SO_4)	SD 002	132	137
1/31/2019	Sulfate, Total (as SO_4)	SD 003	51.7	52
1/31/2019	Sulfate, Total (as SO_4)	SD 012	24.9	25.2
2/28/2019	Sulfate, Total (as SO_4)	SD 002	128.5	132
2/28/2019	Sulfate, Total (as SO_4)	SD 003	51.4	53.5
2/28/2019	Sulfate, Total (as SO_4)	SD 012	25.1	25.3
3/31/2019	Sulfate, Total (as SO_4)	SD 002	114.2	130
3/31/2019	Sulfate, Total (as SO_4)	SD 003	52.7	55.9
3/31/2019	Sulfate, Total (as SO_4)	SD 012	25.8	26.2
4/30/2019	Sulfate, Total (as SO_4)	SD 002	123	134
4/30/2019	Sulfate, Total (as SO_4)	SD 003	63.2	70.3
4/30/2019	Sulfate, Total (as SO_4)	SD 012	25.9	26.5
5/31/2019	Sulfate, Total (as SO_4)	SD 002	133	136
5/31/2019	Sulfate, Total (as SO_4)	SD 003	71.3	77.3
5/31/2019	Sulfate, Total (as SO_4)	SD 012	23.8	24.1
6/30/2019	Sulfate, Total (as SO_4)	SD 002	135	137
6/30/2019	Sulfate, Total (as SO_4)	SD 003	59.3	59.3

6/30/2019	Sulfate, Total (as SO_4)	SD 012	24.1	24.2
7/31/2019	Sulfate, Total (as SO_4)	SD 002	132	134
7/31/2019	Sulfate, Total (as SO_4)	SD 003	55	55
7/31/2019	Sulfate, Total (as SO_4)	SD 012	22.3	Below Limit
8/31/2019	Sulfate, Total (as SO_4)	SD 002	124	125
8/31/2019	Sulfate, Total (as SO_4)	SD 003	59.3	63.5
8/31/2019	Sulfate, Total (as SO_4)	SD 012	22.5	Below Limit
9/30/2019	Sulfate, Total (as SO_4)	SD 002	114	117
9/30/2019	Sulfate, Total (as SO_4)	SD 003	62.2	64.6
9/30/2019	Sulfate, Total (as SO_4)	SD 012	20.1	Below Limit
10/31/2019	Sulfate, Total (as SO_4)	SD 002	114.5	117
10/31/2019	Sulfate, Total (as SO_4)	SD 003	68.9	73.1
10/31/2019	Sulfate, Total (as SO_4)	SD 012	19.7	Below Limit
11/30/2019	Sulfate, Total (as SO_4)	SD 002	129.5	132
11/30/2019	Sulfate, Total (as SO_4)	SD 003	62.9	67.9
11/30/2019	Sulfate, Total (as SO_4)	SD 012	20.9	Below Limit
12/31/2019	Sulfate, Total (as SO_4)	SD 002	125.5	129
12/31/2019	Sulfate, Total (as SO_4)	SD 003	51.2	53.3
12/31/2019	Sulfate, Total (as SO_4)	SD 012	20.8	Below Limit
1/31/2020	Sulfate, Total (as SO_4)	SD 002	130.5	132
1/31/2020	Sulfate, Total (as SO_4)	SD 003	56.4	58.8

1/31/2020	Sulfate, Total (as SO_4)	SD 012	24.7	25.2
2/29/2020	Sulfate, Total (as SO_4)	SD 002	135.5	136
2/29/2020	Sulfate, Total (as SO_4)	SD 003	56.1	56.3
2/29/2020	Sulfate, Total (as SO_4)	SD 012	25.4	25.5
3/31/2020	Sulfate, Total (as SO_4)	SD 002	133	140
3/31/2020	Sulfate, Total (as SO_4)	SD 003	56.8	57.6
3/31/2020	Sulfate, Total (as SO_4)	SD 012	25.4	25.8
4/30/2020	Sulfate, Total (as SO_4)	SD 002	126	135
4/30/2020	Sulfate, Total (as SO_4)	SD 003	61.4	64.9
4/30/2020	Sulfate, Total (as SO_4)	SD 012	27.8	28.1
5/31/2020	Sulfate, Total (as SO_4)	SD 002	148	150
5/31/2020	Sulfate, Total (as SO_4)	SD 003	59.2	59.6
5/31/2020	Sulfate, Total (as SO_4)	SD 012	24.6	24.7
6/30/2020	Sulfate, Total (as SO_4)	SD 002	135.5	140
6/30/2020	Sulfate, Total (as SO_4)	SD 003	62.7	69.4
6/30/2020	Sulfate, Total (as SO_4)	SD 012	24.7	25.2
7/31/2020	Sulfate, Total (as SO_4)	SD 002	141.5	146
7/31/2020	Sulfate, Total (as SO_4)	SD 003	66.7	72.7
7/31/2020	Sulfate, Total (as SO_4)	SD 012	25.2	25.2
8/31/2020	Sulfate, Total (as SO_4)	SD 002	132	136
8/31/2020	Sulfate, Total (as SO_4)	SD 003	68.8	69.7

8/31/2020	Sulfate, Total (as SO_4)	SD 012	23.9	Below Limit
9/30/2020	Sulfate, Total (as SO_4)	SD 002	144	148
9/30/2020	Sulfate, Total (as SO_4)	SD 003	61.9	62.8
9/30/2020	Sulfate, Total (as SO_4)	SD 012	21.3	Below Limit
10/31/2020	Sulfate, Total (as SO_4)	SD 002	142.5	145
10/31/2020	Sulfate, Total (as SO_4)	SD 003	63.9	66.1
10/31/2020	Sulfate, Total (as SO_4)	SD 012	21.9	Below Limit
11/30/2020	Sulfate, Total (as SO_4)	SD 002	139.5	141
11/30/2020	Sulfate, Total (as SO_4)	SD 003	62.6	63.1
11/30/2020	Sulfate, Total (as SO_4)	SD 012	21.5	Below Limit
12/31/2020	Sulfate, Total (as SO_4)	SD 002	131.5	135
12/31/2020	Sulfate, Total (as SO_4)	SD 003	59.2	59.4
12/31/2020	Sulfate, Total (as SO_4)	SD 012	22.6	Below Limit
1/31/2021	Sulfate, Total (as SO_4)	SD 002	141	145
1/31/2021	Sulfate, Total (as SO_4)	SD 003	60.8	61.6
1/31/2021	Sulfate, Total (as SO_4)	SD 012	26.2	26.5
2/28/2021	Sulfate, Total (as SO_4)	SD 002	140.5	146
2/28/2021	Sulfate, Total (as SO_4)	SD 003	60.9	61.4
2/28/2021	Sulfate, Total (as SO_4)	SD 012	26.1	26.3
3/31/2021	Sulfate, Total (as SO_4)	SD 002	135	139
3/31/2021	Sulfate, Total (as SO_4)	SD 003	62.6	64.7

3/31/2021	Sulfate, Total (as SO_4)	SD 012	26	26
4/30/2021	Sulfate, Total (as SO_4)	SD 002	134	134
4/30/2021	Sulfate, Total (as SO_4)	SD 003	69.8	74.3
4/30/2021	Sulfate, Total (as SO_4)	SD 012	24.8	25.3
5/31/2021	Sulfate, Total (as SO_4)	SD 002	146.5	147
5/31/2021	Sulfate, Total (as SO_4)	SD 003	66.1	70
5/31/2021	Sulfate, Total (as SO_4)	SD 012	21.8	Below Limit
6/30/2021	Sulfate, Total (as SO_4)	SD 002	145.5	148
6/30/2021	Sulfate, Total (as SO_4)	SD 003	66.4	70
6/30/2021	Sulfate, Total (as SO_4)	SD 012	22.5	Below Limit
7/31/2021	Sulfate, Total (as SO_4)	SD 002	151	157
7/31/2021	Sulfate, Total (as SO_4)	SD 003	68.2	70.7
7/31/2021	Sulfate, Total (as SO_4)	SD 012	24.1	24.5
8/31/2021	Sulfate, Total (as SO_4)	SD 002	143.5	144
8/31/2021	Sulfate, Total (as SO_4)	SD 003	65.3	67
8/31/2021	Sulfate, Total (as SO_4)	SD 012	23.9	24.2
9/30/2021	Sulfate, Total (as SO_4)	SD 002	135	142
9/30/2021	Sulfate, Total (as SO_4)	SD 003	74.2	84.3
9/30/2021	Sulfate, Total (as SO_4)	SD 012	22	Below Limit
10/31/2021	Sulfate, Total (as SO_4)	SD 002	135	140
10/31/2021	Sulfate, Total (as SO_4)	SD 003	69.5	72.3

10/31/2021	Sulfate, Total (as SO_4)	SD 012	23.1	Below Limit
11/30/2021	Sulfate, Total (as SO_4)	SD 002	143	148
11/30/2021	Sulfate, Total (as SO_4)	SD 003	69.4	73.3
11/30/2021	Sulfate, Total (as SO_4)	SD 012	22.5	Below Limit
12/31/2021	Sulfate, Total (as SO_4)	SD 002	146	146
12/31/2021	Sulfate, Total (as SO_4)	SD 003	65.5	68.8
12/31/2021	Sulfate, Total (as SO_4)	SD 012	22.8	Below Limit
1/31/2022	Sulfate, Total (as SO_4)	SD 002	144.5	146
1/31/2022	Sulfate, Total (as SO_4)	SD 003	65.3	66
1/31/2022	Sulfate, Total (as SO_4)	SD 012	24.5	24.8
2/28/2022	Sulfate, Total (as SO_4)	SD 002	145.5	146
2/28/2022	Sulfate, Total (as SO_4)	SD 003	63.8	64
2/28/2022	Sulfate, Total (as SO_4)	SD 012	24.7	24.8
3/31/2022	Sulfate, Total (as SO_4)	SD 002	141	145
3/31/2022	Sulfate, Total (as SO_4)	SD 003	66.6	68
3/31/2022	Sulfate, Total (as SO_4)	SD 012	25.7	26.1
4/30/2022	Sulfate, Total (as SO_4)	SD 002	151.5	158
4/30/2022	Sulfate, Total (as SO_4)	SD 003	73.7	76.5
4/30/2022	Sulfate, Total (as SO_4)	SD 012	26.1	26.5
5/31/2022	Sulfate, Total (as SO_4)	SD 002	154.5	167
5/31/2022	Sulfate, Total (as SO_4)	SD 003	61.3	72.6

5/31/2022	Sulfate, Total (as SO_4)	SD 012	27.5	27.9
6/30/2022	Sulfate, Total (as SO_4)	SD 002	154	155
6/30/2022	Sulfate, Total (as SO_4)	SD 003	71.8	72.2
6/30/2022	Sulfate, Total (as SO_4)	SD 012	26.7	26.7
7/31/2022	Sulfate, Total (as SO_4)	SD 002	151	151
7/31/2022	Sulfate, Total (as SO_4)	SD 003	71.7	72.2
7/31/2022	Sulfate, Total (as SO_4)	SD 012	26	26
8/31/2022	Sulfate, Total (as SO_4)	SD 002	152.5	153
8/31/2022	Sulfate, Total (as SO_4)	SD 003	73.6	76
8/31/2022	Sulfate, Total (as SO_4)	SD 012	26.5	26.5
9/30/2022	Sulfate, Total (as SO_4)	SD 002	148.5	149
9/30/2022	Sulfate, Total (as SO_4)	SD 003	66.2	66.5
9/30/2022	Sulfate, Total (as SO_4)	SD 012	23.7	25.2

Appendix 2: Exceedances of sulfate limits at the US Steel – Keetac Tailings Basin (NPDES Permit No. MN0055948); September 1, 2019, to September 30, 2022. NPDES Permit No. MN0055948 has an average sulfate concentration limit of 14 mg/L and a maximum sulfate concentration limit of 24 mg/L.

Monitoring Period End Date	Parameter	Outfall	Average Concentration (mg/L)	Maximum Concentration (mg/L)
9/30/2019	Sulfate, Total (as SO_4)	SD 005	95.5	95.6
10/31/2019	Sulfate, Total (as SO_4)	SD 005	92.3	97.5
11/30/2019	Sulfate, Total (as SO_4)	SD 005	103.5	104
12/31/2019	Sulfate, Total (as SO_4)	SD 005	102	105
1/31/2020	Sulfate, Total (as SO_4)	SD 005	115	115
2/29/2020	Sulfate, Total (as SO_4)	SD 005	123	130
3/31/2020	Sulfate, Total (as SO_4)	SD 005	124.5	125
4/30/2020	Sulfate, Total (as SO_4)	SD 005	102	107
5/31/2020	Sulfate, Total (as SO_4)	SD 005	110	110
8/31/2020	Sulfate, Total (as SO_4)	SD 005	103.5	106
9/30/2020	Sulfate, Total (as SO_4)	SD 005	96	96.8
10/31/2020	Sulfate, Total (as SO_4)	SD 005	95.6	95.7
11/30/2020	Sulfate, Total (as SO_4)	SD 005	96.6	97.9
12/31/2020	Sulfate, Total (as SO_4)	SD 005	102.5	104
3/31/2021	Sulfate, Total (as SO_4)	SD 005	112	120
4/30/2021	Sulfate, Total (as SO_4)	SD 005	106.5	107
5/31/2021	Sulfate, Total (as SO_4)	SD 005	109.5	112

12/31/2021	Sulfate, Total (as SO_4)	SD 005	131	131
4/30/2022	Sulfate, Total (as SO_4)	SD 005	105.2	123
5/31/2022	Sulfate, Total (as SO_4)	SD 005	94.9	102
6/30/2022	Sulfate, Total (as SO_4)	SD 005	95.4	95.6
7/31/2022	Sulfate, Total (as SO_4)	SD 005	95.1	95.5
9/30/2022	Sulfate, Total (as SO_4)	SD 005	93.6	93.6

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 6

EPA, Letter to C. Bartovich, U.S. Steel Environmental Director, re Notice of Clean Water Act Violations, May 14, 2024.

REGION 5
CHICAGO, IL 60604

May 14, 2024

Chrissy Bartovich
Environmental Director
Minnesota Ore Operations
United States Steel Corporation
P.O. Box 417
Mt. Iron, Minnesota 55768

Subject: Notice of Clean Water Act Violations, United States Steel Corporation - Keetac Mining Operations and Keetac Tailings Basin

Dear Chrissy Bartovich:

The U.S. Environmental Protection Agency, Region 5 (EPA) has identified violations of the Clean Water Act (CWA) by United States Steel Corporation (US Steel) at the Keetac Mining Operations and Tailings Basin located in Keewatin, Minnesota (Facility). Specifically, EPA has found that US Steel has violated federally enforceable sulfate effluent limits required by the Facility's National Permit Discharge Elimination System (NPDES) permits.

Under Section 309 of the CWA, the EPA has several enforcement options to resolve the alleged violations including issuing an administrative compliance order, issuing an administrative penalty order and bringing a judicial action. The EPA would like to reach an agreement under which US Steel will bring the Facility into compliance with the CWA.

If US Steel would like to confer with the EPA about this letter and the attached Notice of Violation (NOV), you should make the request within 10 calendar days following receipt of this letter. We should hold any conference within 30 calendar days following receipt of this letter. In addition, to make the conference more productive, we encourage you to submit responsive information prior to the conference date. Please plan for your Facility's technical and management personnel to attend the conference to discuss compliance measures and commitments. US Steel may have an attorney at this conference.

The statements in this letter and the NOV are for notification and are not final EPA positions.

If you submit additional information to the EPA in response to this letter, you may assert a claim of business confidentiality under 40 C.F.R. Part 2, Subpart B. Information subject to a

business confidentiality claim is available at 40 C.F.R. Part 2, Subpart B. If you do not assert a business confidentiality claim when you submit the information, the EPA may make this information available to the public without further notice.

If you would like to schedule a meeting to discuss the NOV or if you have any questions, the EPA contact on this matter is Jake Berger who can be reached at (312) 353-8024 or berger.jake@epa.gov, or your legal counsel may contact Jolie McLaughlin at (312) 886-4179 or mclaughlin.jolie@epa.gov.

Sincerely,

MICHAEL HARRIS

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Date: 2024.05.15 08:21:32 -05'00'

Michael D. Harris
Division Director
Enforcement and Compliance Assurance Division

Enclosure: Clean Water Act Notice of Violation

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 7

EPA, Letter to MPCA Commissioner Kessler re Minnesota laws revising MPCA's authority to regulate sulfate in NPDES permits, Feb. 16, 2022.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGIONAL ADMINISTRATOR
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

Katrina Kessler, Commissioner
Minnesota Pollution Control Agency
520 Lafayette Road North
Saint Paul, Minnesota 55155-4194

Re: Minnesota's laws revising the Minnesota Pollution Control Agency's (MPCA) authority to regulate sulfate in NPDES permits

Dear Ms. Kessler:

I am writing regarding the U.S. Environmental Protection Agency's (EPA) review of two Minnesota session laws which, among other effects, impact MPCA's authority to include sulfate controls in National Pollutant Discharge Elimination System (NPDES) permits for discharges into wild rice production waters. Based on our review, we have determined that the session laws constitute a non-substantial change to Minnesota's NPDES program and are inconsistent with the Clean Water Act (CWA). EPA therefore disapproves the program revision affected by these laws as an improper modification to MPCA's authority to implement the NPDES program.

EPA has authority to review statutory or regulatory modifications of a state NPDES program under 40 C.F.R. § 123.62(a), which provides that EPA may initiate a program revision when necessary, including when the controlling state statutory or regulatory authority is modified or supplemented. Our review focused on two Minnesota laws[1]: the "2015 Sulfate Law," Minn. Laws 2015, 1st Spec. Sess., Chapter 4, Article 4, Section 136 at (a)(1)(i)[2] [hereafter 2015 Sulfate Law]; and the "2016 Sulfate Effluent Compliance Law," Minn. Laws 2016, Chapter 165, Section 1 at (a) [hereafter 2016 Sulfate Law]. The details of our review are found in Enclosure A. EPA appreciates Minnesota's assistance with our review, including the Minnesota Attorney General's August 12, 2016 statement (*see* Enclosure B) and a February 11, 2021 meeting between EPA and MPCA.

As described in Enclosure A, our review found that the 2015 Sulfate Law and 2016 Sulfate Law: 1) limited MPCA's ability to include sulfate water quality-based effluent limits in NPDES permits that are required to comply with Minnesota's federally-approved sulfate water quality standard (WQS); and 2) invalidated sulfate effluent limits in any existing state permits,

[1] EPA did not review a third similar 2011 Minnesota law, Minn. Laws 2011, 1st Spec. Sess., Chapter 2, Article 4, Section 32 at (e), because that law's curtailment of sulfate controls in permits was limited to the "extent allowable under the Clean Water Act," and thus does not appear to have modified Minnesota's approved NPDES program.
[2] EPA's review and its findings in this letter are limited to the 2015 law's prohibition on permittee expenditures related to sulfate and do not extend to the remainder of the law which was not related to the Minnesota's approved CWA 402 program. We note that the 2015 Sulfate Law was amended by 2017 Minn. Laws Chapter 93, Article 2, Section 149 at (c) but not the clause reviewed by EPA.

respectively. Because the session laws both limit MPCA's authority to implement its approved NPDES program and improperly modify a facility's existing permit in contravention of the CWA, they constitute an improper modification to MPCA's authority to implement the NPDES program. 40 C.F.R. § 123.62(b)(3). As a result, the effluent limits and permit compliance schedules invalidated by the 2016 Sulfate Law remain subject to any federal enforcement and citizen action as provided for under the CWA. *See* 33 U.S.C. § 1319; 33 U.S.C. § 1365(a)(1).

Accordingly, EPA expects that MPCA's NPDES permits will include effluent limitations to meet all federally-approved WQS as required by the CWA, federal regulations, and EPA-approved Minnesota laws and rules. To this end, EPA urges MPCA to work with State lawmakers in resolving this matter.

Please contact me if you wish to discuss this matter, or your Assistant Commissioner for Water Policy and Agriculture can contact Tera Fong, Water Division Director, at fong.tera@epa.gov or (312) 886-6735.

Sincerely,

DEBRA SHORE

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Date: 2022.02.16 15:44:28 -06'00'

Debra Shore
Regional Administrator & Great Lakes National Program Manager

Enclosures

Enclosure A: A Review of Two Minnesota Sulfate Session Laws

The Clean Water Act (CWA) and federal regulations require states with approved National Pollutant Discharge Elimination System (NPDES) programs to maintain the authority needed to administer their programs in accordance with the CWA at all times. *See* 33 U.S.C. § 1342(c)(2); 40 C.F.R. § 123.63(a). Two Minnesota sulfate session laws -- Minn. Laws 2015, 1st Spec. Sess., Chapter 4, Article 4, Section 136 at (a)(1)(i) [hereafter 2015 Sulfate Law] and Minn. Laws 2016, Chapter 165, Section 1 at (a) [hereafter 2016 Sulfate Law] -- curtail the implementation of Minnesota's sulfate water quality standard (WQS) for wild rice producing waters in state issued NPDES permits. Because these two laws are not consistent with the CWA and its implementing regulations, they constitute an improper modification of Minnesota's approved NPDES program.

The CWA requires states to adopt WQSs subject to approval by the U.S. Environmental Protection Agency (EPA), which remain in effect unless and until EPA approves their modification. 33 U.S.C. § 1313(a) and (c); 40 C.F.R. § 131.2l(a) and (e). Consistent with these authorities, Minnesota promulgated a sulfate WQS of 10 milligrams per liter (mg/L) applicable to waters utilized for the production of wild rice. *See* Minn. R. 7050.0224, subp. 2. Subsequently, EPA approved Minnesota's sulfate WQS. *See* 42 *Fed. Reg*. 56786, 56789 (Sept. 9, 1977). The CWA requires that NPDES permits include any requirements necessary to achieve the state's approved WQS. 33 U.S.C. § 1311(b)(1)(C); 40 C.F.R. § 122.44(d)(1) and (5), made applicable to state programs at 40 C.F.R. § 123.25(a)(15).

Minnesota's 2015 Sulfate Law and 2016 Sulfate Law revise the Minnesota Pollution Control Agency's (MPCA) authority to issue NPDES permits that are protective of Minnesota's federally approved sulfate WQS in at least two significant ways.

First, the 2015 Sulfate Law prevents MPCA from issuing permits that are protective of Minnesota's applicable federally approved sulfate WQS. This law provides in pertinent part, that "the agency shall not require [NPDES] permittees to expend money for design or implementation of sulfate treatment technologies or other forms of sulfate mitigation." Minn. Laws 2015, 1st Spec. Sess., Chapter 4, Article 4, Section 136 at (a)(1)(i). This law prevents MPCA from including effluent limits in NPDES permits that are needed to achieve Minnesota's federally approved sulfate WQS as required by 40 C.F.R. § 122.44(d)(1), on the basis that MPCA "has determined that the Wild Rice Standard is in need of substantial revision and therefore imprudent to apply."[1] Minnesota, however, has not revised the sulfate WQS and the sulfate WQS remains effective for CWA permitting purposes. Therefore, Minnesota's 2015 Sulfate Law is effectively a legislative limit upon MPCA's authority to issue NPDES permits that include effluent limits necessary to meet WQSs, 33 U.S.C. § 1311(b)(1)(C).

[1] *See* Letter from Lori Swanson, Minnesota Attorney General, to Tinka Hyde, Director, Water Division Region 5, August 12, 2016 [found at Enclosure B], at 4: "MPCA believes that it would be unreasonable for it to enforce the sulfate standard in existing permits because requiring compliance with the Standard would result in the expenditure of resources that may ultimately prove unnecessary. MPCA has advised EPA that it is 'pursuing options to reissue delayed mining NPDES permits quickly once there is a revised Wild Rice Standard [citation omitted] ..... The above-described legislative restriction is strictly limited to the Wild Rice Standard, does not affect other water quality standards or MPCA's authority to enforce those standards, and is only in place until no later than January 15, 2018. In any event, as discussed above, MPCA has determined that the Wild Rice Standard is in need of substantial revision and therefore imprudent to apply."

Second, the 2016 Sulfate Law invalidates sulfate effluent limits in existing NPDES permits. In particular, the 2016 Sulfate Law provides that for NPDES permits meeting certain requirements:

> (1) the final sulfate limits resulting from implementation of the wild rice water quality standard in Minnesota Rules, part 7050.0224, subpart 2, are no longer valid; and
>
> (2) any compliance schedule permit conditions related to those final limits are no longer valid.

Minn. Laws 2016, Chapter 165, Section 1 at (a). According to the Minnesota Attorney General, the 2016 Sulfate Effluent Compliance Law aimed to remove effluent limits and a related schedule of compliance from the U.S. Steel Keetac facility.[1] Thus the 2016 Sulfate Law invalidated both the sulfate water quality-based effluent limits and compliance schedule related to those limits in contravention of the CWA and federal regulations. These include those federal requirements that NPDES permits include effluent limits necessary to achieve federally approved WQSs and incorporate schedules of compliance requirements where authorized under federal and state law. *See* 40 C.F.R. §§ 122.44(d)(1) and (5).[2] The 2016 law also circumvents federal regulations for modifying or revoking and reissuing permits (40 C.F.R. § 124.5(c)); public notice and comment procedures for permits (40 C.F.R. § 124.10); EPA's permit review (40 C.F.R. § 123.44); and the *Memorandum of Agreement between EPA and MPCA for the Approval of the State NPDES Permit Program*.[3]

Therefore, the 2016 Sulfate Law is a legislative limit upon MPCA's authority to issue NPDES permits that include effluent limits necessary to meet WQSs, 33 U.S.C. § 1311(b)(1)(C), and to implement permitting procedures consistent with the CWA, 33 U.S.C. § 1342(b)(3) and (4). Accordingly, the NPDES permit effluent limits and compliance schedules, invalidated by that law, remain subject to any federal enforcement and citizen action as provided for under the CWA. *See* 33 U.S.C. § 1319; 33 U.S.C. § 1365(a)(1).

---

[1] Letter from Lori Swanson, Attorney General, State of Minnesota, to Tinka Hyde, Division Director, U.S. EPA (August 12, 2016).

[2] 40 C.F.R. 124.5(c) (*Applicable to State programs, see 40 CFR 123.25 (NPDES), 145.11 (UIC), 233.26 (404), and 271.14 (RCRA)*).
(1) If the Director tentatively decides to modify or revoke and reissue a permit under 40 CFR 122.62 (NPDES), 144.39 (UIC), 233.14 (404), or 270.41 (other than § 270.41(b)(3)) or § 270.42(c) (RCRA), he or she shall prepare a draft permit under § 124.6 incorporating the proposed changes. The Director may request additional information and, in the case of a modified permit, may require the submission of an updated application. In the case of revoked and reissued permits, other than under 40 CFR 270.41(b)(3), the Director shall require the submission of a new application. In the case of revoked and reissued permits under 40 CFR 270.41(b)(3), the Director and the permittee shall comply with the appropriate requirements in 40 CFR part 124, subpart G for RCRA standardized permits.
(2) In a permit modification under this section, only those conditions to be modified shall be reopened when a new draft permit is prepared. All other aspects of the existing permit shall remain in effect for the duration of the unmodified permit. When a permit is revoked and reissued under this section, the entire permit is reopened just as if the permit had expired and was being reissued. During any revocation and reissuance proceeding the permittee shall comply with all conditions of the existing permit until a new final permit is reissued.

[3] *See Memorandum of Agreement Between the United States Environmental Protection Agency and the Minnesota Pollution Control Agency for the Approval of the State NPDES Permit Program* (May 7, 1974), Section II, Agreement, Sections 124.44(d) (Schedule of Compliance in Issued NPDES Permits); and 124.72 (Modification, Suspension and Revocation of NPDES Permits).

Enclosure B: Minnesota Attorney General August 12, 2016 Letter

OFFICE OF THE ATTORNEY GENERAL
State of Minnesota
ST. PAUL, MN 55155

LORI SWANSON
ATTORNEY GENERAL

August 12, 2016

Tinka Hyde
Director, Water Division
United States Environmental Protection Agency
Regional Administrator
77 West Jackson Boulevard
Chicago, IL 60604-3590

VIA U.S. MAIL AND E-MAIL

Re: MPCA's Legal Authority to Implement its Authorized NPDES Program

Dear Director Hyde:

On April 5, 2016, you requested the Minnesota Pollution Control Agency ("MPCA") "provide an updated Attorney General's statement to explain whether the current scope of MPCA's authority remains adequate to issue permits in compliance with all applicable [Clean Water Act] requirements, including whether MPCA continues to have adequate authority to implement all of its federally approved water quality standards consistent with [Clean Water Act] Section 301(b)(1)(C)." You stated that legislation enacted in 2015 by the Minnesota Legislature "appears to modify and/or revise the authority of the State to administer its [National Pollutant Discharge Elimination System] program and implement its federally approved water quality standards." On June 28, 2016, you sent MPCA a second request to "provide an additional updated Attorney General's statement to explain whether the current scope of MPCA's authority remains adequate to enforce all conditions in those [National Pollutant Discharge Elimination System] permits to which the law is expected to apply." You reference legislation enacted by the Minnesota Legislature in 2016 and state it "appears to invalidate water quality based effluent limits and compliance schedules for sulfate that were included in certain [National Pollutant Discharge Elimination System] permits issued by the MPCA." You requested the Attorney General statements be provided by August 12, 2016.

I provide the following in response to both requests.

As you are aware, the Clean Water Act ("CWA") requires States to adopt water quality standards. *See* 33 U.S.C. § 1313(a). Pursuant to the CWA, Minnesota adopted such water quality standards in 1973, which are codified as Minn. R. ch. 7050. The U.S. Environmental

Protection Agency ("EPA") approved these standards in 1977, including the sulfate standard applicable to "waters used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels," which is codified as Minn. R. 7050.0224, subp. 2 ("Wild Rice Standard" or "Standard"). *See* 42 *Federal Register* 56786-03. Minnesota is the only State that has adopted a water quality standard for sulfate relating to waters containing wild rice. MPCA has expansive authority to issue and enforce National Pollutant Discharge Elimination System ("NPDES") permits. *See* Minn. Stat. chs. 115 and 116; Minn. R. chs. 7050, 7052 and 7053.

Under the CWA, "water quality standards should, wherever attainable, provide water quality for the protection and propagation of fish, shellfish and wildlife and for recreation in and on the water and take into consideration their use and value of public water supplies, propagation of fish, shellfish and wildlife, recreation in and on the water, and agriculture, industrial and other purposes including navigation." *See* 40 C.F.R. § 131.2. The CWA further directs that the "State shall from time to time, but at least once every three years, hold public hearings for the purpose of reviewing applicable water quality standards and, as appropriate, modifying and adopting standards." *See* 40 C.F.R. § 131.20. Once approved by the EPA, a State standard will continue in effect unless EPA approves a change. *See* 40 C.F.R. § 131.21(e). Neither the CWA nor its regulations, however, address what a State should do if it determines that an existing standard is in need of material revision and significant expenditures would unnecessarily be required of permittees to comply with the existing deficient standard.

The history of the Wild Rice Standard is described in *Minnesota Chamber of Commerce v. Minnesota Pollution Control Agency*, No. A12-0950, 2012 WL 6554544 (Minn. Ct. App. Dec. 17, 2012) ("MCC"). MPCA applied the Wild Rice Standard for the first time in 1975 to set a wastewater discharge sulfate limit for the Minnesota Power Clay Boswell steam power plant facility. *Id* at 2. In 2009 and 2010, MPCA began taking steps to apply the Standard in the mining areas of northern Minnesota. *MCC* at 2. MPCA began a process to determine *where* the Wild Rice Standard should be enforced by asking certain mining companies to conduct surveys to detect the presence of wild rice in waters to which their facilities discharge wastewater to determine whether they are subject to the Wild Rice Standard for future permitting actions. *Id.* For the first time since 1975, in 2010 MPCA relied upon the Wild Rice Standard to set a discharge limitation in a permit for U.S. Steel. *Id.* MPCA's interpretation of the Wild Rice Standard as applicable to protect natural (uncultivated) wild rice was challenged in the *MCC* case. *Id.* At around the same time, related concerns were raised by MPCA and others regarding the accuracy of the science behind the Standard and how to define "waters used for production of wild rice." *See https://www.pca.state.mn.us/sites/default/files/wq-s6-40b.pd.*

In response to these concerns, the Minnesota Legislature enacted legislation appropriating money and requiring MPCA to "adopt and implement a wild rice research plan using the money appropriated to contract with appropriate scientific experts." Minn. Laws 2011, 1st Spec. Sess., Chapter 2, Article 4, Section 32 at (d) ("2011 Wild Rice Legislation"). This

legislation temporarily restricted MPCA from requiring permittees "to expend funds for design and implementation of sulfate treatment technologies," but provided for an exception if necessary to comply with "federal law." *Id.* The 2011 Wild Rice Legislation further provided that "nothing shall prevent the [MPCA] from including in a schedule of compliance a requirement to monitor sulfate concentrations in discharges and, if appropriate, based on site-specific conditions, a requirement to implement a sulfate minimization plan to avoid or minimize sulfate concentrations during periods when wild rice may be susceptible to damage." *Id.* Based in part on the 2011 legislation, the *MCC* decision concluded that the issues raised in the case were moot. *MCC* at 9.

After receiving the funding from the 2011 Wild Rice Legislation, the MPCA contracted with the University of Minnesota to research how sulfate affects wild rice. *See https://www.pca.state.mn.us/water/wild-rice-sulfate-standard-study.* The research was based on a scientific protocol developed in 2010-2011 by the MPCA in consultation with your agency, Minnesota Tribes, and the Minnesota Department of Natural Resources as well as input from interested and affected stakeholders. *Id.*

In 2014, MPCA published the initial results of its research, which demonstrated that sulfate is not directly toxic to wild rice, but it can be converted into sulfide, which is toxic. The research supported material revisions to the Standard. *See* "Wild Rice Sulfate Standard Study Preliminary Analysis" at *https://www.pca.state.mn.us/sites/default/files/wq-s6-42w.pdf; See also* "Wild rice study reveals more questions for state officials," at *https://www.mprnews.org/story/2014/03/12/wild-rice-study.* The study found that the presence of iron in the water may mitigate the conversion of sulfate to sulfide. The research also found instances where higher levels of sulfate in waters did not result in high levels of the toxic sulfide. *See https://www.pca.state.mn.us/sites/default/file/wqetc.* The Study determined that site-specific standards may be needed for some waters particularly where sulfate is more efficiently converted to sulfide and/or sediment iron levels are not sufficient to mitigate sulfide concentrations. *Id.*

In December 2014, MPCA sought feedback on a preliminary proposed permit that required U.S. Steel to comply with the existing Standard at its "Minntac" facility. *See https://timberjay.com/stories/us-steel-fighting-stricter-pollution-rules,11955.*

In the 2015 legislative session, Minn. Laws 2015, 1st Spec. Sess., Chapter 4, Article 4, Section 136 ("2015 Wild Rice Legislation") was enacted. The 2015 Wild Rice Legislation prohibits MPCA from taking any actions to implement the standard that would require a permittee "to expend money for design or implementation of sulfate treatment technologies or other forms of sulfate mitigation." *Id.* at (a)(1). The legislation did not provide an exception for enforcement necessary to comply with federal law as the 2011 legislation did, but the 2011 Wild Rice Legislation was not repealed. *Id.* The 2015 legislation requires MPCA to complete rulemaking to promulgate a new Wild Rice standard by January 15, 2018. *Id.* at (c). In 2016, the Legislature enacted a statute that essentially applied the substance of the 2015 legislation to

the U.S. Steel Keetac facility, which was subject to a "schedule of compliance" requiring it to take actions necessary to comply with the Standard. Minn. Laws 2016, Ch. 165, sec. 1. The legislation does not apply or restrict the issuance, reissuance or enforcement of any future permits. MPCA has advised this Office that the Keetac facility is idled.

Minnesota Governor Mark Dayton signed the 2011, 2015 and 2016 legislation relating to the revision of the Wild Rice Standard. He publically stated that the Standard is "antiquated" and "not even based on current science directly related to the conditions we're trying to deal with." *See http://www.mprnews.org/story/2015/03/25/mpca-wild-rice.* MPCA similarly has stated that "using the same limit for every river or lake where wild rice grows doesn't make sense, because many factors influence whether wild rice will thrive." *See http://www.mprnews.org/story/2015/03/25/mpca-wild-rice.* MPCA has also stated that "[n]o single sulfate value would be protective of wild rice at all sites." Based on its research, MPCA is developing an equation to calculate appropriate values on a site-by-site basis, reflecting its expert conclusion that higher levels of iron can lead to less sulfide, and higher levels of organic carbon can lead to more sulfide. *See https://www.pca.state.mn.us/sites/default/files/wq-s6-43k.pdf.* In March of 2015, MPCA "announced that it wants to eliminate the current standard of 10 milligrams of sulfate per liter of water in wild rice waters, and begin to apply different standards to different waters based on their chemical makeup." *See https://www.minnpost.com/environment/2015/05/despite-pressure-lower-minntac-sulfate-emissions-status-quo-could-last-awhile.*

MPCA believes that it has made significant progress towards completion of the scientific studies regarding a new Wild Rice Standard and states it will commence the formal rulemaking process soon. *See https://www.pca.state.mn.us/sites/default/files/wq-rule4-15a.pdf.* The CWA provides States with the authority to revise water quality standards. 40 C.F.R. § 131.20. MPCA, on behalf of the State of Minnesota, is exercising this authority regarding the Wild Rice Standard, based on its scientific evidence indicating that the existing standard requires substantial revision. MPCA believes it would be unreasonable for it to enforce the sulfate standard in existing permits because requiring compliance with the Standard would result in the expenditure of resources that may ultimately prove unnecessary. MPCA has advised EPA that it is "pursuing options to reissue delayed mining NPDES permits quickly once there is a revised Wild Rice Standard." *See* July 13, 2016 letter from MPCA to EPA. MPCA has apprised this Office that it is "evaluating each site to determine what data could be gathered during this interim period to ensure [it] ha[s] all data necessary to move expeditiously on reissuances once there is a revised wild rice standard."

The above-described legislative restriction is strictly limited to the Wild Rice Standard, does not affect other water quality standards or MPCA's authority to enforce those standards, and is only in place until no later than January 15, 2018. In any event, as discussed above, MPCA has determined that the Wild Rice Standard is in need of substantial revision and therefore imprudent to apply.

MPCA also believes that it has adequate authority to revise the applicable Standard, and once the Standard is revised (subject to EPA approval), it will have full and unrestricted authority to enforce the Standard. Accordingly, under these unique circumstances, and in accordance with MPCA's expert opinion regarding the deficiencies of the current Standard, I agree with MPCA that it has adequate authority to implement federal law by revising the current Standard that MPCA believes is deficient and then enforcing it as modified.

This analysis is supported by court decisions holding that the CWA is to be given a reasonable interpretation which is not parsed and dissected with the meticulous technicality applied in testing other statutes and instruments. *See Envtl. Def. Fund, Inc. v. Costle*, 657 F.2d 275, 292 (D.C. Cir. 1981). The EPA has the ability to be flexible with regard to revision of State water quality standards, and has exercised this discretion in other cases.

Indeed, if a State fails to fix a deficient water quality standard, 40 C.F.R. § 131.22 requires EPA to replace it with a federal standard in 90 days, but EPA's decision to delay replacement was upheld when EPA reasonably provided Montana more time to modify a deficient standard. *See American Wildlands v. Browner*, 94 F. Supp. 2d 1550, 1165 (D. Colorado 2000) (Montana's stated intention given weight in decision upholding EPA's decision to allow Montana extra time to submit an amended water quality standard). Minnesota's legislation does not allow substantially more time for MPCA to revise the Wild Rice Standard than was allowed for Montana to complete its revision. *Id.* The D.C. Circuit has also recognized that sometimes "it is logical that EPA should refrain from acting until the states have completed an initial effort to update the standards as they deem appropriate." *See Envtl. Def. Fund, Inc. v. Costle*, 657 F.2d 275, 294 (D.C. Cir. 1981) ("EPA's task of determining the need for revised or new salinity standards to meet the Act's requirements would be greatly simplified by its temporary deference.")

Based on the above facts and circumstances of this matter and legal analysis, including the representations of MPCA and the deference owed to its expertise regarding the subject Standard, it is my opinion that the laws of the State of Minnesota provide adequate authority for MPCA to carry out the program elements in 33 U.S.C. § 1342 pertaining to water quality standards.

Sincerely,



LORI SWANSON
Attorney General

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 8

MPCA, Denial of U.S. Steel Application for a Sulfate Site-Specific Standard for Hay Lake, February 14, 2024.

MINNESOTA POLLUTION CONTROL AGENCY

520 Lafayette Road North | St. Paul, Minnesota 55155-4194 | 651-296-6300

800-657-3864 | Use your preferred relay service | info.pca@state.mn.us | Equal Opportunity Employer

February 14, 2024

VIA EMAIL

Chrissy Bartovich
U.S. Steel Corporation
Minnesota Ore Operations
PO Box 417
Mountain Iron, MN 55768

RE: Application for a Sulfate Site-Specific Standard for Hay Lake (AUID 31-0037-00), located downstream of the U.S. Steel – Keetac (Keetac)

Dear Chrissy Bartovich:

The Minnesota Pollution Control Agency (MPCA) received United States Steel Corporation's (U.S. Steel) application for a sulfate site-specific standard (SSS) for Hay Lake, dated August 17, 2022. This request seeks to modify the applicable Class 4A sulfate water quality standard for the protection of wild rice in Hay Lake from the statewide 10 milligrams per liter (mg/L) standard to a site-specific standard of 79 mg/L.

The MPCA reviewed the application for conformity with applicable regulations, scientific defensibility, and appropriateness for the site-specific context of Hay Lake. The application fulfills the required site-specific standard submission process but does not contain sufficient information to justify a modification to the existing wild rice standard. Therefore, the MPCA denies the sulfate site-specific standard request and has determined that the application is not suitable for approval and submission to U.S. Environmental Protection Agency (EPA) for final review.

Consistent with federal regulations (40 C.F.R. § 131.11) and state rules (Minn. R. 7050.0220, subp. 7), the application is insufficient because it does not demonstrate that the wild rice beneficial use will be protected at the proposed sulfate standard, the method used to derive the sulfate standard is not scientifically defensible, and the proposed sulfate standard is not demonstrated to be more appropriate than the currently applicable statewide standard.

During a conference call with U.S. Steel on November 27, 2023, MPCA shared its decision and feedback regarding the company's SSS application for Hay Lake. The following written comments provide more information about the MPCA's review of the Hay Lake SSS application and the basis for the Agency decision to deny the SSS request. The issues outlined below address broad themes and do not represent a comprehensive listing of MPCA's concerns on all aspects of the application. If U.S. Steel chooses to continue to pursue a SSS for Hay Lake, working to resolve these issues will be foundational in developing a sound application.

Issue 1: Insufficient data are presented to demonstrate the beneficial use is protected (40 C.F.R. § 131.11(a)(1)).

Applications for a SSS must demonstrate that the proposed numeric standard will protect the beneficial use. For a SSS request from the Class 4A sulfate water quality standard for waters used for production of wild rice (Minn. R. 7050.0224, subp. 2.), the applicant must articulate how the proposed standard will protect the wild rice beneficial use. This requires a demonstration that the waterbody will maintain a wild rice population that is productive, meaning the proposed sulfate standard allows for the continued generation of wild rice biomass into the future.

An approach recognized by the MPCA to make this demonstration is to apply the current ambient sulfate concentration as the proposed standard, if and only if the wild rice population is shown to be "productive" over the long-term and is not trending towards local extirpation. This method would need to include long-term data collection on wild rice population metrics, such as abundance and density, that yield valuable insight into productivity trends and potential boom-bust cycles in the waterbody of interest. The presence of any amount of wild rice in sporadic years does not, in and of itself, constitute sufficient evidence of a long-term, self-sustaining wild rice population.

U.S. Steel's SSS application does not include sufficient information to demonstrate that the wild rice beneficial use is met, or will be met, in Hay Lake at the proposed numeric sulfate value. The wild rice population monitoring data from field surveys spanning 2009-2012, 2014, and 2021, are discontinuous and do not show a clear and consistent picture of wild rice health in Hay Lake (see section 3.2 of the application). The data from 2009-2012 and 2014 show varying degrees of spatial extent, density, and water levels, as expected given known annual variability in wild rice's population growth. However, the most recent year of data, 2021, documents no wild rice after July. U.S. Steel acknowledges that hydrologic changes from documented upstream beaver activity is a contributing factor to the observed variable wild rice abundance, especially the years with low or absent wild rice. The limited extent of provided data and analysis are not sufficient to enable MPCA to identify a possible population trend or to ascertain whether such variations, especially the years of sparse or absent wild rice, are primarily due to natural cyclicity or anthropogenic causes.

U.S. Steel asserts that the presence of wild rice over a decade ago is evidence enough that the wild rice population is productive and that the beneficial use is met. However, providing historical documentation of wild rice presence and articulating a general expectation that it will be present into the future does not, by itself, establish that the beneficial use is protected. Further reflection on the condition and robustness (level of production and resilience of the population) of wild rice in Hay Lake is necessary to demonstrate that the beneficial use is protected.

Given the wild rice data provided in the application, MPCA is unable to determine with certainty that the wild rice beneficial use is currently being met. Further, because the application does not demonstrate that the wild rice beneficial use is currently met in Hay Lake, it is not possible to demonstrate that U.S. Steel's proposed sulfate standard will protect the beneficial use in the future.

Issue 2: Proposed sulfate standard derivation method must be scientifically defensible (40 C.F.R. § 131.11(b)(1)(iii)).

In the Hay Lake SSS application, U.S. Steel derives a sulfate standard of 79 mg/L that relies exclusively on the sediment-based equation from MPCA's 2018 rulemaking effort to revise the sulfate water quality standard for waters used for production of wild rice. However, the equation output is a prediction, based on geochemical relationships, of the sulfate concentration at which wild rice is likely protected from harm due to elevated sulfate and the associated accumulation of sulfide in the sediment porewaters, but it neither reflects any on-site biological observations nor considers the long-term ecological production of the waterbody's wild rice population. Thus, MPCA does not support the use of this equation as the primary means to determine the proposed sulfate standard because it does not directly link to a demonstration of wild rice health and therefore cannot show beneficial use attainment (40 C.F.R § 131.11(a)(1)). Additionally, the use of the sediment-based equation may return sulfate concentration values that are thought to be generally unsupportive of wild rice, at least in some environments, as evidenced by growth experiments in mesocosms, and recent concerns have emerged that suggest the degree of protection against sulfide that is afforded by iron may not be as great as originally conceived.

Further, the Hay Lake SSS application does not include consideration of recent publications and updated scientific understanding of wild rice ecology. An applicant for a sulfate SSS should engage with the current state of wild rice science, reflect upon important recent scientific literature and reports, and identify whether their efforts are consistent with current knowledge about wild rice and suggested approaches to analyzing population robustness. This effort is necessary to establish a proposed standard that is derived through scientifically defensible methods and is scientifically sound itself. A list of important references (not exhaustive) is included as an attachment to this letter.

The derivation and analysis of the proposed sulfate SSS exclusively focuses on defining the magnitude (79 mg/L). The Hay Lake SSS application does not consider or mention the duration and frequency of the SSS, which are required elements of a water quality standard.

Lastly, the Hay Lake SSS application does not provide other lines of evidence to indicate that the proposed sulfate value will be protective of wild rice.

For these reasons, MPCA finds the method used to derive the proposed site-specific sulfate standard for Hay Lake to be scientifically indefensible.

Issue 3: Proposed sulfate standard must be demonstrated to be more appropriate than currently applicable standard (Minn. R. 7050.0220, subp. 7).

Minn. R. 7050.0220, subp. 7, authorizes the MPCA to approve a SSS where specific conditions in a waterbody indicate that a site-specific water quality standard is "more appropriate" than the currently applicable statewide standard.

The application should explain why a modified standard is more appropriate than the statewide standard. As submitted, the Hay Lake SSS application lacks adequate description and analysis on the matter of whether conditions in Hay Lake are unique and justify the application of a site-specific modification of the sulfate standard, i.e., what exceptional circumstances would allow wild rice to thrive and the beneficial use to be protected under a less stringent standard at this location.

Other comments:

1. The application does not include a review of all relevant historical data and information covering Hay Lake's wild rice population and sulfate concentrations. Meaningful reflection on how sulfate concentrations have changed in concert with wild rice would provide valuable background knowledge and is also critical in understanding the context of the current variations in sulfate concentrations and wild rice productivity.

2. The application should not seek to influence how effluent limits for the Keetac tailings basin would be determined. The MPCA requests that any subsequent site-specific standard application not contain any effluent limit determination for National Pollutant Discharge Elimination System/ State Discharge System (NPDES/SDS) permit holders, as it is outside the scope of a water quality standard action. It is the MPCA's responsibility to determine whether effluent limitations are needed in permits, not the site-specific standard applicant. Consistent with Minn. R. 7050. Subp. 7(c), any effluent limit determined to be necessary based on a modified standard shall only be required after the discharger has been given notice of the specific proposed effluent limits and an opportunity to request a hearing, as provided in Minn. R. 7000.1800. Additionally, any new or revised effluent limitation in a NPDES/SDS discharge permit is subject to public notification and comment during the re-issuance of that permit, and EPA has final authority to review effluent limitations.

The MPCA appreciates the considerable effort undertaken to develop a SSS application and hopes these comments provide greater clarity. U.S. Steel may submit a future SSS application should it compile the additional information, data, and justification needed to support an appropriate sulfate SSS for Hay Lake that protects the wild rice beneficial use. If you have follow-up questions, please reach out to me at paul.pestano@state.mn.us or 651-757-2090.

Sincerely,

Paul Pestano

This document has been electronically signed.

Paul Pestano
Manager
Water Assessment Section
Environmental Analysis and Outcomes Division

PP:rjp

cc: See next page.

cc: Eric Williams, U.S. Steel Corporation (electronic)
Tom Moe, U.S. Steel Corporation (electronic)
Nicole Everson, U.S. Steel Corporation (electronic)
Dana Vanderbosch, MPCA
Darin Broton, MPCA
Todd Biewen MPCA
Courtney Ahlers-Nelson, MPCA
Doug Wetzstein, MPCA
Tanya Maurice, MPCA

Important references (not exhaustive):

Johnson, N. W., Pastor, J., & Swain, E. B. (2019). Cumulative sulfate loads shift porewater to sulfidic conditions in freshwater wetland sediment. *Environmental Toxicology and Chemistry,* 38(6), 1231-1244.

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Vogt, D. J. (2023). *Wild Rice Monitoring and Abundance in the 1854 Ceded Territory (1998-2022)*. 1854 Treaty Authority. https://www.1854treatyauthority.org/management/biological-resources/fisheries/reports.html?id=281&task=document.viewdoc.

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 9

MPCA Brief, *In re Sulfate Site-Specific Standard for Hay Lake,* Oct. 11, 2024 (excerpt).

No. A24-0428

STATE OF MINNESOTA

IN COURT OF APPEALS

Application for a Sulfate Site-Specific Standard for Hay Lake (AUID 31-0037-00), located downstream of the U.S. Steel – Keetac (Keetac).

RESPONDENT MINNESOTA POLLUTION CONTROL AGENCY'S BRIEF

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F. The MPCA Cannot Move Forward With U.S. Steel's Application.

On November 27, 2023, the MPCA held a conference call with U.S. Steel. Add.0001; R.3 at MPCA000008. The agency stated that it was unable to approve U.S. Steel's request for a sulfate site-specific standard for Hay Lake due to insufficient information and provided feedback on the deficiencies in the application. *Id*. On February 14, 2024, the MPCA followed up with a letter summarizing the parties' discussion and provided additional written information regarding the agency's decision. *Id*.

1. The application's data does not meet federal and state water quality standard requirements.

The agency noted that U.S. Steel's application failed to comply with three critical requirements for water quality standards. First, U.S. Steel did not provide enough data to show that the beneficial use—i.e. the production of wild rice—will be protected at 79 mg/L as required by federal law. Add.0002; R.3 at MPCA000009; 40 C.F.R. § 131.11(a)(1). The field survey data provided covered six of the last fourteen years and only two in the last ten. R.32 at MPCA000736-737. A chart showing the discontinuous and incomplete nature of U.S. Steel's data is below.

Summary Chart of U.S. Steel's Wild Rice Monitoring Outcomes

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Wild Rice Density	>75%	25%-50%	0%	10%-50%	N/A	>75%	N/A	N/A	N/A	N/A	N/A	N/A	0%	N/A

***See* MPCA000736-37**

MPCA Add.001.

A. Federal Law Requires That the MPCA Apply the Sulfate Standard to Hay Lake.

U.S. Steel argues that the MPCA exceeded its statutory authority by applying the Sulfate Standard to Hay Lake. Br. at 36-39. Specifically, U.S. Steel asserts that the MPCA designated approximately 2,400 lakes throughout the state as subject to the Sulfate Standard without engaging in formal rulemaking. *Id*. But the MPCA did not rely on its "preliminary" list of lakes that may be subject to the Sulfate Standard. *See* Br. at 20 n.16. The MPCA applied the Sulfate Standard to Hay Lake because it is required to under federal law.

As mentioned above, the EPA approved the Sulfate Standard in 1973. *See supra* n.9. This means it is a federally enforceable water quality standard until amended or removed by the EPA. 40 C.F.R. § 131.21(e). Further, in 2020, the *EPA* (not the MPCA) listed Hay Lake as impaired under the Sulfate Standard.[25] 33 U.S.C. § 1313(d);[26] R.123 at MPCA005616 (line 3007). Once a waterbody is listed as impaired for a pollutant by the EPA, states enforcing the CWA must take steps, such as developing additional criteria, to bring the impaired water back into compliance with the applicable water quality standard.

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same time it was reviewing U.S. Steel's application, the agency could not apply the Framework to the application due to the inadequate and missing information. *See* Add.0001-05; R.3.

[25] *See Attachment 1: Waters Added by U.S. EPA to the Minnesota 2020 Impaired Waters List*, EPA, https://www.epa.gov/system/files/documents/2021-11/2_attachment-1_cl_final-list-of-32-waters.pdf

[26] A waterbody is "impaired" when required existing pollution controls alone will not help the waterbody meet its applicable water quality standards. 33 U.S.C. § 1313(d)(1)(A).

33 U.S.C. § 1313(d)(1)(C). Hay Lake remains on the state's EPA-approved impaired waters list. *See* R.123 at MPCA005616 (line 3007).

In other words, the MPCA has no choice but to apply the Sulfate Standard to Hay lake. Further, any state legislation that purports to prevent the MPCA from doing so is preempted by the MPCA's obligations under the CWA. *See Hous. and Redev. Auth. of Duluth v. Lee*, 832 N.W.2d 868, 873 (Minn. Ct. App. 2013) ("[S]tate law is preempted to the extent that it actually conflicts with federal law."); *see*, *e.g.*, R.130 at MPCA009139 (EPA letter stating the 2015 and 2016 session laws, to the extent they prevent the MPCA from implementing the state's NPDES program, are impermissible limitations on federally enforceable laws).

B. The MPCA Did Not Change the Sulfate Standard's Beneficial Use.

Similarly, U.S. Steel argues that the MPCA exceeded its statutory authority by creating a "new" beneficial use for the Sulfate Standard in the Framework without undergoing rulemaking. Br. at 45. This argument also lacks merit.[27]

The MPCA's February 14 letter identifies the same beneficial use that has been in place since the Sulfate Standard's inception in 1973.[28] *Compare* Add.0002; R.3 at MPCA000009 (Applicants must show "the waterbody will maintain a wild rice population that is *productive*, meaning the proposed sulfate standard allows for the continued

[27] The Court should disregard U.S. Steel's assertion that the Sulfate Standard's beneficial use conflicts or is inconsistent with the 2011 Law's directive for the MPCA to promulgate rules governing "waters containing natural beds of wild rice." As explained above, federal law requires that the MPCA apply the Sulfate Standard and its EPA-approved beneficial use to Hay Lake. *See* arg. § II(A).

[28] *See supra* n.10.

generation of wild rice biomass into the future.") *with* R.107 at MPCA004949 (In the 1970s, "production" "describe[d] the amount of rice harvested *or* yielded from both natural beds of wild rice [and] cultivated paddies.") (emphasis added). Since that time, this beneficial use has applied to waters with naturally occurring wild rice, as well as those in which wild rice is cultivated. *See* R.107 at MPCA004949 ("Natural lakes and streams with wild rice beds, as well as commercial paddies, were collectively described as wild rice production areas."). This is the same beneficial use the EPA applied to Hay Lake when adding it to the impaired waters list in 2020. *See* R.123 at MPCA5616 (line 3007's "affected designated use"). MPCA's acknowledgement of the ambiguous nature of the phrase "production of wild rice" does not mean the agency has altered its longstanding interpretation. *See*, *e.g.*, R.107 at MPCA004949 (MPCA's proposal to rephrase "water use for production of wild rice" with "wild rice water" "without changing the concept of the use or whether it applies. The change only modernizes the language, given that the word 'production' has different connotations today than it did historically."). Rather, the MPCA has discussed ways to explain, in more easily understood terms, the Sulfate Standard's beneficial use, which does not run afoul of its rulemaking responsibilities. *See Logic Tech. Dev. LLC*, 84 F.4th at 553 ("Reasoned disagreement among civil servants is the stuff of good government, not APA violations.").

In declining to pursue U.S. Steel's proposed site-specific sulfate standard, the MPCA applied the same beneficial use that has applied to the Sulfate Standard since the 1970s. The agency's decision does not exceed its statutory authority nor constitute unpromulgated rulemaking.

CONCLUSION

For the foregoing reasons, the court should affirm the MPCA's decision not to pursue U.S. Steel's proposed site-specific sulfate standard for Hay Lake.

Dated: October 11, 2024

Respectfully submitted,

KEITH ELLISON
Attorney General
State of Minnesota

/s/ Christina Brown
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Attorneys for Respondent Minnesota Pollution Control Agency

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 10

MPCA, Protecting Wild Rice Waters, September 2025.

Protecting wild rice waters

SECTION MENU



Wild rice is an important part of the biological community in many Minnesota lakes, streams, and wetlands. Wild rice is also a cultural resource to many, particularly members of the Dakota and Ojibwe Tribal Nations in Minnesota, and it is an important economic resource to those who harvest and market it. Minnesota recognizes wild rice as its official state grain.

Wild rice is found primarily in low-sulfate waters. Sulfate is a naturally occurring chemical and can also be found in discharges from mining operations, wastewater treatment plants, and industrial facilities.

The MPCA is currently working to fully implement a water quality standard to protect wild rice from excess sulfate. The standard, 10 mg/L sulfate, which was adopted in 1973, applies to "waters used for production of wild rice." The agency is also working with permittees, researchers, tribal partners, other

levels of government, as well as the public to investigate ways to protect wild rice.

History

The MPCA has sponsored studies on how sulfate affects wild rice. Research projects in 2012-2013, including a field survey, laboratory experiments, and mesocosm (outdoor growth tank) experiments, helped to inform a 2017 proposal to amend the existing sulfate water quality standard. This rulemaking attempt was ultimately unsuccessful. Consequently, the 1973 sulfate water quality standard remains in effect. MPCA is committed to implementing this standard.

Implementation

The 10 mg/L sulfate water quality standard is designed to protect wild rice and applies in specific waters called “waters used for production of wild rice” (Minn. R. 7050.0224).

Where the standard applies. The MPCA has developed a list of approximately 2,400 waters used for production of wild rice. This list was developed from multiple sources of information — biological monitoring data, survey databases, and various inventories — to determine where the wild rice beneficial use has been, or could be, attained.



Wild rice producing waters

This online search tool will assist in identifying waters used for production of wild rice, as well as in identifying facilities that require a permit review because they are located in a watershed upstream or partially upstream of such waters.

Open tool

NPDES/SDS permitting

The MPCA is continuing to work with permittees, the public, and state, local, federal partners, and tribal nations to develop ways to protect this important Minnesota resource through implementation of the long-standing 10 mg/L sulfate standard via monitoring, assessment, and permitting.

- The MPCA held an informational meeting (May 24, 2023) for representatives of NPDES/SDS permitted facilities, to discuss where the standard applies and how the standard would be considered in NPDES/SDS permits.
- In a follow-up meeting (June 28, 2023) we discussed options if a facility can't meet a permit limit and the framework for developing site-specific sulfate standards to protect waters used for production of wild rice.
- In the final meeting in the series (Sept. 27, 2023), MPCA staff responded to NPDES/SDS permit-related questions received during the feedback periods, and leaders from the University of Minnesota Duluth Natural Resources Research Institute provided information about their sulfate treatment technology research.
- Minnesota Wild Rice Sulfate Water Quality Standard NPDES/SDS wastewater permit implementation (wq-wwprm1-42)

- Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES wastewater permits in Minnesota (wq-wwprm2-109)

Impaired waters

In the 2024 Impaired Waters List, MPCA identified a total of 43 waterbodies (56 assessment units) as impaired due to measured sulfate levels in excess of 10 mg/L.

Site-specific standards

- Framework for developing and evaluating site-specific sulfate standards for the protection of wild rice (wq-s6-66a) (December 2023)

More information

- Johnson, N. W., Pastor, J., & Swain, E. B. (2019). Cumulative sulfate loads shift porewater to sulfidic conditions in freshwater wetland sediment. Environmental Toxicology and Chemistry, 38(6), 1231-1244. https://doi.org/10.1002/etc.4410.
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sulfate reduction is a primary controller of the occurrence of wild rice (Zizania palustris) in shallow aquatic ecosystems. Journal of Geophysical Research: Biogeosciences, 122(11), 2736-2753. https://doi.org/10.1002/2017JG003787.

- Pastor, J., Dewey, B., Johnson, N. W., Swain, E. B., Monson, P., Peters, E. B., & Myrbo, A. (2017). Effects of sulfate and sulfide on the life cycle of Zizania palustris in hydroponic and mesocosm experiments. Ecological Applications, 27(1), 321-336. https://doi.org/10.1002/eap.1452.

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 11

Moyle JB (1944) Wild rice in Minnesota. *J. Wildlife Management* 8(3):177-84.

WILD RICE IN MINNESOTA

John B. Moyle
Bureau of Fisheries Research, Minnesota Department of Conservation, St. Paul, Minnesota

Wild rice (*Zizania aquatica*) is an aquatic grass of the Tribe Zizanieae which produces grain valued as food for waterfowl and as a table delicacy for mankind. It is a native plant and not the ancestor of the cultivated rice of commerce. Wild rice grows throughout the eastern half of the United States and adjoining portions of Canada (Hitchcock, 1935), but is more abundant in central and northern Minnesota than in other parts of its range. Minnesota wild rice stands are autumn feeding grounds for waterfowl on the Mississippi flyway. Martin and Uhler (1939) report that this rice formed 5.10 per cent of the food in the stomachs of many game ducks taken in the eastern United States, and Morse (1941) found it made more than 50 per cent of the food for wild ducks on some Minnesota lakes in autumn. Wild rice has long been gathered for food by the Minnesota Indians and at present is harvested in considerable amounts by both Indians and whites.

Ecology of Wild Rice

Wild rice grows in shallow lakes and along streams in water 1 to 3 feet deep. The seeds, buried in the bottom mud since the preceding autumn, germinate in May and June to produce ribbon-like submerged leaves. By late June and July these leaves have grown to float on the water surface. The blossom stalks emerge during the first 2 weeks in July, and when a few inches above the surface begin to flower; the stalks continue to grow until the grains are nearly mature. At the time of ripening, in late August and September, the "straw" extends 2 to 8 feet above the water. Each stalk produces a terminal panicle of unisexual spikelets—pistillate on the upper ascending branches and staminate on the lower spreading branches. The pistillate portion matures from the top downward and about 10 days are required for the ripening of all the seeds. Around each kernel is a hull of the persistent palea and awned lemma. When fully mature, the entire spikelet disarticulates from the pedicle, drops into the water, and settles into the bottom mud. Most wild rice plants have but one stalk with a terminal panicle or "head," but stooling may occur in shallow water when an individual plant will produce five or six stalks.

Wild rice usually grows in nearly pure stands. The lakes producing this crop show marked seasonal differences: in spring they are expanses of open water, in midsummer covered with a mat of floating leaves, and in late August and September resemble fields of cultivated grain. The vegetational complex of wild rice stands is essentially one of annual development. The aquatic plants usually associated with this grass begin growth each season from seeds, winter buds, or other types of propagules. Rooted perennials are uncommon. In Minnesota the most common aquatics associated with wild rice are bushy pondweed (*Najas flexilis*), coontail (*Ceratophyllum demersum*), duckweeds

(*Lemna minor, L. trisulca* and *Spirodela polyrhiza*), bladderwort (*Utricularia macrorhiza*), and a pondweed (*Potamogeton zosteriformis*). The bushy pondweed is especially abundant in some stands and, like the wild rice itself, is avidly eaten by waterfowl (Morse, 1941).

In Minnesota, the chemical nature of the water seems to be the principal factor affecting the natural distribution of wild rice. This crop tolerates the entire carbonate (total alkalinity) range of Minnesota waters (5 to 250 p.p.m.), but is intolerant of sulphates. No large stands of rice occur in waters having a SO_4 content greater than 10 p.p.m., and rice generally is absent from water with more than 50 p.p.m. Best growth is made in carbonate waters having total alkalinity greater than 40 p.p.m. Most Minnesota wild rice stands are on mucky soils over gravel or sand. The crop grows best in lakes having some water moving through and often is lacking from stagnant lakes and pools, especially bog lakes with dark brown water. It is frequent along streams and at lake inlets and outlets.

THE CROP AND ITS HARVEST

Surveys in 1940–42 showed at least 15,000 acres of wild rice in stands of 5 acres or more; the total probably would approach 30,000 acres if all smaller stands were considered. The stands vary from small patches fringing lakes and creeks to nearly 1,000 acres in some large shallow lakes; about 150 are large enough to warrant harvesting. The principal stands of more than 500 acres each are in Nett Lake, Koochiching County; Upper and Lower Rice lakes, Clearwater County; Star Lake, Otter-tail County; Lake Minnewawa, Aitkin County; and Big Rice Lake, Cass County.

The Minnesota harvest (calculated from returns by about 10 per cent of the harvesters), was 1,586,000 pounds, or 793 tons of parched or processed grain, in the bumper crop of 1940. In 1941 only 20,000 pounds were taken but in 1942 the harvest was 337,000 pounds, about 75 per cent of normal (estimated annual production of processed rice about 500,000 pounds). The poundage of non-processed grain was 2.5 times the foregoing figures. In 1940, 2,500 persons were engaged in the harvest. In most years the grain has a gross sales value between $100,000 and $400,000. The price paid on the stands for non-processed rice in 1940 to 1943, was 5 to 12 cents a pound. During the same period processed rice brought 20 to 40 cents a pound on the stands and retailed in Minnesota at 40 to 60 cents per pound. In addition to the processed rice sold for table use, considerable amounts of non-processed grain are purchased by aquatic nurseries and sold to sportsmen for planting as a waterfowl attraction.

HISTORY OF RICE HARVEST

Wild rice has long been harvested by the Minnesota Indians and prior to the coming of the white man was one of their staple foods. Before 1800, most of the stands were controlled by the Sioux; the Chippewas, now the bulk of the state's Indian population, then inhabited only the north shore of Lake Superior. The earlier and more general use of firearms by the Chippewas and the pressure of white settlement on both tribes, allowed the Chippewas to gain control of most of the wild rice be-

tween 1820 and 1860. Later these Indians were settled on reservations, most of which included or were close to the more important rice stands, and until recent years they have harvested most of the grain. At present, about one-third of the licensed harvesters are of Indian blood. In 1888 it was estimated that wild rice comprised a quarter of the food of the Winnibigoshish, Cass, and Leech Lake Chippewa bands (U. S. Supreme Court Transcript, 1922, p. 160). Estimates of the harvest between 1861 and 1909 by Indian agents (Jenks, 1898; Winchell, 1911) suggest that probably not more than 6,000 or 7,000 bushels were harvested each year by the Indians and in most years the harvest was considerably less. At least twice as much wild rice probably now is harvested annually as was taken formerly by the Indians.

HARVESTING AND PROCESSING

The primitive Indian method of harvesting, as related by Jenks (1898) and as described to the writer by older Chippewas, involved sheaving or tying the standing heads. The standing sheaves then remained on rice beds until all of the kernels matured. The harvester then would pole through the stand, bend the sheaves over the edge of the canoe, untie the heads, and knock off the grains with a short flail. When a boatload was gathered, it was taken ashore, spread on blankets for a day or two to dry, and then heated and stirred in a large iron kettle until the hulls were brown and brittle. Often the heating was continued until most of the grains were popped. This heating process is called parching. Threshing was accomplished by dancing on or beating the grains with poles until the parched hulls were loosened. The grain was then separated from the hulls by winnowing. In recent years, binding the heads into sheaves has been abandoned, both because of the labor involved and of the ease with which such rice can be pilfered by less industrious harvesters. Rice now is harvested by poling a narrow flat-bottomed boat through the ripening stand and knocking the ripe grains into the boat. Harvesting is generally a family affair. The man usually stands in the rear to shove the push-pole and the woman, seated in the middle, gathers armfuls of the stalks with aid of a tapered stick 2 to 3 feet long, bends the heads over the edge of the boat, and taps them lightly with a similar stick to remove the ripened grain. Since the heads ripen over a 10-day period and the kernels fall as they ripen, each stand must be harvested several times to get even a small percentage of the crop. Stands usually are harvested four times at 2-day intervals.

The primitive processing now is used by only a few of the older Indians. Most of the rice is processed with simple homemade machines. A common device for parching consists of a steel oil barrel rotated over a low wood fire on a central iron shaft through the barrel that terminates in a crank. Threshing is done with another barrel fixed horizontally on a platform; centered in this barrel is a revolving shaft carrying eccentric paddles shod with pieces of old automobile tire casing. On the end of the shaft is a pulley, belted to a gasoline engine or to the rear wheel of a jacked-up automobile. The hulls are removed as the grains are thrown back and forth against the paddles. An ordinary farm

fanning mill is commonly used for winnowing. In the larger ricing camps there usually is a division of labor and certain individuals spend most of their time at processing the grain.

Much of the wild rice now harvested is sold to commercial processers as it comes from the stands. These firms have developed better mechanical means for processing the grain and can produce a more uniform finished article. The rice usually is heated only until the hulls are brittle enough to thresh and the grains not popped, as often occurs in hand processing. Popped grains tend to fragment and make a less attractive product. Machines for harvesting wild rice have been devised but are no longer allowed on Minnesota stands because the harvesting is being maintained as a self-perpetuating hand industry. A harvester used with some success is a flat-bottomed motorboat with a mechanically-operated reel on the front, similar to that of a grain binder, to knock the grains from the heads into the boat.

VARIABILITY OF WILD RICE

Two kinds of wild rice have long been recognized by plant taxonomists: a tall, robust, wide-leafed type (*Zizania aquatica*) and a shorter, narrow-leafed rice *Z. aquatica* var. *angustifolia* (Hitchcock, 1935). In Minnesota stands much of the material appears to be intermediate, although both varieties can be found. Plants fitting both descriptions frequently occur in a single stand. In general, var. *angustifolia* is commoner in the softer waters of northeastern Minnesota (total alkalinity less than 50 p.p.m.) and the taller *Zizania aquatica* is more characteristic of the harder waters of the southern and western parts of the wild rice area.

Distinct strains of wild rice occur in many Minnesota beds, and an experienced buyer often can tell from a sample of grain the stand which produced it. Detailed examination of the more important stands in 1940, 1941, and 1942 showed them to differ markedly in the average size and number of kernels per head, and these characteristics were fairly constant from year to year. This is generally recognized by harvesters of wild rice and some areas, such as Nett Lake and Lake Minnewawa, have long been famous for the large kernels produced.

The length of the kernel or spikelet, from base of spikelet to base of awn, commonly varies from 6 to 20 mm. The averages, for length of kernel, from 85 stands were as follows:

Average length, millimeters	*Number of stands*
8	2
9	3
10	2
11	9
12	10
13	14
14	14
15	18
16	5
17	1
18	7

The average length of kernels for all stands was 13.6 mm. Strains with kernels 15 to 18 mm. long are sold by aquatic nurseries as "giant wild rice," and those shorter than 10 mm. are known as "bird or river rice." The average number of kernels per head was 15 to 212 on the 50 stands examined:

Average kernels per head	*Number of stands*
15 to 50	17
51 to 100	18
101 to 150	14
151 or more	1

The grains and grain scars on a dozen or more typical heads from each stand were counted. The leaves varied from

under 10 mm. to about 30 mm. in width. Variation also occurs in the length of awn and color of the heads. Most maturing heads are green but nearly every stand has a sprinkling of purplish heads; the grain produced by the two color phases, however, is identical. The height of mature stands above the water surface was 2 to 8 feet.

Different stands exhibited nearly every combination of these variable characteristics, but the shorter, narrow-leafed rice generally produces fewer and larger grains than the taller, wide-leafed type. All stands producing grains that averaged 18 mm. in length had panicles with fewer than 50 kernels and had or approached the growth form of var. *angustifolia*. This type is most valued by the harvester because the large grains and short straw facilitate harvesting from a boat.

There is considerable variation in the number of days required to mature the crop. The first stands begin to ripen about August 18 and the last about September 12; most of them begin between August 24 and September 3, the greatest number usually ripening about September 5. Since about 10 days are required to complete the ripening, most of the harvesting occurs between August 25 and September 12. Ripening dates are fairly constant and do not vary more than 2 or 3 days in any stand over a period of years. The first to ripen has both short straw and small grains; the taller rice and that with more grains per head, generally is later.

The most distinct strains are found either in small isolated stands or in the large continuous stands of the general rice area; their natural development may be attributed to self-pollination over a long period of years. The age of most Minnesota stands is not known, but harvesting has been carried on regularly in some large beds for at least 100 years.

CROP FLUCTUATIONS AND FAILURES

On the basis of harvest data for 24 years at Nett Lake in Koochiching County, for 21 years at Platte and Sullivan lakes in Morrison County, and for shorter periods on other waters,[1] the harvest during any 4 years is likely to fail once, and to produce one bumper and two fair crops. Jenks (1898) gathered considerable evidence on harvest failures and reached the same conclusion as to their frequency. Failure results mainly from high water during June and July. The best crops occur in years of sub-normal rainfall with receding water levels. Comparison of the water levels in 1940 (bumper crop) and in 1941 (poor crop) shows that a water stage 12 inches or more above normal during the period from May 15 to July 1 caused a failure and a stage 6 inches above normal reduced the harvest on some stands by more than half. Lake Minnewawa, Aitkin County, had a water stage 6 to 8 inches higher in 1941 than in 1940 and suffered a reduction in harvest from 60 tons to less than one ton.[2] Continued high water when the plants have only submerged leaves results in such weak, attentuated growth that the plants are easily destroyed by

[1] Data for Nett Lake from memorandum by S. D. Walker to M. L. Burns, Acting Superintendent, Consolidated Chippewa Agency, Cass Lake, Minnesota, Sept. 15, 1939. Data for Platte and Sullivan Lake from Walter Zak, Hillman, Minnesota (letter, Dec. 29, 1941).

[2] William Simpson (letter Sept. 11, 1941) to the Division of Drainage and Waters, Minnesota Department of Conservation.

wave action and adverse weather (Chambliss, 1940). This phenomenon is locally known as "drowning." Heavy wind, hail, and rain storms while the kernels are maturing also bring about failure or reduction of the harvest by lodging and uprooting the plants.

In some years many of the rice flowers do not set grains. The cause is unknown but usually is attributed to hot, dry weather when the plants are in flower. Eleven of the 14 stands observed in detail during 1941 produced heads on which less than 50 per cent of the spikelets matured. Rice harvested from such stands is light in weight and the sterile grains must be removed by water flotation before it can be processed.

The army worm (*Agrotis* sp.) occasionally destroys limited amounts of wild rice near shores by feeding on the maturing grains, and a few grains sometimes are infected with ergot. Stands in southern Minnesota have been destroyed by German carp, and muskrats frequently gnaw off the stems at the waterline.

YIELD AND HARVEST

In 1941 an estimate of the total yield was made on 14 stands. Two to 11 representative sample areas were selected on each and delimited by floating wooden hoops, each enclosing an area of 11.5 square feet. The number of areas sampled depended upon the size and the uniformity of the stand. On each area, all panicles were removed and bagged for study. To obtain the total yield per unit area, the following data were obtained from these collections: (1) the average number of panicles per square foot, (2) average number of grains and grain scars per panicle, (3) average weight of dry grain per square foot, and (4) percentage of sterile spikelets. The 1941 harvest on most stands was regarded as a failure, but all 14 stands produced some rice and averaged 168 (50 to 401) pounds of processed rice per acre.

All these stands were open to harvesting but only two were harvested: Upper Rice Lake in Clearwater County with a total production of 401 pounds per acre, and Big Rice Lake in Cass County with 323 pounds per acre. Harvesting was attempted on some others but abandoned. It seems, therefore, that unless a stand produces more than 300 pounds of processed rice (or 750 pounds nonprocessed) per acre, hand harvesting is not profitable.

The long record of harvest data for Nett Lake showed the harvest there has varied from 6 to 43 tons, averaging about 15 tons. The stand usually comprises about 800 acres of harvestable rice and has, therefore, an average yield of 37.5 pounds per acre. In contrast, the total production in 1941 (poor crop) was 185 pounds. A crude estimate of the average on all stands can be gained by dividing the average annual take per licensed harvester by the number of acres allotted to him for harvesting. The average allotment is about 10 acres; the average take for 1940 was 393 pounds and for 1942 was 315 pounds. This suggests the usual amount taken as between 30 and 40 pounds of processed rice per acre. Stewart (1926) carefully checked the harvest on a 2,000 acre Minnesota stand and found 50 pounds of processed rice per acre taken in 1924, a good crop year.

Several factors are involved in the marked difference between total yield

and total harvest; most important are incomplete harvesting of individual heads by hand methods and incomplete coverage of the stands by the harvesters. Since several of the best Minnesota stands are known to have been harvested by hand for at least a century, it is evident that such harvesting does no damage to them and leaves most of the grain for waterfowl and reseeding.

PROPAGATION OF WILD RICE

Because of its obvious value as an attraction for waterfowl, wild rice has been planted in many waters where it did not occur naturally. Some plantings have succeeded, but more have failed. Of eight made in the wild rice area of northern Minnesota during 1940, four produced good crops, three fair crops, and one failed the following year. Three other plantings during 1940 in waters high in sulphates failed completely. Two earlier seedings in the wild rice area produced fair crops the first year but failed thereafter. Miller (1943) examined the results of 50 plantings of wild rice in Michigan and found that 74 per cent of them failed to become permanent.

The conditions that appear most conducive to success of wild rice in Minnesota are: (1) clear water, 1 to 3 feet deep, with total alkalinity greater than 40 p.p.m. and SO_4 concentration less than 10 p.p.m.; (2) organic soil 6 inches or more in depth, preferably with some calcareous material such as snail shells; (3) some movement of water through the area; (4) fluctuation of water level less than 6 inches throughout the growing season; and (5) absence of carp. Almost all such waters within the wild rice area now have rice, and planting is usually advisable only when stands have been destroyed by drought or a long period of fluctuating water levels.

Since wild rice is available as waterfowl food only for about a month and provides good shelter for only about 2 months each year, it is less desirable as a food species than the pondweeds (*Potamogeton*) and less desirable for cover than the perennial bulrushes (*Scirpus*). It does, however, provide much excellent food during the autumn waterfowl migration and therefore is one of the most effective aquatic plants to attract and concentrate waterfowl.

Wild rice seed should be kept cool and moist from the time it is harvested until planted; two methods of storage have been found to be effective. It can be stored in double burlap sacks encased in cages of chicken wire and submerged in a lake; the wire excludes muskrats, which have a great liking for the seed. Seed also can be stored in a cool root cellar in double burlap sacks, so arranged that water from melting ice will drip upon the sacks continuously and keep the seed moist.

Planting is best done from a boat or canoe. The seed should be scattered over the surface of waters that are 1 to 3 feet deep in depth. All good seeds will sink to the bottom immediately. The best rate for seeding is about 1 bushel per acre or, in small areas, a large handful to an area 6 by 6 feet. Preferably, plantings should be made a short time before ice forms in fall or as soon as the ice breaks up in spring.

SUMMARY

Minnesota contains more than 15,000 acres of wild rice (*Zizania aquatica*) growing in shallow lakes and along

streams in the northern and central parts of the state. This native, unimproved grain exhibits considerable variation in the size and number of kernels per head and in other characteristics, and it tends to develop local strains.

The crop, in addition to having value for waterfowl, provides an average annual harvest of about 500,000 pounds of processed rice. Up to 2,500 persons, about one-third of Indian blood, engage annually in the harvesting and the grain usually has an annual value of $100,000 to $400,000. The grain is harvested by hand methods similar to those long used by the Minnesota Indians. Simple mechanical procedures have now largely replaced hand labor for parching the grain and removing the hulls.

On any stand the harvest will fail, on the average, one year in four, the principal cause being a high water level during May and June. Sufficient grain for reseeding usually is produced in years of harvest failure.

The few data available suggest that often as little as one tenth of the crop on a stand is taken by hand harvesting leaving most of the grain for waterfowl and reseeding. When total production, calculated as processed rice, is below 300 pounds per acre, hand harvesting usually is unprofitable. The average harvest in Minnesota is about 30 to 40 pounds per acre (processed rice).

Wild rice, is more of an attraction than a staple food plant for waterfowl, and shows marked preference for certain habitat conditions; unless these conditions are supplied plantings are apt to fail.

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EXHIBIT 12

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Iron sulfide formation on root surfaces controlled by the life cycle of wild rice (*Zizania palustris*)

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Abstract Iron sulfide plaques have been observed on roots of wild rice (*Zizania palustris*) and other wetland plants grown in sulfur-impacted freshwater ecosystems, but the mechanism of their formation and ramifications for plants have not been investigated. We exposed a model annual wetland plant, *Zizania palustris*, to elevated sulfate concentrations (3.1 mM) and quantified the development of iron oxide and iron sulfide precipitates on root surfaces throughout the plant life cycle. During the onset of seed production, root surfaces amended with sulfate transitioned within 1 week from iron (hydr)oxide plaques to iron sulfide plaques. During the same week, Fe(III) decreased on roots of plants not amended with sulfate but FeS did not accumulate. Prior to FeS accumulation, sulfate-amended plants had taken up the same amount of N as unamended plants. After FeS accumulation, total plant nitrogen did not increase further on sulfate-amended plants, indicating a cessation in nitrogen uptake, whereas total plant N continued to increase in unamended plants. Sulfate-amended plants produced fewer and lighter seeds with less nitrogen than unamended plants. FeS precipitation on roots may be associated with elevated sulfide and inhibited nitrogen uptake before the end of the plant's life cycle, thus affecting the populations of this annual aquatic plant. We propose a mechanism by which a physiologically-induced decline in radial oxygen loss near the end of a plant's life cycle initiates a precipitous decline in redox potential at the root surface and in adjacent porewater, initiating accumulation of iron sulfide plaques. These plaques could be an important locus for iron sulfide accumulation in wetland sediments.

Keywords Root plaques · Radial oxygen loss · Iron–sulfur cycling · *Zizania palustris* · Electron accepting buffer

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Introduction

Introduction of sulfate to low-sulfate freshwater ecosystems and subsequent reduction to sulfide can induce eutrophication, enhance methylmercury production, and decimate populations of sensitive aquatic plant species (Caraco et al. 1989; Gilmour et al. 1992; Smolders et al. 2003). Field observations have correlated elevated sulfide concentrations in sediment with population declines and decreased density of some aquatic plants (Myrbo et al. 2017; Pulido et al. 2012; Smolders et al. 2003). Black iron sulfide (FeS) plaques have been observed on the roots of aquatic plants grown with elevated sulfide in several sulfur addition experiments (Gao et al. 2003; Jacq et al. 1991; Koch and Mendelssohn 1989) including our outdoor mesocosm experiment with self-perpetuating wild rice (*Zizania palustris*) populations (Pastor et al. 2017); however, little is known about conditions conducive to iron sulfide precipitation on roots and the mechanism by which it occurs.

Roots of aquatic plants create redox interfaces that are hot spots for cycling of nitrogen, sulfur, iron, and other metals (Soana et al. 2015; Schmidt et al. 2011; Lee and McNaughton 2004). Many aquatic plants transport oxygen from the atmosphere to the roots through porous tissue called aerenchyma (Armstrong and Armstrong 2005). Radial oxygen loss from roots reacts with ferrous iron in sediment to form iron (hydr)oxide plaques at the interface of the oxidized root surface and the reduced sediment (Christensen and Sand-Jensen 1998; Mendelssohn and Postek 1982; Snowden and Wheeler 1995). Together, radial oxygen loss and iron (hydr)oxide plaques provide a supply of electron accepting compounds at the root surface, hereafter referred to as an electron accepting buffer. This buffer may inhibit sulfide formation and precipitation in several ways. The release of oxygen by plant roots may reoxidize sulfide and inhibit sulfate reduction (Holmer et al. 1998). In addition, Fe(III) can oxidize sulfide, and the reduction of Fe(III) to Fe(II) may outcompete sulfate reduction (Roden and Wetzel 1996; Hansel et al. 2015). Others have observed increased FeS precipitation on roots and in sediments shortly after plant senescence (Jacq et al. 1991; Giblin and Howarth 1984), suggesting a decrease in the strength of the electron accepting buffer. However, the timing of sulfide interactions with iron on root surfaces, particularly in relation to the life cycle of the plants, remains largely unexplored.

To explore these processes, we subjected wild rice, *Zizania palustris*, an annual plant that forms large monotypic stands in the lakes and rivers of Minnesota, Wisconsin, northern Michigan, and Ontario, to enhanced sulfate concentrations. Although radial oxygen loss has not been directly quantified in wild rice, aerenchyma tissue and root surface iron oxides have been studied and documented in this species (Stover 1928; Jorgenson et al. 2012). In a previous mesocosm experiment with wild rice, increasing concentrations of porewater sulfide decreased vegetative biomass production only slightly, but strongly decreased annual seed production, leading to population declines in subsequent years (Pastor et al. 2017). Hydroponics experiments have demonstrated that sulfide reduces nutrient uptake in wetland plants (Joshi et al. 1975; Koch and Mendelssohn 1989) through inhibition of metallo-enzymes in the electron transport chain and subsequent inhibition of ATP production required for nutrient transport (Allam and Hollis 1972; Koch et al. 1990; Martin and Maricle 2015). It is not well understood why the seed production life stage of wild rice is especially vulnerable to sulfide, but decreased seed production may be associated with the timing of favorable conditions for sulfate reduction and concomitant FeS accumulation on roots.

To identify the drivers of FeS formation on the root surfaces, we tested the hypothesis that surface water sulfate loading induces FeS formation on roots. To investigate the implications of FeS root plaques for nitrogen uptake during seed production, we explored the timing of FeS formation on wild rice roots. We exposed wild rice plants to elevated surface water sulfate and quantified the speciation of iron and sulfur on root surfaces and in rooting-zone porewater during reproductive life stages. Throughout the life cycle of the plant, we also monitored growth and seed production.

Methods

Sediment was collected from Rice Portage Lake (MN Lake ID 09003700, 46.703810, − 92.682921) on the Fond du Lac Band of Lake Superior Chippewa Reservation in Carlton County, Minnesota on 5/15/15 and placed in a 400 L polyethylene stock tank (High Country Plastics) where it was homogenized by

MPCA004330

shovel. Initial total carbon in the sediment was 14.8 ± 1.70% and initial total nitrogen was 1.12 ± 0.13% by dry weight. Eighty 4 L plastic pails were then filled with 3 L of the sediment. Each 4 L pail was placed inside a 20 L bucket that was filled with 12 L of groundwater from an on-site well to provide a 12–15 cm water column. In each pail, two seeds that were harvested in 2014 from Swamp Lake on the Grand Portage Reservation (MN Lake ID 16000900, 47.951856, − 89.856844) were planted on 5/15/15 (Julian day 135).

Forty randomly chosen buckets were amended with sulfate and forty were left unamended. On 6/3/15, the forty amended buckets received an aliquot of stock solution (5.15 g of Na_2SO_4 dissolved in 200 mL of deionized water) to result in 300 mg L^{-1} (3.1 mM) sulfate. We hereafter refer to all porewater, sediment, and plants in these buckets as "amended". This concentration is close to the EPA secondary standard for drinking water, 250 mg L^{-1} (2.6 mM), intended to prevent laxative effects and an unpleasant taste. Although northeastern Minnesota generally has sulfate concentrations less than 10 mg L^{-1} (0.1 mM), concentrations of sulfate higher than 2.6 mM are found in some Minnesota waters, either naturally from geologic sources or from anthropogenic inputs (Myrbo et al. 2017). A sulfate concentration of 3.1 mM caused wild rice populations to go extinct within 5 years in previous mesocosm experiments with the same sediment (Pastor et al. 2017). The overlying water was sampled twice throughout the trial and re-adjusted to 3.1 mM SO_4 by adding additional Na_2SO_4 stock solution on 7/10/15. Unamended buckets had an average surface water sulfate concentration of 0.15 ± 0.01 mM when sampled on 6/23/15, consistent with the concentration of sulfate in groundwater from the on-site well. This is only slightly above observations of Moyle (1944) that wild rice grows best in waters less than 10 mg L^{-1} sulfate. We hereafter refer to all porewater, sediment, and plants in these buckets as "unamended." Shoots were thinned on 6/23/15 to one plant per bucket. Shoot height ranged from 10 to 20 cm and the tallest, most robust shoot in each bucket was left in place.

The annual life cycle of wild rice begins with emergence from the sediment and water column in June, continues with vegetative growth in July, followed by flowering and seed production in August, and ends with the shedding of seeds and death of the plant from late August to late September. Seeds overwinter in the sediment until they germinate in May (Grava and Raisanen 1978; Sims et al. 2012). Four plants were harvested every 2 weeks from randomly chosen amended and unamended buckets beginning at the onset of flowering (7/9/15, day 190) and continuing to the onset of seed production (8/20/15, day 232), after which plants were harvested weekly until senescence (9/22/15, day 265). The first seeds were collected on 8/20/15 (day 232) but were unripe and not yet filled. Mature seeds were not produced until 1 week after the start of seed production (day 239). On the last sample date (day 265) seeds were collected but were unfilled. Stems and leaves were no longer green, indicating that the plants had senesced. Of the four amended replicates sampled on this date, two plants did not produce seeds. Thus, "mature seed production" refers to seeds produced between Julian days 239–253.

Each plant was removed from the sediment and immediately rinsed in buckets of deoxygenated water continuously bubbled with a rapid stream of molecular nitrogen. If seeds were present, they were removed prior to sampling the plant and saved for separate analysis. While submerged in deoxygenated water, the stem was cut just above the root ball so that the shoots could be saved for mass and N analysis. The still submerged roots were then placed in jars full of deoxygenated water, which were immediately placed in a plastic bag flushed with molecular nitrogen and transported to an oxygen-free glove box (Coy Lab Products, 97.5% N_2, 2.5% H_2). In the glove box, the roots were cleaned of sediment and all organic matter except living wild rice roots prior to removing a 1–2 g section of wet root mass for acid volatile sulfide (AVS) and iron analysis.

The plants and seeds were rinsed with deionized water and dried in paper bags for 7 days at 65 °C. The dried plants were weighed, placed in polycarbonate vials with stainless steel balls, and shaken in a SPEX 800 M mixer mill until the samples were in a powdered form. Seeds were counted, weighed, and powdered using the same method. The samples were transferred to glass vials and dried again overnight at 65 °C with caps loosely covering the vials. Samples were quantified for total N on an elemental analyzer coupled to a Finnigan Delta Plus XP isotope ratio monitoring mass spectrometer.

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Sediment was collected at the beginning and end of the growing season. Immediately after sediment homogenization (5/15/15), five replicate samples were placed in jars and analyzed for AVS and simultaneously extracted iron. At the end of the growing season (9/22/15), a 7 cm diameter sediment core was collected from the top 10 cm of each bucket prior to root sampling. Jars were filled completely with sediment and placed in a plastic bag filled with nitrogen to prevent oxidation during transport to a glove box. In the glove box, sediment was homogenized and allocated for AVS and iron extraction.

From both sediment and roots, AVS and iron were extracted simultaneously from a 1–3 g wet sample (0.1–0.5 g dry) using 7.5 mL 1 N HCl for 4 h using a modified diffusion method (Brouwer and Murphy 1994). During a room temperature acid incubation with gentle mixing, sulfide was trapped in an inner vial containing 3 mL Sulfide Antioxidant Buffer (SAOB) and subsequently quantified using a ThermoScientific sulfide ion-selective electrode with a detection limit of 0.01 mmol L^{-1}. After the extraction, two aliquots of the 1 N HCl extracts were used for iron quantification. Ferrous iron was immediately quantified colorimetrically using the phenanthroline method on a HACH DR5000 UV–Vis spectrophotometer (Greenberg et al. 1992), and weak acid extractable iron (sum of Fe(II) + Fe(III) concentrations, hereafter referred to as "total extractable iron") was quantified using a Varian fast sequential flame atomic absorption spectrometer with an acetylene torch.

A subset of roots was tested for chromium(II)-reducible sulfur (CRS) to determine whether AVS included all total reduced inorganic sulfur on the roots. A diffusion-based CRS method was used, which can fully extract all amorphous iron sulfide and pyrite and can partially extract elemental sulfur (Burton et al. 2008). The same sampling apparatus was used for extraction of AVS and CRS (see Burton et al. 2008 Fig. 1 for a diagram of the sampling apparatus). Chromic acid for CRS analysis was prepared according to Burton et al. (2008). Inside an oxygen-free glove box, a section of root from a plant previously analyzed for AVS was placed in the analysis bottle. An inner vial containing SAOB was also placed inside the bottle prior to sealing. Bottles were removed from the glove box and injected with chromic acid with no oxygen exposure. CRS was extracted for 48 h and quantified using a ThermoScientific sulfide ion-selective electrode.

One day prior to each root sampling date, the porewater was sampled for sulfide, sulfate, iron, and pH. First, pH was measured in situ with a ThermoScientific Orion pH electrode at a depth of 5 cm below the sediment surface and 2 cm from the stem of the wild rice plant. Porewater was collected using 5 cm length, 2 mm diameter tension lysimeter filters (Seeberg-Elverfeldt et al. 2005) (Rhizons) attached with a hypodermic needle to an evacuated, oxygen-free serum bottle sealed with a 20 mm thick butyl-rubber stopper (Bellco Glass, Inc). The entire filter end of the Rhizon was inserted vertically into the sediment just below the surface. The goal was to draw water from approximately the upper 5 cm of sediment without drawing surface water. The filter was placed with minimal jostling to avoid creating a cavity around the filter that would allow surface water to enter the sediment and contaminate the porewater. The Rhizon was placed approximately 2 cm away from the stem of the wild rice plant and on the opposite side from where pH was measured (Supplementary Fig. S1).

Porewater sulfide samples were drawn into 50-mL serum bottles preloaded with 0.2% 1 M ZnAc and 0.2% 6 M NaOH to preserve sulfide. Sulfide bottles were left to fill overnight, then stored at 4 °C in the sealed serum bottles used for sample collection for approximately 30 days before sulfide was quantified. Samples for porewater sulfate analysis were withdrawn from sulfide sampling bottles and filtered through a Dionex 1 cc metal cartridge and a 0.45 μm polyethersulfone filter approximately 3 months after they were collected. Porewater iron was collected in 8 mL serum bottles preloaded with 40% deionized water, 40% phenanthroline, 20% acetate buffer, and 1% concentrated hydrochloric acid. Iron bottles were filled until the solution turned light red, approximately 10 min. If the solution turned red before 8 mL were collected, samples were diluted with deionized water to bring the total solution to 8 mL. Iron samples were quantified within 2 h of sampling. Iron and sulfide in porewater were quantified colorimetrically using the phenanthroline and methylene blue methods, respectively, on a HACH DR5000 UV–Vis spectrophotometer (Greenberg et al. 1992). Sulfate was quantified using a Dionex ICS-1100 Integrated IC system (AS-DV Autosampler) (Greenberg et al. 1992). The saturation index was calculated to determine if the porewater was saturated with respect to iron sulfide (Eq. 1, $K_{sp} = 10^{-2.95}$)

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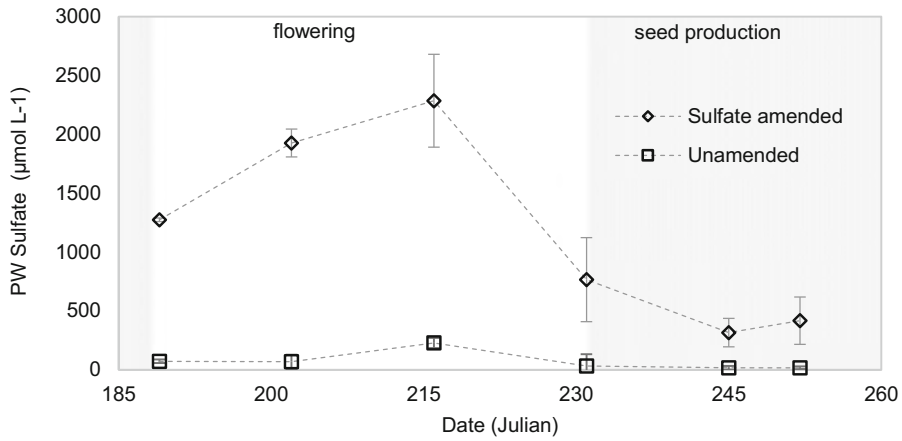


Fig. 1 Seasonal measurements of porewater sulfate concentrations 2 cm from the root surface. Diamonds depict amended plants while squares depict unamended plants. Error bars show one standard deviation around the mean. Shading represents different life stages. Shading on left side of figure represents pre-flowering, unshaded represents flowering, and shading on right represents seed production

(Stumm and Morgan 1996). A positive saturation index indicates oversaturation and a thermodynamic force to drive precipitation, and a negative value indicates undersaturation (and potential dissolution).

$$SI = \log \frac{[IAP]}{K_{sp}} \text{ where } IAP = \frac{[Fe^{2+}][HS^{-}]}{[H^{+}]} \quad (1)$$

Geochemical parameters and measured attributes of plants were analyzed using repeated measures analysis of variance to determine differences between amended and unamended treatments over the course of the growing season. Analyses were performed with a repeated measures ANOVA because although individual plants were harvested on each date, each sampling date was not independent of the prior sample dates. A paired *t* test was used to determine differences between AVS and CRS concentrations on subsamples from the same roots. Analyses were performed using the statistical software SAS. Logarithmic transformations were used when data was non-normal. Data are available at the Data Repository for the University of Minnesota (https://doi.org/10.13020/D68W98).

Results

Porewater sulfate and sulfide

Immediately before sulfate was added to amended buckets on Julian day 154, porewater sulfate concentrations were near 40 µmol L^{-1}. By the start of flowering (day 185), sulfate concentrations in amended porewater were over 1200 µmol L^{-1}, 30 times higher than the initial concentration (Fig. 1). Sulfate concentrations continued to rise for the first 30 days of flowering (until day 217), peaking at nearly 2300 µmol L^{-1}. Over a 4 week period (days 217–245) surrounding the onset of seed production, sulfate concentrations in amended porewater decreased by 86% to 315 µmol L^{-1}. Sulfate concentrations in unamended porewater were about 70 µmol L^{-1} at the start of flowering, roughly double the initial concentrations. Sulfate concentrations peaked at 230 µmol L^{-1} in unamended buckets on the same day as in amended buckets. During the same period that sulfate concentrations declined in amended porewater (days 217–245), sulfate concentrations in unamended buckets decreased by a similar proportion, 91%, to 20 µmol L^{-1}. Porewater sulfide did not differ between amended and unamended treatments (Supplementary Fig. S2). Concentrations averaged between 1 to 5 µmol L^{-1} during flowering and increased to an average of 8–17 umol L^{-1} at the start of seed production. Amended rhizospheres had a higher average sulfide concentration than unamended rhizospheres during seed production, but variability was high on the days porewater sulfide was elevated. Porewater sulfide concentrations decreased near the end of seed production and rose slightly at senescence.

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Acid volatile sulfur on root surfaces

When grown in sediment with sulfate-amended overlying water (3.1 mM), amended plants developed a black coating on their root surfaces by the beginning of seed production on Julian day 231 (Fig. 2). The black precipitate started just above the root ball and extended along the entire length of the roots in the sediments. Adventitious roots that grew at the surface of the sediment, however, remained white, the natural color of wild rice root tissue. Unamended plants, grown in sediment with low concentrations of sulfate in overlying water (0.15 mM), developed amber coatings characteristic of iron (hydr)oxides over the same time period.

Roots of amended plants began accumulating AVS during the flowering stage (Julian days 190–230) of the life cycle (Fig. 3a). The rate of AVS accumulation abruptly accelerated during the seed production stage (days 231–252) from approximately 2 μmol g^{-1} day^{-1} to over 15 μmol g^{-1} day^{-1}. During the seed production stage, amended roots accumulated up to 100 times more AVS than unamended roots, reaching a maximum mean concentration of 298 ± 74 μmol g^{-1} dw at the end of seed production. In contrast, AVS on unamended roots remained at 3.2 ± 1.7 μmol g^{-1} dw throughout the season (Fig. 3b). Between the end of seed production and final senescence (day 265), AVS concentrations on amended roots remained elevated or decreased slightly.



Fig. 2 Sulfate-amended (left) and unamended (right) roots. Sulfate-amended (3.1 mM sulfate in surface water) root has black color extending from about 0.5 cm above the root ball down to the tips of the roots. Unamended (0.15 mM sulfate in surface water) root has amber color characteristic of iron (hydr)oxides, especially in the 2–3 cm below root ball. The photograph was taken during senescence in October, 2014 from a pilot experiment, but color is typical of roots in this experiment. (Color figure online)

Although AVS concentration in amended sediment increased by one order of magnitude over the life cycle (0.5–5 μmol g^{-1} dw, Supplementary Fig. S3), sediment contained approximately 50 times less AVS per gram than the roots. Concentrations of chromium reducible sulfur on both amended and unamended roots did not differ from AVS concentrations on the same roots during seed production, indicating that crystalline forms of FeS did not make up a significant proportion of reduced sulfur (paired t test, $p = 0.27$, $t = 0.63$, $n = 20$).

Iron speciation on root surfaces

During flowering, concentrations of Fe(III) and Fe(II) were similar between amended and unamended roots (Fig. 3). During seed production, the redox state of iron was altered by the presence of sulfate. Concentrations of Fe(II) were much higher on amended roots compared to unamended roots ($p < 0.001$, $F = 19.1$, $df = 1, 31$), despite no significant difference in concentrations of Fe(III) between treatments. During the first week of seed production (between days 232 and 239), the concentration of ferric iron on amended roots decreased by 86%, from 233 ± 135 to 31.7 ± 30.4 μmol g^{-1} dw while ferric iron on unamended roots decreased by 67%, from 438 ± 208 to 144 ± 131 μmol g^{-1} dw. This abrupt reduction of Fe(III) occurred the same week that the rate of net AVS accumulation increased on amended roots (Fig. 2). Following this transition, Fe(II) concentrations continued to increase (doubled) on amended roots but did not change on unamended roots.

Saturation index in porewater

Although the amended and unamended plants had significant differences in the speciation of solid-phase sulfur and iron on roots, the saturation index of FeS in the sediment porewater 2 cm away from the roots was

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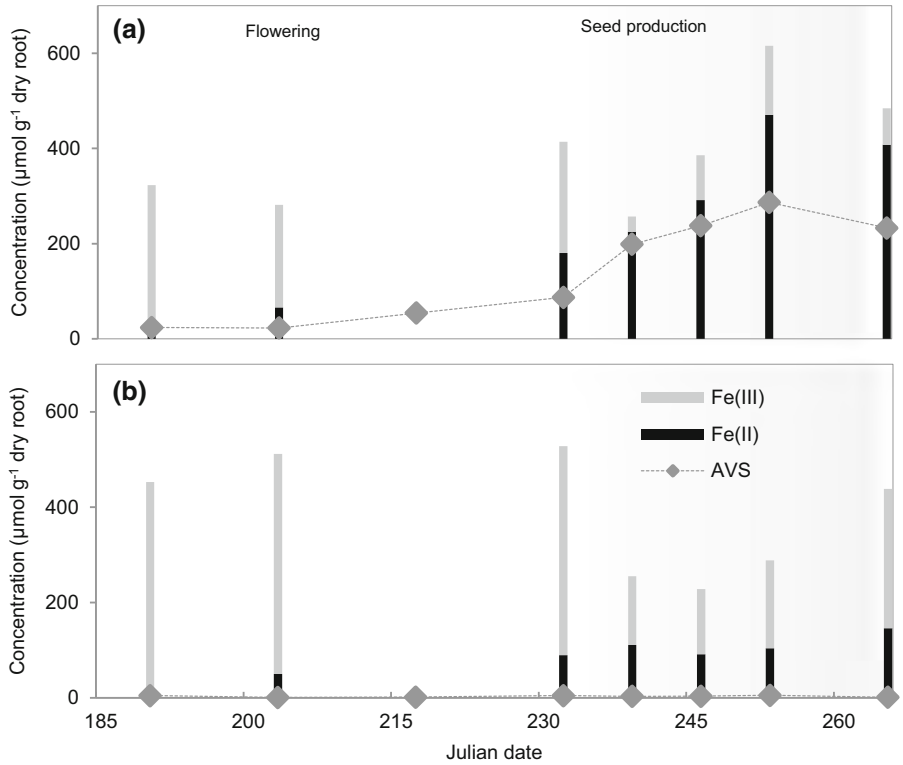


Fig. 3 Seasonal variations in iron speciation and root AVS for **a** sulfate-amended and **b** unamended conditions, and effective E_H on root surfaces. The gray bars in panels **a** and **b** indicate ferric iron and the black bars represents ferrous iron. Root AVS concentrations are shown by gray diamonds. Error bars are omitted for clarity, but standard deviation is on average 33% of the mean

not affected significantly by sulfate amendment ($p = 0.177$, $F = 2.68$, $df = 1,4$) and remained, on average, near zero but mostly negative (-1.4 ± 0.3 to 0.1 ± 1.0) throughout the life cycle (Supplementary Table S1).

Effects on plants

The transition of plants from the vegetative growth stage to the flowering and seed production stages of the life cycle coincided with the onset of a yellowing and senescence of leaves beginning the third week of August (around day 232). Amended plants, all of which developed FeS plaques on roots, produced fewer seeds ($p = 0.067$, $F = 5.00$, $df = 1,6$, Fig. 4) with less nitrogen ($p = 0.052$, $F = 5.84$, $df = 1,6$) and smaller mass ($p = 0.069$, $F = 4.88$, $df = 1,6$). During flowering, total plant N was similar between amended and unamended plants. But, during the subsequent seed production stage, total plant N continued to increase in the unamended plants, but not in the amended plants ($p = 0.084$, $F = 4.27$, $df = 1,6$).

Discussion

We observed rapid shifts in sulfur and iron speciation at the surface of wild rice roots during the plant life cycle that differed depending on sulfate amendment. At the onset of leaf senescence and seed production, sulfate concentrations in the porewater decreased. This was followed shortly by decreased Fe(III) concentrations on the root surface as well as increased, but highly variable, dissolved sulfide concentrations in porewater. At this stage, solid phase-sulfide sulfide increased clearly and consistently on roots of amended plants, but not on unamended plants. The rapid development of FeS plaques was concomitant with the development of fewer filled seeds with lower nitrogen contents. Total plant nitrogen continued to

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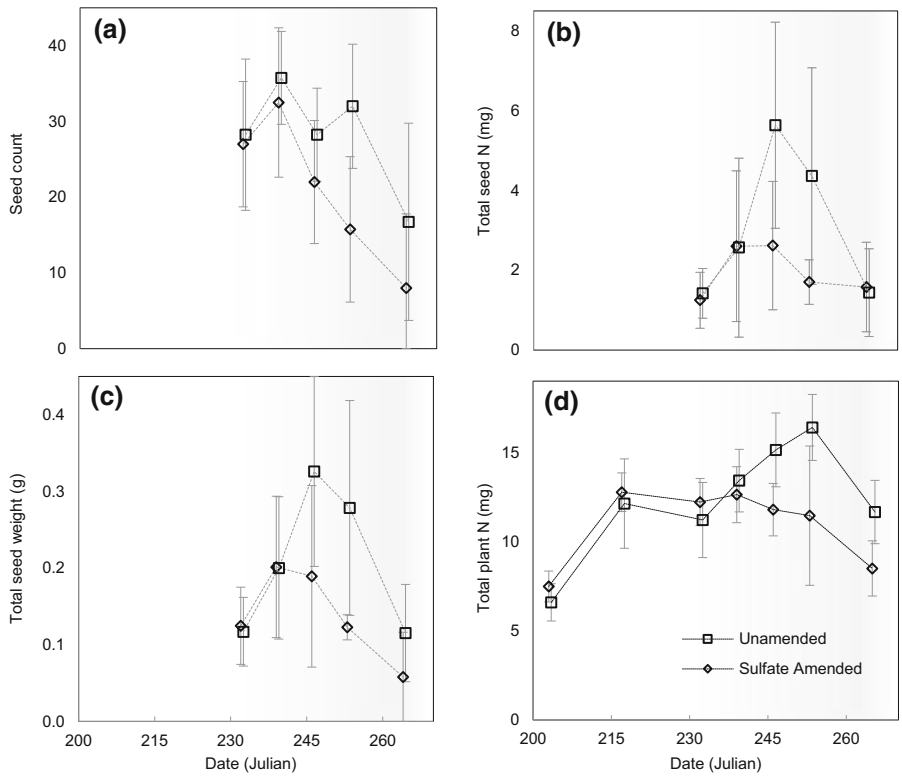


Fig. 4 Plant response in sulfate-amended and unamended conditions; **a** seed count. **b** Total seed mass. **c** Total mass of nitrogen in seeds, **d** total plant nitrogen, calculated by summing nitrogen from seeds, stems, and leaves. Diamonds represent plants grown in surface water with 3.1 mM sulfate and squares represent unamended plants. The shaded background represents the seed production life stage. Error bars represent one standard deviation of four replicates

increase in unamended plants but not in amended plants. The strong divergence between amended and unamended plants in total plant nitrogen and precipitation of FeS suggests a feedback between sulfur biogeochemistry on or near the root surface and plant nutrient uptake.

Sulfate amendments led to more reduced conditions and a more rapid development of iron sulfide precipitate on root surfaces, clearly confirming our hypothesis that surface water sulfate induces FeS accumulation on roots. In the absence of elevated sulfate, unamended plants filled out their seeds even when redox potential declined (Fig. 3, Supplementary Fig S4). In previous experiments with self-sustaining populations of wild rice (Pastor et al. 2017), elevated sulfate had little effect on total vegetative growth of adult plants but was associated with a decrease in the number and weights of seeds produced by mature plants at the late stages of the life cycle. FeS accumulates on roots during the last stages of wild rice's life cycle in which nitrogen taken up by the plant is allocated exclusively to panicles and seeds (Grava and Raisanen 1978; Sims et al. 2012). Porewater sulfide, which is known to decrease nitrogen uptake in plants, increased simultaneously with FeS on roots of amended plants. However, porewater sulfide was variable and increased in both amended and unamended rhizospheres, whereas FeS only increased on amended roots. Nitrogen uptake continued through the seed production phase of unamended plants but not in amended plants, which contained FeS plaques. FeS on roots may be a symptom of elevated porewater sulfide or further exacerbate its effects; our experiment was not able to distinguish between these possibilities. Regardless, the presence of root surface FeS strongly suggests that during seed production, a plant-induced reversal in the flow of electrons occurred: from a net flow of e-accepting capacity away from the root, sustaining Fe(III) in the rhizosphere, to a net flow of e- towards the root, reducing Fe(III) and introducing S(II).

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The decline in nitrogen uptake and seed production concomitant with the initiation of FeS plaque precipitation on roots and porewater sulfide accumulation may explain the disproportionate effect of sulfate on seeds compared with its negligible effect on cumulative vegetative biomass prior to flowering and seed production. We suggest that plants are especially vulnerable to sulfide during seed production, because a seasonal decrease in root surface redox potential is compromised by further sulfide-induced depletion of the electron accepting buffer capacity of iron (hydr)oxides. The oxidation states of the amended and unamended root surfaces diverged during the transition from flowering to seed production (Supplementary Fig. S4), suggesting that root surface redox potential is, in part, controlled by a physiological mechanism tied to the plant's life cycle.

We hypothesize a pathway for how the living wild rice roots transition from iron (hydr)oxide plaques to iron sulfide plaques over the growing season (Fig. 5). Initially, conditions in the rooting zone are oxic, likely from radial oxygen loss (Fig. 5, stage [1]), as evidenced by precipitation of iron (hydr)oxides that accumulate equally on both amended and unamended root surfaces. At this initial stage, the root is protected from the electrons contained in sulfide and other reduced species by an ongoing supply of electron accepting inputs, composed of both oxygen from roots and iron (hydr)oxide coatings on roots (Holmer et al. 1998; Roden and Wetzel 1996). Sulfide encountering the iron (hydr)oxide buffer is oxidized or precipitates with iron while the electron accepting buffer is maintained. In amended conditions, some of this electron accepting buffer may be consumed (Fig. 5, stage [2]) during the flowering stage, allowing dissolved sulfide to penetrate nearer to the root surface. A decrease in radial oxygen loss near the onset of seed production, as vegetative growth ceases and leaves senesce, allows dissolved sulfide to reach the root surface. Sulfide exposure may further suppress radial oxygen loss by inducing suberization, the thickening of cell walls that prevents exchange of dissolved gases across the root (Armstrong and Armstrong 2005). After radial oxygen loss is suppressed, the electron accepting buffer capacity of iron (hydr)oxides can no longer be maintained and the remaining quantity of iron (hydr)oxides is then rapidly reduced due to a net decrease in the supply of electron acceptors to the rooting zone. A decrease in radial oxygen is likely tied to the end of the vegetative growth stage of the life cycle because both the amended and the unamended root surfaces simultaneously experience a loss of Fe(III) and a decline in porewater sulfate concentrations. Concentrations of

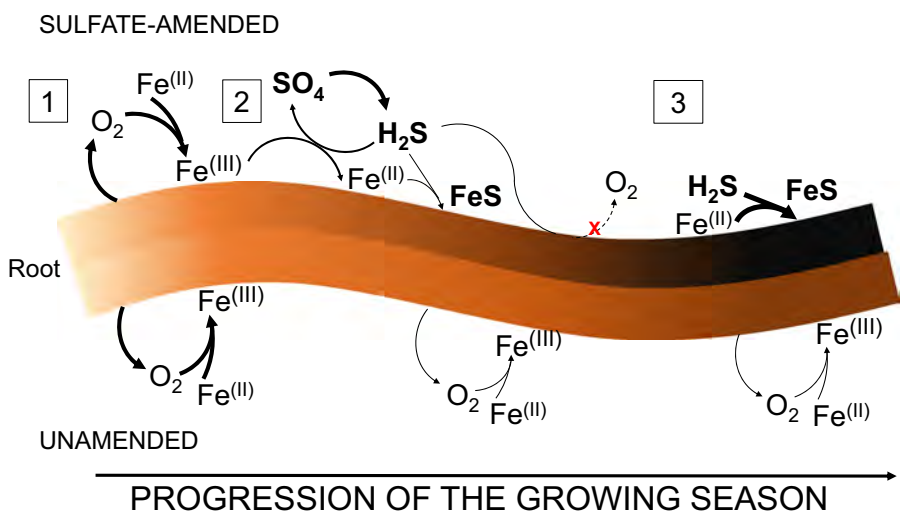


Fig. 5 Proposed mechanism of iron sulfide formation on wild rice roots exposed to elevated sulfate concentrations. Reactions depicted above the root occur on sulfate-amended root surfaces, and reactions depicted below the root occur on unamended root surfaces. Roots are protected by iron (hydr)oxides [1], but these iron (hydr)oxides are reduced by sulfide [2]. Exposure of roots to sulfide may induce suberization, the thickening of root cell walls, which leads to decreased radial oxygen loss. Root surface anoxia accelerates the precipitation of iron sulfides [3]. In unamended roots, radial oxygen loss creates iron (hydr)oxides that remain present the entire growing season but decrease slightly in response to the life-cycle. (Color figure online)

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root Fe(III) and porewater sulfate remained low in unamended plants for the rest of the growing season. But, as the amended root surface shifts toward reducing conditions, sulfide almost exclusively precipitates with reduced iron rather than being re-oxidized (Fig. 5, stage [3]). In our amended buckets, rapid accumulation of root Fe(II), root AVS, and porewater sulfide occurred within a 1–2 week period during seed production immediately following the precipitous decline of porewater sulfate and root surface Fe(III). In unamended buckets, root Fe(II) and AVS did not accumulate further, and while porewater sulfide increased, it was highly variable.

The most likely explanation for a redox transition at both the unamended and amended roots is a decrease in radial oxygen loss at the end of the vegetative growth stage when the leaves begin to senesce. Many mechanisms of rhizosphere oxidation have been described, including diffusion of atmospheric oxygen (Armstrong 1980), advection induced by temperature and vapor gradients (Dacey 1980) and Venturi-induced convection (Armstrong et al. 1992). Several studies have observed a correlation between light and rhizosphere oxygenation on diurnal time scales (Lee and Dunton 2000; Pedersen et al. 2004; Jensen et al. 2005), suggesting that some, if not most, radial oxygen loss may be photosynthetically derived. It has been previously suggested that accumulation of FeS occurs on white rice (*Oryza sativa*) roots only after plant senescence because dead roots no longer oxidize the rhizosphere (Jacq et al. 1991). However, as the plant approaches senescence, oxygen transport to the roots may decrease due to lower photosynthesis rates, subsequently slowing the regeneration of the electron accepting buffer of the root surface (Biswas and Choudhuri 1980). We observed a decrease in redox around the time that plants started to yellow and show early signs of senescence, consistent with a life-cycle-induced decline in radial oxygen loss.

Despite the rapid accumulation of FeS on roots in amended plants, the saturation index in sediment 2 cm from the roots remained relatively low, suggesting that the most severe decline in redox potential was confined to near the root surface. The Fe(II) in the FeS plaques may have come from the reduction of iron (hydr)oxides previously accumulated on the root surface. On the other hand, the sulfide in FeS plaques must have been supplied from a source external to the root. Although experimental conditions may have impacted the timing of sulfate intrusion to the rooting zone, porewater sulfate concentrations were already well above the half saturation constant for biological sulfate reduction at the start of flowering (Pallud and Van Cappellen 2006), making it unlikely that the redox transition occurred from a delay in sulfate availability and reduction at the root surface. Once leaf senescence began, porewater sulfate concentrations ($\sim$ 2000 μmol L^{-1}) declined by more than 80% followed by rapid accumulation of porewater sulfide (from $\sim$ 2 to 12 μmol L^{-1}) and AVS on the root surfaces ($\sim$ 300 μmol g^{-1}). Adjacent porewater sulfide was relatively low compared to the amount of sulfur in the porewater sulfate and root AVS pools. This suggests that a large amount of sulfur passes through the porewater sulfide pool very quickly, a scenario consistent with our proposed mechanism by which sulfide near the root surface is either oxidized by the electron accepting buffer or precipitated with Fe(II). Sediment AVS (5 μmol g^{-1}) was a larger component of overall solid-phase S accumulation due to its larger mass, but did not, apparently, experience the concentrated introduction of sulfide in the same way as roots. The rapid and concentrated accumulation of iron sulfide on roots in the setting of undersaturated porewater suggests an overwhelmingly plant-dominated geochemical niche very close to the root surface.

Beyond affecting wild rice populations, the mechanism behind the rapid accumulation of FeS on roots has implications for the fate of iron and sulfide in wetland sediments. Vegetated sediment in white rice paddies (Jacq et al. 1991) and in riparian wetlands containing *Phragmites australis* and *Zizania latifolia* (Choi et al. 2006) has higher concentrations of FeS than non-vegetated sediment. Significant accumulation of FeS on white rice roots has been observed after senescence (Jacq et al. 1991), likely because decaying root material stimulates iron and sulfate reduction. When roots coated with FeS decompose, the FeS becomes incorporated into the bulk sediment. Due to the concentrated introduction of both electron donors and acceptors to the subsurface, each generation of an annual plant is effectively a "pump" for the incorporation of FeS precipitate into the sediment. In dense stands of aquatic plants, annual contributions of FeS from roots could significantly alter the geochemistry of the sediment within years to decades. If FeS plaques occur concomitantly with population declines in

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wetland plants, the plant-induced sulfur pump may only last a few generations but would have implications for changes in species composition in wetland plant communities. Understanding the rates of the distinctly plant-induced sulfur pump and the short- and long- term interactions of near-root processes with bulk sediment could help to predict how the distribution of wetland vegetation and sulfur accumulation change in response to a perturbation in surface water sulfate concentrations.

The results of this study may provide a mechanistic link between observed sulfide toxicity in lab hydroponic experiments (Koch et al. 1990; Koch and Mendelssohn 1989; Pastor et al. 2017) and empirical evidence of sulfur-induced population declines of wetland plants (Lamers et al. 2002; Myrbo et al. 2017; Pastor et al. 2017; Pulido et al. 2012; Smolders et al. 2003). Our observation that sulfur cycling is altered *during* the life cycle rather than after senescence allows for the possibility of rapid feedbacks between sediment and porewater geochemistry on the one hand and annual plant populations on the other. Understanding the timing of when electron accepting buffers are present or absent and how that correlates with the plant life cycle can provide insight into how populations of wild rice and other aquatic plant species will respond to perturbations in sulfur loading to ecosystems.

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Author contributions SL-H and BD collected and analyzed samples. SL-H performed statistical analyses with guidance from JP. All authors contributed to interpreting the data and writing the manuscript.

Compliance with ethical standards

Conflict of interest The authors declare no competing financial interests.

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WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 13

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Environmental Toxicology

Cumulative Sulfate Loads Shift Porewater to Sulfidic Conditions in Freshwater Wetland Sediment

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Abstract: It is well established that sulfide can be toxic to rooted aquatic plants. However, a detailed description of the effects of cumulative sulfate loads on sulfide and iron (Fe) porewater geochemistry, plant exposure, and ecological response is lacking. Over 4 yr, we experimentally manipulated sulfate loads to self-perpetuating wild rice (*Zizania palustris*) populations and monitored increases in the ratio of sulfur (S) to Fe in sediment across a range of sulfide loading rates driven by overlying water sulfate. Because natural settings are complicated by ongoing Fe and S loads from surface and groundwater, this experimental setting provides a tractable system to describe the impacts of increased S loading on Fe–S porewater geochemistry. In the experimental mesocosms, the rate of sulfide accumulation in bulk sediment increased linearly with overlying water sulfate concentration up to 300 μg-SO_4 cm^{-3}. Seedling survival at the beginning of the annual life cycle and seed mass and maturation at the end of the annual life cycle all decreased at porewater sulfide concentrations between 0.4 and 0.7 μg cm^{-3}. Changes to porewater sulfide, plant emergence, and plant nutrient uptake during seed production were closely related to the ratio of S to Fe in sediment. A mass balance analysis showed that porewater sulfide remained a small and relatively transient phase compared to sulfate in the overlying water and Fe in the sediment solid phase. The results illuminate the evolution of the geochemical setting and timescales over which 4 yr of cumulative sulfate loading resulted in a wholesale shift from Fe-dominated to sulfide-dominated porewater chemistry. This shift was accompanied by detrimental effects to, and eventual extirpation of, self-perpetuating wild rice populations. *Environ Toxicol Chem* 2019;38:1231–1244.
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Keywords: Sulfide; Porewater; Wetland sediment; Rooting zone; Wild rice

INTRODUCTION

The introduction of sulfate to freshwater ecosystems can alter the processing of nitrogen (N), phosphorus (P), iron (Fe), mercury, carbon (C), and other elements (Ardon et al. 2013; Myrbo et al. 2017b), thereby enhancing eutrophication (Lamers et al. 1998) and greenhouse gas emissions (Helton et al. 2014), changing contaminant transformations and mobility (Besser et al. 1996; Jeremiason et al. 2006) and the life cycles of vegetative and benthic organisms (Wang and Chapman 1999; Lamers et al. 2013; Hopfensperger et al. 2014). Because sulfate is a terminal electron acceptor capable of driving heterotrophic anaerobic microbial metabolism (Weston et al. 2011; Myrbo et al. 2017b), rooted freshwater plants and other sediment-dwelling organisms are affected when sulfate is converted to sulfide in anoxic sediments (Bagarinao 1992; Lamers et al. 2013; Pastor et al. 2017). Changes in sulfate loads to freshwater ecosystems occur because of hydrologic modification in coastal zones, increased atmospheric sulfur (S), municipal and industrial wastewater inputs, and differences in wetting/drying cycles induced by climate change (Driscoll et al. 2001; Craft et al. 2009; Hao et al. 2014; Schoepfer et al. 2014). These changed sulfate loads have had ecological consequences including shifts in vegetation, accelerated eutrophication, toxicity to benthic organisms, increased organic matter mineralization in sediment, and increased mercury methylation (Lamers et al. 2002; Smolders et al. 2003; Li et al. 2009; Neubauer 2013; Kinsman-Costello et al. 2015; Myrbo et al. 2017b).

In wetland plants, dissolved sulfide interrupts metalloenzymes in the electron transport chain and disrupts the ability to take up nutrients (Joshi et al. 1975; Koch et al. 1990;

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Martin and Maricle 2015). In contrast, solid-phase sulfides are inert and nontoxic to organisms (Morse et al. 2007). The extent to which microbial sulfate reduction can increase sulfide concentrations in sediment porewaters to toxic levels depends, in part, on the quantity of reactive metals available to precipitate with sulfide, thus removing sulfide from porewaters (Wang and Chapman 1999; Heijs et al. 1999; Pollman et al. 2017). Iron, often the most abundant metal in aquatic sediment, has been identified as having an ameliorating effect on the impacts of sulfide loading to aquatic plants in both experimental (Van der Welle et al. 2006) and natural (Schoepfer et al. 2014) settings. The amount of sulfide in sediment, relative to the quantity of Fe, has been termed "degree of sulfidation", and this framework has been used extensively to understand the current and paleolimnological implications of S and Fe cycling (Morse and Luther 1999; Wijsman et al. 2001). More recently, Schoepfer et al. (2014), van der Welle et al. (2007), and Julian et al. (2017) have studied the balance of Fe and S loads specifically in freshwater systems impacted by sulfate from agricultural pollution and seawater intrusion.

Hydroponic and short-term mesocosm experiments, involving the direct (and often continuous) injection of sulfide or Fe to aquatic media or sediment (compiled in Lamers et al. 2013), have been widely used to identify mechanisms of sulfide's toxicity to plants (Koch and Mendelssohn 1989; Martin and Maricle 2015). However, these typically short-term experiments are not conducive to examining natural processes related to coupled Fe and S cycling that occur during natural loading to intact aquatic sediment. Several field studies at sulfate-impacted freshwater systems have interpreted the vegetative and in situ porewater chemistry implications of S loading in the framework of degree of sulfidation (Burton et al. 2006; Morse et al. 2007; Hopfensperger et al. 2014; Schoepfer et al. 2014; Julian et al. 2017). Studies in natural settings, however, typically cannot control conditions in a manner conducive to a detailed evaluation of evolving sediment sulfide in response to altered sulfate loading. Long-term (e.g., multiyear) mesocosm studies employing a slow and continuous production of sulfide in sediments (Lamers et al. 1998; Howes et al. 2005; van der Welle et al. 2006; Geurts et al. 2009) are most conducive to investigating the progressive depletion of reactive Fe in a setting analogous to natural wetlands with enhanced sulfate loads. No studies of this nature, however, have described in detail the evolution of toxic, sulfide-rich, geochemical conditions in porewater over the entire timescale needed for increased sulfide production to overwhelm the loading of Fe to sediment in a natural setting.

The objective of the present study was to test the impacts of sulfate loading on Fe geochemistry and the population dynamics of an annual freshwater wetland species, wild rice (*Zizania palustris* L.). Wild rice grows in thick monotypic stands mostly confined to shallow lakes and rivers of the Lake Superior region in North America (Day and Lee 1990) and is usually found in waters with sulfate concentrations <10 mg L^{-1} (Moyle 1944). Sulfate-poor freshwater ecosystems have experienced increases in surface water sulfate in response to elevated rainwater sulfate over the past century (Driscoll et al. 2001). More recently, wild rice and other freshwater aquatic plants have become threatened by increases to sulfate loading from agricultural and industrial discharges (Lens et al. 1998; Orem et al. 2011; Berndt et al. 2016), which can elevate surface water sulfate significantly above natural levels and those elevated from acid rain. Hydroponic, mesocosm, and field results have shown that porewater sulfide is toxic to wild rice at levels near 0.3 μg cm^{-3} (Pastor et al. 2017) and that sediment Fe is a key factor controlling the presence of wild rice in field conditions (Myrbo et al. 2017a; Pollman et al. 2017). However, the evolution of sediment geochemistry in response to altered S loads has not been described in detail. The present study was conducted in outdoor mesocosms containing self-perpetuating wild rice populations growing in natural wild rice sediment. The experimental design allowed for a precise manipulation of the loading rate of S to continuously inundated sediment by controlled concentrations of sulfate in the overlying water (Pastor et al. 2017). The temporal and spatial evolution of porewater geochemistry, solid-phase geochemistry, and impacts to the self-perpetuating wild rice populations were quantified over 4 yr. The present results interpret how the interannual increases in porewater sulfide in mesocosm sediment correspond to the loading of sulfate from surface water and contextualize the geochemical setting in which detrimental effects to, and eventually extirpation of, wild rice was observed.

METHODS

Sulfate amendments to the overlying water of wild rice tank mesocosms described by Pastor et al. (2017) began in the summer of 2011 and continued through 2015 at 5 different amendment levels: nominally approximately 0, 50, 100, 150, and 300 mg-SO_4 L^{-1}. This range is well above that found in remote regional streams impacted only by atmospheric S sources but spans that found in Minnesota surface waters (Myrbo et al. 2017b), some of which are impacted by neutral pH mining-influenced water (Berndt et al. 2016). This range of sulfate also encompasses the US Environmental Protection Agency's (USEPA's) 250 mg L^{-1} secondary drinking water standard and the existing 10 mg L^{-1} standard to protect wild rice in the state of Minnesota (Myrbo et al. 2017a). Methods of maintaining the mesocosms are described in detail by Pastor et al. (2017). Briefly, 6 replicate tanks at 5 sulfate amendment levels were maintained using polyethylene stock tanks (0.75 m^2 area, 61 cm depth) containing a 10-cm-thick layer of sediment rich in organic matter (15% C, 1.1% N, 1.5% Fe, 0.005% S) from a local wild rice water body and a 23-cm-deep overlying water column. Water and sulfate levels in mesocosms were maintained by weekly additions of well water averaging 8 to 10 mg L^{-1} sulfate, 0.17 mg L^{-1} Fe, and <0.05 mg L^{-1} N and P. When necessary (approximately every 2 wk during the growing season), sodium sulfate stock solution was added to each of the 30 experimental mesocosms to account for rain water dilution, evaporation, and flux of sulfate into sediment. The exact concentrations of overlying water in sulfate-amended tanks are slightly less than the targeted nominal concentrations because of rainfall and other factors, whereas the overlying water of control tanks (no extra sulfate addition) averaged approximately 8 mg/L because of sulfate in well

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water. The exact overlying water sulfate concentrations over the 4 yr are reported in Pastor et al. (2017).

Sample collection

During each of the summers from 2012 to 2015, passive porewater equilibrators (peepers) were deployed to make depth-profile porewater measurements in mesocosms. During the summer of 2012 and 2013, peepers were deployed in 2 mesocosms at each of 4 sulfate treatment levels (control, 50, 150, and 300 mg L^{-1}). In 2014 and 2015, peepers were deployed in to mesocosms at all 5 treatment levels. During each of the 4 experimental yr, depth profiles of porewater chemistry were collected with peepers in early summer (June) and late summer (August). Sediment cores were collected in 2013 and 2015 during peeper retrieval in locations coincident with peepers, sectioned into 1- to 3-cm intervals, and frozen for preservation. Cores were collected with a 2.5-cm-diameter, thin-walled polycarbonate manual piston corer to minimize disturbance and preserve sediment structure during collection. Cores and porewater sampling locations were targeted to remain at least 5 to 10 cm away from wild rice stems and roots.

Peepers similar to those described in Teasdale et al. (1995) were constructed of 0.5-inch-thick, 24 × 6–inch acrylic sheet plastic beveled at one end and milled to contain 35 wells that were 1 cm deep and spaced 1.56 cm apart. Large-diameter (~12 inch) circular filter paper (0.45 µm polyethersulfone; Supor; Pall Life Sciences) and a protective nylon mesh (200-µm openings; Industrial Netting) were cut to fit over the wells and secured in place using a face plate with openings corresponding to each well. Small stainless steel machine screws were used to seal the face plate tightly against the filter paper and prevent water from bypassing filter material. Peepers were assembled in the laboratory while submerged in distilled water to avoid any bubbles. They were then immediately placed in an upright container filled with distilled water that was purged of oxygen by a continuous flow of N through a fine bubble diffuser. After 4 to 6 d, the peepers were transported to the field mesocosms in deoxygenated water, inserted into the sediment, and secured to the edge of the mesocosms with nylon string. Following a 2- to 3-wk deployment (Fisher and Reddy 2001), peepers were removed from the sediment and submerged in water purged of oxygen during the brief (<2 min) transport to a processing station. Mud was quickly removed from the filter paper surface with distilled water, and the tops of wells were quickly dried with Kimwipes before the peeper was placed into a N-filled bag for sample extraction (Koretsky et al. 2008). Beginning with the deepest well, samples were extracted from each peeper by puncturing the N-filled bag, nylon mesh, and filter paper with a hypodermic needle affixed to a polypropylene syringe barrel. The extracted sample was immediately injected into vials preloaded with reagents for Fe and sulfide analysis. pH was measured immediately (within 30 s) on a separate sample aliquot prior to degassing of carbon dioxide from the sample. A final aliquot of porewater sample for anion analysis was filtered through a cation exchange filter (Dionex; OnGuard II-M) to remove Fe, acidified with 0.25% concentrated hydrochloric acid, and purged with a slow stream of N for 10 min to remove dissolved inorganic sulfide. Although all anion samples were acidified, only those with a noticeable colorimetric response for sulfide were purged with N. The entire extraction and preservation process for 12 to 16 wells in a single peeper profile typically took less than 45 min, during most of which the peeper was under a N atmosphere.

Analytical methods

Sulfate was measured on a Dionex ICS-1100 ion chromatograph (Thermo Scientific AS22 IonPac 4 × 250–mm anion exchange column) using the Chromeleon software for peak integration. Sulfide and ferrous Fe were quantified spectrophotometrically using the methylene blue method (Eaton et al. 2005a) as implemented with Hach sulfide reagents (method 4500 S2-D) and the phenanthroline method (Eaton et al. 2005b), respectively. The sulfide method quantifies all dissolved sulfide (both H_2S and HS^-) and is therefore not sensitive to pH. Sulfide was quantified within 1 h of collection on a field spectrophotometer, and Fe was stored on ice and transported to the laboratory for quantification within 4 h of collection. A Thermo Orion epoxy pH electrode, with temperature correction calibrated in the field immediately prior to sample measurements was used to measure pH. The detection and reporting limits for each dissolved analyte are summarized in Supplemental Data, Table SI-1.

Frozen sediment samples were used to quantify acid volatile sulfides (AVSs) immediately after thawing using a strong acid digestion (9 N hydrochloric acid [HCl] + stannous chloride; Eaton et al. 2005a). A separate, homogenized, and split aliquot was used to quantify solid content and loss on ignition as a proxy for C content (Dean 1974). Iron in the solid phase was extracted from freeze-dried sediment using a weaker acid digestion (0.5 N HCl), as outlined in Myrbo et al. (2017a), and quantified on an Elan 3000 inductively coupled plasma mass spectrometer using a customized standard from Inorganic Ventures. For a subset of sediment samples from the mesocosms, Fe speciation and quantity were investigated using paired weak acid digestions (0.5 N HCl) in which both ferrous and total Fe were quantified with a strong acid digestion (aqua regia) for total Fe. A sequential extraction on the same subset of samples was also used to quantify recalcitrant (pyrite) phases that resist extraction with weaker methods. For these samples, sulfide was extracted sequentially with 0.5 N HCl (paired with Fe speciation [Myrbo et al. 2017a]), 9 N HCl with stannous chloride (Eaton et al. 2005a), and chromium reducible S (Fossing and Jørgensen 1989) and captured for spectrophotometric quantification in 0.2 M zinc actinium using a modified diffusion method (Brouwer and Murphy, 1994) sequentially.

Data analysis

Depth-dependent estimates for porosity and bulk density were made from solid content and loss on ignition

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measurements on sediment samples from intact cores using the relationship outlined in Gosselink et al. (1984). The depth-integrated mass of S over depth was calculated by integrating the product of concentration and porosity (for dissolved phase) or concentration and bulk density (for solid phase). In most cases, experimental quantities are aggregated over all 4 experimental yr (porewater sulfate mass, porewater sulfide concentration, solid-phase sulfide) so that each experimental treatment level had 8 replicates during each season (June and August), providing a basis for statistical comparisons. In cases where significant changes in experimental quantities occurred over time (porewater Fe mass, porewater sulfide mass, solid-phase sulfide), results are presented as the average of duplicate measurements. In these cases, regressions of average measurements versus treatment level or time are used in the interpretation rather than analysis of variance (ANOVA) statistics.

The maximum rate of diffusion-driven flux was estimated from porewater observations by identifying the largest change in sulfate concentration between adjacent peeper wells and multiplying this gradient by an effective diffusion coefficient by adjusting molecular diffusion for porosity (Boudreau 1996). Significant differences in the main effects of treatment level and year on sulfide and Fe mass in porewater were evaluated using 2-way ANOVA with repeated measures in SigmaPlot for each season. For sulfate, measurements from all experimental years were aggregated, and the effects of treatment level and season were evaluated using 2-way ANOVA with repeated measures. Linear regressions using Pearson's correlation test on the average of sulfate porewater mass for all experimental years were used to evaluate the significance of the relationship with overlying water sulfate and time.

The slope of a linear regression of sediment AVS versus year was used to provide an estimate for the rate of annual accumulation of solid-phase sulfide and to make an estimate for the S:Fe ratio in sediment during years in which sediment cores were not collected. Plant emergence, juvenile survival, filled seed ratio, seed mass, and total biomass data reported in Pastor et al. (2017) were normalized to observations in the control mesocosms during each year to place all observations (from different years) on a consistent basis for comparison to the accumulating solid-phase and porewater sulfide. In most cases, the mass of sulfate in sediment porewater is expressed in terms of "sulfate as S" (96 mg sulfate = 32 mg sulfate as S) to facilitate stoichiometric comparisons with sulfide quantities in sediment. Surface water sulfate concentrations are expressed "as sulfate" to maintain consistency with prior work on S impacts to wild rice ecosystems (Pastor et al. 2017; Myrbo et al. 2017b).

RESULTS

Constant mass of sulfate in porewater

In porewater near the sediment–water interface, sulfate was consistently elevated at concentrations approaching those present in the overlying water and depleted below 2 to 5 cm (Figure 1A). This pattern unambiguously indicates a supply of sulfate from the overlying water and is consistent with the reduction of sulfate to sulfide in anoxic sediments. Sulfate mass in porewater was strongly correlated with overlying water sulfate concentration in amended mesocosms (Figure 1B; $p < 0.01$, regression coefficient provided in Supplemental Data, Table SI-2). The mass of sulfate (presented as mass of S) in the top 10 cm of sediment porewater (Figure 1B) ranged from <5 to >75 μg-S cm^{-2} and did not differ significantly (at each sulfate amendment level) over the course of the 4-yr experiment ($p > 0.3$ for regression with year; data not shown). Concentrations of sulfate in porewater and surface water were more variable in June, owing to less consistent sulfate amendments and rainwater dilution, though the overall mass of sulfate in porewater was not significantly different in June relative to August ($p = 0.55$).

The observed maximum spatial gradient in porewater sulfate provides an estimate for the maximum diffusive flux of sulfate into sediment. Consistent with the overall mass of sulfate in mesocosm porewater, these estimates for diffusive mass flux of sulfate into sediment (presented as S mass flux) were almost perfectly correlated with overlying water sulfate (Figure 1C; $p < 0.001$, June and August, regression coefficients provided in Supplemental Data, Table SI-2). Although surface water concentrations were, on average, slightly lower during August (by ~15%), maximum observed sulfate gradients, and hence estimated diffusive fluxes, were significantly ($p < 0.005$) higher in August than June.

Cumulative increases in porewater sulfide, decreases in porewater Fe

Sulfide concentrations were highest in the top 3 to 5 cm of sediment porewater in all sulfate-amended tanks at locations coincident with steep spatial gradients in sulfate concentration (Figure 2A). In later years of the experiment, maximum porewater sulfide concentrations exceeded 5 to 10 μg cm^{-3} in tanks amended with 300 mg L^{-1} sulfate in overlying water. Depth-integrated porewater sulfide mass in the top 10 cm of sediment showed clear patterns both with overlying water sulfate and progressively over the 4-yr study (Figure 2C and D). During August, porewater sulfide mass increased with overlying water sulfate during every year of the study (regressions included in Supplemental Data, Figure SI-1). Increases from year to year in porewater sulfide mass were largest during August in the tanks with 150 and 300 mg L^{-1} sulfate in overlying water, but porewater sulfide mass of tanks amended with only 10 and 50 mg L^{-1} sulfate in overlying water also experienced consistent interannual increases in August porewater sulfide mass. During August, depth-integrated porewater sulfide mass was <0.4 μg cm^{-2} in tanks without sulfate amendment during all years of the experiment, but porewater sulfide mass in sediment subject to the highest sulfate amendments progressively increased to 25 μg cm^{-2} over the 4-yr experiment.

Dissolved Fe concentration in porewater increased with distance from the sediment–water interface to >25 μg cm^{-3} at depths >5 cm (Figure 2B) in porewaters without sulfate amendment. In mesocosms with >50 mg L^{-1} sulfate in the overlying water, porewater Fe was lower, especially in the

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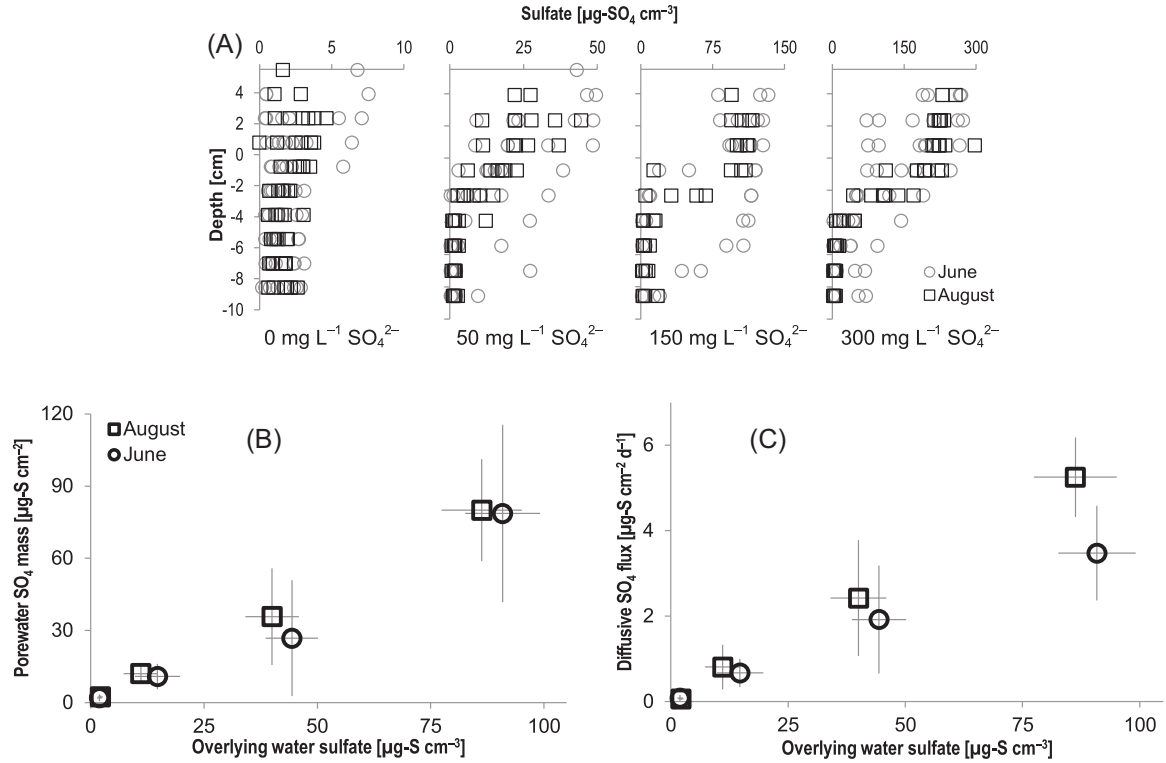


FIGURE 1: (**A**) Depth profiles of porewater sulfate concentrations (as sulfate) in sulfate-amended mesocosm sediment in June and August. Data compiled for all years between 2012 and 2015. (**B**) Depth-integrated porewater sulfate mass (as sulfur) between 0 and 10 cm versus overlying water sulfate (as sulfur). (**C**) Estimated maximum diffusive sulfate mass flux (as sulfur) versus overlying water sulfate (as sulfur). Sulfate labels in (**A**) refer to nominal overlying water concentration (as sulfate) applied during experiments. Vertical error bars in (**B**) and (**C**) represent 1 standard deviation from the mean of 8 replicate measurements for each amendment level, aggregated over 4 experimental yr. Horizontal error bars in (**B**) and (**C**) represent 1 standard deviation from the mean of biweekly measurements of overlying water sulfate concentration during June and August, aggregated over 4 experimental yr.

surface 5 cm of sediment where sulfide concentrations were elevated. Interannual comparisons showed progressive depletion of depth-integrated porewater Fe mass, especially in the heavily sulfate-amended mesocosms (Figure 2E and F). Depth-integrated porewater Fe mass ranged from 70 to 100 µg cm^{-2} in the tanks without sulfate amendment to 2 to 20 µg cm^{-2} in the tanks with the highest sulfate amendments. The observed patterns showed increases in porewater sulfide mass and decreases in porewater Fe mass both with increasing overlying sulfate and over the course of the 4-yr study. This strongly suggests that, especially in the tanks receiving the highest sulfate loads, a progressive depletion in the Fe available to complex with dissolved sulfide caused increases in porewater dissolved sulfide.

Seasonal differences in porewater geochemistry are of interest because specific life stages of wild rice appear to be impacted by porewater sulfide. The seedling phase in spring and the seed production phase in late summer are impacted by sulfide, but sulfide only weakly affected the period of vegetation growth in between (Pastor et al. 2017; LaFond-Hudson et al. 2018). During August, the porewater sulfide mass was 2 to 7 times higher than during June at the highest 2 sulfate treatment levels; however, concentrations in June were more variable and not as consistently related to surface water sulfate (Supplemental Data, Figure SI-1). Porewater Fe mass was significantly lower during August in all sulfate addition treatments, consistent with the pattern of elevated sulfide during August and the insolubility of Fe–sulfide solid phases. The seasonal differences in porewater sulfide and Fe mass (Figure 2) between June and August suggest that the sediment is experiencing faster rates of sulfate reduction during warmer temperatures in mid-August (18.5 °C average) relative to early June (11.7 °C average). It is also possible that faster rates of sulfate transport (Figure 1C) enabled faster diffusion under warmer conditions or that the development of sulfate-reducing biomass led to faster rates of sulfate reduction later in the growing season.

The increases in porewater sulfide mass between June and August (of 10–20 µg cm^{-2} at the highest amendment level) show that inputs of sulfide to sediment porewater are occurring at a (net) rate faster than removal through oxidation or Fe–sulfide precipitation. This is consistent with a progressive increase in oversaturation of FeS in sediment porewater through the summer (ion activity product; Supplemental Data, Figure SI-2). A more rapid input of dissolved sulfide later in the summer would increase the driving force for FeS precipitation. The consistent relationship between Fe and sulfide in porewater observed during August was likely attributable to the

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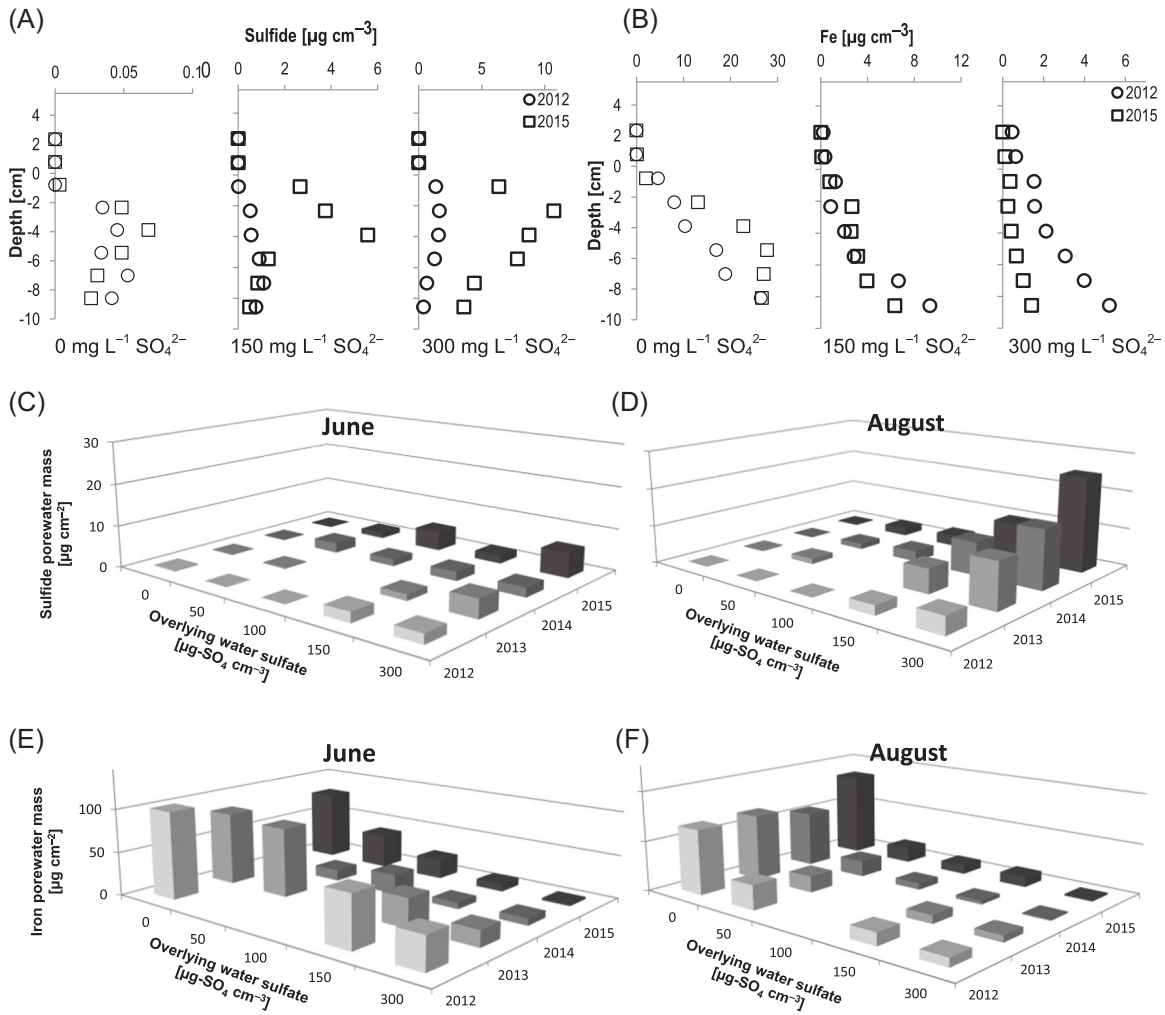


FIGURE 2: Depth profiles of mean porewater (**A**) sulfide and (**B**) iron in mesocosm sediment at 3 sulfate amendment levels (0, 150, 300 mg L^{-1}) in August 2012 and August 2015. Values are the mean of 2 replicate measurements. Depth-integrated mass of porewater (**C**,**D**) sulfide and (**E**,**F**) iron in sediment between 0 and 10 cm for all sulfate amendment levels during all years in June (**C**,**E**) and August (**D**,**F**). Overlying water sulfate labels refer to nominal overlying water concentration (as sulfate) applied during experiments.

consistent, thermodynamically driven process of FeS precipitation driven by oversaturation. The more variable dissolved Fe and sulfide concentrations in June and the less significant relationships of dissolved sulfide to overlying water sulfate are consistent with less sulfide-driven thermodynamic constraints on porewater Fe and sulfide when the introduction of sulfide is slower or more variable earlier in the summer.

Cumulative increases in solid-phase sulfide

Sulfide in the sediment solid phase (extracted with 9 N HCl) began uniformly low at the outset of the experiment (~80 µg g^{-1}, or 212 µg cm^2) and increased to >4000 µg g^{-1} in surficial sediment after 4 yr in the most heavily sulfate-amended sediment (Figure 3A and B). Regressions of sediment sulfide against year suggest that, on average, over the first 4 yr of sulfate amendments to mesocosms, sulfide is accumulating in sediment linearly with time (Figure 3C; regression coefficients provided in Supplemental Data, Table SI-2) and at faster rates in proportion to overlying sulfate concentrations (Figure 3D). Approximately 22 µg cm^{-2} yr^{-1} of sulfide accumulated in the top 10 cm of the sediment solid phase for every µg cm^{-3} of sulfate (as S) present in the overlying water (Figure 3D). Even in experimental mesocosms receiving no sulfate amendments to the overlying water, the sulfate present in the overlying well water (averaging 5–10 mg L^{-1} as sulfate) led to increases in sediment sulfide. In sediment amended with 300 mg L^{-1} sulfate, depth-integrated sulfide mass in the sediment solid phase exceeded 4000 µg-S cm^{-2} after only 2 yr of amendment, whereas sediment amended with 150 mg L^{-1} sulfate reached 4000 µg-S cm^{-2} after 4 yr (Figure 3C).

Sulfate reduction rates in sediment are not typically proportional to sulfate at concentrations above 50 to 200 mg L^{-1} (as sulfate; Pallud and Van Cappellen 2006). However, the linear relationship between solid-phase sulfide accumulation rate and overlying water sulfate suggests that in these mesocosm sediments the accumulation of sulfide in the solid phase continued to be (at least in part) limited by the supply of sulfate up to approximately 300 mg L^{-1} (as sulfate) in surface waters. In heavily amended mesocosms, the zone of sulfate reduction in

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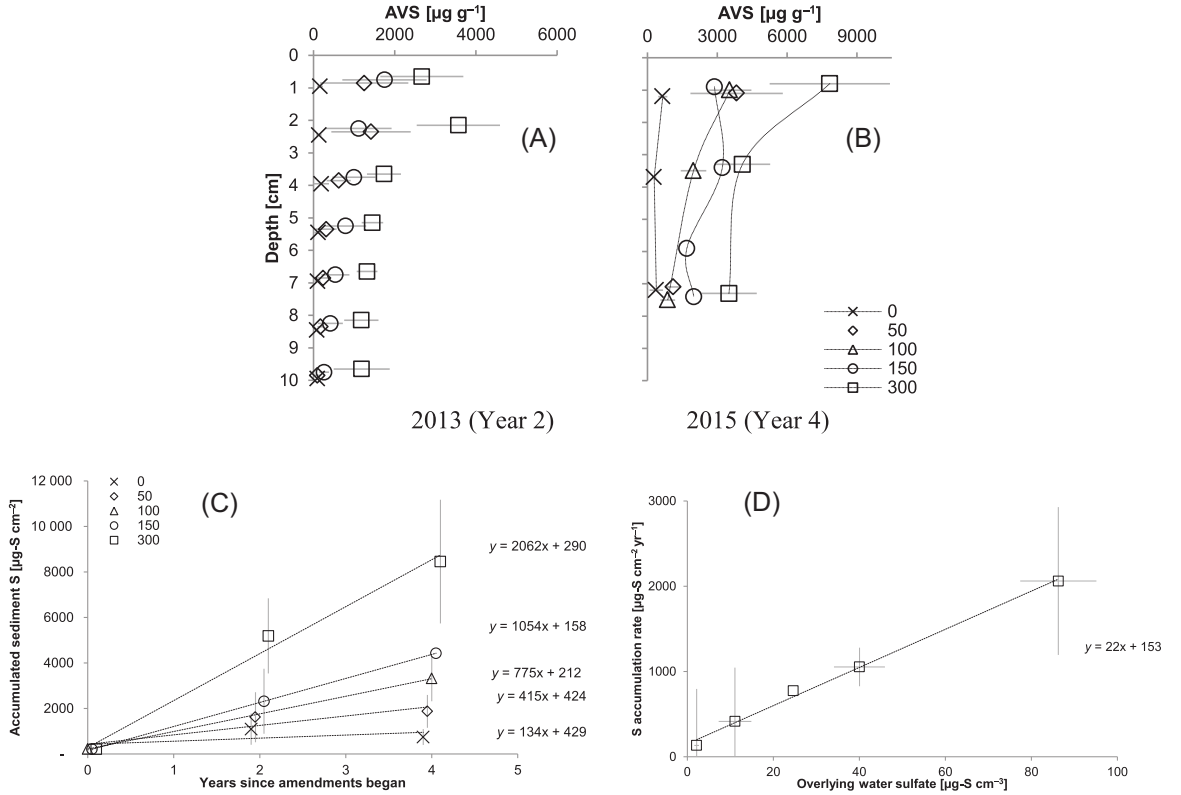


FIGURE 3: Depth profiles of sediment sulfide concentration (extracted with 9 N HCl + stannous chloride) in sulfate-amended mesocosm sediment in (**A**) August 2013 and (**B**) 2015. Error bars represent 1 standard deviation from the mean of triplicate measurements at each depth. Depth-integrated sediment sulfide mass between 0 and 10 cm: (**C**) depth-integrated mass over 4 yr and (**D**) annual sulfide accumulation rate versus overlying water sulfate. Symbols in (**A**–**C**) refer to nominal overlying water concentration (as mg sulfate L^{-1}) applied during experiments. In (**C**) error bars represent 1 standard deviation from the mean of sulfide mass estimates from triplicate depth profiles. In (**D**) vertical error bars represent the 95% confidence interval in the slopes of regressions in (**C**); horizontal error bars represent 1 standard deviation in biweekly measurements of overlying water sulfate concentration during June and August aggregated over 4 experimental yr.

sediment may have expanded in response to overlying water sulfate amendments (Figure 1A), thereby creating an opportunity for a net increase in the depth-integrated (areal) rate of sulfate reduction and Fe sulfide accumulation, even above approximately 100 mg L^{-1} overlying water sulfate.

Cumulative increase in solid-phase S:Fe ratio

Iron concentration in the surface 10 cm of the mesocosm sediment solid phase (extracted with 0.5 M HCl) averaged 144 (±20) µmol g^{-1} (Supplemental Data, Table SI-4). This equates to a depth-integrated Fe mass of 305 (±61) µmol-Fe cm^{-2}. Over the course of the 4-yr study and across a 2–orders of magnitude range in sulfate loading rate, sulfide in sediment porewater began to build up as the stoichiometric quantity of sulfide approached that of Fe in the solid phase (Figure 4A and B). The trend of increasing porewater sulfide with S:Fe ratio was particularly stark during August when average porewater sulfide in the surface 7 cm of sediment ranged from 1 to 8 µg cm^{-3} in mesocosms during years when the S:Fe ratio exceeded 0.2 to 0.5 in the sediment solid phase. In June, concentrations of porewater sulfide were also low (<0.1 µg cm^{-3}) in mesocosms with low S:Fe ratios (<0.5), but sulfide increased considerably (>0.5 µg cm^{-3}) in mesocosms with S:Fe ratios exceeding 0.2 to 0.5. Analogous trends were present in the relationship between S:Fe ratio and dissolved ferrous Fe (Figure 4C and D). Adverse effects to wild rice have been observed at both the early and late life stages of wild rice's annual life cycle (LaFond-Hudson et al. 2018). It is, therefore, notable that a similar threshold in S:Fe ratio was related to higher porewater sulfide during both June and August because the processes that control porewater sulfide may differ between seasons.

Although sulfate remained in the overlying water during experiments, Fe was always below detection limits in overlying water (<100 µg L^{-1}). An average addition of 178 L yr^{-1} well water with a maximum observed concentration of 0.6 µg cm^{-3} would have increased the extractable Fe content of sediment in mesocosms by <0.4% over the course of the 4-yr study (18 µg cm^{-2} yr^{-1}), assuming all the Fe from the well water went into the 0.5 N extractable phase. On average, >85% of loosely bound (0.5 N HCl) Fe was found to be in the reduced (ferrous) form at all sediment depths (Supplemental Data, Table SI-4). Assuming a 1:1 stoichiometry in amorphous FeS, approximately 10 000 µg-S cm^{-2} of sulfide would be needed to bind all extractable Fe into insoluble FeS complexes in the top 10 cm of sediment.

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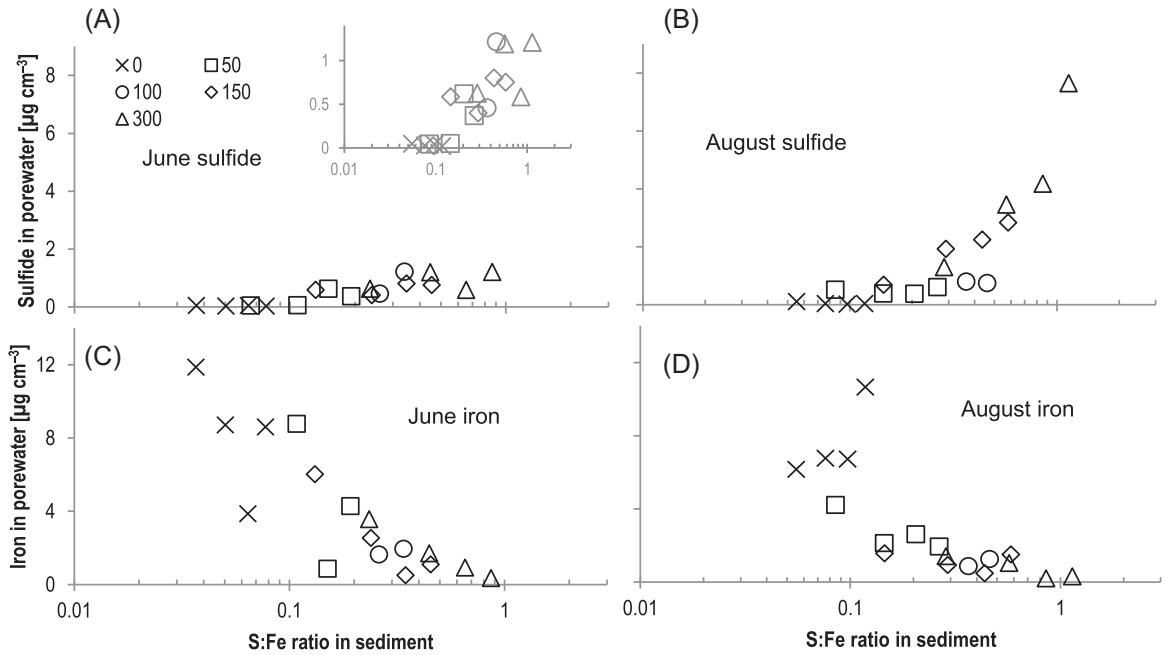


FIGURE 4: Porewater concentration of (**A**,**B**) sulfide and (**C**,**D**) iron versus the S:Fe molar ratio in sediment during (left) June and (right) August over the course of continuous sulfate loading to sediment in mesocosms. Each point on the graphics corresponds to the average of measurements (top 7 cm of sediment) made during a single season for individual years. Symbols refer to nominal overlying water concentration (as mg sulfate L^{-1}) applied during experiments.

Chromium reduction of sediment S typically extracted <15% additional S from the sediment following 9 N acid extractions in heavily S-amended tanks. A weaker extraction, using 0.5 N acid, quantified S at levels similar to the 9 N acid (Supplemental Data, Table SI-4). These sequential extractions suggest that most of the new, solid-phase inorganic S is present as amorphous or weakly bound monosulfur FeS complexes. For the present analysis, the accumulation of sulfide mass in the sediment solid phase was quantified by normalizing AVS (9 N HCl + stannous chloride) by the pool of ferrous Fe extracted with a 0.5 N acid digestion. Total aqua regia–extractable Fe was 15 to 40% higher than the 0.5 N acid Fe for heavily sulfate-amended mesocosms and 70 to 120% higher than the 0.5 N acid Fe for control mesocosms (Supplemental Data, Figure SI-3). Though the exact nature of the pool of solid-phase Fe and its reactivity toward sulfide was not investigated in detail, the S:Fe ratio chosen for weakly bound FeS (analogous to degree of sulfidation) was used as a means of characterizing the accumulation of S under different loading rates.

Cumulative impacts on plant growth and reproduction

Early in wild rice's annual life cycle, plant emergence and juvenile survival decreased during years when porewater sulfide concentrations during June averaged >0.4 µg cm^{-3} in the top 7 cm of sediment (Figure 5A and C). These results are consistent with the range of sulfide concentrations at which wild rice seedling growth is stunted in hydroponic experiments with wild rice (Pastor et al. 2017) and in the range of those measured for other sensitive freshwater wetland plants (Lamers et al. 2013). These concentrations are well below those reported to be toxic by Fort et al. (2017) in hydroponic experiments. The seedlings in the Fort et al. (2017) experiment (maximum age 21 d) were allowed to emerge into ambient air above the water, whereas the seedlings in the Pastor et al. (2017) experiment (maximum age 17 d) were maintained under water. The greater tolerance of wild rice to sulfide observed by Fort et al. (2017) may be the result of the seedlings' access to atmospheric oxygen, which would allow the internal detoxification of absorbed sulfide by S dioxygenase (SDO; Krüssel et al. 2014). The activity of SDO is limited by oxygen availability. In nature, 21-d-old wild rice seedlings have typically not emerged into the atmosphere (Fort et al. 2017) but are not uniformly subject to sulfide exposure of all tissue (Pastor et al. 2017).

Later in the life cycle, decreases (relative to the control mesocosms) in filled seed ratio, filled seed mass, and total biomass were observed in mesocosms during years when porewater sulfide concentrations during August exceeded 0.7 µg cm^{-3} in the surface 7 cm of sediment (Figure 4E, G, and I). Effects on later life stages of wild rice were observed at higher porewater sulfide concentrations than those known to be toxic to seedlings. However, effects on later life stages may be realized as a result of inhibition of N uptake as Fe sulfide precipitates accumulate on roots and sulfide erodes an oxidized Fe barrier around the root, allowing sulfide to penetrate closer to root surfaces (LaFond-Hudson et al. 2018).

Across a range of sulfate-loading rates (<200–2000 µg S cm^{-2} yr^{-1}) and times needed to titrate uncomplexed Fe in sediment, the S:Fe ratio was consistently related to biological responses in wild rice plants (Figure 4B, D, F, H, and J). Though

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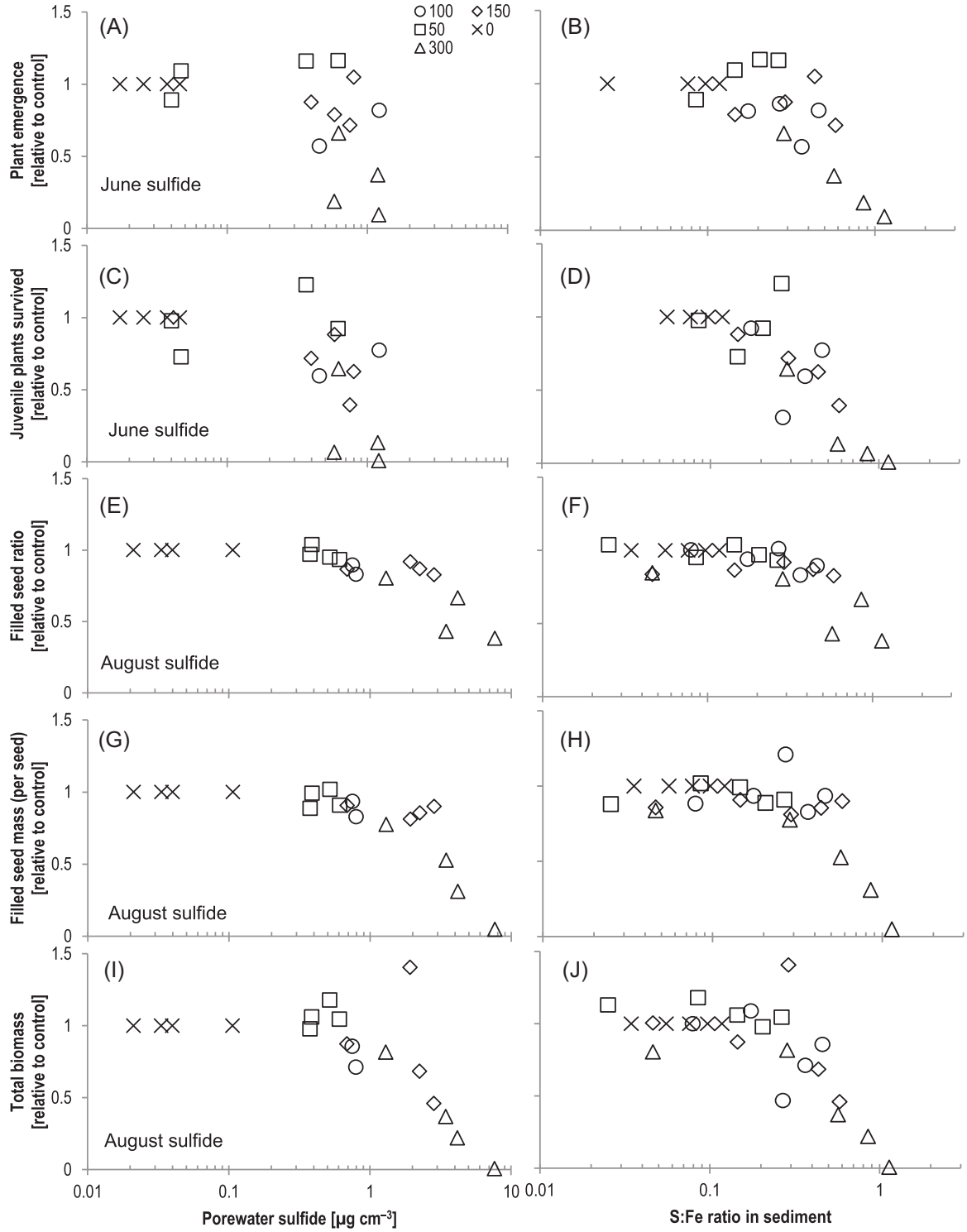


FIGURE 5: Impacts of sulfide in (left) porewater and (right) sediment solid phase to wild rice reproduction/growth including (**A**,**B**) emergence, (**C**,**D**) juvenile survival, (**E**,**F**) filled seed ratio, (**G**,**H**) filled seed mass, and (**I**,**J**) total biomass. Each point on the graphics corresponds to the average of measurements made at one treatment level during each year. Symbols refer to nominal overlying water concentration (as mg sulfate L^{-1}) applied during experiments.

effects on wild rice populations observed in June and August occurred when different sulfide levels were present in sediment, molar S:Fe ratios between 0.3 and 0.6 in the sediment solid phase are consistently associated with rapid declines in plant growth and reproductive ability in this mesocosm system with limited inputs of external Fe. This suggests that the S:Fe ratio is important in defining geochemical conditions in sediment that impact wild rice during both spring and summer,

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even if different thermodynamic and kinetic processes control porewater sulfide in different seasons. Others have suggested that bulk sediment geochemistry is decoupled from wild rice rooting-zone geochemistry because of radial oxygen loss, root exudates, and consequent microbial niches near and on root surfaces (Jacq et al. 1991; Emerson et al. 1999; LaFond-Hudson et al. 2018). However, the bulk quantities of Fe and sulfide in the solid phase and porewater provide the boundary condition in which near-root processes occur, and the solid-phase S:Fe ratio appears to be an important factor even if near-root processes introduce additional complexity.

Porewater sulfide in relation to bulk sediment and surface water

In the experimental mesocosms described in the present study, the sediment solid phase accumulated a net quantity of 1000 to 2000 μg S cm^{-2} yr^{-1} in the highest 2 amendment levels, and a stoichiometrically equivalent quantity of uncomplexed (by sulfide) Fe was bound into AVS (Table 1, rows 1 and 2). However, only 2 to 20 μg S cm^{-2} were present as dissolved sulfide in the sediment porewater during August of the experiment's fourth year, the most sulfidic conditions observed (Table 1, rows 3). Porewater sulfate mass (30–70 μg SO_4 as S cm^{-2} at the highest 2 amendment levels) was constant over the course of the 4-yr study but small relative to the quantity of sulfate present in the approximately 23 cm of overlying water of the experimental mesocosms (Table 1, rows 4 and 5). Across more complex, hydrologically dynamic natural settings with a balance between ongoing Fe and S loads, the specific quantities involved will differ; however, in many sulfate-impacted freshwaters, the relative magnitude of porewater sulfide mass is likely to be much smaller than solid-phase sulfide mass or mass of sulfate in the overlying water. Although critically important for defining conditions toxic to wild rice and other aquatic plants, porewater sulfide is itself a small phase relative to the ultimate reactants that produce AVS in sediment: sulfate in the overlying water and Fe in the sediment solid phase. In contrast to overlying water sulfate quantity and relatively large cumulative interannual increases in solid-phase sulfide, the small size of the porewater sulfide pool relative to other phases involved may make it susceptible to the seasonal changes observed in the mesocosms.

Discussion

Impacts of plants on S accumulation

The maximum sulfate flux into sediment, estimated from diffusion and observed sulfate profiles, ranged from <1 to 5 μg-S cm^{-2} d^{-1} in sulfate-amended tanks. If the ice-free season of approximately 180 d is used as an estimate of the time conducive to sulfate diffusion into and accumulation within sediment, net annual diffusion-driven sulfate transport to sediment is between 100 and 850 μg-S cm^{-2} yr^{-1}. This is roughly half the observed solid-phase sulfide accumulation rates. Therefore, an additional transport mechanism besides diffusion is leading to S accumulation in the sediment solid phase. Evapotranspiration could have drawn sulfate-amended water into the rooting zone and increased the rate of S loading to sediment beyond transport by molecular diffusion. Evaporation rates of 0.2 to 0.6 cm d^{-1} have been found for wetland plants in the region (Lott and Hunt 2001). An evaporation-driven advective flux of surface water into sediment is alone sufficient to explain the mass accumulation of S in the sediment solid phase (Table 1, rows 6; 0.3 cm d^{-1} × 50 μg-S as SO_4 cm^{-3} = 15 μg-S cm^{-2} d^{-1} for 150 mg sulfate L^{-1} overlying water). The balance between advective and diffusive transport of sulfate into sediment cannot be discerned from our experiments; however, both occur at a rate proportional to overlying water sulfate.

Wild rice and other wetland plants can release oxygen to the rooting zone and sometimes decrease the accumulation of sulfide in sediment (e.g., Koretsky et al. 2008; Myrbo et al. 2017b). Observations in rooted and unrooted locations in the same mesocosms reported by Myrbo et al. (2017b) suggest that the rooting zone of the rice could facilitate subsurface sulfate cycling through the oxidation of AVS in the sediment solid phase. However, interannual increases of solid-phase S of 200 and 2000 μg-S cm^{-2} yr^{-1} (Table 1) mean that a net accumulation of S in sediment occurred, even despite some subsurface reoxidation of sulfide. In these mesocosms, plants were

TABLE 1: Quantities, accumulation, and fluxes of sulfur (S) in porewater and solid phases in experimental mesocosms

		Overlying water SO_4	
		50 mg L^{-1}	300 mg L^{-1}
1	Fe(II) mass in solid phase (μg cm^{-2} [as S])[a]	10 000	10 000
2	S(II) accumulation in solid phase (μg-S cm^{-2} yr^{-1})	400	2000
3a	S(II) mass in porewater (June) (μg-S cm^{-2})	1.2	4.5
3b	S(II) mass in porewater (August) (μg-S cm^{-2})	2.2	18
3c	S(II) accumulation in porewater (June–August)[b] (μg-S cm^{-2})	1	13.5
4	SO_4 mass porewater (June and August) (μg-S cm^{-2})	8	70
5	SO_4 mass in overlying water (μg-S cm^{-2})[c]	390	2300
6a	SO_4 flux estimated from diffusion (μg-S cm^{-2} yr^{-1})[d]	150	850
6b	SO_4 flux potential from advection (μg-S cm^{-2} yr^{-1})[d]	400	2400

[a]Mass of Fe (as S) estimated assuming a 1:1 stoichiometry for FeS.
[b]Assuming 80-d accumulation between early June and late August.
[c]For 23-cm overlying water column.
[d]Assuming 180 d of ice-free time conducive to diffusive transport for 0.3 cm d^{-1} advective flow induced by transpiration for a 90-d growing season.

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thinned to a density that prevented significant competition for nutrients. This limited density may have reduced the ability of plants to oxidize the rhizosphere relative to thicker natural stands.

The net accumulation of between 6 and 13 μg-S cm^{-2} in sediment porewater between June and August also suggests changes in the balance between sulfide oxidation and sulfate reduction processes over wild rice's annual life cycle (LaFond-Hudson et al. 2018). Radial oxygen loss should be highest during the portion of the growing season when growth and photosynthesis are greatest. For wild rice, this happens in June and July. Growth and photosynthesis decline in mid-August when resources in the stems and leaves are transferred to flowers and seeds (Sims et al. 2012). Consistent with this phenology of growth, there was significantly greater porewater sulfide in August compared to June in the mesocosm sediment amended with 150 and 300 mg L^{-1} overlying water sulfate. Changes to plant-induced oxygen inputs to sediment cannot be easily separated from increased biological activity or more rapid diffusion under warmer August conditions, but both would be expected to result in a shift toward more reducing conditions later in the summer.

Implications of Fe speciation in sulfate-impacted sediment

Iron in the solid phase was not quantified each year; however, the observed annual patterns of dissolved Fe and sulfide are consistent with a depletion in the activity of ferrous Fe that has not been sequestered to insoluble and stable Fe sulfide complexes. In some cases the quantity of Fe in sediment porewater could be limited by Fe(III) reduction. However, the relatively small amount of labile (0.5 N) oxidized Fe extracted from sediment (Supplemental Data, Table SI-4) and Fe(III)'s low solubility under neutral pH conditions (6.2–7.4) suggest that the main control on porewater Fe in the sulfate-amended mesocosm sediment is the inputs of dissolved sulfide. The solid-phase Fe measured in the present study (extracted with 0.5 N acid extractable Fe) may not have precisely reflected the total quantity of Fe available to react with sulfide. Indeed, 30 to 120% additional Fe was extracted with aqua regia compared to 0.5 N HCl, suggesting that an additional, more recalcitrant Fe pool is present. The large and consistent increases in porewater sulfide at S:Fe ratios of near 0.5 (based on 0.5 N acid Fe), however, suggest that some Fe extracted with even the weak acid was not available to efficiently remove dissolved sulfide. Reaction rates of solid-phase Fe with dissolved sulfide can be slow depending on the nature of Fe phases (Wan et al. 2017).

Reduced S was extracted routinely in the present study using 9 N HCl with stannous chloride (Eaton et al. 2005a), a stronger extraction than the 1 N HCl employed in a USEPA draft standard method (Allen et al. 1991). A significant fraction of chromium-reducible S (20–70%; Supplemental Data, Table SI-4) was found in sediment from the tanks without sulfate amendment, possibly as a result of aged FeS minerals present in native, unamended sediment. However, little additional S was extracted with chromic acid from mesocosm sediment that had received large experimental sulfate additions, suggesting that most recent S accumulation was in a labile phase accessed by both 0.5 and 9 N acid extractions (Supplemental Data, Table SI-4). The nature of the Fe pools present in natural settings would need to be investigated across a wider variety of geologic and hydrologic conditions and utilizing a larger suite of extraction methods to understand the significance of the thresholds of S:Fe ratios that lead to increased porewater sulfide in the mesocosm conditions of the present study.

Implications of S accumulation in natural systems

The nearly static quantity of Fe in the present study provides a convenient and tractable system to describe the impacts of a change in S loading on porewater geochemistry. Natural settings, however, have ongoing Fe loads from surface water and groundwater that compete stoichiometrically with ongoing S loads to determine the net S:Fe ratio in surficial sediment. A more thorough analysis, via modeling or detailed observations in a variety of S- and Fe-loading scenarios, would be needed to constrain the importance of ongoing sulfate loads, Fe loads, and sediment accumulation rates in determining S:Fe ratios in a natural setting. The quantity of sulfide in the solid phase (AVS) was highest in surface 0- to 5-cm sediment at all sulfate amendment levels, showing that sulfide accumulates most rapidly in the surficial sediment where sulfate reduction is most rapid. Because sulfate was almost completely depleted at depths >5 cm, the elevated AVS concentrations at depths <5 cm suggest that significant mixing of surficial sediment with sediment from lower depths occurred in these mesocosms. The present analysis integrated S and Fe mass over the top 10 cm of sediment to facilitate consistent stoichiometric comparisons in the simplified mesocosm system. However, there were variations in the S:Fe ratio over the top 10 cm of sediment, and the distribution in a natural setting would depend on the source of Fe and S to surficial sediment (groundwater vs surface water). In addition, the relevant depth for assessing S:Fe ratios and porewater sulfide could be different for different wetland plants. The results observed in the present simplified system are useful to understand how porewater geochemistry evolved over time in the context of a range of loading rates and accumulations of S mass in sediment. However, in natural settings the specific quantities, net loading rates, and times related to porewater sulfide accumulation and biological effects are likely to differ from these controlled observations.

In a broad survey of sediment chemistry in natural wild rice stands, sediment C, surface water sulfate, and sediment extractable Fe (0.5 N HCl) were used to predict porewater sulfide (Pollman et al. 2017). The inclusion of solid-phase AVS (or the difference between extractable Fe and AVS) did not improve the model performance appreciably. The Pollman et al. (2017) field data set was composed mostly of freshwater sediment from ecosystems relatively low in sulfate, with consequently low S:Fe ratios in sediment. In a large data set with typically great stoichiometric excess of Fe over sulfide, it is understandable

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that the quantity of sulfide in sediment did not rise to the top as an important variable. However, an analysis that included only sediments with relatively large S:Fe ratios may conclude that sediment AVS, in addition to sediment Fe, is consequential in controlling porewater sulfide. An analysis of, for instance, the upper quartile of sediment S:Fe ratios would be especially relevant because these sites are likely the ones most at risk of experiencing a buildup in porewater sulfide in response to additional sulfate loads.

The observation that sulfate did not increase in sediment porewater over the course of the experiments suggests that in this system sufficient C and Fe were both present in sediment to continue driving the reduction of sulfate to sulfide and the removal of sulfide from the dissolved phase, thereby maintaining the flow of sulfate from the overlying water. If C had become limiting before Fe, sulfide would continue to be removed from porewater by excess Fe and an increase in porewater sulfate would be expected as a result of continued diffusion and a lack of electron donors to drive the reduction of porewater sulfate. If Fe had become limiting before C, porewater sulfide would be expected to build up in the absence of a process to remove it from solution and lower its activity. Eventually, porewater sulfide would increase to levels sufficient to cause upward diffusion and oxidation of sulfide near the oxidized sediment–water interface. In this case of excess C relative to Fe, a finite pool of S could continue to cycle in the dissolved phase of the sediment between sulfate near the surface and sulfide at deeper depths.

CONCLUSIONS

The sediment Fe buffer against a buildup in dissolved sulfide during continuous sulfate loading was overwhelmed relatively quickly (2–4 yr) in experimental mesocosms with 300 and 150 mg L^{-1} sulfate in overlying water. Across a range of sulfate-loading rates, conditions in sediment porewater shifted from Fe-rich (>2–5 μg cm^{-3}) toward sulfidic (>0.5–2 μg cm^{-3}) as S:Fe ratios (as defined by the weak acid extract used in the present study) approached 0.5. Though different sulfide concentrations were present in June and August, S:Fe ratios approaching 0.5 were consistently associated with effects in both early and late stages of wild rice's annual growth and reproductive life cycle. The quantity of uncomplexed Fe (low S:Fe ratio) appears to be important in defining porewater sulfide and consequent effects on wild rice under both spring and summer conditions.

The net S loading rates to the sediment (<200 to >2000 μg-S cm^{-2} yr^{-1}) across the overlying water sulfate amendments in the present study (8–300 mg L^{-1} as sulfate) were proportional to overlying water sulfate. Approximately 22 μg-S cm^{-2} yr^{-1} accumulated in the sediment solid phase for every μg of S per cm^{-3} of sulfate (as S) present in the overlying water. Eventually, in the absence of significant external Fe inputs, the supply of Fe in the tanks with <10 and 50 mg L^{-1} sulfate in the overlying water would be expected to be overwhelmed by external sulfate loads. The simple linear trends for sulfide accumulation rate in this experiment suggest that this might occur in 10 to 35 yr for the 50 and approximately 10 mg L^{-1} overlying water sulfate, respectively. Analyses of natural systems, however, should consider external loads of Fe, the potential for oxidation of sulfide, and rates of sediment burial (or mobility) to constrain the time frame of impacts attributable to an increase in S loading. In addition, efforts to predict dissolved sulfide from bulk sediment and water parameters should account for the fact that, although ultimately driven by the quantities of Fe, S, and C, the concentration of porewater sulfide is a relatively small phase, potentially subject to seasonal variability, compared with solid-phase Fe and S.

The results from the present mesocosms are not entirely equivalent to natural settings with ongoing loads of Fe and complex hydrologic conditions. They do, however, provide an opportunity to examine in detail some of the mechanisms involved in the dynamic relationship among surface water chemistry, sediment geochemistry, and the health and reproduction of sensitive freshwater organisms following a change in S loading. In addition to toxicity to wild rice, many other aquatic species are sensitive to sulfide (Kinsman-Costello et al. 2015), and the present results could help us to understand and develop management strategies to alleviate the ecological effects of increased S loading (Geurts et al. 2009; Greaver et al. 2012). The results illuminate more fully an evolving geochemical setting in which cumulative S loading over a 4-yr mesocosm study resulted in a wholesale shift from Fe-dominated to sulfide-dominated porewater chemistry. This shift was accompanied by detrimental effects to and eventually extirpation of self-perpetuating wild rice populations.

Supplemental Data—The Supplemental Data are available on the Wiley Online Library at DOI: 10.1002/etc.4410.

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Disclaimer—The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of Fond du Lac, Minnesota Pollution Control Agency, NOAA, the Sea Grant College Program, or the US Department of Commerce.

Data Accessibility—The present study contains supplemental online material. Readers interested in data can contact N. Johnson (nwjohnso@d.umn.edu).

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WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

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Interactions between sulfide and reproductive phenology of an annual aquatic plant, wild rice (*Zizania palustris*)

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ABSTRACT

Aquatic plants live in anoxic sediments that favor formation of hydrogen sulfide, a known phytotoxin. We investigated how the phenology of reproductive life stages of wild rice (*Zizania palustris* Poaceae), an annual aquatic graminoid, is influenced by rooting zone sulfur geochemistry in response to elevated sulfate and sulfide. In addition, we characterized how redox conditions in the rooting zone change throughout reproduction to determine if they are tied to plant life stage. The redox conditions in sediment decreased just prior to flowering, and again just prior to seed production for all plants, allowing sulfide to accumulate at the root surface of sulfate-amended plants. Plants exposed to sulfide initiated seed production later than unamended plants. Sulfide appears to slow plant development in a way that gives the plant less time to allocate nutrients to seeds before senescence. The impact of sulfide in delaying reproductive life stages of wild rice and changing seasonal rooting zone biogeochemistry could extend to other plant species and additional chemical species that change mobility with redox potential, such as phosphate, manganese, mercury, and other metals.

1. Introduction

Many aquatic plants grow in sediments with low redox potential that favors formation of toxic reduced compounds like sulfide. To cope with these conditions, some aquatic plants transport oxygen to the roots through hollow aerenchyma tissue, release it into the rhizosphere, and form iron oxide plaques on root surfaces (Stover, 1928; Mendelssohn et al., 1995; Colmer, 2003; Jorgenson et al., 2012). The released oxygen and iron oxides may protect roots from dissolved sulfide species (Trolldenier, 1988; Van der Welle et al., 2007; Schmidt et al., 2011; Soana and Bartoli, 2013). Many wetland plants, including wild rice, are vulnerable to dissolved sulfide (Koch and Mendelssohn, 1989; Carlson et al., 1994; Lamers et al. 1998; Pastor et al., 2017). Wild rice (*Zizania palustris*, Poaceae), an annual aquatic graminoid which forms large monotypic stands in lakes of the Western Lake Superior region, is especially sensitive during the seedling and seed production life stages, suggesting that the ability to withstand sulfide varies throughout their life cycle (Pastor et al., 2017; LaFond-Hudson et al., 2018).

Plants growing in nutrient-limited conditions sometimes experience ontogenetic drift, a phenomenon in which morphological development through successive life stages is slowed (McConnaughay and Coleman, 1999; Sims et al., 2012). Because the allocation of biomass to different tissues changes throughout a plant's life cycle, delayed development has sometimes been misdiagnosed as morphological plasticity in experiments in which plants are normalized by date or age, rather than size or life stage (Coleman et al., 1994). Nitrogen is the limiting nutrient to wild rice (Sims et al., 2012) and its uptake is tied to specific life stages (Grava and Raisanen, 1978). About 30 % of nitrogen is taken up during early vegetative growth, 50 % is taken up during the growth of the stem until flowering, and 20 % is taken up during seed production (Grava and Raisanen, 1978). Dissolved sulfide inhibits nutrient uptake (Allam and Hollis, 1972; Koch et al., 1990; Martin and Maricle, 2015). If nitrogen uptake in wild rice is inhibited or slowed by sulfide, it may slow the rate at which the plant progresses through subsequent life stages and limit the quantity of N uptake available for seed production.

Near the end of an annual plant's life cycle when plants allocate resources from leaves into flowers and seeds, photosynthesis declines and radial oxygen loss from roots may also decrease, creating favorable conditions for reduction of iron oxides and sulfate (Schmidt et al., 2011). Several mechanisms for maintaining radial oxygen loss from roots have been described, including pressure gradients that actively pump oxygen from new leaves, through roots, to old leaves (Dacey, 1980; Armstrong, 1980; Armstrong et al., 1992); and production and transport as a byproduct of photosynthesis (Marzocchi et al., 2019).

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Table 1
Descriptions of the life stages of wild rice and the range of dates for each life stage in which at least one *Zizania palustris* plant was observed (initially $n = 64$, followed by incrementally smaller sample sizes due to destructive sampling). Ranges are described for plants grown in water amended with 300 mg L^{-1} sodium sulfate or grown in water unamended, with background sulfate concentrations of ~8-14 mg L^{-1}. Life stages 1 through 3 pertain to seedling and early emergent stages that did not develop iron sulfide plaques on roots. Designation and description of life stages from Grava and Raisanen (1978) and Sims et al. (2012).

Lifestage Name	Lifestage Number	Characteristics	Dates Observed	
			Amended	Unamended
Mid tillering	4	Tiller (main stem) grows more than one leaf	210-235	210-222
Jointing	5	Internodes elongate	210-240	210-240
Boot	6	Panicles emerge from stems	235-249	235-245
Early flowering	7	A few flowers bloom, some not yet emerged	235-245	235-245
Mid flowering	8	Most flowers bloom	235-249	235-245
Late flowering	9	Most panicles empty, few flowers still bloom	235-249	235-249
Seed production	10	Seed hull develops, seed filling occurs	240-263	235-263
Seed maturity	11	Filled, ripe seeds present, a few dropped	255-263	255-263
Senescence	12	All seeds dropped, green tissues disappear	280	280

Although the exact mechanism of radial oxygen loss in wild rice is not yet known, the aforementioned mechanisms may be inhibited by the senescence of leaves during reproduction. We previously reported a decline in the redox potential of root surfaces during the seed production life stage (LaFond-Hudson et al., 2018). In plants grown in sediment without sulfur amendment, iron oxide plaques on root surfaces decreased, but in sulfate-amended plants, iron oxide plaques transitioned to iron sulfide, which further accumulated on root surfaces and coincided with production of fewer, smaller seeds with less nitrogen relative to unamended plants. In plants exposed to sulfide, the total uptake of nitrogen ceased during the onset of iron sulfide plaque formation and thickening while unamended plants continued to accumulate nitrogen in seeds (LaFond-Hudson et al., 2018). In this paper, we specifically explore the relationship between sulfur geochemistry and phenology of life stages, as both may control each other through interactions that culminate in the redox potential of root surfaces. We use wild rice (*Zizania palustris,* Poaceae) as our model organism to investigate connections between sulfide and iron geochemistry in the rhizosphere and reproductive phenology and ontogeny. Because wild rice is an annual plant, the ontogeny of development is equivalent to the annual phenology. So in this case, the two words are synonymous, except that ontogeny has the connotation of development whereas phenology has the connotation of seasonality.

Wild rice is a culturally, economically, and ecologically important macrophyte that is harvested for its grain (Fond du Lac Band of Lake Superior Chippewa, 2018). An advantage of using an annual plant is the relatively simple life cycle; root and shoot growth starts over each year, photosynthesis declines and vegetative structures senesce during the transition from vegetative to reproductive life stages, and seeds are produced at the end of the growing season just prior to death. In addition, standard markers of transitions in life cycle stages for wild rice have been established in prior research in the context of nutrient limitation (Grava and Raisanen, 1978; Sims et al., 2012).

Motivated by acute and population-level impacts of sulfide on aquatic plants, we compare the ontogenetic progression of life stages with the development of iron sulfide plaques throughout the life cycle of wild rice. Sulfide may slow ontogenetic development, but plant life stage may in turn control rhizosphere redox conditions and the amount of sulfur present as reactive sulfide. To investigate these geochemical and phenological interactions, we quantify the timing and length of life stages and seed production along with the concurrent accumulation of iron sulfide plaques.

2. Methods

2.1. Experimental design

Individual wild rice plants were grown outside in polyethylene buckets, 32 of which were amended with 300 mg L^{-1} sulfate and 32 of which were left unamended. Although many lakes and rivers in central and northern Minnesota have concentrations of sulfate lower than 10 mg L^{-1}, several current and former wild rice lakes and rivers have sulfate concentrations near or above 300 mg L^{-1}. Additionally, 300 mg L^{-1} is close to the EPA secondary standard for drinking water and is a concentration we have used in several prior sulfate-addition experiments with wild rice. Sediment was collected on 01-Jun-2016 from Rice Portage Lake (MN Lake ID 09003700, 46.7038, -92.6829) on the Fond du Lac Band of Lake Superior Chippewa Reservation in Carlton County, Minnesota. This lake is a productive and unpolluted wild rice lake with little or no settlement along its shores and its sediment is organic-rich mud. The sediment was not sieved, but thoroughly homogenized and loaded into 4 L plastic pails that were set inside 12 L buckets (see LaFond-Hudson et al., 2018) on 25-Jun-2016. Water was added from a nearby well (sulfate concentration ranging from 8 to 14 mg L^{-1}) to provide a 12−15 cm water column. Two wild rice seeds obtained from Rice Portage Lake were planted in each bucket on 26-Jun-2016 (Julian day 177). All buckets had at least one seedling by 28-Jun-2016 (day 179), and the lesser robust plant of the two was removed a week later. Half of the buckets had sodium sulfate added on 28-Jun-2016 and 05-Aug-2016 (days 179, 217) to maintain surface water sulfate concentrations of 300 mg L^{-1}. Plants remained outside for the entire duration of the experiment. Further details on the maintenance of buckets can be found in LaFond-Hudson et al. (2018).

2.2. Sampling methods

To compare changes in pace of progressions through the life cycle, we examined initiation of life stages from a subset of plants that completed their entire life cycle through seed production. We define initiation as the first date a plant was observed to be in a life stage. Life stages were identified visually and nondestructively according to the descriptions codified by Grava and Raisanen (1978) and further subdivided by Sims et al. (2012).

Our observations of the phenology of wild rice began with mid tillering, a life stage in which the main stem, the tiller, grows more than one leaf above the surface of the water (Table 1). Prior life stages include emergence of the seedling from sediment (life stage 0), the floating leaf stage (life stage 1), the first aerial leaf (life stage 2), and the formation of the tiller, the main stem that will eventually produce flowers and seeds (life stage 3). We started observations with mid tillering (life stage 4) because it is the last vegetative growth stage before reproductive life stages. After mid tillering, the internodes of the tiller elongate (jointing, life stage 5) and the panicles emerge (boot, life stage 6) in preparation for flowering (life stages 7–9). Flowering is broken into early (7), mid (8), and late (9) flowering by the proportion of flowers emerged and blooming. Once flowers have finished blooming, a

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seed hull develops and seed production begins (life stage 10). Filled seeds start to drop once they reach maturity (life stage 11), and senescence is reached once all seeds have dropped and leaves have turned completely yellow (life stage 12). Life stages of each plant and date were recorded eight times during the growing season.

When at least half of the plants were in a specific life stage, four sulfate-amended plants and four unamended plants in that life stage were destructively harvested to determine root surface geochemistry. When the plants entered the seed production life stage, harvests were made on three separate dates, each approximately a week apart, spanning the duration of the seed production life stage. Sampling at a more frequent temporal resolution during seed production enabled us to make detailed observations of the accumulation of iron sulfide (or lack thereof) on the roots during a potentially critical time for sulfide exposure.

2.3. Biological and chemical analysis

On each sampling date, the same eight plants that were harvested were separated into aboveground vegetative tissue, seed tissue, and root tissue according to LaFond-Hudson et al. (2018). Vegetative tissue and seed tissues were dried for seven days at 65 °C and weighed. Total N concentrations were determined with a Thermo Electron Flash EA 1112 CHNS Analyzer. Fresh roots were analyzed for acid volatile sulfide (AVS) and weak acid extractable iron the same day plants were harvested, taking great care to avoid exposure to oxygen (LaFond-Hudson et al., 2018). Iron and acid volatile sulfur (AVS) were simultaneously extracted from entire roots using 1 M deoxygenated HCl for four hours. AVS was volatilized and trapped in a sulfide antioxidant buffer (SAOB) using a modified diffusion method (Brouwer and Murphy, 1994). AVS was quantified using a sulfide-selective electrode. Iron was extracted into the 1 M HCl and analyzed for total extractable iron and Fe(II). Fe (III) was estimated from the difference between total iron and Fe(II). Total iron was quantified using a Varian fast sequential flame atomic absorbance spectrometer with an acetylene torch. Fe(II) was quantified on the day of extraction using the phenanthroline method on the spectrophotometer. After extraction, roots were dried at 38 °C for 24 h to determine dry mass.

2.4. Data analysis

Data are publicly available in the Data Repository of University of Minnesota (DRUM) and can be accessed at https://conservancy.umn.edu/handle/11299/208579. We used a two-sample *t*-test to compare differences between sulfate-amended and unamended conditions for seed measurements and root sulfide. Because we sampled destructively to measure root surface sulfide and iron, dates for the initiation of early reproductive life stages contain a larger sample size relative to the seed production life stage. Conclusions about the initiation of life stages between treatments are based only on the subset of plants that reached seed production in this experiment, and thus are not influenced by changes in sample size. For this subset of plants, we calculate the cumulative distribution of the date on which each life stage was initiated by summing the number of plants that are at or beyond the life stage. We also calculated the duration of seed stage for each plant in this subset using the difference between the first day we observed filled seeds and the first day we observed dropped or missing seeds. In many plants, seed production ended artificially early due to our destructive sampling design. In these cases, we used the harvest date as the end date in our calculation of duration and refer to the resulting value as "experimental duration". We investigated correlations between experimental duration and yield of seed production (seed count, seedhead mass, and seedhead nitrogen mass) to understand progression in seed development within the seed production life stage. We used these linear relationships to infer the seed yield at "true duration", which we define as the probable duration of seed production if plants were not harvested. For true duration, we use the average last date seeds were observed in parallel wild rice experiments. These parallel experiments occurred in the same year, used the same sediment and tested sulfate-addition but did not use destructive sampling (Table S1).

The effective redox potential at the root surface was calculated using a modified Nernst equation (Stumm and Morgan, 2012).

$$p\varepsilon = p\varepsilon^{\circ} + \frac{1}{n} log \frac{\{ox\}}{\{red\}} \quad (1)$$

$$p\varepsilon = 16 - 3pH + log \frac{\{Fe(III)\}}{\{Fe(II)\}} \quad (2)$$

$$E_h{}^{*} = \frac{2.3RTp\varepsilon}{F} \quad (3)$$

While not strictly representative of the activity in solution, we use root surface Fe(III) and Fe(II) as a proxy for the activity of oxidized and reduced Fe in the rooting zone. Because the system is dynamic, root surface (solid-phase) quantities likely mirror the activity of iron in solution enough to draw general conclusions about the direction of the flow of electrons.

3. Results

3.1. Sulfide effects on phenology

When life stage observations began (Julian day 210), unamended plants were ahead by nearly a full life stage (mean life stage of 4.5 ± 0.5 unamended compared with mean life stage of 3.8 ± 0.6 amended, $p < 0.01$, two-sample t test), indicating that vegetative growth life stages were delayed by sulfate amendment. Most amended plants initiated jointing later than unamended plants (mean Julian day 217 ± 9 unamended, mean Julian day 226 ± 9 amended, $p = 0.005$, $n = 17$), but both treatments initiated the boot stage at similar times (mean Julian day 237 ± 3 for both, Fig. 1a, b). Because the boot stage occurs quickly, our temporal resolution may not have captured any differences in timing if they existed. From days 220–235, about half of the unamended plants initiated mid flowering, compared to only a quarter of amended plants (Fig. 1c). During the same time frame, one third of unamended plants initiated seed production, compared to no amended plants (Fig. 1d). Eight days later, day 243, a comparable number of amended plants entered seed production. Amended plants entered seed production during a narrower range of time, with ~75 % of plants reaching this life stage between days 240–250 (mean Julian day 247 ± 5), while the initiation of seed production was spread over a 2 week window for unamended plants (244 ± 7 days). Due to the destructive sampling required by our experimental design, we were unable to quantify the end date of seed production in this experiment, but we estimated the end date of seed production from parallel, non-destructive experiments involving sulfate-addition to wild rice mesocosms. The final date of seed collection was consistently close to day 260 for several years and experiments (Table S1). Using day 260 as the final date of seed production, we estimated a 20 % decrease in the true duration of seed production in amended plants compared to the unamended plants.

3.2. Seed production and vegetative biomass

Sulfate amended plants produced 33 % fewer seeds ($p = 0.03$), 50 % less total seedhead mass ($p = 0.01$), and 40 % total seedhead nitrogen ($p = 0.02$) compared to unamended plants (Table 2). Individual seeds were smaller by 33 % ($p = 0.02$), but individual seed N mass did not differ significantly between treatments. Sulfate amended plants had lower vegetative biomass (leaves and stems) during late flowering ($p < 0.01$, $n = 4$), but not prior life stages (Fig. S1). The experimental duration of seed production, calculated from the difference between

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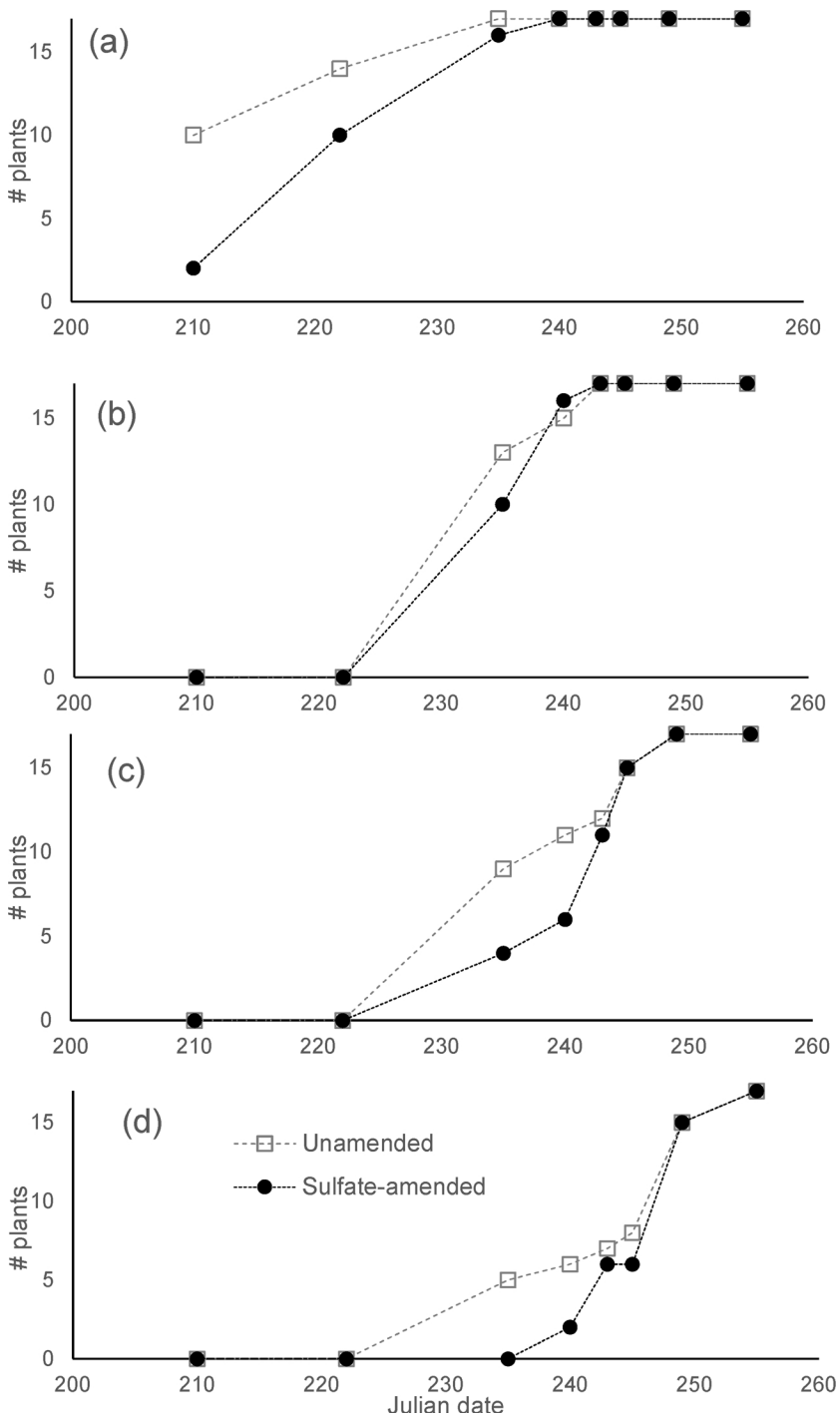


Fig. 1. Cumulative frequency of sulfate-amended (300 mg L^{-1}, filled circles) and unamended plants (open squares) that have initiated a) jointing, life stage 5, when internodes elongate just prior to reproduction, b) boot, life stage 6, when panicles emerge, c) mid flowering, life stage 8, when most flowers bloom, and d) seed production, life stage 10, when seed filling occurs.

first day seeds were observed and the day the plant was destructively sampled, was positively correlated with more filled seeds (p = 0.027), greater seed mass (p = 0.042), and more seed nitrogen (p = 0.012, Fig. 2).

3.3. Root geochemistry

Concentrations of AVS on amended root surfaces were one to two orders of magnitude higher than on unamended root surfaces during jointing, boot, mid flowering, and seed production (Table 2, Fig. S2). Porewater sulfate decreased from mid flowering until senescence, indicating that sulfate-amended plants were likely exposed to sulfide as a consequence of sulfate reduction (Fig. S3). On amended roots, AVS increased from about 10 μmol g^{-1} to about 65 μmol g^{-1} between jointing and boot. Concentrations of root surface sulfide then remained around 65 μmol g^{-1} until seed production. The AVS concentration doubled during seed production (life stages 10–11). On unamended roots, the concentration of sulfide steadily increased from 0.5 to 5 μmol g^{-1}, with the highest concentrations occurring during seed production. However, roots were not visibly black on unamended plants. Decreases

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Table 2
Comparisons of acid volatile sulfide (AVS) concentration on root surfaces (μg g^{-1}) and of seed measurements in sulfate-amended (300 mg L^{-1}) and unamended conditions using a two-sample *t* test. AVS concentrations are compared during four reproductive life stages. The average for each treatment is reported with the standard deviation in parentheses (n = 4 for AVS during jointing, boot, and flowering; n = 12 for AVS during seed production, n = 10-12 for seed measurements; not all replicate plants had seeds).

Reproductive life stage	Sulfate-amended	Unamended	P value
Jointing	9.7 *(± 3.7)*	0.6 *(± 0.3)*	***P* < 0.01**
Boot	64.9 *(± 39.7)*	1.4 *(± 0.2)*	***P* = 0.05**
Mid flowering	68.9 *(± 42.9)*	2.6 *(± 0.5)*	***P* = 0.03**
Seed production	144.8 *(± 61.6)*	3.3 *(± 0.8)*	***P* < 0.01**
Seed Measurements			
Filled seed count (# per plant)	10.5 *(± 7.3)*	16 *(± 7.1)*	***P* = 0.03**
Total seedhead mass (g)	0.14 *(± 0.07)*	0.28 *(± 0.16)*	***P* = 0.01**
Total seedhead N mass (mg)	3.05 *(± 1.36)*	4.93 *(± 2.28)*	***P* = 0.02**
Individual seed mass (mg)	11.1 *(± 3.27)*	15.26 *(± 4.75)*	***P* = 0.02**
Individual seed N mass (mg)	0.26 *(± 0.15)*	0.28 *(± 0.08)*	*P* = 0.38
Seed N %	2.28 (± 0.63)	1.89 (± 0.48)	*P* = 0.06

in effective redox potential (E_h*), calculated from the ratio of Fe(III) to Fe(II) at root surfaces (Fig. 3, Fig. S4), occurred near both amended and unamended root surfaces between boot and jointing (life stage 5–6) and at the end of flowering (life stage 8–9). During seed production, the effective redox potential decreased more steeply at amended root surfaces.

4. Discussion

The phenology of seed production was delayed in sulfate-amended plants, suggesting ontogenetic drift induced by sulfide. Across both amended and unamended conditions, seedhead mass, seed number, and seedhead N mass correlated with length in the seed production life stage. In the presence of sulfate, delayed seed production and lower seed N uptake both co-occurred with a precipitous drop in redox potential and rapid accumulation of sulfide on roots.

In a natural setting, plants with a delayed start to seed production would have to compensate by either increasing N uptake rate or delaying senescence until a later calendar date. In our experiment, sulfate-amended plants contained less seedhead nitrogen than unamended plants, so the N uptake rate likely did not increase much, if at all. Our experimental design, requiring destructive sampling during seed production, was unable to test the completion of the seed production life stage. To address these limitations, we examined average end dates of seed production in parallel wild rice experiments. The date of last seed collection happened at similar dates or even earlier dates for sulfate-amended plants in these other experiments (Table S1). Thus, it seems likely that sulfate-amended plants do not extend the seed production life stage to compensate for a delay in the initiation of seed production and have a shorter true duration of seed production. Because the seed production yield (number of filled seeds, seedhead mass, seedhead nitrogen) is positively and linearly correlated with experimental duration of seed production (Fig. 2), we suggest that the implications of delayed initiation without delayed completion of seed production are lower reproductive outputs by plants.

The curious timing of iron sulfide precipitation on root surfaces coincident with the beginning of seed production suggests that plants

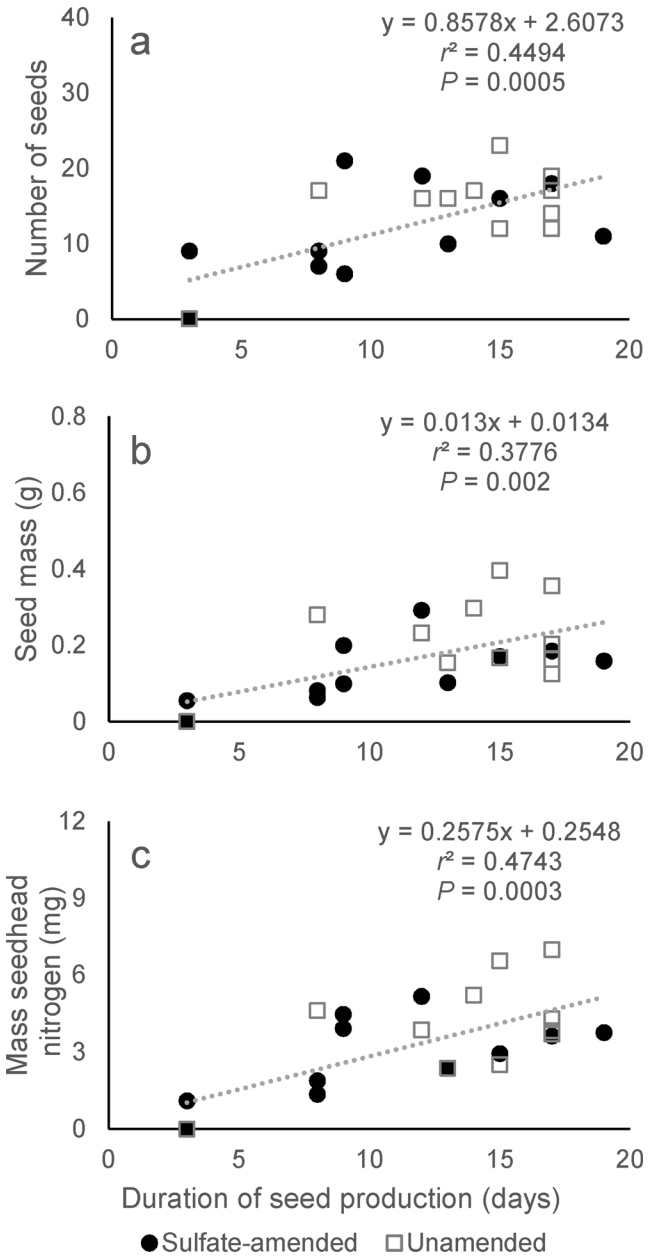


Fig. 2. Relationship between the experimental duration of seed production (days) and a) filled seed count, b) seedhead mass (g), and c) seedhead nitrogen (mg). Filled circles indicate sulfate-amended plants (300 mg L^{-1}) and open squares indicate unamended plants. End dates of duration for each plant were determined either by the date they entered seed maturity or by harvest date if they were harvested before reaching seed maturity.

influence the geochemistry of the sediments and that this influence changes during the plant's life cycle. The redox potential at the root surface, calculated from the ratio of Fe(III):Fe(II), decreased from jointing to boot (life stage 5–6), and again at the end of flowering (life stage 8–9). AVS concentrations increased on amended roots at the same life stages that redox declined. During seed production, the redox potential of amended and unamended plants diverged as the redox potential declined precipitously in amended plants. These decreases in redox potential reflect a net flow of electrons toward the plant root surfaces, suggesting a loss in the oxidizing capacity of the root surface. Transitions into new reproductive life stages are plausible times for plants to reallocate resources from photosynthetic tissues to reproductive tissues (Grava and Raisanen, 1978; McConnaughay and

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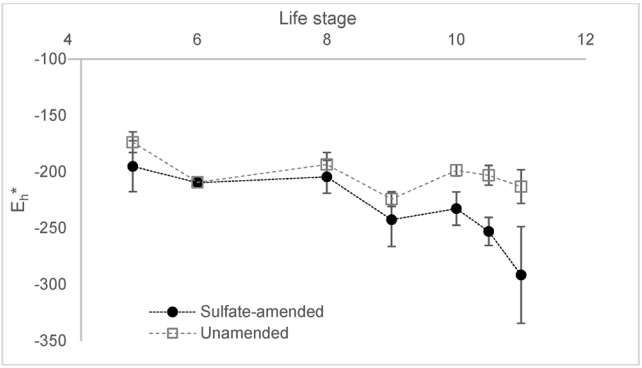


Fig. 3. Effective redox potential calculated from Fe(III) and Fe(II) concentration on roots amended with sulfate (300 mg L^{-1}, filled circles) or left unamended (open squares). Error bars show one standard deviation (n = 4). Life stages were assigned as 10, 10.5, and 11 for Julian dates 252, 257, and 264 respectively to show chronological progression in E_h* during seed production and maturity.

Coleman, 1999; Sims et al., 2012). Experiments with white rice (*Oryza sativa*), a closely related plant, have shown changes from iron oxide to iron sulfide in rhizosphere sediment as the plant entered flowering (Schmidt et al., 2011). We suggest that the change in redox conditions of the root surface at reproductive life stage transitions could be explained by a decrease in radial oxygen loss tied to the life stage of the plant, creating conditions conducive to iron sulfide formation in environments with elevated sulfur.

Plants concomitantly control and are controlled by sulfide. During vegetative growth life stages, plants maintain low sulfide in the rooting zone by releasing O_2 and accumulating Fe(III). However, at key reproductive life stage transitions, excess sulfide appears to overwhelm the plant's ability to oxidize the rhizosphere. The geochemical consequences of both life stage transition and excess sulfide are a precipitous drop in Fe(III):Fe(II) ratio and an accumulation of solid-phase sulfur on roots. The ecological consequences of life stage transitions in the presence of excess sulfide are a delay in reproductive phenology and a decrease in N uptake to seeds. Slower development rates in the presence of sulfide may delay life stage transitions and the geochemical consequences of these life stage transitions for redox potential. Our experimental design was not able to directly determine if redox potential decreased at a later date due to delayed phenology in amended plants. However, our observations do provide evidence that the net effect of sulfide-induced ontogenetic drift is shortened and decreased seed production. This finding hints at a phenological mechanism underlying sulfide-induced inhibition of nitrogen uptake observed in prior work (LaFond-Hudson et al., 2018). Considering that seedlings also experience high mortality when exposed to sulfide, 50 % less total seed mass in the presence of elevated sulfide may lead to rapid population declines, as has been previously observed in a mesocosm experiment (Pastor et al., 2017). Additionally, decreased density of plants in subsequent generations may lead to lower oxygen fluxes into sediment and exacerbate redox conditions that favor production of sulfide.

Sulfide inhibition of nutrient uptake has been demonstrated in other plants (Koch et al., 1990; Martin and Maricle, 2015), as has ontogenetic drift ((McConnaughay and Coleman, 1999; Sims et al., 2012), so other freshwater annual aquatic plant populations may face similar reproductive challenges if exposed to sulfide. Additionally, sulfide and iron interact with nutrients besides nitrogen. Iron plaques can adsorb phosphorus and metals, controlling their availability for uptake (St-Cyr and Campbell, 1996; Christensen and Sand-Jensen, 1998). Reduction of iron plaques in the presence of sulfide may affect uptake of both macro- and micronutrients. Some studies have investigated changes in radial oxygen loss over the growing season in perennial aquatic plants (Soana and Bartoli, 2013, 2014). However, because perennial plants may have different life cycle patterns of radial oxygen loss, the ways sulfide might interact with phenology or reproduction of perennial aquatic plants remains unknown. Clarifying how sulfide interacts with nutrients in rhizospheres of both annual and perennial plants may be important for understanding how wetlands or vegetated littoral zones respond to elevated sulfide conditions on an ecosystem level.

Redox conditions at root surfaces are closely tied to wild rice phenology. Sulfide, through delaying phenology, has the potential to control the timing of changes in redox conditions. By changing the timing and duration of reproductive life stages, sulfide's effects on phenology likely play a role in decreased survival of wild rice populations.

CRediT authorship contribution statement

Sophia LaFond-Hudson: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing - original draft, Visualization. **Nathan W. Johnson:** Conceptualization, Supervision, Writing - review & editing, Funding acquisition. **John Pastor:** Conceptualization, Supervision, Writing - review & editing, Funding acquisition. **Brad Dewey:** Conceptualization, Methodology, Investigation, Data curation, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no conflict of interest.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.aquabot.2020.103230.

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WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 15

LaFond-Hudson S, Johnson NW, Pastor J, Dewey B (2022) Sulfur geochemistry destabilizes population oscillations of wild rice (*Zizania palustris*).
J. *Geophysical Research Biogeosciences* 10.1029.

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RESEARCH ARTICLE
10.1029/2022JG006809

Sulfur Geochemistry Destabilizes Population Oscillations of Wild Rice (*Zizania palustris*)

Sophia LaFond-Hudson[1,2], Nathan W. Johnson[1], John Pastor[3], and Brad Dewey[3]

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Key Points:

- Populations exposed to elevated sulfate went extinct in 6 years, overriding interannual biomass oscillations
- Iron addition and litter removal slightly alleviated sulfide toxicity but did not prevent population extinction
- Stability of oscillating populations can be evaluated with only a few years' data using an eigenvalue

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Methodology: Sophia LaFond-Hudson, Nathan W. Johnson, John Pastor, Brad Dewey
Writing – original draft: Sophia LaFond-Hudson
Writing – review & editing: Sophia LaFond-Hudson, Nathan W. Johnson, John Pastor, Brad Dewey

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Abstract Elevated inputs of sulfate to freshwater systems can increase sulfide concentrations in anoxic soils and subsequently destabilize aquatic plant populations, but the interactions between sulfate, other geochemical cycles, and interannual plant population cycles are poorly understood. Increased sulfate loading increases mineralization of nitrogen from litter, but the sulfide produced during this process can limit nitrogen uptake by plants. In some cases, iron may mitigate sulfide's impacts on plants by precipitating iron sulfide. We examined the interannual effects of sulfate loading on mesocosm populations of wild rice, an emergent aquatic plant that undergoes population oscillations and is sensitive to sulfide. Using experimental mesocosms with self-perpetuating populations, we investigated how population dynamics respond to manipulations of surface water sulfate (10 mg L^{-1} or 300 mg L^{-1}), sediment iron (4.3 mg g^{-1} or 10.9 mg g^{-1} dry weight), and shoot litter (present or removed). Populations exposed to constant 10 mg L^{-1} sulfate concentrations had stable biomass oscillations of approximately 3-year periods, consistent with previous studies that demonstrated litter-driven oscillations in nitrogen availability. Populations exposed to 300 mg L^{-1} sulfate concentrations produced fewer and smaller seeds and declined to extinction in 6 years or less. We did not find a strong effect of iron loading or litter removal on wild rice biomass or seed production. Our observations show the potential of elevated surface water sulfate to rapidly destabilize wild rice populations under varying iron and organic carbon concentrations.

Plain Language Summary Plants that naturally grow in freshwater do not survive well if the water contains elevated concentrations of sulfate. Sulfate reduction produces sulfide that subsequently inhibits the uptake of nitrogen, an essential plant nutrient. Some annual plants go through boom-bust cycles with years alternating between high and low biomass because nitrogen takes more than a year to be released from dead plant matter. We investigated the combined effect of sulfate and natural biomass cycles on the stability of wild rice populations by growing plants in large tanks and exposing them to high-sulfate and low-sulfate concentrations, high and low iron concentrations, and with plant matter from the previous growing season either returned or removed. Nearly all plant populations exposed to high sulfate had died by 6 years into the experiment, regardless of iron concentration or litter removal. We show a method to analyze population stability with just a few years of data.

1. Introduction

Northern wild rice (*Zizania palustris*) is one of four species in the genus *Zizania*, which are the only native aquatic grains in North America. The range of northern wild rice (hereafter wild rice) is centered across the Great Lakes region and is most abundant in the rivers and lakes of the watersheds of Lakes Superior and Michigan in northern Minnesota, Wisconsin, and Ontario. Wild rice beds are usually very large (tens or hundreds of hectares) and monotypic. Because of its widespread distribution and tendency to form large monotypic stands, wild rice has great potential to control the quality of waters draining into Lakes Superior and Michigan and influence the food supply for waterfowl, muskrats, and other members of the food web. In addition, harvesting and eating wild rice are essential traditional practices that provide food sovereignty and well-being for the native Ojibway people of the watersheds of Lakes Superior and Michigan (Fond du Lac Band of Lake Superior Chippewa, 2018). Therefore, the productivity, perpetuation, and restoration of wild rice are of great ecological and cultural significance.

Production of wild rice biomass is limited by the supply of nitrogen from decomposing plant litter, sediment organic matter, and hydrologic inputs (Pastor & Walker, 2006; Sims et al., 2012; Walker et al., 2006, 2010). Because it is an annual plant, wild rice's nitrogen requirements must be fully supported by uptake during each year. Over 60% of nitrogen uptake happens during a 2-week window in early summer (Grava & Raisanen, 1978;

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Sims et al., 2012). Nitrogen, however, is not released from the previous year's litter until later in summer or even the following year (Hildebrandt et al., 2012; Sain, 1984; Walker et al., 2010). In fact, there is considerable microbial immobilization of nitrogen into fresh litter during the period when the demands of wild rice growth for nitrogen are greatest (Hildebrandt et al., 2012; Walker et al., 2010). The coincidence of microbial nitrogen immobilization with the period of rapid nitrogen uptake causes wild rice biomass and litter production to cycle with a period of approximately 4 years (Pastor & Walker, 2006; Walker et al., 2010).

Inputs of sulfate from bedrock weathering, mine drainage, and agriculture enhance sulfide production in natural wild rice ecosystems (Bailey et al., 2017; Lamers et al., 2013; Myrbo et al., 2017a). Wild rice production appears to be adversely impacted by sulfide in the vicinity of its rooting zone. The survival of juvenile seedlings and weights of seeds decrease with increased hydrogen sulfide concentrations in wild rice's rooting zone in aquatic sediments (Pastor et al., 2017). The production of sulfide may be coupled to increased litter deposited in sediment during productive years of the wild rice population cycle. These large litter cohorts could reduce sediment redox potential (Eh) by providing additional labile carbon to support additional bacterial growth and hence oxygen demand the following year, thereby enhancing the potential for reduction of sulfate to sulfide (Azam et al., 1991; Gao et al., 2003, 2004).

Other biogeochemical reactions in the sediments may impede the bioavailability of sulfide to wild rice roots. The most important reaction is precipitation of sulfide with reduced iron (Morse et al., 1987). In both mesocosm and lake studies (Bailey et al., 2017; Myrbo et al., 2017a), iron in sediments appear to exert a strong control on the accumulation of dissolved sulfide in sediments. Bulk sediment iron content is strongly associated with lower porewater sulfide in field conditions and mitigates sulfide toxicity to macrophytes in other aquatic ecosystems (Lamers et al., 2002; Ruiz-Halpern et al., 2008; Van der Welle et al., 2007).

However, iron sulfide can precipitate on roots of mature plants and is associated with impaired nitrogen uptake and inhibited seed production (LaFond-Hudson et al., 2018, 2020a). Plant-mediated gas transport of oxygen from the atmosphere into the rhizosphere allows formation of iron oxides on root surfaces, and oxygen fluxes are typically highest when plants are photosynthetically active (Blossfeld et al., 2011; Han et al., 2018; Marzocchi et al., 2019). As observed on many emergent macrophytes, iron oxide forms on wild rice roots as the plant grows (Jorgenson et al., 2012; Mendelssohn et al., 1995; Sundby et al., 1998). At maturity and the start of seed production, however, root plaques transition from iron oxide to iron sulfide if porewater sulfate is abundant (LaFond-Hudson et al., 2018). We have imaged iron sulfide plaques and quantified plaque iron and sulfide concentrations from plants grown in mesocosms with 300 mg L^{-1} sulfate (Pastor et al., 2017) and have visually observed black root plaques in the field at lower sulfate concentrations (unpublished data). Plants that accumulate greater concentrations of iron sulfide plaques have lower seed nitrogen mass (LaFond-Hudson et al., 2018, 2020a).

There are, therefore, complex and as yet poorly understood couplings among biomass and litter cycles, nitrogen availability, sulfide inhibition of seed production, control of sulfide concentrations in sediments by iron and litter, and precipitation of iron sulfide on roots during seed production. Here, we investigate how litter-driven population oscillations interact with sulfate geochemistry in wild rice using controlled mesocosm experiments that allow us to scale rhizosphere geochemistry-plant physiology interactions from individual plants to an entire population for several generations. In our mesocosms, we elevated geochemical inputs of sulfate and iron and manipulated carbon through the presence or absence of litter. We investigated: (a) the patterns of biomass oscillations in high-sulfate and low-sulfate conditions, and (b) whether litter and iron enhance or alleviate sulfate's effects on biomass oscillations through the production and precipitation of sulfide.

2. Methods

2.1. Experimental Design

The interactions of sulfate, iron, and litter in wild rice sediment and their effect on wild rice population dynamics were studied using 40 mesocosms. Polyethylene stock tanks (High Country Plastics 400 L, 132 × 78 × 61 cm) were used to assemble the mesocosms (Figure 1). Sediment in the tanks was taken from Rice Portage Lake (MN Lake ID 09003700, 46.7038, −92.6829) on the Fond du Lac Band of Lake Superior Ojibway Reservation in Carlton County, Minnesota (Table 1). This lake is a productive wild rice lake with little surrounding development and its sediment has been used successfully to grow wild rice in previous experiments (Pastor et al., 2017). Sediment was homogenized before it was added to the tanks. Clean sand (10 cm) was added to the bottom of the

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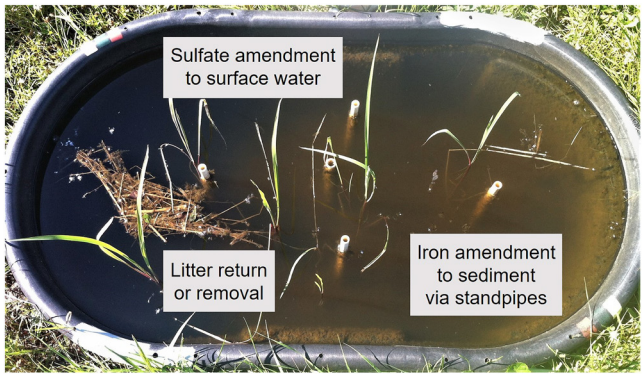


Figure 1. Picture of a mesocom showing the application of sulfate, iron, and litter treatments. The center standpipe was used to moderate the water level after rain events. The other four standpipes connect to a ring of perforated PVC pipes in the sediment to allow release of iron(II) chloride. Sulfate was applied as sodium sulfate several times over each growing season to maintain surface water concentrations near 300 mg L^{-1} sulfate. Litter was weighed at the end of each growing season, and either returned to the mesocosms, or permanently removed.

tanks before 50 L of lake sediment were placed in each tank, resulting in a sediment depth of about 10 cm on top of 10 cm of sand. Water levels were maintained at 22 cm with a drain standpipe during precipitation and well water additions to account for evaporation. These depths of sand, sediment, and water represent typical wild rice rooting depth and water column heights in the field and have been used in several wild rice mesocosm experiments previously (Hildebrandt et al., 2012; Pastor et al., 2017; Walker et al., 2010).

To test the effects and interactions of sulfate, iron, and litter, we used a factorial design with five replicates for each of eight combinations of elevated or background sulfate, elevated or background iron, and the presence or absence of litter (Figure 1). These combinations were randomly assigned to the tanks in the first year of the experiment. For high-sulfate treatments, enough sodium sulfate was added to the surface water to bring the sulfate concentration to a target level of 300 mg L^{-1}. Surface water sulfate concentrations were tested weekly and sodium sulfate was added as required to maintain concentrations at the target level of 300 mg L^{-1} throughout the growing season for the duration of the experiment. The low-sulfate tanks were filled with water from an on-site well with concentrations around 10 mg L^{-1} and received no additional sulfate additions except for precipitation, which averaged 2.3 ± 1.5 mg L^{-1} sulfate. The sulfate concentrations in the low-sulfate tanks averaged around 7 mg L^{-1} over several years (Pastor et al., 2017). The low-sulfate conditions for our experiment are still higher than the median sulfate concentration of Minnesota wild rice waters, 1.8 mg L^{-1} (Myrbo et al., 2017a), but is just below Minnesota's protective sulfate standard for wild rice waters. At 300 mg L^{-1}, our high-sulfate treatment is close to the EPA's secondary standard for sulfate in drinking water (250 mg L^{-1}) and represents surface water concentrations of a few lakes and rivers in Minnesota that contain wild rice (Myrbo et al., 2017a). Prior to both sulfate and iron amendment, sediment iron was extracted from homogenized sediment samples using 1 M HCl and quantified on a Varian fast sequential flame atomic absorption spectrometer with an acetylene torch (Federation & Association, 2005). The sediment initially contained 77 µmol Fe g^{-1} dry weight (Table 1), 85% of which was Fe(II) (Phenanthroline method, see Section 2.2). Each iron-amended tank received 96 g Fe^{2+}, bringing total iron concentrations up to approximately 196 µmol Fe g^{-1}, or 10.9 mg g^{-1} dry weight. This amendment level aimed to noticeably increase iron concentrations without causing iron toxicity (Kinsman-Costello et al., 2015). Iron was applied gradually in four separate aliquots during the first growing season. For each addition, 75 g $FeCl \cdot 4H_2O$ was dissolved in 400 mL well water and added directly into the sediment through PVC standpipes connected to a buried perforated PVC ring. The standpipes and ring were flushed with 100 mL of tank water immediately after the iron(II) chloride was injected. Samples of pore water iron were taken several times over the course of the first growing season in 10 points distributed across the tank to ensure that the iron loading was distributed evenly. Noniron tanks did not receive additional iron except for occasional well water that contained 0.17 mg L^{-1} Fe. Noniron tanks did not have a buried PVC ring, but all mesocosms had a center standpipe draining into an external bucket to restore the water level after rain events.

Table 1
Initial Bulk Sediment Physical and Chemical Characteristics

Sediment property	Value
Porosity	0.87
Bulk density	0.29 g cm^{-3}
Percent solids	30
Solid-phase acid volatile sulfide (AVS)	0.346 ± 0.054 µmol g^{-1}
Solid-phase extractable iron	76.7 ± 5.1 µmol g^{-1}
Solid-phase ferrous iron	65.2 ± 4.8 µmol g^{-1}
Porewater sulfide	0.659 ± 0.239 µmol L^{-1}
Porewater ferrous iron	435 ± 200 µmol L^{-1}
Initial solid phase S:Fe ratio	0.00450
Initial porewater ΣS^{2-}:Fe^{2+} ratio	0.0015

Note. Sulfide was measured from initial sediment and porewater iron is an average from fall measurements in tanks unamended with iron.

To test the effect of shoot litter cohorts on sulfide production, shoot litter produced by the wild rice population was retained in half the tanks and removed from the remaining tanks. Litter removal was chosen as the experimental treatment rather than litter addition because in typical freshwater, organic-rich wild rice habitats, sulfide production is generally limited by sulfate rather than organic carbon, so increasing litter may have had little effect. Only aboveground litter was removed for two reasons: (a) to minimize sediment disturbance, and (b) to focus on litter effects on sulfide production. Litter-driven biomass oscillations are driven primarily by recalcitrant root litter (Walker et al., 2010), so aboveground litter manipulation was not

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expected to disrupt interannual cycles. Initial organic carbon content of the sediment was 14.8 ± 1.7% by dry weight (Pastor et al., 2017).

2.2. Geochemical Sampling and Analysis

In 2019 (year 5 of study), passive diffusion samplers (peepers) were installed in the tanks during vegetative growth (July) and seed production (September) to obtain porewater measurements from discrete depths in the top six cm of sediment. The peepers were placed in deionized water that was bubbled with nitrogen for 1 week prior to installation (Johnson et al., 2019). The peepers were transported to mesocosms in degassed water and installed in three tanks for each treatment. Each peeper contained four wells, the top of which was in the flocculant litter layer at the sediment surface and the bottom of which was approximately six cm below the sediment surface. Two weeks after peepers were installed, each peeper was removed and quickly placed in a large, resealable plastic bag purged with nitrogen gas to keep porewater anoxic during porewater extraction. Approximately 6 mL of porewater from each well was extracted with a syringe and allocated for immediate sulfide and iron measurements in vials preloaded with reagents. A separate aliquot was used to measure pH within 30 s.

Iron(II) and sulfide were quantified colorimetrically using the phenanthroline and methylene blue methods, respectively, on a HACH DR5000 UV-Vis spectrophotometer (Federation & Association, 2005). The pH of the pore water was measured by placing a calibrated ThermoScientific Orion pH electrode in porewater immediately after it was extracted from peepers.

2.3. Biological Sampling and Analysis

Seedlings usually began to germinate around mid-May. When seedlings grew to the water surface, populations in each mesocosm were thinned to approximately 30 plants per tank, which is the optimal density to limit competition and minimize overlapping rhizospheres (Lee, 2002). In August, as plants began to flower, six plants from each tank were randomly selected and tagged. Seed data were collected from these six plants and extrapolated to the total number of plants in the tank. Seeds from the remaining plants were left in the tank to reseed the sediment for the next year. Seeds were sorted as filled or unfilled by visual inspection, counted, and dried at 65 °C and weighed to determine seed mass. After all plants had completely senesced in October, all aboveground biomass was removed and weighed with a small subsample dried at 65 °C and weighed for moisture correction. The litter that was not dried was returned to the mesocosms assigned to retain litter within a few days.

2.4. Data Analysis

The data collected in this experiment are available at the Digital Repository for University of Minnesota (LaFond-Hudson et al., 2020b). Porewater data collected from peepers were examined to understand how porewater sulfide to iron ratios and saturation with respect to FeS were changed 5 years after geochemical manipulation. A three-way ANOVA was used to test the effect of each geochemical manipulation (sulfate, iron, litter). Repeated measures ANOVAs were used to determine the effect of time, sulfate addition, iron addition, and litter removal on biological traits and porewater measurements. Data were checked for normality and heteroscedasticity using R's standard diagnostic plots and for sphericity using the ez R package (Lawrence, 2016), which provides sphericity corrections in the case of violated assumptions. For porewater data, nondetects (12% of samples) and lost samples (11%) were removed. Zeros were not removed in biological data, as these were true absences of plant or seed tissue. Including zeros in biological data resulted in large variance under high-sulfate conditions, making it harder to detect differences between treatments using ANOVA tests. However, averages calculated including zeros (extinction of the population) represent the effects of high sulfate more completely than removing zeros.

To test the propensity of the population to oscillate in high-sulfate and low-sulfate conditions, we regressed the change in vegetative biomass ($B(t) - B(t-1)$) against the vegetative biomass from the previous year ($B(t-1)$). A negative slope of this regression indicates that high productivity 1 year leads to lower productivity the following year and, conversely, that years with low productivity are followed by years with higher productivity (Walker et al., 2010). The slope of this line is $\partial(\mathrm{d}B/\mathrm{d}t)/\partial B$, which is effectively an eigenvalue of system. A critical value of -1 of this eigenvalue defines a Hopf bifurcation giving birth to stable limit cycles (Pastor & Walker, 2006; Strogatz, 1994; Walker et al., 2010). A slope of -1 or more negative indicates propensity for stable oscillations,

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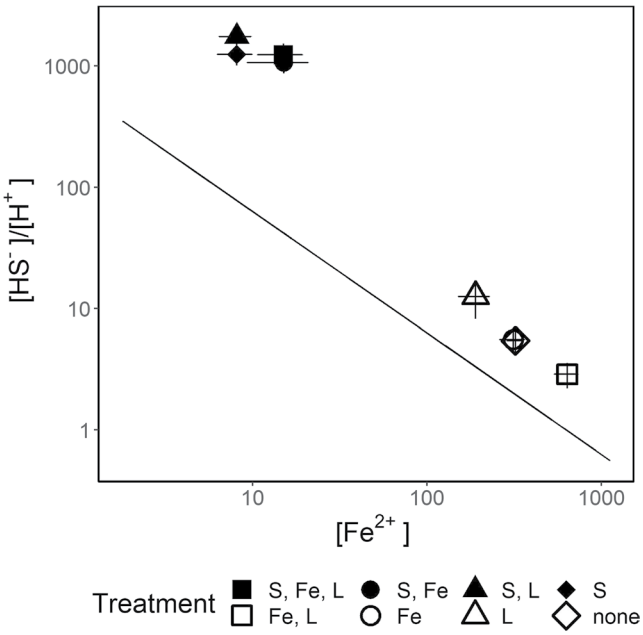


Figure 2. Comparison of ferrous iron (μmol L^{-1}) and sulfide concentrations (both sulfide and H+ in mol L^{-1}) in sediment porewater after 5 years of sulfate amendment (S), iron amendment (Fe), and litter retention (L). Data points represent average porewater measurements for each treatment (n = 12–30; most n = 24). Error bars represent the standard error around the mean. Porewater was collected 2, 4, and 6 cm below the sediment surface using peepers. Open symbols are for mesocosms with background sulfate concentrations and closed symbols are for mesocosms with nominal sulfate concentrations of 300 mg L^{-1} in overlying water. The line depicts the ion activity product at saturation for iron and bisulfide at pH 7.0 (log K_{sp} = −3.2). Porewater pH in elevated sulfate mesocosms ranged from 6.85 to 8.56 with a mean of 7.33 while porewater pH in low-sulfate mesocosms averaged ranged from 6.18 to 8.83 with a mean of 6.67.

while a slope between −1 and 0 indicates dampened oscillations (Walker et al., 2010). Dampened oscillations will eventually converge on a stable value of biomass, which may include zero (extinction). When no biomass is produced the following year, the population is at the boundary line $y = -x$ and the population is extinct. Vegetative biomass, rather than total biomass (vegetative + seeds), was used in this analysis because asynchrony in nitrogen mineralization and nitrogen uptake is expected to affect plants most during vegetative growth (Grava & Raisanen, 1978; Walker et al., 2010).

3. Results

3.1. Geochemical Context

Both high-sulfate and low-sulfate conditions contained sulfide and iron concentrations that favored precipitation of FeS (ion activity product > Ksp, Figure 2) in the fifth year of the study. Sulfate amendments to the surface water increased porewater sulfide and pH, and decreased porewater ferrous iron concentrations ($p < 0.001$ for all, Table 2). Sulfate addition raised porewater sulfide from an average of 4 μmol L^{-1} in unamended tanks to 110 μmol L^{-1} and lowered porewater ferrous iron concentrations by a similar order of magnitude, from 309 to 12 μmol L^{-1}. The pH in high-sulfate mesocosms was 0.65 units higher than in low-sulfate conditions (7.32, 6.67). Iron amendment increased porewater ferrous iron concentrations by approximately 70–80% ($p < 0.001$, Table 2) but did not notably change sulfide or pH. Litter removal did not significantly change sulfur or iron geochemistry.

3.2. Geochemical Effects on Biomass and Reproduction

All measured traits of wild rice growth and reproduction changed with time (Table 3). Sulfate addition strongly and consistently decreased all measured traits of wild rice growth (Table 3). The main effects of iron addition and litter removal were much weaker and inconsistent relative to sulfate addition, therefore we examined how iron and litter affected wild rice growth and reproduction using separate repeated measures ANOVAs for the high and low sulfur populations, respectively.

Total aboveground biomass density (hereafter referred to as biomass) was similar between high-sulfate and low-sulfate populations during the first year of the experiment (100 g m^{-2}), but biomass in high-sulfate populations declined to less than 5 g m^{-2} during the subsequent 5 years (Figure 3). In 2017, 4 years into the experiment, 8 out of the 20 populations receiving high sulfate loads produced no biomass regardless of iron addition and litter removal. Seven populations recovered partially in 2018, possibly from the germination of seeds from previous years buried in the sediment, but by 2019, 16 out of these 20 populations produced no biomass. In low-sulfate

Table 2
The Effect of Five Years of Sulfate, Iron, and Litter Additions on Porewater Concentrations of Sulfide and Iron, Porewater pH, and the Saturation Index With Respect to FeS Calculated From the Former Three Measurements in 2019 (Three-Way ANOVA)

Variable	Sulfate	Iron	Litter	Significant interactions
Porewater sulfide	**$p < 0.001$**	$p = 0.53$	$p = 0.64$	S × Fe, Litter × Fe, S × Litter × Fe
Porewater iron	**$p < 0.001$**	**$p < 0.001$**	$p = 0.16$	
Porewater pH	**$p < 0.001$**	$p = 0.64$	$p = 0.57$	S × Litter × Fe
Saturation index of FeS	**$p < 0.001$**	$p = 0.19$	$p = 0.96$	

Note. Significant interactions (in bold) refer to combinations of sulfate, iron, and/or litter that are significant at $p < 0.05$.

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Table 3
Repeated Measures ANOVA Testing the Influence of Sulfate Amendment, Iron Amendment, and Litter Removal on Wild Rice Growth and Reproduction for 2014–2020

Trait	Year	Sulfate	Iron	Litter	Significant interactions
Vegetative biomass	$\mathbf{p < 0.001}$	$\mathbf{p < 0.001}$	$p = 0.81$	$p = 0.44$	S × L × Fe × Year, S × L × Year, S × Year, Fe × Year
Population seed mass	$\mathbf{p < 0.001}$	$\mathbf{p < 0.001}$	$p = 0.59$	$p = 0.09$	S × L × Year, S × Year
Filled seed ratio	$\mathbf{p < 0.001}$	$\mathbf{p < 0.001}$	$\mathbf{p < 0.001}$	$p = 0.25$	S × Year
Mass per filled seed	$\mathbf{p < 0.001}$	$\mathbf{p < 0.001}$	$\mathbf{p = 0.002}$	$p = 0.40$	S × Year, Fe × Year
Total biomass	$\mathbf{p < 0.001}$	$\mathbf{p < 0.001}$	$p = 0.71$	$p = 0.23$	S × Fe × L × Year, S × L × Year, S × Year
High-sulfate conditions					
Vegetative biomass	$\mathbf{p < 0.001}$	–	$p = 0.82$	$p = 0.83$	L × Year, Fe × L × Year Fe × Year
Population seed mass	$\mathbf{p < 0.001}$	–	$p = 0.28$	$p = 0.67$	
Filled seed ratio	$\mathbf{p < 0.001}$	–	$\mathbf{p = 0.01}$	$p = 0.42$	
Mass per filled seed	$\mathbf{p < 0.001}$		$\mathbf{p = 0.04}$	$p = 0.20$	
Total biomass	$\mathbf{p < 0.001}$	–	$p = 0.74$	$p = 0.97$	L × Year, Fe × L × Year
Low-sulfate conditions					
Vegetative biomass	$\mathbf{p < 0.001}$	–	$p = 0.68$	$p = 0.30$	Fe × Year
Population seed mass	$\mathbf{p < 0.001}$	–	$p = 0.82$	$p = 0.08$	
Filled seed ratio	$\mathbf{p < 0.001}$	–	$\mathbf{p = 0.01}$	$p = 0.41$	Fe × Year
Mass per filled seed	$\mathbf{p < 0.001}$	–	$\mathbf{p = 0.02}$	$p = 0.86$	Fe × Year
Total biomass	$\mathbf{p < 0.001}$	--	$p = 0.82$	$p = 0.18$	

Note. Bold values highlight p-values < 0.05. Separate tests for high-sulfate and low-sulfate conditions are also included. Interactions are listed if significance is $p < 0.05$.

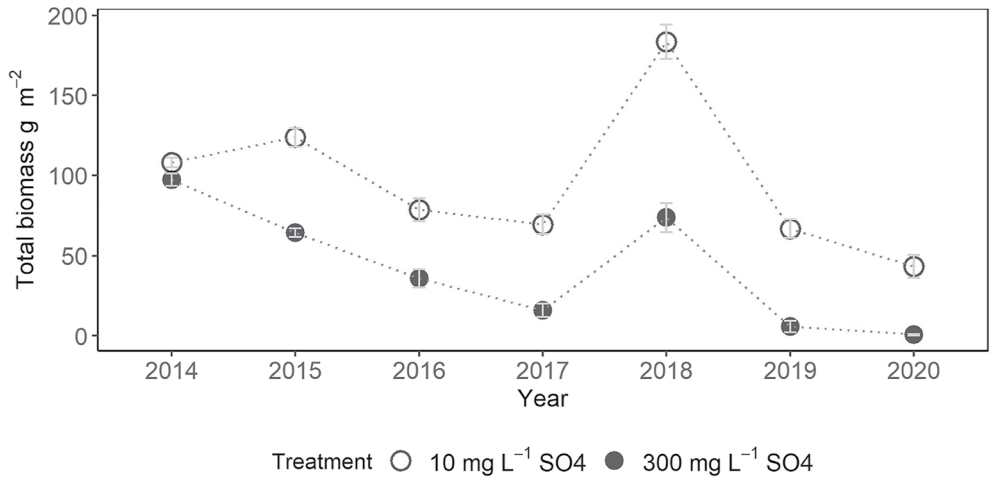


Figure 3. Annual average aboveground biomass (total) density (g m^{-2}) in populations grown in high sulfate (300 mg L^{-1}, filled circles) and low sulfate (10 mg L^{-1}, empty circles) in the overlying water. Error bars depict the standard error around the mean ($n = 20$).

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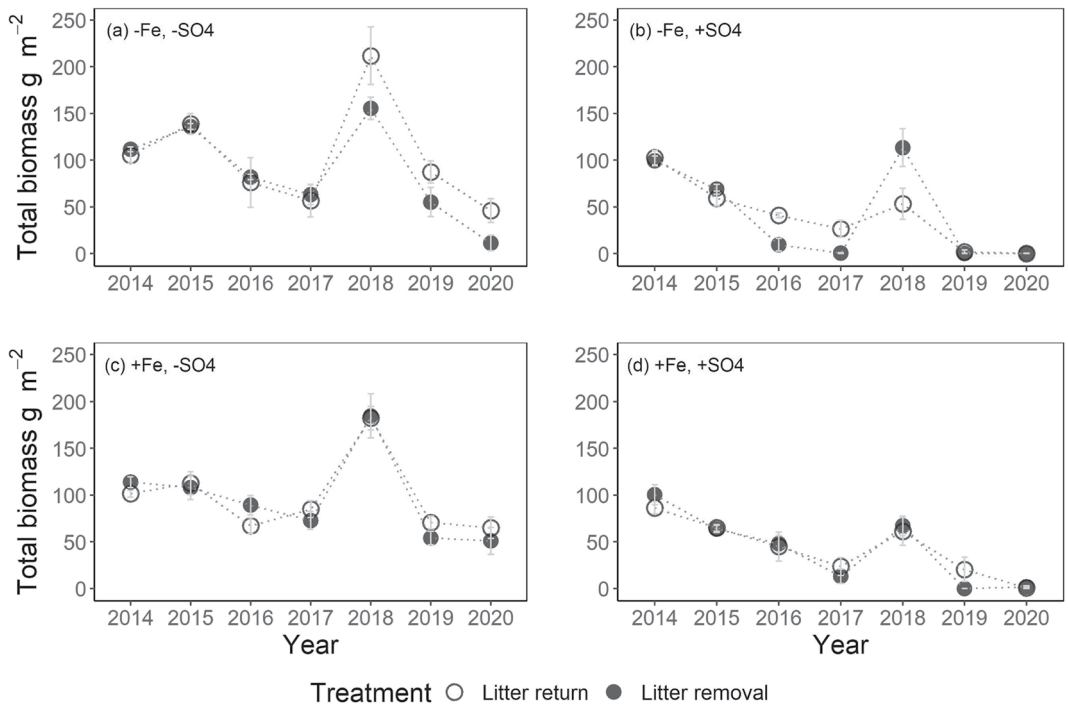


Figure 4. Annual average aboveground biomass (total) density (g m^{-2}) in populations grown with the previous year's aboveground litter returned (empty circles) or removed (filled circles). Populations were treated with combinations of low sulfate (−SO_4, 10 mg L^{-1}; a, c) or high sulfate (+SO_4, 300 mg L^{-1}; b, d) and low iron (−Fe, 4.3 mg g^{-1}; a, b) or high iron (+Fe, 10.9 mg g^{-1}; c, d). Error bars depict the standard error around the mean ($n = 5$).

conditions, populations showed a stable 3-year cycle of biomass (Figure 3) that oscillated between about 50 and 175 g m^{-2} on average, with peaks in the second and fifth growing season (2015 and 2018).

When biomass was examined separately in high-sulfate and low-sulfate treatments, populations grown in low sulfate were not affected by iron, litter, or their interaction (Figures 4a and 4c). Populations grown in high sulfate were not consistently influenced by iron and litter but were affected by interactions between iron, litter, and year (Table 3). In high-sulfate conditions, litter removal amplified oscillations in the treatments that did not receive iron addition, with lower biomass in years 3–4 of the experiment and higher biomass in year 5 compared to the populations with litter return (Figure 4b). In high-sulfate treatments that received additional iron, no differences in biomass were observed between litter removal and litter return (Figure 4d).

The proportion of filled seeds, individual seed mass, and population seed mass approached zero after six generations in high-sulfate conditions, while the same seed traits remained constant in low-sulfate conditions (Figure 5, seed mass not shown). Sulfate-amended populations that received iron amendment had a 20% higher filled seed ratio for 2015–2017 ($p = 0.01$, Table 3 and Figure 5b), but the effect of iron diminished in 2018 and 2019. In high-sulfate conditions, iron increased the average individual seed mass by approximately 40% in 2016 and by 20–30% in 2017–2018 ($p = 0.04$, Table 3 and Figure 5d). By 2020, only two sulfate-amended populations produced seeds; both also received iron amendment. In low-sulfate conditions, the proportion of filled seeds and average mass per filled seed were slightly increased by iron amendment (Figures 5a, 5c and Table 3). Litter removal did not affect any seed traits (Table 3).

3.3. Stability of Population Cycles

Changes in vegetative biomass from 1 year to the next were regressed against the biomass of the previous year to examine population oscillations for stability (Walker et al., 2010). All treatments with low sulfate were aggregated to compare to all treatments exposed to elevated sulfate since iron and litter manipulations had little effect in comparison to sulfate. In low-sulfate conditions, biomass oscillations are stable, as indicated by the slope of −1.3 for years 2015–2018 (Figure 6a) and a consistent annual biomass production between 50 and 125 g m^{-2}.

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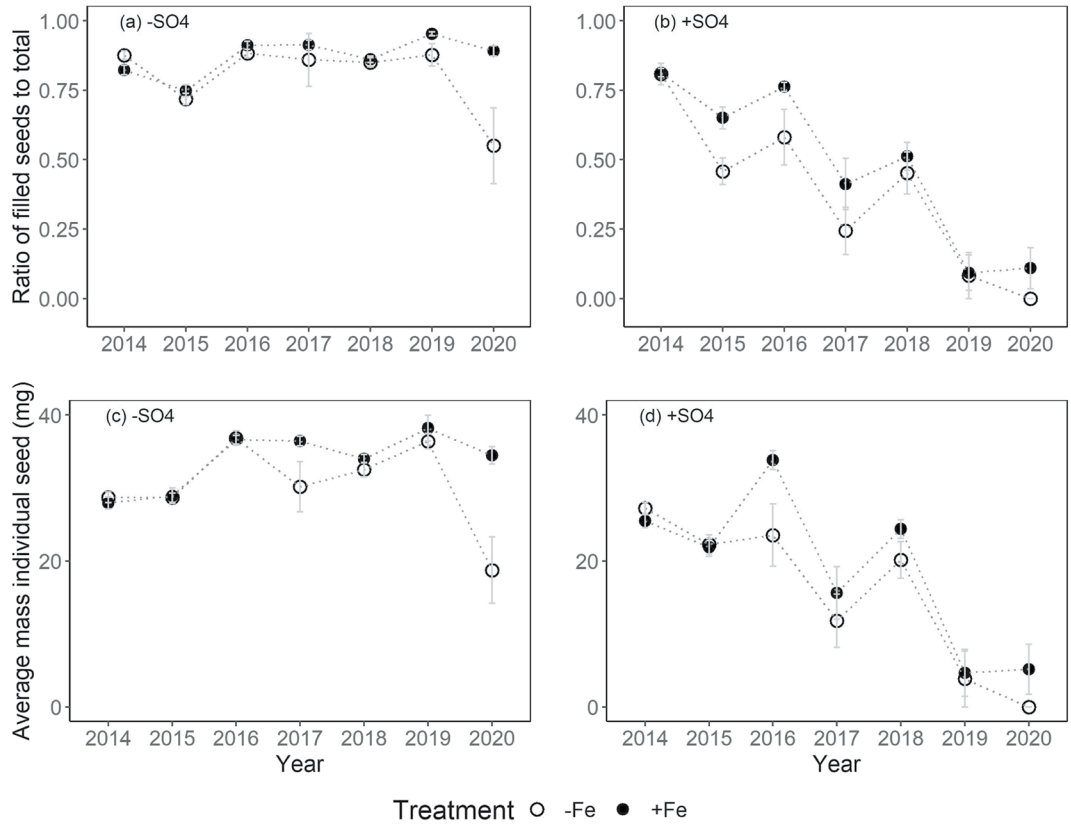


Figure 5. Effects of iron addition (+Fe, 10.9 mg g^{-1}; −Fe, 4.3 mg g^{-1}) on the ratio of filled seeds to total seeds (includes empty husks; a, b) and on average individual seed mass (c), (d) in 10 and 300 mg L^{-1} sulfate. Error bars depict the standard error around the mean ($n = 10$).

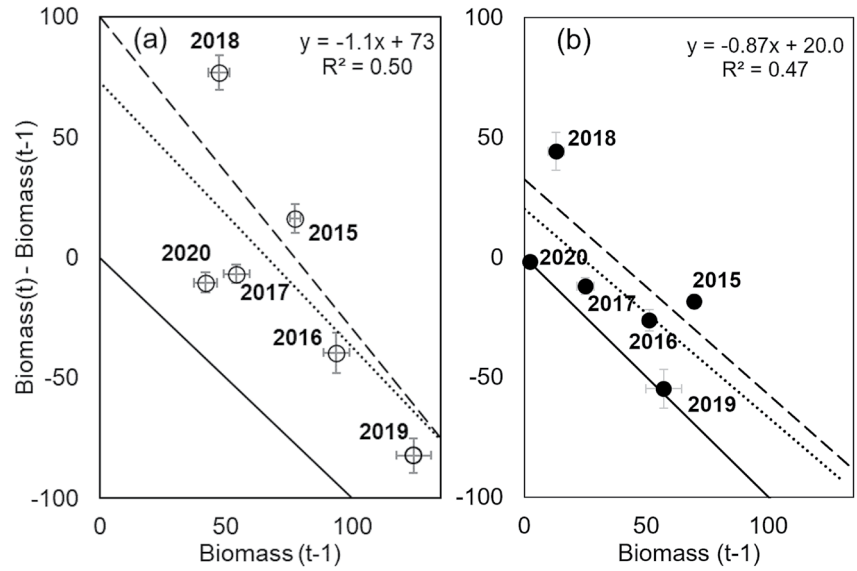


Figure 6. The relationship between average year-on-year change in vegetative biomass (g m^{-2}) to the previous year's vegetative biomass in (a) 10 mg L^{-1} sulfate and (b) 300 mg L^{-1} sulfate. Error bars show the standard error. The slope of the dashed line represents $\partial(dB/dt)/\partial B$ and is calculated from populations in 2015–2018, representing approximately one population cycle. The dotted line also represents $\partial(dB/dt)/\partial B$ and is calculated from 2015 to 2020, to show the stability after 1.5 population cycles. The solid line represents extinction, when all biomass from the previous year is lost.

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This slope is nearly identical to the slopes found a previous experiment (−1.04 to −1.20) that showed wild rice undergoes litter-driven productivity cycles (Walker et al., 2010). When data from 2019 to 2020 are included in this analysis, the slope is −1.1, still representing stable oscillations. The present experiments and those of Walker et al. (2010) were done during different time periods and in different wild rice populations. Therefore, the two experiments provide independent corroboration of one another.

In high-sulfate conditions, a slope of −0.9 for year 2015–2018 indicates dampened oscillations (Figure 6b). Biomass decreased every year except for 2018, when the populations partially recovered. From 2018 to 2019, almost all points from sulfate-amended mesocosms fell on the boundary line $y = -x$, indicating that populations lost the entirety of the biomass produced during 2018 and produced no new biomass in 2019 (Figures 6b and 3). The data point for 2020 is near zero, indicating two consecutive years of extinct populations. The trajectory of mean biomass over time decreases in the presence of sulfate under our experimental conditions (Figure 3) and oscillations were dampened. In low-sulfate concentrations, biomass peaked in 2015 and 2018, demonstrating a 3-year cycle. Elevated sulfide produced in tanks with high-sulfate concentrations extinguished the population cycle which persisted in tanks with low-sulfate concentrations.

4. Discussion

Elevating surface water sulfate to 300 mg L^{-1} led mesocosm populations of wild rice to extinction in six growing seasons. This study adds to the growing body of literature describing the impacts of sulfate loading and subsequent sulfide exposure on wild rice, including lower rates of seedling survival, delayed phenology, impaired seed production, and declining biomass (Johnson et al., 2019; LaFond-Hudson et al., 2020a; Pastor et al., 2017). In conjunction, field observations both recently as well as decades ago show that wild rice presence becomes increasingly unlikely with elevated surface water sulfate and porewater sulfide (Moyle, 1945; Myrbo et al., 2017a). Statistical modeling of environmental parameters associated with wild rice presence has suggested that iron and organic carbon play the strongest role in controlling sulfide's effects on wild rice populations (Pollman et al., 2017), and similar conclusions have been reached about other sensitive aquatic plant species growing in freshwater wetlands with increasing sulfate loads (Lamers et al., 2002; Van der Welle et al., 2007). In our study, iron addition and organic carbon removal did not limit sulfide accumulation in sediment enough to stabilize wild rice populations.

In anoxic freshwater systems, sulfide production is generally limited by the supply of sulfate, whereas in marine systems or other systems with high sulfate, sulfide production is generally limited by the supply of organic matter (Ruiz-Halpern et al., 2008). Wild rice naturally grows in low-sulfate, organic-rich habitats (Myrbo et al., 2017a), meaning sulfate is the likely limiting factor for sulfide production. In mesocosms with elevated sulfate, litter removal alone did not appear to decrease sulfide concentrations and instead led to slightly faster population decline. It is possible that litter removal decreased the availability of macronutrients or micronutrients, such as nitrogen, potassium, or iron that might be replenished in natural ecosystems with more hydrologic connectivity. Notably, for populations with sulfate added and litter removed, population biomass declined faster in populations with ambient iron compared to populations receiving iron addition (Figures 4b and 4d). Another possibility is that in the litter return treatments, sulfate addition increased rates of litter decomposition and nutrient availability (Myrbo et al., 2017b). Under the conditions in this study and previous studies (Pastor et al., 2017), sulfide's inhibition of nitrogen uptake influenced population biomass more strongly than sulfate-enhanced nutrient mineralization, but the interactions of these two processes warrant further study.

In the presence of excess uncomplexed Fe(II), sulfide reacts quickly with iron, forming relatively stable iron sulfide solid phases. The ratio of sulfur to iron or similar metrics related to the degree of pyritization can be used to determine the capacity of sediment to precipitate iron sulfide and keep porewater sulfide concentrations low (Johnson et al., 2019; Julian et al., 2017). We added iron only during the first growing season of the experiment, making this treatment a pulse (one time) rather than a press (ongoing). In contrast, our sulfate and litter manipulations were maintained throughout the experiment. This decision was made to avoid Fe^{2+} toxicity to the plants (Kinsman-Costello et al., 2015; Sahrawat, 2005) and likely contributed to our findings of little alleviation of sulfide toxicity by iron compared to other studies with freshwater vegetation in environments with natural differences in groundwater upwelling of iron (Lamers et al., 2002) or seagrasses in experiments with monthly iron addition (Ruiz-Halpern et al., 2008). We observed some mitigation of sulfide's effects on seed production by

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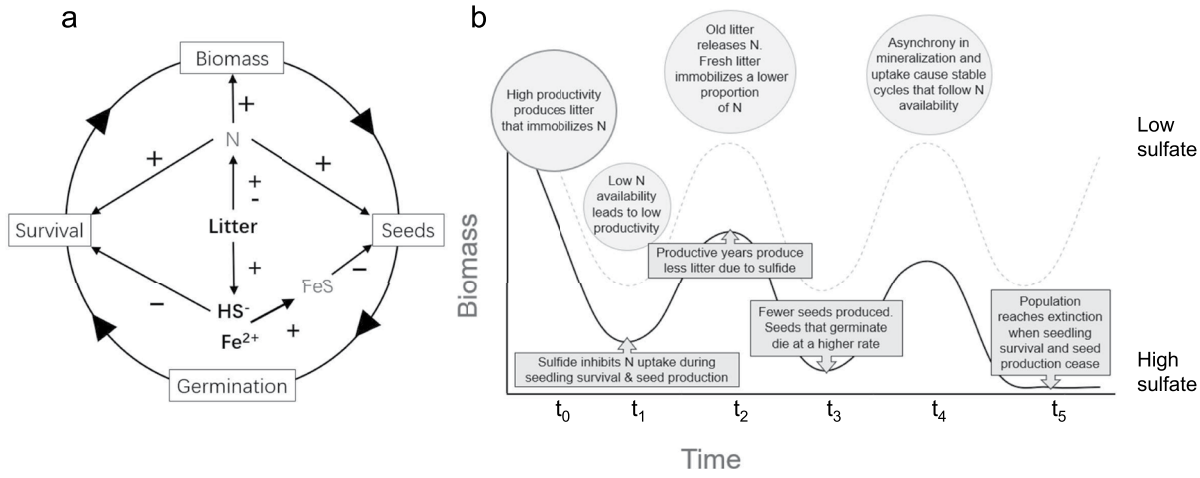


Figure 7. A conceptual model synthesizing the interactions of sulfur, iron, and litter during the life cycle of wild rice (a), and the effect of sulfur on interannual biomass cycles of wild rice (b) based on this study, Walker et al. (2010), and LaFond-Hudson et al. (2018). In (a), the (+) and (−) symbols in (a) represent positive or negative relationships between geochemical constituents and plant traits. In (b), the top, dashed line represents low-sulfate conditions, and the lower, solid line represents conditions with elevated sulfate loading. Time intervals ($t_0 - t_5$) do not represent consecutive years, because time between peaks is typically 3–5 years for wild rice.

iron in the first 4 years of the experiment, but iron's effect diminished by 2018 and 2019 (Figure 5) and porewater measurements in 2019 confirmed that iron concentrations were low in all elevated sulfate treatments, regardless of whether the mesocosms received additional iron (Figure 2).

The effect of sulfur on wild rice population dynamics is further complicated by oscillations due to a lag in nitrogen mineralization from litter relative to the timing of nitrogen uptake during the life cycle (Walker et al., 2010). We present a conceptual model built on the synthesis of previous work elucidating the connection between nitrogen and biomass cycles (Pastor & Walker, 2006; Walker et al., 2010); connections between sulfate, biomass, and seed production (Johnson et al., 2019; LaFond-Hudson et al., 2018; Pastor et al., 2017); and the present study which explores the role of sulfate and biomass cycles (Figure 7). Within each life cycle, nitrogen controls plant growth, and seed production (Grava & Raisanen, 1978). Litter immobilizes then slowly mineralizes nitrogen, leading to alternating negative and positive effects on nitrogen availability (Walker et al., 2010, Figure 7a). When sulfate is added to the system, production of sulfide directly decreases seedling survival and seed production (Figure 7a and Pastor et al., 2017). Iron precipitates sulfide into less-reactive iron sulfide, potentially alleviating some of the effects of sulfide on seedling survival and seed production, although iron sulfide also accumulates on root surfaces concomitant with decreased seed nitrogen (LaFond-Hudson et al., 2018). As the life cycle repeats each year (Figure 7a), these geochemistry-plant interactions lead to different interannual trajectories depending on the level of sulfate present in the system (Figure 7b). In low-sulfate conditions, high biomass production 1 year leads to an above average amount of litter that immobilizes nitrogen and decreases nitrogen availability in the following year(s) (Figure 7b, t_0, t_1). The lower nitrogen availability creates competition among seedlings for scarce nitrogen, leading to diminished biomass and seed production. As litter slowly decays, it releases nitrogen during subsequent years (Figure 7b t_2), and thereby increases seedling survival, biomass, and seed production. Alternating nitrogen availability leads to stable biomass cycles in low-sulfate environments (Figures 3 and 7b, t_4 etc.). At the levels of experimental sulfate addition we used, sulfur impacts overwhelmed the effects of litter-controlled N availability, causing the populations to quickly decrease (Figures 3 and 7b, t_3). When constant sulfate loading sustains declines in seedling survival and seed production, both germination and population biomass decline, eventually to extinction (Figure 7b, t_5).

Although we examined complicated interactions among sulfur, iron, organic carbon, nitrogen, and plant cycles, the mesocosms we used in this study are a relatively simple system containing only one species, homogenized sediment across mesocosms, and little hydrological mixing or external nutrient inputs. Projects that manage or restore plant populations in aquatic ecosystems occur in systems affected by interactions between geochemistry, surface and groundwater hydrology, and competing ecological communities. Many such projects monitor biomass annually, but traditional time series analyses require lengthy monitoring periods. When the monitoring period is

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too short to detect population oscillations with a time series analysis, it may be insightful to use annual biomass data from one or two population cycles to calculate and analyze eigenvalues that describe the population's stability. In our experiment, we calculated and analyzed eigenvalues from less than two population cycles and our eigenvalue for populations in low-sulfate conditions corresponded closely to the results of Walker et al. (2010). Even though these were different experiments done during nonoverlapping time periods, the two experiments corroborate one another and strongly suggest that wild rice populations unimpeded by sulfate loadings oscillate stably with an approximate period of 4 years. Additionally, these findings are consistent with observations in some regional lakes and rivers containing wild rice stands (Vogt, 2021). This method is general enough to be applied analogously to data from other field studies and may be useful for identifying at-risk populations or determining whether management and restoration of an oscillating population is effective.

Only some aquatic plants experience population oscillations; however, many are limited by nitrogen and experience sustained or occasional exposure to sulfide, for example, the salt marsh species *Spartina alterniflora* (Mendelssohn & Morris, 2000). Estuarine wetlands receive sulfate from tidal inputs and interannual changes in precipitation can lead to wide variations in interannual nitrogen loading and sulfate intrusion (Sinha & Michalak, 2016). Understanding how plants respond to sulfate and sulfide under fluctuating nitrogen availability may be critical for understanding wetland vegetation dynamics. Perhaps species with different patterns of nitrogen uptake compared to wild rice can be more resilient to sulfide exposure, or plants with greater sulfide tolerance benefit more from increased sulfur-mediated nutrient availability.

5. Conclusion

This study demonstrates the importance of both litter-driven biomass oscillations and sulfate concentrations to population trajectories over several generations and corroborates studies that investigated these processes separately (Johnson et al., 2019; Pastor et al., 2017; Walker et al., 2010). Our observations show predictable and stable biomass oscillations in systems with less than 10 mg L^{-1} sulfate in surface water and rapid population declines in systems with surface water sulfate elevated to 300 mg L^{-1}. Although population biomass did oscillate in elevated sulfate conditions, oscillations were unstable and less predictable than in low-sulfate conditions. This work aggregates well-understood rhizosphere and geochemical processes to interpret the effects realized at a population scale. We did not find consistent or sustained contributions of iron or litter to stability of wild rice populations. Instead, interactions between sulfate, litter, and iron in this study point to complex couplings among plant life cycles, nutrient availability, and iron and sulfur cycling that become manifest over several generations through at least one population cycle. We conclude that both geochemical context and plant life cycle patterns play a considerable role in determining the stability of oscillating plant populations.

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Conflict of Interest

The authors declare no conflicts of interest relevant to this study.

Data Availability Statement

Data are publicly available at the Digital Repository for University of Minnesota at https://doi.org/10.13020/cq0g-r486 and are cited within the data analysis section of the methods.

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WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 16

Tedrow O, and Lee P (2022) Use of Wild Rice (*Zizania palustris L.*) in paddy-scale bioassays for assessing potential use of mining-influenced water for irrigation. *Mine Water and the Environment* 41:938-953.

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https://doi.org/10.1007/s10230-022-00908-0

TECHNICAL ARTICLE

Use of Wild Rice (*Zizania palustris* L.) in Paddy-Scale Bioassays for Assessing Potential Use of Mining-Influenced Water for Irrigation

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Abstract

As surface water resources become more intensely used, and occasionally non-useable, consideration of non-conventional water resources for anthropogenic use has become more prevalent. Potentially critical non-conventional water sources include flooded mine-pit lakes. However, water in these lakes can contain potentially problematic concentrations of contaminants of concern. We evaluated the potential use of elevated sulphate (SO_4) mining-influenced waters with low to non-detect metals concentrations for irrigation of wild rice (Zizania palustris L.; WR), a culturally and economically important species. Two flow-through in-situ paddies were developed adjacent to two mine-pit lakes with differing chemical water characteristics; specifically, Pit A contained ≈350 mg SO4 L^{-1} and Pit C contained ≈1350 mg SO4 L^{-1}. Throughout the course of multiple consecutive growing seasons, no adverse WR responses to these mining-influenced water exposures were observed. Based on data and observations from this study, potential use of mining-influenced waters containing elevated SO_4 as the primary contaminant for appropriate irrigation purposes is supported. However, site-specific conditions and potential environmental risks must be considered prior to use of mining-influenced waters for anthropogenic applications.

Keywords Water resources · Sulfate · Sulfide mining

Introduction

Mining activities throughout the world influence water quality even as water shortages become increasingly more common in many locations (Miller 2006; Northey et al. 2013; Liu et al. 2021). As such, strategies are being developed to identify beneficial mining-influenced water use and reuse opportunities (Apostu et al. 2020; Doupe' and Lymbery 2005; Gunson et al. 2012; Jones 2012; McCullough et al. 2020; Schultze 2012; Schultze et al. 2022) including aquaculture (Axler et al. 1992, 1996; McNaughton and Lee 2004), recreational and industrial uses (McCullough and Lund 2006), irrigation of some crops (Annandale et al. 2002, 2009, 2017, 2018, 2019, 2021), and sources of potable water (APUC 2021; VPUC 2020). However, mining-influenced water can be associated with concentrations of potentially toxic elements which may be of concern in areas of use (Doupe' and Lymbery 2005; Gerdol et al. 2018; Herbert et al. 2015; Karanthasis and Johnson 2003; Khan et al. 2005; Kumar et al. 2009; McCullough and Lund 2006; Miller et al. 1996; Nordstrom 2011).

Concentrations of potentially toxic elements such as Al, Cu, and Zn found in other locations (Nordstrom 2011) are not observed in most mining-influenced waters in Minnesota (MN, USA). Instead, sulphate (SO_4) from mining activities entering wild rice (WR) waters is the primary concern in MN. Use of WR in aquatic bioassays has increased in recent years in an effort to better understand how exposures of SO_4 (> 10 mg L^{-1}; current MN WR water quality criterion) may influence phenology, distribution, and productivity. Laboratory, and small-scale field, investigations have focused on measuring responses of WR to well-defined exposures of SO_4 and hydrogen sulphide (H_2S) associated with mining-influenced waters (Fort et al. 2014, 2017; Pastor et al. 2017; LaFond-Hudson et al. 2018, 2020). Development and use of these paddy-scale bioassays was critical to better understanding larger-scale and longer-term in-situ responses of

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WR to exposures of elevated SO_4 (≈350 and 1350 mg L^{-1}) in mining-influenced waters under a more realistic scenario. Critically, these paddies represent, on a smaller-scale, commercial paddy WR production.

WR Water Review

Various surveys have examined water quality in lake-grown WR. In a survey of WR lakes in MN and Ontario, Lee (1979) observed that most lakes supporting WR had an average alkalinity of ≈40 mg L^{-1}, and average pH values of ≈6.9. Pip (1984) examined the distribution of 59 species of aquatic macrophytes in Manitoba, including WR, concluding that SO_4 concentrations were of minor importance for WR distribution. Pillsbury and McGuire (2009) attributed losses of WR in MN and Wisconsin to increased ammonia, pH, water depth, and residential and agricultural developments in study areas. Jorgenson et al. (2013a) showed that WR could grow in waters with seasonal total P concentrations reaching 1500 µg L^{-1}. Although WR distribution may be at least correlated to water chemistry, WR also influences chemical characteristics of water in which it lives. Lee and McNaughton (2004) showed that water surrounding WR stands contained lower SO_4, and higher conductivity, Ca, and Fe concentrations than adjacent open-water areas.

One concern with use of some mining-influenced waters for WR irrigation is exposure to potentially toxic elements. Bioassays conducted by Lee and Hughes (1998) determined concentrations (≥1.0 mg L^{-1}) of Al, Cd, Cu, Hg, and Pb in water that were detrimental to early WR development. An additional concern with using mining-influenced water for WR irrigation is a possible effect from SO_4 (Moyle 1944, 1945, 1956). Moyle documented WR was primarily found in waters with a SO_4 concentration of less than 10 mg L^{-1}. However, WR was also observed growing in waters ranging from 2- > 200 mg SO_4 L^{-1} (Lee and Hughes 2000; Lee and Stewart 1981; Moyle 1945; Paulishyn and Stewart 1970; Rogalski et al. 1971). In a comprehensive field study completed by the MN Pollution Control Agency (MPCA) during 2011–2013, WR was observed growing in surface waters ranging from < 0.5–838 mg SO_4 L^{-1}. More recent microcosm studies concluded aqueous SO_4 may not be a primary chemical characteristic adversely influencing WR phenology; rather, pore water (PW) H_2S may be more adversely influential on WR plant development (Myrbo et al. 2017; Pastor et al. 2017; LaFond-Hudson et al. 2018, 2020). Fort et al. (2017) concluded that iron (II) complexation with sulphide may decrease adverse WR responses to these sulphide exposures. In a bucket-style mesocosm study in MN, LaFond-Hudson et al. (2018, 2020) inferred FeS coatings on WR roots may have resulted in decreased plant height, dry weight biomass (DWB), decreased overall developmental rate, and seed characteristics including per-plant productivity. It was hypothesized that more realistic assessments of the importance of SO_4 and H_2S exposures to WR could be achieved using paddy-scale bioassays and longer-term in-situ exposures of elevated SO_4 (≈350 and 1,350 mg L^{-1}) in mining-influenced waters. Detailed descriptions of WR paddy cultivation include Oelke (2006), Oelke et al. (1982, 1997), and Marcum and Porter (2006), with foci on nutrient amount and timing requirements (Grava 1977; Grava and Raisanen 1978; Grava and Rose 1975; Oelke et al. 1982, 1997; Sims et al. 2012a, b). Nitrogen deficiency has been suggested as a particular problem for growing WR in mining-influenced sediments (Tedrow 2020; Tedrow and Lee 2021).

Materials and Methods

Paddy Design, and Inflow/Outflow and Substrate Sampling

In an effort to quantify influences of elevated SO_4 from mining-influenced waters on WR growth and development, flow-through WR paddies were constructed adjacent to two mine pit lakes ≈2.5 km apart (Paddy A adjacent to Pit A; Paddy C adjacent to Pit C). Water contained within the two pits is sufficiently different to encompass a range of aqueous SO_4 [≈350 mg L^{-1} (Pit A) to 1,350 mg L^{-1} (Pit C)] theorized to adversely influence WR distribution, phenology, and productivity. Water depth (Thomas and Stewart 1969) and competing vegetation were mitigated as adverse influence variables (Vicario and Halstead 1968; Stevenson and Lee 1987; Elakovich and Wooten 1989; Quayyum et al. 1999; Tucker et al. 2011).

Wild rice (WR; *Zizania palustris* L.) was chosen as the aquatic test species for this work due to its cultural and economic importance to the NE region of MN; and for its overall phenology. WR is an aquatic annual, and therefore must produce viable seeds each year to have re-growth the following year. Initiating/planting paddies of WR is also made simpler by this fact—broadcasting grain is less resource intensive than individual cutting, rhizome, or root-ball planting. Additionally, potential vegetation management (removal of competing vegetation; adding viable seed; substrate nutrient management) was simplified through use of this annual aquatic grain.

Paddy A (initiated May 2017; ≈55 m^2 surface area) and Paddy C (initiated May 2018; ≈150 m^2 surface area) were constructed using onsite materials as impermeable perimeter berms, with an impermeable liner as the base. Average substrate and water depths at initial seed distribution were ≈25 and 25 cm in Paddy A, and 46 and 33 cm in Paddy C. Source seeds were harvested from lakes in northern MN, and were broadcast at a rate of ≈56 kg ha^{-1} (wet weight) in

each paddy—approximately one Kg in Paddy A, and 2.5 kg in Paddy C. In an effort to ensure viable WR seed would be present in Paddy A substrate during winter months, additional seed was broadcast (0.45 kg; one lb.) throughout Paddy A during October 2017. As a result of observed spring 2018 WR germination in Paddy A, no additional WR seed was broadcast in either paddy—Paddy C only received WR seed in May 2018 for initial seeding. Paddies were visited approximately weekly during their respective growing seasons; Fig. 1 details typical Paddy A temporal observations during 2017–2019 growing seasons; Fig. 2 details typical Paddy C temporal observations during 2018–2019 growing seasons.

Unlike commercial WR paddies, neither of these paddies were drained at the end of, or between, growing seasons. Inflow water from their respective pits was maintained until freeze-up, and was re-initiated in late-March/early-April each year; no nutrients (fertilizer) were amended to substrate in either paddy. The planted area of each paddy was delineated into one-square-meter quadrats for randomized substrate, plant, and seed sampling purposes. Water was directly sampled from the inflow and outflow of each paddy once per growing season during harvest. Water samples were delivered to Pace Analytical Laboratories (Pace) in Virginia, MN. Substrate samples from the top 10 cm of each paddy were obtained from randomly selected quadrats using a 4.8 cm internal diameter sediment core sleeve. All substrate samples were frozen and delivered to the Lakehead University Environmental Laboratory (LUEL; Lakehead University, Thunder Bay, ON, Canada).

Pore Water Sampling

Pore water (PW) characteristic samples were obtained approximately every 30 days from inflow, middle, and outflow areas within each paddy throughout each growing season. Two PW sampling methods were used during this study: diffusion-based peepers and Rhizons. At least 50 mL

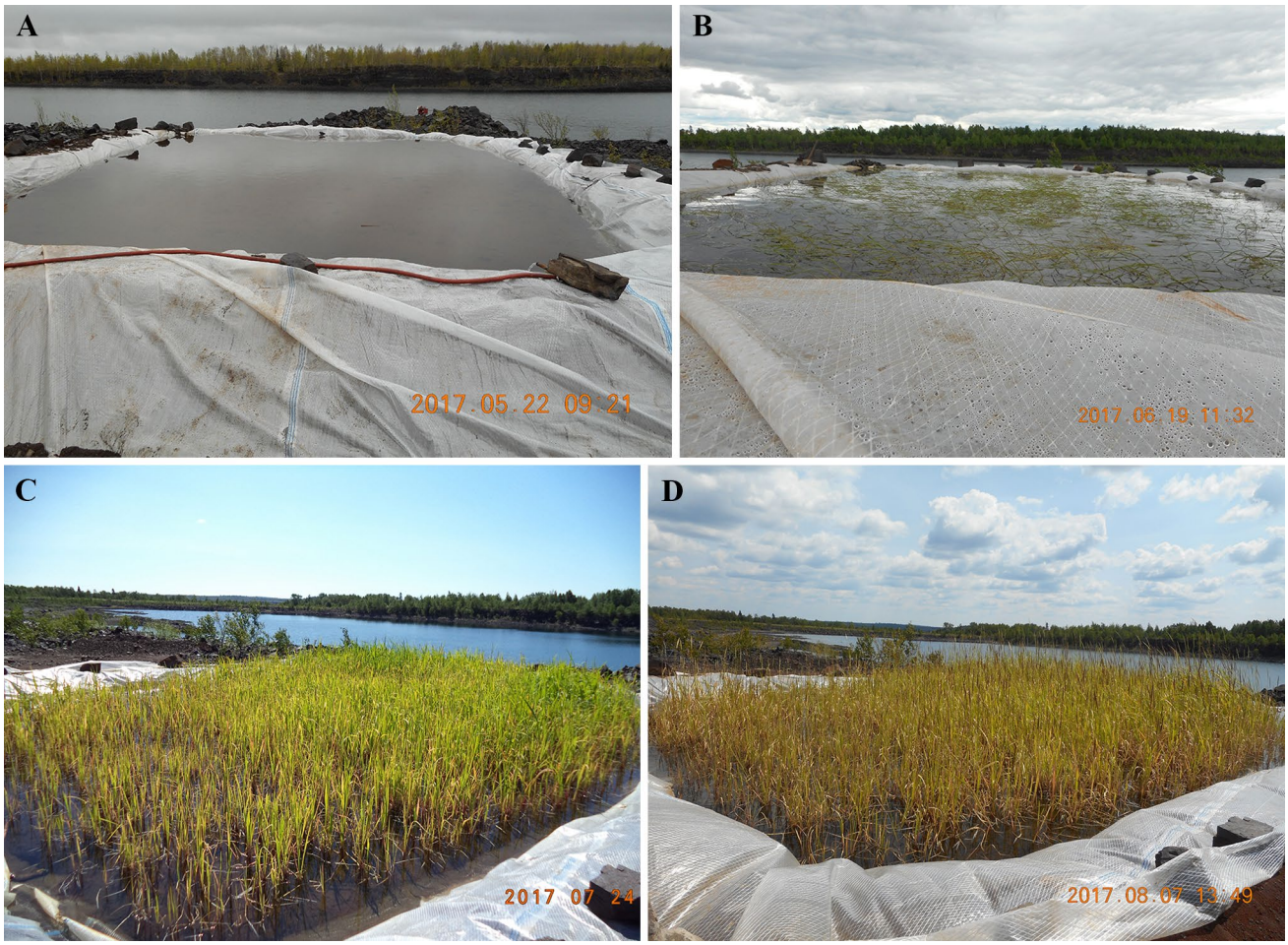


Fig. 1 Paddy A. Images represent typical temporal WR phenological observations during 2017–2019 growing seasons: **A** seed distribution date and approximate yearly germination (2017-05-22); **B** floating leaf (2017-06-19); **C** aerial, flowering, seed production (2017-07-24); and **D** filled seeds throughout (2017-08-07). Yearly harvest occurred in August

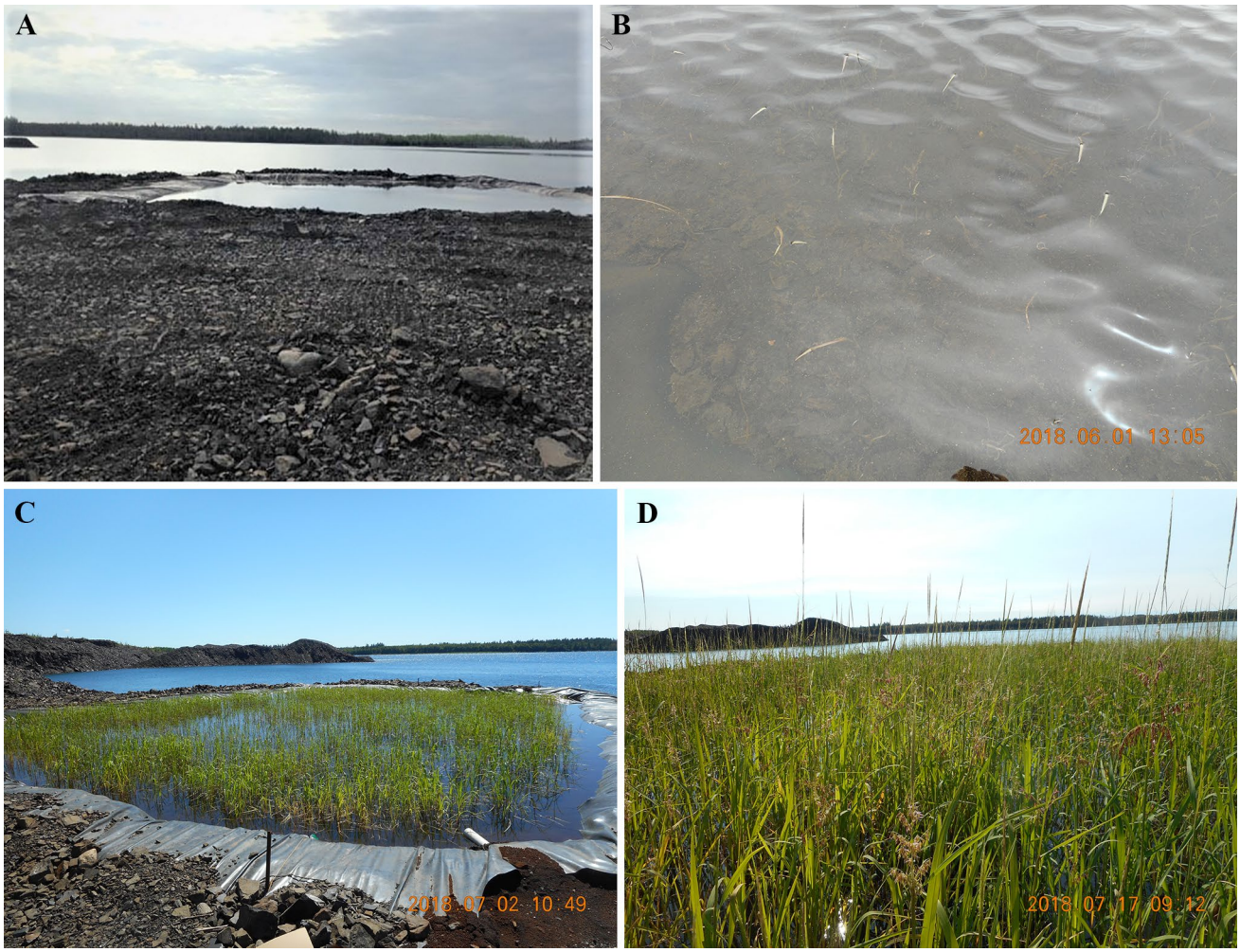


Fig. 2 Paddy C. Images represent typical WR phenological observations during 2018 and 2019 growing seasons: **A** seed distribution date and approximate yearly germination (2018-05-22); **B** floating leaf (2018-06-01); **C** aerial (2018-07-02); and **D** flowering and seed production (2018-07-17). Yearly harvest occurred in August

were required for H_2S concentration determination. All PW samples were delivered to Pace. Field measurements of *p*H, dissolved oxygen, temperature, and specific conductance were obtained immediately prior to PW sampling from at least the inflow and outflow of each paddy using a calibrated YSI® ProPlus® or a Hach® MS5 HydroLab®.

Diffusion-based peepers were 50 mL centrifuge tubes with a 0.45 µM pore-size filter sealed to the cap, filled (no headspace) with deoxygenated double-distilled water (Hesslein 1976; Teasdale et al. 1995; Azcue et al. 1996; LaForce et al. 2000; Jacobs 2002; Jorgenson 2013; Peijnenburg et al. 2014). These peepers were prepared and maintained under nitrogen headspace for ≈14 d prior to deployment; and transported to field sites in sealed nitrogen-purged and -filled bags. Rhizons are filter assemblies (0.12–0.18 µM pore-size) used for PW aspiration into the sample container protected from atmospheric exposure. All peepers and Rhizon assemblies were deployed at a 10 cm substrate depth. A mixture of sodium hydroxide and zinc acetate (C&G Containers) was used as the preservative for PW H_2S samples.

Initially, Rhizons were attached to peepers with an aspiration tube connected and anchored on the paddy berm. Pore water was aspirated into the sample container, immediately prior to peeper retrieval. This avoided substrate disturbance prior to PW aspiration. New Rhizon assemblies were used for each peeper re-deployment. However, due to Rhizon filter pore size limitations, clogging was an observed problem, periodically resulting in lower than required sample volume. Due to filter clogging and subsequent periodic insufficient sample volumes, use of Rhizons was discontinued following 2018. Diffusion-based peepers were used to capture PW characteristics throughout the 2019 growing season.

Plant and Seed Sampling

Groups of plants were sampled from randomly selected quadrats in Paddy A during 2018 and 2019, and the stem count was completed in a 0.1 m^2 area inside each selected quadrat. Stem density in Paddy C was ≈1/10 of Paddy A; therefore, all individual stems were counted, and random plants were sampled, from randomly selected quadrats during 2018 and 2019. Following observation of filled seeds, plant and seed samples were harvested from randomly selected quadrats in both paddies typically on the same date. However, due to repeated extensive goose herbivory in Paddy C during 2019, plants were sampled on Aug. 01, and seeds were sampled on Aug. 23, 2019.

On July 10, 2018, during the early flowering stage, whole WR plants (including roots) were harvested from randomly selected quadrats within each paddy. Roots were rinsed in paddy surface water to remove substrate and other materials. Plants were stored refrigerated in Ziploc® bags, transported to LUEL, and prepared for scanning electron microscope (SEM) and energy dispersive x-ray (EDX) characterization. SEMs were obtained from root surface areas visually suspect of (1) typical root tissue; and (2) iron-containing coatings [Fe (III) O-(OH) and FeS]. Points for EDX characterization were chosen based on visual appearance and SEM imagery of the WR root surface. SEM–EDX characterization was completed at Lakehead University Instrumentation Laboratory (LUIL; Lakehead Univ, Thunder Bay, ON, Canada) as described in Jorgenson et al. (2013).

Laboratory Analytical Methods

Quality assurance/quality controls (QA/QC) for water samples characterized by Pace included reference standards, matrix spikes, and conformed to The National Environmental Laboratory Accreditation Conference (NELAC) Standards and the Pace Quality Assurance Manual. QA/QC field-sampling practices included collection of field blank and duplicate inflow and outflow water samples. Analytical methods for water and PW conformed to NELAC Standards and followed those described in Pace (2020a, b). Specifically, Al, B, Ca, Fe, Mg, Mn, and Na in water and Fe in PW were measured using ICP-OES (EPA 200.7); and Cu was measured using ICP-MS (EPA 200.8) following acidification to pH < 2.0 using trace metal grade HNO_3. Chloride (Cl) and SO_4 were separated from non-chemically-preserved samples through a series of ion-selective columns and measured using IC (method 300.0). Samples for sulfide (as H_2S) were preserved using a sodium hydroxide and zinc acetate mixture (C&G Containers) and were measured according to Standard Method 4500-S2-G.

All substrate, plant, and seed sample analyses were completed at LUEL, a Canadian Association of Laboratory Accreditation (CALA) ISO 17025 accredited laboratory. Preparation and analytical procedures for substrate, plant, and seed samples reference Forest Canada, ASTM, American Soil and Plant Council, and/or USEPA methods; the LUEL Quality Assurance Manual; and followed those described in Lee and McNaughton (2004). All analyses followed standard operating procedures and included blank, quality control, and replicate samples. Substrate samples were collected using new 4.5 cm internal-diameter cellulose acetate butyrate sediment core sleeves. As a result of observed variability between substrate samples, laboratory (LUEL) replicate samples were used in place of field duplicate samples. Total nitrogen (when possible) was measured on dry substrate using a combustion ELVario cube carbon-hydrogen–nitrogen-sulphur analyzer. Loss on ignition (LOI) was measured by drying 20 mL of substrate at 80 °C, weighing, ashing at 600 °C, and re-weighing. Substrate pH was measured as a 1:1 substrate:deionized water mixture using a Mettler Toledo meter with an InLinePro pH sensor. Bulk density was measured by weighing 20 mL of wet substrate, drying at 80 °C, and re-weighing. Phosphate was determined using the BRAY P2 method—Al and Fe phosphates are dissolved in ammonium fluoride and measured colorimetrically using a SKALAR analyzer. Al, Cu, Fe, Mn, S, and Zn were extracted in 0.1 N trace metal grade HCl, while Ca, K, Mg, and Na were extracted in ammonium-acetate at pH 7.0; all of which were measured using ICP. Substrate samples were processed as wet samples to better represent field conditions. Measured analyte concentrations were corrected for bulk density. Plant, or seed, biomass (≥ 0.5 g) was digested using a CEM Mars Express microwave in Express Teflon closed vessels in one mL of HNO_3 and three mL of trace metal grade HCl and diluted using 25 mL of deionized water. Total P, Al, Ca, Cu, Fe, Mg, Mn, Na, S, and Zn in this dilution were measured using a Varian ICP-AES. Total N was measured using a SKALAR analyzer following microwave digestion and concentration in trace metal grade H_2SO_4 catalyzed with a metal sulphate.

Statistical Analyses

All surface water, substrate, WR plant and seed, and PW data were organized using Microsoft® Excel® or SigmaPlot-SigmaStat® v14.0 (Systat Software, Inc.) for table and graphical representation. Statistical analyses and treatment of WR plant data were completed using SigmaPlot-SigmaStat® v14.0. t-Tests or one-way analysis of variance (ANOVA) were used to compare two or more groups; specifically, WR stem density, stem height, shoot DWB, seed production, and seed DWB. Holm-Sidak multiple comparison was used to discern significant differences between three or more groups if data met assumptions of normal distribution and equal variance. Data were natural logarithmic transformed if

normal distribution and/or equal variance assumptions were not met. If data transformation failed to correct non-normal distribution and/or variance inequality, raw data were used for statistical treatment, followed by ANOVA on ranks between three or more groups and Dunn's multiple comparison to discern significant differences between groups. A Mann–Whitney Rank Sum test was used to discern significant differences between groups used for t-test comparisons when data were not corrected for non-normal distribution or variance inequality through natural logarithmic transformation. Non-transformed data were used for table and figure display purposes.

Results

Water, Substrate, and Pore Water Characteristics

Characteristics of Paddy A and C inflow and outflow waters remained similar between 2017–2019 growing seasons (Table 1; Supplemental Table S-1). In particular, aqueous SO_4, calcium, and magnesium remained similar between and during growing seasons, and between inflow and outflow of each respective paddy. Concentrations of Al, Cd, Cu, Hg, and Pb in Pit A water have been at or below detection limit ($<$ 1–5 µg L^{-1}); in the case of Hg less than 1.0 ng L^{-1}. Pit C water Hg concentrations have been $<$ 2.0 ng L^{-1} (Table S-1). These concentrations are approximately three orders of magnitude less than those resulting in toxicity to WR (Lee and Hughes 1998; Supplemental Figs S-1 and S-2); and not likely to result in adverse WR responses. Measured substrate characteristics from Paddies A and C are listed in Table 2. General decreases in plant nutrient elements were observed in each paddy; in particular, ammonium decreased six- and twelve- fold in Paddy A and C substrate, respectively, since initiation. Variability was observed between diffusion-based peepers and Rhizon H_2S concentrations in both paddies. Average Paddy A and C peeper PW characteristics are listed in Table 3 (Paddy A and C peeper and Rhizon data available in Supplemental Tables S-2–4 and 5–6, respectively). Average Paddy A H_2S concentrations ranged from $<$ 0.078–1.58 mg L^{-1} in peeper samples. Average Paddy C PW H_2S concentrations ranged from 0.337 to 2.528 mg L^{-1} in peeper samples. Notably, H_2S exceeded the suggested 0.165 mg L^{-1} protective level (MPCA March 2015) for WR in nearly all PW samples by several fold.

Wild Rice Phenology and Productivity

Wild rice phenological development was similar between 2017–2019 growing seasons for Paddy A (Fig. 1) and 2018–2019 growing seasons for Paddy C (Fig. 2). Dates on which specific WR phenological stages were observed in Paddies A and C are listed in Tables 4, 5, respectively. Plant and seed harvest dates for each paddy were typically the same date during each growing season, and within the same two weeks of August between growing seasons indicating no identifiable adverse influences on WR temporal phenological development within or between growing seasons from Pit A or C water-associated exposures under these conditions.

One-way ANOVAs were used to discern differences between stem density, stem height, shoot DWB, seeds per panicle, and seed DWB in Paddy A (Fig. 3). Wild rice stem density throughout the paddy differed significantly between growing seasons ($F_{(2,40)} = 365.362$ $p < 0.001$). Specifically, stem density increased by ≈10 × between 2017 and 2018,

Table 1 Paddy A and C inflow and outflow characteristics

	Paddy A						Paddy C			
	Inflow			Outflow			Inflow		Outflow	
	2017 (n = 9)	2018 (n = 5)	2019 (n = 6)	2017 (n = 9)	2018 (n = 5)	2019 (n = 6)	2018 (n = 5)	2019 (n = 6)	2018 (n = 5)	2019 (n = 6)
*p*H (SU)	8.3 ± 0.2	8.4 ± 0.1	8.2 ± 0.2	8.5 ± 0.2	8.0 ± 0.2	8.0 ± 0.1	8.4 ± 0.1	8.4 ± 0.1	8.4 ± 0.1	8.3 ± 0.1
Cond. (µS cm^{-1})	1235 ± 149	1202 ± 24	1157 ± 26	1252 ± 154	1195 ± 28	1133 ± 77	2593 ± 100	2585 ± 128	2543 ± 146	2576 ± 139
Alk. (mg L^{-1})	329	288	354	328	310	364	461	554	487	556
Ca	50	47	43	49	46	40	29	31	32	32
Mg	134	126	119	131	130	121	383	369	405	380
Na	32	28	25	32	30	25	53	49	54	50
SO_4	403	368	359	405	370	360	1,310	1,270	1,340	1,290
Cu (µg L^{-1})	NM	1.8	BD	NM	1.3	BD	2.1	BD	2.3	1.1
Mn	NM	25	32	NM	42	14	20	25	79	68

*p*H and conductance measured monthly (avg ± one SD). Alk. through Mn measured at season harvest. Units for Alk. through SO_4 are mg L^{-1}; Cu and Mn are µg L^{-1} ($n = 1$ for each inflow-outflow sampling event per location)

NM not measured, *BD* below detection limit

Table 2 Substrate characteristics during WR harvest events (avg ± one SD). Units for NH_3 through Na are µg g^{-1}

	Source (n = 1)	Paddy A			Paddy C	
		2017 (n = 3)	2018 (n = 3)	2019 (n = 11)	2018 (n = 3)	2019 (n = 8)
Total N (%)	NM	0.2 ± 0.1	0.2 ± NC	0.4 ± 0.2	0.1 ± NC	0.8 ± 0.3
LOI	12.3	8.2 ± 3.8	NM	16.5 ± 6.2	5.0 ± 1.1	27 ± 10
*p*H (SU)	6.6	5.8 ± 0.1	7.6 ± 0.1	7.0 ± 0.2	7.4 ± 0.1	6.9 ± 0.1
Bulk Density (g cm^{-3})	0.4	0.3 ± 0.1	0.5 ± 0.1	0.6 ± 0.1	0.2 ± NC	0.3 ± 0.1
$NH_3 + NH_4$-N (µg g^{-1})	24.8	14.7 ± 5.4	18.1 ± 4.9	3.4 ± 1.2	6.2 ± 1.2	1.5 ± 0.5
PO_4	5.1	2.0 ± 0.5	6.8 ± 2.6	1.5 ± 0.7	0.7 ± 0.1	0.6 ± 0.3
Al	357	149 ± 31	382 ± 26	112 ± 43	86 ± 5	39 ± 17
Cu	2.1	1.0 ± 0.2	3.1 ± 0.3	0.4 ± 0.4	0.7 ± 0.1	0.1 ± 0.1
Fe	1,819	296 ± 45	1013 ± 106	2,181 ± 856	222 ± 5	803 ± 217
Mn	267	47 ± 22	75 ± 17	40 ± 31	27 ± 1	12 ± 7
S	214	115 ± 28	178 ± 9	240 ± 216	175 ± 26	97 ± 62
Zn	7.0	2.1 ± 0.3	5.3 ± 0.7	1.8 ± 0.9	1.0 ± 0.1	0.4 ± 0.2
Ca	3,235	1,031 ± 421	1468 ± 277	766 ± 225	271 ± 48	172 ± 72
K	86	37 ± 6	59 ± 23	21 ± 7	11 ± 3	6 ± 3
Mg	1,246	573 ± 202	716 ± 136	294 ± 80	359 ± 61	156 ± 52
Na	23	42 ± 18	59 ± 12	24 ± 6	29 ± 3	11 ± 4

NM not measured, *NC* not calculable

Table 3 Paddy A and C peeper H_2S data (mg L^{-1}; avg ± one SD; n = 3 for each sampling event at each location)

Paddy A		Paddy C	
Jul. 31, 2017	BD	NM	NM
Aug. 31	0.421 ± 0.122	NM	NM
Sept. 29	0.715 ± 0.245	NM	NM
Oct. 27	0.427 ± 0.193	NM	NM
Jun. 01, 2018	0.287 ± 0.051	NM	NM
Jul. 02	0.929 ± 0.682	Jul. 02, 2018	0.485 ± 0.190
Aug. 02	0.484 ± 0.332	Aug. 02	0.337 ± 0.049
Aug. 30	0.773 ± 0.202	Aug. 30	0.402 ± 0.069
Oct. 01	1.05 ± 0.086	Oct. 01	0.422 ± 0.079
Jun. 04, 2019	1.14 ± 1.094	Jun. 04, 2019	0.903 ± 0.585
Jul. 02	0.469 ± 0.182	Jul. 02	0.562 ± 0.132
Aug. 01	1.50 ± 1.091	Aug. 01	2.528 ± 2.477
Sept. 03	1.58 ± 0.748	Sept. 03	0.565 ± 0.098
Oct. 03	0.896 ± 0.462	Oct. 03	0.930 ± 0.120

BD below detection limit (0.078 mg L^{-1}), *NM* not measured

and remained at this density through 2019. Paired comparison tests indicated that, the average 2019 stem density was statistically higher than in 2017 ($p < 0.001$), but was not significantly different from 2018 ($p = 0.106$). Average 2018 stem heights were significantly higher ($F_{(2,68)} = 8.560$ $p < 0.001$) than both 2017 ($p = 0.016$) and 2019 ($p = < 0.001$), with a concurrent statistical decrease in 2019 shoot DWB ($t_{(21)} = 4.568$ $p < 0.001$). No statistical difference ($F_{(2,26)} = 5.615$ $p = 0.010$) was identified between average seeds per panicle between 2017 and 2018 ($p = 1.000$), despite the ≈10× increase in stem density. However, paired comparison tests indicated that the average number of seeds per panicle during 2019 was significantly higher than in 2017 ($p = 0.046$) and 2018 ($p = 0.030$). t-Tests indicated no statistical difference between seed DWB between 2017 and 2019 growing seasons ($t_{(13)} = 1.467$ $p = 0.166$).

T-tests were used to discern differences between WR stem density, stem height, shoot DWB, seeds per panicle, and seed DWB in Paddy C (Fig. 4). On July 09, 2019, goose herbivory was observed throughout the paddy. Also documented on this date were initial observations of flowering; male flowers were present on several plants throughout this paddy. Despite extensive and repeated goose herbivory, t-test indicated no statistical difference between average 2018 and 2019 stem density ($t_{(22)} = -0.877$ $p = 0.390$). However, the 2019 average stem height was significantly less than in 2018 ($t_{(34)} = 11.995$ $p < 0.001$). Additionally, the average WR shoot DWB ($t_{(19)} = 16.971$ $p < 0.001$) and seeds per panicle ($t_{(16)} = 8.060$ $p < 0.001$) were significantly less than in 2018. Due to a freezer failure in 2018, all harvested seeds were lost. Therefore, average 2019 Paddy C seed DWB was contrasted to average 2017 and 2019 Paddy A seed DWB. ANOVA indicated that the average 2019 Paddy C seed DWB was significantly less than the average 2017 Paddy A seed DWB ($F_{(2,20)} = 8.679$ $p = 0.002$). Significantly decreased stem height, seed production, shoot DWB, and seed DWB during 2019 is likely resultant from extensive and repeated goose herbivory.

Table 4 Paddy A wild rice phenology as observed during 2017–2019 growing seasons. Phenological development stages as used by Oelke et al. (1982)

	Stages of Wild Rice Development	*Oelke et al. (1982)	Date of Stage Observation (Approximate Growing Days)		
			2017	2018	2019
Veg. Growth Phase	Germination	0	Jun. 01 (0)	May 17 (0)	May 07 (0)
	Emergence	12	Jun. 05 (4)	May 22 (5)	May 22 (15)
	Floating Leaf	29	Jun. 12 (11)	May 29 (12)	May 30 (23)
	Aerial Leaf	39	Jun. 19 (18)	Jun. 01 (15)	Jun. 04 (28)
	Early Tillering	49	Jul. 03 (32)	Jul. 02 (46)	Jul. 02 (56)
Reprod. Growth Phase	Jointing	67	Jul. 11 (40)	Jul. 02 (46)	Jul. 18 (72)
	Boot	75	Jul. 17 (47)	Jul. 10 (54)	Jul. 18 (72)
	Early Flowering	83	Jul. 24 (54)	Jul. 10 (54)	Jul. 18 (72)
	Mid Flowering	91	Jul. 31 (61)	Jul. 17 (61)	Jul. 18 (72)
	Grain Formation	105	Aug. 07 (68)	Aug. 07 (83)	Jul. 26 (80)
	Maturity / Harvest	121	Aug. 31 (92)	Aug. 16 (91)	Aug. 23 (108)

*Days from germination; from Oelke et al. (1982) – WR plant development (K2 variety) Aitkin County, MN, USA

One-way ANOVAs were used to discern differences between Paddy A and Paddy C WR stem density, stem height, shoot DWB (Fig. 5). Average stem density in Paddy A (2017, 2018, 2019) was statistically higher ($F_{4,60}=451$; $p<0.001$) than Paddy C in 2018 ($p<0.001$) and 2019 ($p<0.001$) in all growing seasons. With the exception of Paddy A (2018), average stem height in Paddy C (2018) was statistically higher than other growing seasons ($p<0.001$). Despite higher stem height, average Paddy C (2018) shoot DWB was not significantly different from Paddy A (2018) ($p=0.636$), but was statistically higher than other growing seasons ($p<0.001$).

Plant and Seed Characteristics

Chemical characteristics of WR plant and seed samples from both paddies are listed in Table 6. With the exception of Ca and Zn, which were higher in plants harvested in 2019 than 2018, chemical characteristics of WR between growing seasons in Paddy A were similar; specifically, total plant N averaged 0.74% (±0.10) for each season. Shoots of plants harvested in 2019 from Paddy C contained higher concentrations of N, P, and S than in 2018, potentially due to nutrient uptake into plant tissues and internodal re-growth following herbivory prior to plant harvest. Regardless of surface water, substrate, PW, or plant tissue characteristics, seed characteristics were similar between growing seasons. Percent N and S content of seeds harvested from Paddy A during 2017 averaged 1.24 (±0.12) and 0.12 (±0.013), respectively. The average percent N content of seeds harvested in 2019 significantly increased to 1.55 (±0.05) ($t_{(13)}=-5.411$; $p=0.0002$); the average percent S content remained at 0.12 (±0.004). During 2019, t-tests indicated that seeds harvested from Paddy C contained significantly higher concentrations of N ($t_{(10)}=-4.116$ $p=0.002$) and S ($t_{(10)}=-3.449$ $p=0.006$) when contrasted to seeds harvested from Paddy A. No significant difference was identified between concentrations of P ($t_{(10)}=-0.175$ $p=0.865$) or K ($t_{(10)}=0.376$ $p=0.715$) in Paddy C seeds contrasted to Paddy A seeds. Despite goose herbivory in Paddy C, harvested plants appeared generally healthy (no observations of nutrient deficiencies or WR diseases), seeds had been filled, and overall WR did not appear to have been adversely influenced by chemical characteristics of Pit C water or water-associated exposures under these conditions.

SEM–EDX WR Root-Surface Characterization

Surfaces of WR roots harvested during July 2018 were characterized by SEM and EDX as described by Jorgenson et al. (2013). Points chosen for EDX characterization were selected based on visual appearances: white appearance may

Table 5 Paddy C wild rice phenology as observed during 2018 and 2019 growing seasons. Phenological development stages as used by Oelke et al. (1982)

Stages of Wild Rice Development		*Oelke et al. (1982)	Date of stage observation (approximate growing days)	
			2018	2019
Veg. Growth Phase	Germination	0	May 26 (0)	May 07 (0)
	Emergence	12	Jun. 01 (6)	May 07 (0)
	Floating Leaf	29	Floating leaf and initial aerial stages not documented.	May 22 (15)
	Aerial Leaf	39		Jun. 04 (28)
	Early Tillering	49	Jul. 02 (37)	§Jul. 02 (56)
Reprod. Growth Phase	Jointing	67	Jul 10 (45)	§§Jul. 09 (63)
	Boot	75	Jul 10 (45)	§§Jul. 09 (63)
	Early Flowering	83	Jul. 13 (48)	§§Jul. 09 (63)
	Mid Flowering	91	Jul 17 (58)	§§§Jul. 26 (80)
	Grain Formation	105	Aug. 02 (76)	Aug. 23 (108) (Plant, seed harvest)
	Maturity / Harvest	121	Aug. 15 (87)	

*Days from germination; from Oelke et al. (1982)—WR plant development (K2 variety) Aitkin County, MN, USA

§Goose herbivory first observed

§§Extensive goose herbivory; first flowering observed

§§§Additional, extensive goose herbivory observed; early seed formation observed on some remaining WR

be more indicative of typical root tissue; orange appearance may be more indicative of Fe (III) oxide/hydroxide coating. Neither Paddy A nor Paddy C plants contained identifiable root coatings indicative of FeS (supplemental Figs S-3 and S-4). However, visual appearance of most roots on WR plants was likely indicative of iron (III) oxy / hydroxide coatings. On Paddy A plants, C, O, and Ca were dominant elements in areas suspect of typical root tissue; and C, O, and Fe were dominant elements in areas suspect of Fe (III) oxide/hydroxide coatings. On Paddy C plants, C, O, S, and at times K, were dominant elements in areas suspect of typical root tissue; and C, O, and Fe (at times, multi-peak) were dominant elements in areas suspect of Fe (III) oxide/hydroxide root coatings. Despite aqueous SO_4, PW H_2S, and dissolved PW Fe concentrations all theoretically conducive to FeS complexation, neither visual appearance nor EDX-characterization of root coatings were indicative of FeS. However, during and following WR plant and seed harvest events, black coatings on roots were observed in both paddies. These coatings closely resemble FeS root coatings inferred and described by LaFond-Hudson et al. (2018, 2020) near/at growing season conclusion. Their observations and concluded rationale for FeS root coatings tend to represent phenological life stages of WR—near seed abscission from pedicels, root radial oxygen loss (ROL) ceases allowing for conditions more favorable to FeS complexation to occur. Additional surface characterization of black-appearing WR roots in the current study was not pursued due to the similarity with those described by LaFond-Hudson et al. (2018, 2020) as likely FeS. Throughout growing seasons, WR plants appeared healthy, were productive, and observations of Fe-containing root coatings appeared more representative of WR phenological stage and root ROL than overlying water, pore water, or substrate characteristics.

Discussion

Primary concerns influencing use of mining-influenced waters for irrigation are sufficiently high concentrations of potentially toxic elements and SO_4 concentrations. Mining-influenced waters used for the current study did not contain sufficiently high concentrations of elements such as As, Cu, Ni, Fe, Pb, Cd, Hg, and/or Zn to be considered potentially problematic (Lee and Hughes 1998). However, aqueous SO_4 concentrations (Table 2) were higher than 1) the MN SO_4 water quality criterion for WR (10 mg L^{-1}), and 2) concentrations suggested to be problematic for WR in general (Myrbo et al. 2017; Pastor et al. 2017; LaFond-Hudson et al. 2018). Since no adverse responses from WR were observed in the current study, the overall focus shifted to plant and seed characteristics and substrate nutrient availabilities. Tedrow and Lee (2021) successfully grew WR to maturity in mining- and non-mining- influenced lake sediments. Time

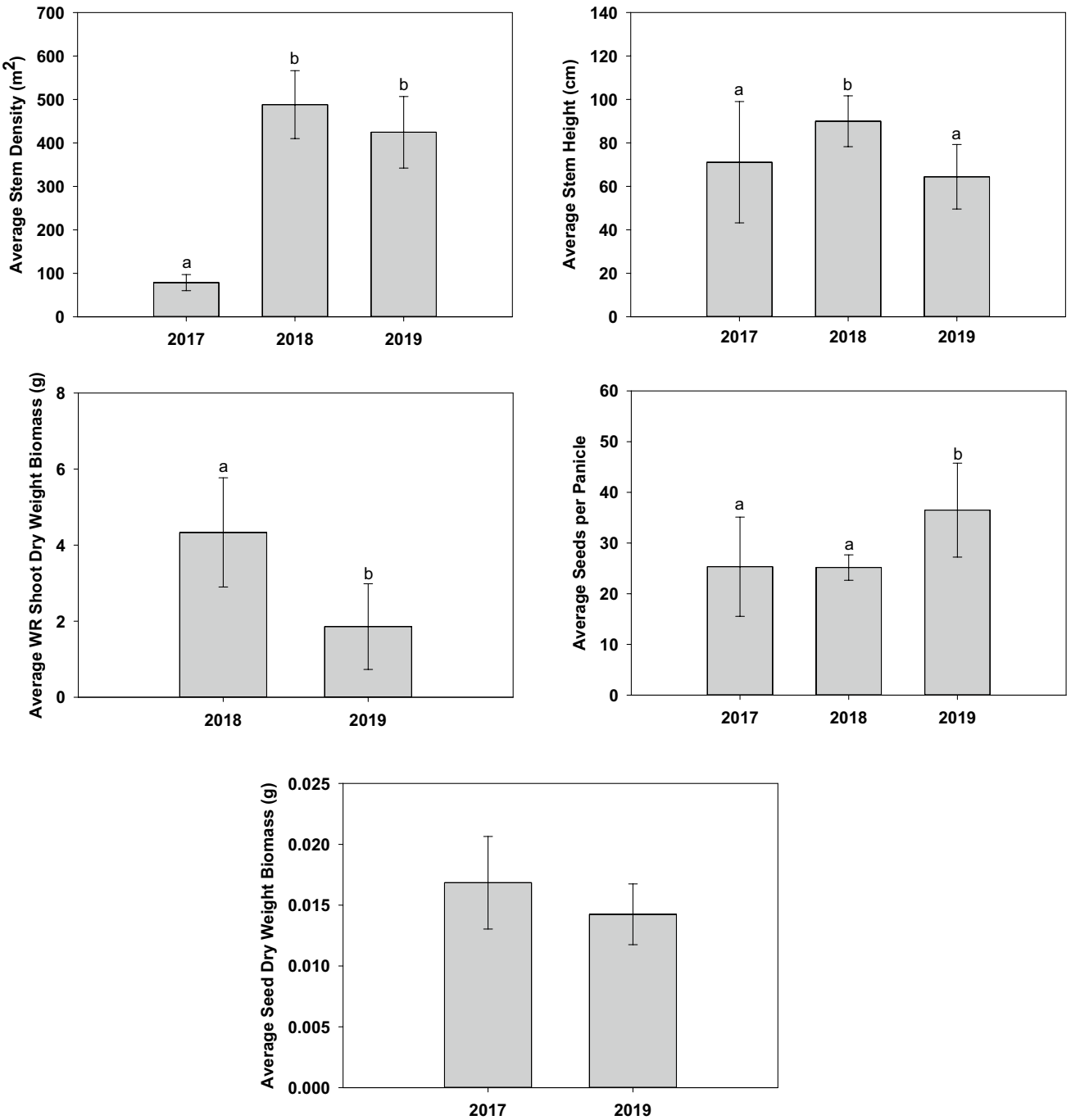


Fig. 3 Paddy A average stem density, stem height, shoot dry weight biomass, filled seeds per panicle, and seed dry weight biomass. No plant samples were obtained during 2017. All seeds harvested during 2018 were lost due to a freezer failure. Error bars represent one standard deviation. Differing letters (a and b) indicate statistical significance at alpha 0.05

to maturity was the same for all plants but height and DWB were lower for plants grown in mining sediments. The size difference was attributed to lower concentrations of ammonium in mining-influenced sediments than the reference sediment. Seed chemical characteristics between all exposures were similar and not necessarily reflective of respective sediment characteristics. Physical plant characteristics such as overall size and productivity were primary differences between these sediment exposures, more likely a result of multi-fold lower concentrations of ammonium in these mining-influenced sediments than the reference sediment.

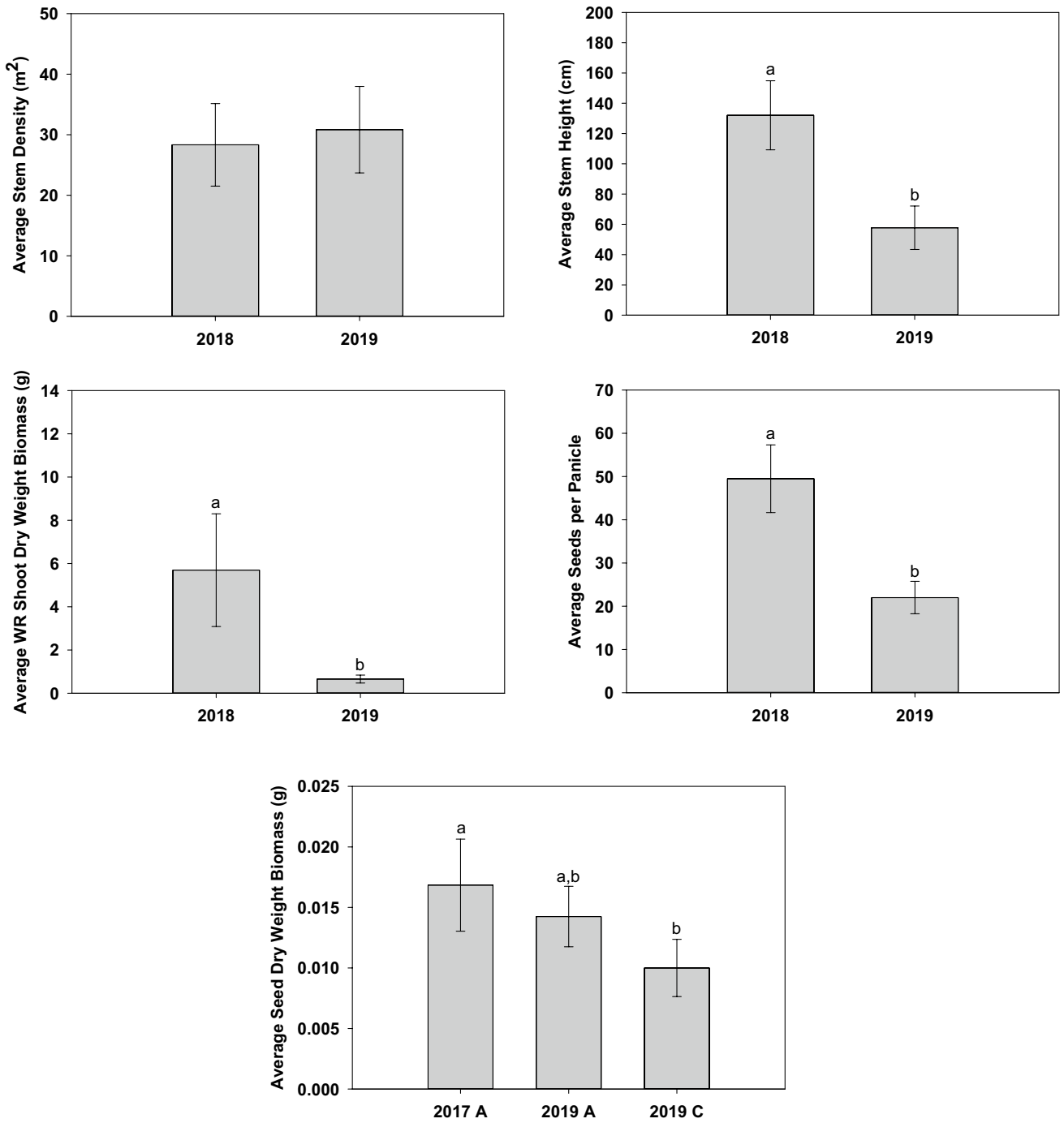


Fig. 4 Paddy C average stem density, stem height, shoot dry weight biomass, filled seeds per panicle, and seed dry weight biomass. All seeds harvested during 2018 were lost due to a freezer failure. Error bars represent one standard deviation. Differing letters (a and b) indicate statistical significance at alpha 0.05

Wild Rice Responses

In previous microcosm and bucket-style studies, WR tended to grow more slowly, decrease in overall size, be less productive, and generally fail to thrive specifically in exposures of 300 mg SO_4 L^{-1} (Pastor et al. 2017; LaFond-Hudson et al. 2018). In the current study, SO_4 exposure concentrations exceeded these previous studies by ≈50 mg L^{-1} (Pit A water) and 1,050 mg L^{-1} (Pit C water). Hydrogen sulfide is known to be toxic to aquatic plants in concentrations ranging from 0.4–11.0 mg L^{-1} (Armstrong and Armstrong 2005; Lamers et al. 2013). In both paddies, concentrations of pore water

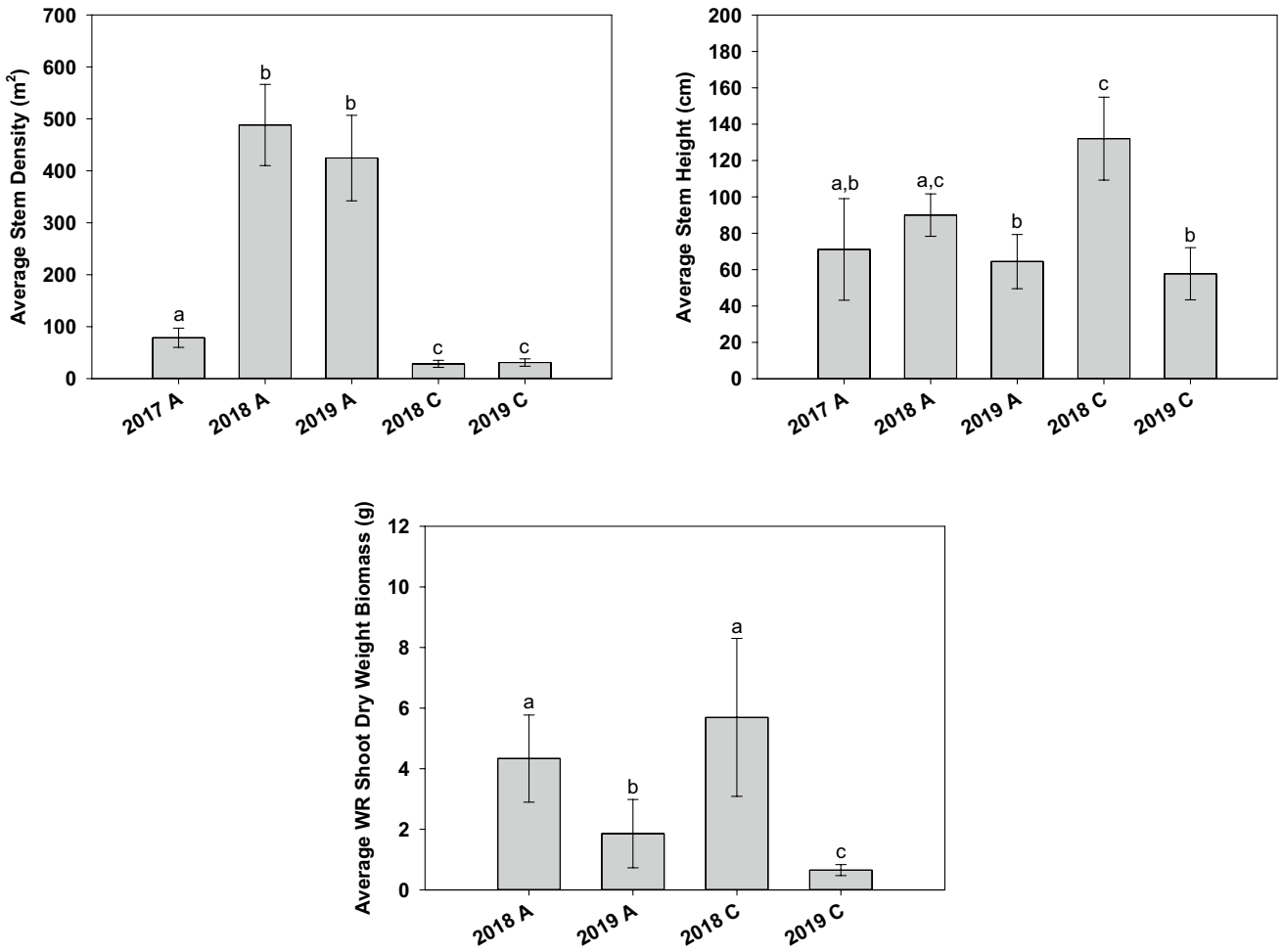


Fig. 5 Comparison between average Paddy A and C stem density, stem height, and shoot dry weight biomass. Error bars represent one standard deviation. Differing letters (a, b, c) indicate statistical significance at alpha 0.05

H_2S routinely exceeded the MPCA-suggested 0.165 mg L^{-1} (MPCA 2015) protective level by multiple-fold. Despite these exposures, no adverse WR responses were observed (decreased size and/or productivity; delayed development) that could be attributable to SO_4- or H_2S- specific exposures.

In October 2017, an additional 0.45 kg of WR seed was amended to Paddy A to ensure viable WR would be present immediately prior to freeze-up and would have the chance to overwinter in Paddy A. WR stem density increased ≈10 × between 2017 and 2018/2019 in Paddy A. WR stem density in Paddy C ranged from 18 to 41 stems m^{-2} and did not statistically differ between 2018 and 2019; and was 50–90% lower than Paddy A stem density in 2017–2019. Paddy A germination in Spring 2018 verified viable WR seed could overwinter in Pit A water; therefore, no additional WR seed was amended to Paddy C. In the absence of a significant stem density decrease in either paddy between growing seasons, SO_4 does not appear to be detrimental for WR germination. Increased stem density in Paddy A is more likely a result of viable seed amendment in October 2017.

Wild Rice Development

In addition to concerns about adverse influences from SO_4 on WR distribution, density, and productivity, specific developmental delays have been documented. LaFond-Hudson et al. (2018, 2020) concluded that an observed decrease in developmental rate(s) beginning during vegetative growth phase, and promulgated through reproductive maturity, was in response to exposures of 300 mg SO_4 L^{-1}. Although the observed delay was only a few days, the difference was significant between specific treatment groups. In the current study, although differences existed between dates of phenological stages observation, this difference cannot be attributed to SO_4 exposure alone. Time between paddy inspections and subjective assessments of phenological development stages (Oelke et al. 1982; Sims et al. 2012a,

Table 6 Characteristics of shoot and seed tissue (avg ± one SD). Units for total N through Fe are %; Al through Zn are μg g^{-1}

	*Rat River Bay		Paddy A				Paddy C		
	Shoots	Seeds	Shoots		Seeds		Shoots		Seeds
	2018 (n = 3)	2018 (n = 24)	2018 (n = 12)	2019 (n = 11)	2017 (n = 9)	2019 (n = 6)	2018 (*n* = 12)	2019 (n = 9)	2019 (n = 6)
Total N (%)	0.83 ± 0.04	1.19 ± 0.12	0.68 ± 0.08	0.75 ± 0.09	1.24 ± 0.12	1.55 ± 0.090	0.74 ± 0.34	1.89 ± 0.31	1.86 ± 0.10
P	0.10 ± 0.01	0.32 ± 0.02	0.13 ± 0.02	0.08 ± 0.02	NM	0.243 ± 0.028	0.10 ± 0.03	0.25 ± 0.16	0.25 ± 0.03
K	0.49 ± 0.07	0.42 ± 0.08	1.50 ± 0.23	1.18 ± 0.39	NM	0.361 ± 0.024	2.37 ± 0.49	2.18 ± 0.42	0.35 ± 0.05
S	0.09 ± 0.01	0.11 ± 0.01	0.30 ± 0.07	0.46 ± 0.1	0.12 ± 0.01	0.118 ± 0.010	0.31 ± 0.06	0.90 ± 0.17	0.14 ± 0.01
Ca	1.14 ± 0.05	0.02 ± 0.01	0.59 ± 0.32	1.73 ± 0.81	NM	0.038 ± 0.006	0.16 ± 0.03	0.32 ± 0.22	0.04 ± 0.01
Mg	0.23 ± 0.03	0.10 ± 0.01	0.36 ± 0.05	0.37 ± 0.03	NM	0.102 ± 0.008	0.43 ± 0.09	0.78 ± 0.13	0.12 ± 0.02
Na	0.60 ± 0.06	0.01 ± 0.01	0.50 ± 0.08	0.48 ± 0.10	NM	0.004 ± 0.001	0.42 ± 0.11	0.67 ± NC	0.01 ± 0.01
Fe	0.12 ± 0.02	0.01 ± 0.01	0.10 ± 0.04	0.32 ± 0.20	NM	0.020 ± 0.003	0.10 ± 0.02	0.11 ± 0.08	0.01 ± 0.01
Al (μg g^{-1})	804 ± 136	22 ± 35	80 ± 37	248 ± 314	NM	7 ± 3	235 ± 57	172 ± 146	6 ± 1
Cu	19 ± 15	5 ± 2	1.5 ± 0.3	2.2 ± 0.7	NM	4.4 ± 0.8	1.4 ± 0.4	2.4 ± 1.1	4.2 ± 0.9
Mn	1434 ± 122	25 ± 7	1199 ± 406	586 ± 256	NM	33 ± 7	333 ± 81	1664 ± 869	37 ± 12
Zn	21 ± 3	32 ± 8	9.6 ± 1.2	22 ± 11	NM	25 ± 2	8.3 ± 2.2	12.1 ± 5.9	11.5 ± 2.7

*Non-mining/-SO_4 influenced site; data fromTedrow and Lee (2021)

NM not measured

b) are also potential reasons for observed temporal development differences; and must be ruled-out as causative prior to considering SO_4 as the reason for developmental delay. Phenological development of WR in both paddies followed typical temporal patterns (Tables 4, 5).

Plant and Seed Tissue Chemistry

Nutrient element concentrations of WR plant tissue have been reported by Hildebrandt et al. (2012), with total N (%) in shoot tissue reported as 0.85. In the current study, Paddy A WR shoot N (%) was 0.68 and 0.75 in 2018 and 2019; and Paddy C WR shoot N (%) was 0.74 and 1.89 in 2018 and 2019, respectively. The higher Paddy C WR % plant tissue N in 2019 may be attributed to N uptake and internodal regrowth, a response to repeated goose herbivory throughout the paddy (Weir and Dale 1960). Following observation of goose herbivory, netting was installed around Paddy C to exclude waterfowl. LaFond-Hudson et al. (2020) reported WR seed N (%) content of 1.89 for non-SO_4 exposed WR, and 2.28 for SO_4 exposed (300 mg L^{-1}) WR. In the current study, seeds harvested from Paddy A WR were 1.24 and 1.55% N in 2017 and 2019, respectively. Seeds harvested from Paddy C WR contained 1.86% N in 2019. These values are close to the N content of non-SO_4 amended WR reported by LaFond-Hudson et al. (2020). Additionally, average seed DWB was similar between non-SO_4 amended WR (15.26 mg; LaFond-Hudson et al. 2020) and Paddy A WR (15.00 mg). These data indicate a lack of measurable influence of aqueous SO_4 in determining specific seed characteristics of WR grown in Pit A and C waters.

Nutrient Limitations

As detailed in Day and Lee (1989), Lee (2002), Lee and McNaughton (2004), Oelke (1982, 1997), and Sims (2012a, b), sufficiently high nutrients such as ammonium and P are of critical importance to WR growth, development, and distribution; specifically, during early- and mid- season phenology. In the current study, a general decrease in substrate ammonium has been observed in each paddy between growing seasons. In the absence of other adversely influential factors, we can likely expect WR plants to decrease in density, biomass, productivity, or a combination of these and other characteristics as a result of decreased and decreasing ammonium bioavailability. This effect from N depletion on WR productivity was documented by Keenan and Lee (1988). In their study, after five years of intensive cultivation of WR in a northwestern Ontario lake, % N levels in the sediment had decreased from 1.5 to 0.2 with corresponding declines in WR productivity. Only after the lake remained fallow for two years was commercial WR production again feasible. A similar ammonium trend may be developing in paddies used in the current study. Walker et al. (2006, 2010) documented N sequestration in accumulated WR plant and root litter, concluding that decreases in WR density, distribution, and productivity may be attributed to N limitation as a result of litter sequestration. In the current study, this may be a developing condition based on decreased substrate ammonium and observed WR plant litter in each paddy. Inflow water *p*H (≈8.3) to each paddy is sufficiently high to decrease some elemental nutrient bioavailabilities such as Fe and Cu. However, this may be unlikely due to substrate pH

typically slightly acidic to circumneutral (5.8–7.6) Therefore, the potential for decreased WR density, distribution, and productivity exists resulting from bioavailable N limitation and/or deficiency.

Conclusions

The current study provided critical support for potential use of mining-influenced waters for WR irrigation. Throughout multiple consecutive growing seasons, WR was grown in paddy-scale in-situ exposures of mining-influenced waters of substantially different chemical characteristics. In this current study, WR did not adversely respond to these exposures, and in both paddies developed and produced viable seed. Based on data and observations obtained during this study, overlying water characteristics such as aqueous SO_4 appeared to play a less important role in WR phenology, distribution, and productivity, than previously suggested. In the current study, any differences between multiple measured WR characteristics were associated with substrate nutrient availability. Additionally, no adverse effects from H_2S were observed; and observed increases in S in Paddy A were correlated to increases in Fe. If additional significant adverse WR responses are observed, elements becoming more concentrated in paddy substrate will be investigated as potential sources of those responses.

Development and use of these paddy-scale bioassays allowed more accurate and field-relevant predictions of responses of WR to exposures of mining-influenced waters with elevated SO_4. Continued research will focus on substrate nutrient-element amendment in these paddies to help verify or refute potential adverse WR influences due to substrate nutrient depletion. These data would help to inform water use decisions less focused on characteristics of overlying water and more focused on substrate nutrient bioavailability. More broadly, the current study provides some refutation of the concern specific to SO_4 adversely influencing WR phenology in general. Research on Fe-H_2S toxicity mitigation and use of WR for phytoremediation of mine influenced water are important and relevant subjects that would be best answered by the paddy approach used in this study. Further study is also required to discern influences on WR from water depth increases, herbivory, and other organisms such as *Apamea apamiformis* (wild rice worm) within these paddies.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10230-022-00908-0.

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WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 17

U.S. Steel, Application for Sulfate Site-Specific Standard, August 2022 (excerpt).

U. S. Steel Corporation
Minnesota Ore Operations
P.O. Box 417
Mt. Iron, MN 55768

August 17, 2022

Catherine Neuschler
Minnesota Pollution Control Agency (MPCA)
Environmental Analysis & Outcomes Division
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

Re: Application for a Sulfate Site-Specific Standard for Hay Lake (AUID 31-0037-00), Located Downstream of the U. S. Steel – Keetac (Keetac)

Dear Ms. Neuschler:

Please find attached an application for a sulfate site-specific standard for Hay Lake, located downstream of the Keetac facility. This submittal is an update to the *Application for Site-Specific Sulfate Standard(s) for Hay Lake, Hay Creek, Swan Lake (including Swan Lake Southwest Bay), and Swan River (Swan Lake outlet to confluence with Snowball Creek)*, submitted in December 2014 with MPCA acknowledgement of receipt on December 29, 2014. To date, the MPCA has not acted on this application for Keetac. U. S. Steel requests the MPCA approve and implement this revised request for a sulfate site-specific standard of 79 mg/L at Hay Lake, which will replace the existing Class 4A sulfate standard of 10 mg/L. The site-specific standard is being requested in accordance with Minn Rules, part 7050.0220, subpart 7.

The application shows that the proposed sulfate site-specific standard of 79 mg/L is protective of the Class 4A narrative standard found in Minnesota Rules, part 7050.0224, subpart 2, which requires that the "quality of Class 4A waters of the state must be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area."

U. S. Steel developed the enclosed application in support of its conclusion that Keetac's discharges will not exceed the proposed site-specific standard and that the proposed site-specific standard will not result in inhibition or injurious effects to wild rice growth. Furthermore, no discharge limits for sulfate are necessary to protect the growth of wild rice in Hay Lake at the proposed site-specific standard in the National Pollutant Discharge Elimination System (NPDES) / State Disposal System (SDS) Permits for Keetac's mining area and tailings basin (No. MN0031879 and No. MN0055948, respectively).

A hard copy of this request will also be sent. If you have any questions or need additional information regarding this request, please feel free to contact me at (218) 749-7364 or clbartovich@uss.com.

Sincerely,

Chrissy Bartovich
Environmental Director
U. S. Steel – Minnesota Ore Operations

cc: MPCA Water Quality Submittals Center
Richard Clark, MPCA
Jeff Udd, MPCA
Eric Williams, U. S. Steel
Tom Moe, U. S. Steel

Application for Sulfate Site-Specific Standard

Hay Lake

Prepared for
United States Steel Corporation

August 2022

325 South Lake Avenue, Suite 700
Duluth, MN 55802
218.529.8200
www.barr.com

1 Introduction

U. S. Steel developed this report to support its request for a sulfate site-specific standard for Hay Lake (AUID 31-0037-00), to show that current discharges will not exceed the site-specific standard and that limitations on the discharges from U. S. Steel's Keetac mining area and tailings basin are not necessary to protect the growth of wild rice in Hay Lake at the proposed sulfate site-specific standard.

Regarding the site-specific standard request, U. S. Steel developed this document in accordance with Minnesota Rules, part 7050.0220, subpart 7. A scientifically sound approach to developing the site-specific standard was used to derive a sulfate concentration of 79 mg/L. This calculated sulfate site-specific standard will apply at Hay Lake, which is located downstream of all active outfalls associated with U. S. Steel's Keetac facility, and will replace the existing Class 4A sulfate standard of 10 mg/L.

A summary of the proposed change is shown in Table 1-1. As this report details, the proposed site-specific standard will be protective of the Class 4A use and will not result in inhibition or injurious effects to wild rice growth.

Table 1-1 Site-Specific Standard Request Included in this Application

Waterbody	Current Sulfate Standard	Proposed Sulfate Site-Specific Standard
Hay Lake (AUID 31-0037-00)	*Numeric:* 10 mg/L *Narrative:* "The quality of class 4A waters of the state must be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area."	*Numeric:* 79 mg/L *Narrative:* No change

The Keetac facility mining area, tailings basin, and receiving waters are shown on Figure 1. The tailings basin, which receives tailings from the Keetac taconite mining and processing facility, has a footprint of approximately 6,500 acres and includes a perimeter dike surrounding the basin over a length of 8.25 miles.

Water from the mining area and from the tailings basin leaves the sites as authorized surface discharges, as shown in Figure 1. The mining area discharge from SD002 and the tailings basin discharge from SD005 flow through a series of unlisted reservoirs and creeks before entering Hay Creek, which leads to Hay Lake. The mining area discharges from SD003 and SD012 flow through the O'Brien Diversion Channel into Hay Creek and then Hay Lake. Hay Lake is unlisted and thus is classified under the default designated beneficial use Classes 2B, 3, 4A, 4B, 5, and 6 (Minnesota Rules, part 7050.0415, subpart 4).

U. S. Steel conducted RPAs using both the USEPA's statistical method and the MPCA's statistical method. These analyses show that, with respect to protecting the growth of wild rice in Hay Lake, discharges from the existing Keetac permitted outfalls will be able to maintain concentrations of sulfate below the

MPCA000727

3 Existing Water Quality and Hydrology of Wild Rice in Hay Lake

This section discusses the existing sulfate water quality in Hay Lake and summarizes hydrologic and wild rice observations in Hay Lake from studies conducted by U. S. Steel.

Since Hay Lake is an unlisted lake per Minnesota Rules, part 7050.0415, the general unlisted designated beneficial uses and associated water quality standards apply to Hay Lake, including Classes 2B, 3, 4A, 4B, 5, and 6 (Minnesota Rules, part 7050.0415, subpart 4). These designated beneficial uses are the same as those general classification applied to all waters of the state in Minnesota Rules, part 7050.0415, subpart 2, which verifies that these are the correct classes to apply to Hay Lake. This request focuses on a site-specific standard for sulfate that applies to the numeric Class 4A standard of 10 mg/L (Minnesota Rules 7050.0224, subpart 2) and the numeric interpretation of the narrative standard (Minnesota Rules, part 7050.0224, subpart 2).

3.1 Hay Lake Water Quality

Sulfate water quality data for Hay Lake is summarized in Table 3-1. Hay Lake is shown in Figure 1 and Figure 2. Various sources were used to compile sulfate surface water quality data in Hay Lake, including U. S. Steel's past studies and MPCA's surface water data access tool. Based on the dataset of 55 samples collected between June 23, 2009 and October 27, 2021, the average sulfate concentration in Hay Lake is 34 mg/L. There were no instances where the sulfate concentration exceeded the proposed sulfate site-specific standard of 79 mg/L. Therefore, Hay Lake is already achieving the sulfate site-specific standard and the discharges, which were present during the time this data was collected, did not cause or contribute to sulfate concentrations greater than the proposed sulfate site-specific standard of 79 mg/L.

Table 3-1 Hay Lake Sulfate Water Quality Summary

Waterbody Name	Sulfate Concentration (mg/L)			No. of Samples
	Minimum	Average	Maximum	
Hay Lake (31-0037-00)[1]	10	32	78	55

[1] Sulfate data for Hay Lake was collected between June 23, 2009, and October 27, 2021. See references (9); (10); (11); (12); (13) for data sources.

3.2 Hydrologic and Wild Rice Observations in Hay Lake

Several studies have been conducted in Hay Lake to evaluate hydrologic conditions, wild rice presence, and wild rice density. The results of these studies, summarized in Table 3-2, have shown abundant wild rice populations in most years. See Appendix B for the complete studies.

Water depth is one factor controlling the location of the presence of wild rice in the lake. Fluctuations in water levels influence wild rice populations; well-documented beaver activity is assumed to contribute to these fluctuations in Hay Lake. Wild rice occurs primarily along the perimeter of Hay Lake, where water depth is shallow. Where the lake is deepest, from 6 to 12 feet in depth, wild rice is not present. Further, as

MPCA000735

Survey Date	Hydrologic Monitoring Outcome	Wild Rice Monitoring Outcome
August 2012 (conducted by Barr Engineering Co.)	• Water levels were monitored monthly from April 25 through October 24, 2012 using a staff gage. • When 2012 monitoring activities began, the water level was approximately one foot lower than the elevation observed in May 2011. • The elevation of the lake rose by 0.71 feet between April 26, 2012 and June 26, 2012. • Between June 26, 2012 and August 17, 2012, the water level dropped 1.45 feet.	• Density 3 wild rice (25-50% coverage) observed along northwest perimeter. • Density 2 wild rice (10-25% coverage) observed along the remaining perimeter. • Average stem density in sampling grids were between 8.0 to 20.8 stems per 0.5 m^2.
August 2014 (conducted by Barr Engineering Co.)	Not observed.	Density 5 wild rice (>75% coverage) observed along the perimeter.
May through October 2021 (conducted by NTS)	Water level increased slightly throughout the year.	• In June, early wild rice growth was noted at floating leaf stage. • In July, wild rice was found to be aerial but sparse. • No wild rice was observed after July.

The evaluation of chemical conditions at Hay Lake, as well as the historical presence of wild rice and the geomorphological conditions that encourage wild rice growth indicate that Hay Lake supports the presence of wild rice. Wild rice growth has historically been present on Hay Lake and is expected to continue to be present on Hay Lake in the future. These reasons support that a site-specific standard of 79 mg/L would be protective of the wild rice growing on Hay Lake.

MPCA000737

Table 5-4 Estimated Sulfate Concentration in Reservoir 2, Leaving Reservoir 2, and Entering Hay Lake Based on Monitoring Data and Mass Balance Calculations

Data Set	Sulfate (mg/L)
Input into Reservoir 2 (from SD002 and SD005; mass balance approach)	100.38
SW001 2017 data (n = 12)	52.46
SW001 2018 data (n = 12)	54.34
SW001 2019 data (n = 12)	63.25
SW001 2020 data (n = 12)	50.65
SW001 2021 data (n = 5) [1]	81.52
SW001 2022 data (n = 2) [2]	68.35
Output from Reservoir 2 (Average of Annual Averages (n = 5))	**66.76**
Output from Reservoir 2 (SW001 2017-2022 data (n = 55))	**64.59**
Input into Hay Lake	**47.63**

[1] There was no outflow from Reservoir 2 from July 2021 through December 2021.
[2] There was no outflow from Reservoir 2 from January 2022 through March 2022; flow and concentration data available from April and May 2022.

For water leaving Reservoir 2, the resulting five-year sulfate averages of 66.76 mg/L (average of individual year averages) and 64.59 mg/L (average of monthly concentrations) are below the proposed sulfate site-specific standard of 79 mg/L. The results of the mass balance and results verification evaluation indicate there is some sulfate removal occurring in Reservoir 2. Sulfate inputs average 100.38 mg/L while outputs average as low as 64.59 mg/L. Sulfate loss also occurs in the Hay Creek watershed as the input to Hay Lake is estimated to be about 48 mg/L, well below the measured average sulfate concentrations at SW-001 (includes discharge from SD002 and SD005), as well as SD003 and SD012. It can be thus assumed that compliance with the proposed sulfate site-specific standard at SW001 will result in compliance with the site-specific protective value of 79 mg/L at Hay Lake. This is supported by the fact that the estimated sulfate concentration entering Hay Lake is 47.63 mg/L, even further below the proposed sulfate site-specific standard.

MPCA000744

Field Report

Hay Lake/Hay Creek Wild Rice and Stream Conditions Survey

Date: 15 September 2009

Staff: Michael Crotteau, DNR-Water/L&M, Grand Rapids

Purpose: To verify the occurrence, density and health of wild rice in Hay Creek and determine geomorphic or other controls (i.e. beaver dams) that affect water level in Hay Lake.

Location: Hay Lake (31-37W) (UTMX 492455, UTMY 5236990) and outlet of Hay Lake and Hay Creek downstream to Swan Lake.

Description: Traveled from the east-southeast side of Hay Lake to the outlet of the lake where Hay Creek exits. Observations were made from an inflatable kayak for approximately 1.4 miles downstream of Hay Lake.

Hay Lake – Water level was high. Water level elevation equipment was not available; therefore, no elevation was recorded. A loon and bald eagle were present as well as a 14-foot boat on the south side of the lake. A beaver lodge was present on the south side of the lake. Approximately 3 acres of wild rice was present in medium to abundant density. However, the crop was severely damaged (rotten) and appeared to be un-harvestable (see photos 1-12). This is more than likely due primarily to an increase in water level in the lake due to beaver activity (see below). The outside edge of the wild rice (lake-side) was 4 - 5 feet in depth.

Hay Creek – Water level was very high, though no elevation was captured. Wild rice was abundant at the outlet of the lake (mid-channel) with cattails bounding the shore margins (see photo 13). The crop, like the lake, was very un-healthy and had virtually no seeds. From the outlet to approximately 0.6 miles downstream, wild rice was present, but sparse and unhealthy (see photo 14). At 0.6 miles downstream of the outlet, an area of moderate wild rice density was encountered that was approximately 200 feet in channel length (see photo 16). Wild rice abundance dropped off to sparse after this section.

A beaver dam (BD 1) was encountered 0.66 miles downstream from the lake outlet; however, the dam was nearly at grade and created virtually no head drop from upstream to downstream (see photo 17). Approximately 0.84 miles downstream from the lake outlet, another beaver dam (BD 2) was encountered (see photo 20). This beaver dam was the controlling factor of stream and lake levels in Hay upstream and created a two to three foot head drop from upstream to downstream (see photo 21). Two meanders downstream (0.1 from BD2, 0.94 miles from lake), another beaver dam (BD 3) was encountered creating another one foot head drop in the stream (see photos 22). The last full stream width beaver dam (BD 4) was 1.08 miles downstream of the lake outlet and created an approximate 1.5 foot head drop in the creek

MPCA000789

HAY LAKE - HAY CREEK WILD RICE SURVEY, 15 SEPT 2009



Wild rice and lily pads approaching Hay Creek outlet



Unhealthy wild rice stalk



Hay Lake wild rice



Hay Lake wild rice looking northwest to Hay Creek inlet

HAY LAKE - HAY CREEK WILD RICE SURVEY, 15 SEPT 2009



Hay Lake wild rice - very unhealthy/rotten



Hay Lake wild rice



Hay Lake wild rice - very unhealthy/rotten



Wild rice and cattails approaching Hay Creek outlet

MPCA000793



Photograph H-13. Hay Lake, August 4, 2011.



Photograph H-14. Hay Lake, August 4, 2011.



Photograph H-15. Hay Lake, August 16, 2011.



Photograph H-16. Hay Lake, August 16, 2011.



Photograph H-17. Hay Lake, August 16, 2011.



Photograph H-18. Hay Lake, August 16, 2011.

Hay Lake - Sediment and Water Quality Monitoring Results Summary and Evaluation

Composite Sample Monitoring Results						Calculated Site-Specific Sulfate (mg/L) *(based on previously proposed multiple binary logistic regression (MBLR) equations)*	Potential Site-Specific Wild Rice Sulfate Standard (mg/L)
Location ID	Sample Date	Sediment Total Organic Carbon (TOC) [1] (%)	Sediment Total Extractable Iron (TEFe) (mg/kg)	Porewater Sulfate (mg/L)	Porewater Sulfide (mg/L)	2018 MPCA Proposed MBLR Equation [2] sulfate = 0.0000854 x TOC $^{-1.041}$ x TEFe $^{1.637}$ sulfide protective threshold = 120 µg/L	2018 20th Percentile Procedure [3]
HL-1	5/24/2021	1.81	9,370	--	--	146	79
HL-1	6/21/2021	2.29	9,740	< 1.0	< 0.10	122	
HL-1	7/27/2021	1.38	13,400	1.1	< 0.10	348	
HL-1	8/24/2021	1.71	10,900	< 1.0	0.113	199	
HL-1	9/28/2021	1.65	10,100	< 1.0	< 0.10	182	
HL-1	10/27/2021	--	--	< 1.0	< 0.10	--	
HL-2	5/24/2021	5.03	22,700	--	--	215	
HL-2	6/21/2021	5.80	10,700	< 1.0	< 0.10	54	
HL-2	7/27/2021	2.94	13,800	< 1.0	< 0.10	166	
HL-2	8/24/2021	2.54	9,450	24.8	< 0.10	104	
HL-2	9/28/2021	2.78	6,800	20.0	< 0.10	55	
HL-2	10/27/2021	--	--	1.9	0.19	--	
HL-3	5/24/2021	8.06	21,400	--	--	119	
HL-3	6/21/2021	8.43	19,500	< 1.0	0.112	98	
HL-3	7/27/2021	5.67	22,300	< 1.0	0.106	184	
HL-3	8/24/2021	6.41	13,800	5.4	< 0.10	74	
HL-3	9/28/2021	2.79	17,400	15.7	< 0.10	257	
HL-3	10/27/2021	--	--	< 1.0	< 0.10	--	
HL-4	5/24/2021	7.05	16,400	--	--	89	
HL-4	6/21/2021	9.80	18,700	1.5	0.383	78	
HL-4	7/27/2021	6.62	14,700	< 1.0	0.331	79	
HL-4	8/24/2021	6.06	10,900	< 1.0	0.568	53	
HL-4	9/28/2021	4.75	13,900	2.8	0.141	102	
HL-4	10/27/2021	--	--	< 1.0	0.316	--	
HL-5	5/24/2021	3.11	19,100	--	--	267	
HL-5	6/21/2021	4.34	19,400	< 1.0	< 0.10	194	
HL-5	7/27/2021	2.99	26,700	< 1.0	< 0.10	481	
HL-5	8/24/2021	3.56	20,400	< 1.0	0.124	258	
HL-5	9/28/2021	2.92	19,100	< 1.0	< 0.10	285	
HL-5	10/27/2021	--	--	< 1.0	0.133	--	

(1) Average value of the 9060A double run total organic carbon (TOC) analysis.

(2) Reference: MPCA. *Letter to Chief Administrative Law Judge Tammy L. Pust Re: In the Matter of the Proposed Rules of the Pollution Control Agency Amending the Sulfate Water Quality Standard Applicable to Wild Rice and Identification of Wild Rice Waters* . March 28, 2018. OAH Docket # 80-9003-34519, Revisor ID #4324.

(3) Procedure for determining wild rice sulfate standard based on 20th percentile of calculated values as described in MPCA March 28, 2019 letter response to Report of the Chief Administrative Law Judge.

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 18

Hay Lake Porewater Sulfide Monitoring Results Summary and Evaluation Table with MPCA July 2017 SONAR Pages.

Hay Lake Porewater Sulfide Monitoring Results Summary and Evaluation				
Composite Sample Monitoring Results			Evaluation	
Location ID	Sample Date	Porewater Sulfide (mg/L)	"Protective" Sulfide Limit (mg/L)	Exceed Sulfide Threshold
HL-1	6/21/2021	< 0.10	0.120	no
HL-1	7/27/2021	< 0.10	0.120	no
HL-1	8/24/2021	0.113	0.120	
HL-1	9/28/2021	< 0.10	0.120	no
HL-1	10/27/2021	< 0.10	0.120	no
HL-2	6/21/2021	< 0.10	0.120	no
HL-2	7/27/2021	< 0.10	0.120	no
HL-2	8/24/2021	< 0.10	0.120	no
HL-2	9/28/2021	< 0.10	0.120	no
HL-2	10/27/2021	0.19	0.120	YES
HL-3	6/21/2021	0.112	0.120	
HL-3	7/27/2021	0.106	0.120	
HL-3	8/24/2021	< 0.10	0.120	no
HL-3	9/28/2021	< 0.10	0.120	no
HL-3	10/27/2021	< 0.10	0.120	no
HL-4	6/21/2021	0.383	0.120	YES
HL-4	7/27/2021	0.331	0.120	YES
HL-4	8/24/2021	0.568	0.120	YES
HL-4	9/28/2021	0.141	0.120	YES
HL-4	10/27/2021	0.316	0.120	YES
HL-5	6/21/2021	< 0.10	0.120	no
HL-5	7/27/2021	< 0.10	0.120	no
HL-5	8/24/2021	0.124	0.120	YES
HL-5	9/28/2021	< 0.10	0.120	no
HL-5	10/27/2021	0.133	0.120	YES

Data in this exhibit is derived from the U.S. Steel Site-Specific Standard Application at MPCA002445, which is Exhibit 17 in WaterLegacy's comments on the U.S. Steel Keetac mining area and tailings basin permits. Orange rows reflect Hay Lake porewater sulfide exceeding MPCA's sulfide toxicity threshold of 120 µg/L (0.120 mg/L), and yellow rows reflect Hay Lake porewater exceeding MPCA's identified sulfide level of 100 µg/L (0.100 mg/L) where wild rice cover declines. An excerpt of MPCA's July 2017 SONAR specifying these thresholds is copied from the administrative record *In re Site-Specific Standard for Hay Lake* and provided on the following pages.

MINNESOTA POLLUTION CONTROL AGENCY

STATEMENT OF NEED AND REASONABLENESS

Amendment of the sulfate water quality standard applicable to wild rice and identification of wild rice waters.

Minn. R. chapters 7050 and 7053

Minnesota Pollution Control Agency

Environmental Analysis and Outcomes Division

July 2017

wq-rule4-15i

106 µg/L is most defensible. Additional discussion of the MPCA's selection of EC10 is provided in the TSD.

The MPCA also calculated EC10 values from the mesocosm experiments described in Pastor et al., 2017, which yielded two statistically-significant effects of sulfide on wild rice, (1) percent filled, or viable, seeds and (2) number of plants that emerged in the spring. Calculation of EC10 values from linear regressions yields EC10 values of 228 and 121 µg/L, respectively. All of these point estimates of EC10 concentrations have confidence intervals within which the true EC10 value is likely to fall. For the mesocosm data in particular, the 95% confidence intervals are relatively wide.

The peer review panel (Exhibit 9, page 6) also noted that "the field survey provides some of the best data that the MPCA has available to investigate the relationship between wild rice and surface water sulfate levels. These data also offer a means of determining sulfide levels that are protective of wild rice. Much more analysis should be done on this data set." One particular member of the panel also noted (Exhibit 9, pp. F36-37) that a visual estimate of the field survey data "indicates that the cover of wild rice declines at porewater sulfide concentrations above about 0.1 mg/L (100 µg/L)".

The MPCA therefore evaluated the field data in order to derive a protective sulfide concentration. The field data comes from a survey of 108 water bodies, of which 96 water bodies had sufficient water transparency to support wild rice. In order to develop the protective level of sulfide, the MPCA looked at the porewater sulfide concentrations and the presence or absence of wild rice. Most of the data analysis was done on the 96 water bodies with appropriate water clarity, since it is not reasonable to calculate a protective sulfide concentration with data from sites that would not support wild rice no matter how low the sulfide concentration is. [12]

Following the observation from the peer reviewer, the MPCA did a simple visual analysis of the data, looking for a sulfide level at which there was a noticeable reduction in the proportion of sites with wild rice present. The data were examined for such a threshold by calculating the average proportion of sites with rice above any given sulfide concentration, and the pattern examined without any statistical analysis. This showed that the percentage of sites with wild rice declines as sulfide increases, but the decline is relatively slow until the sulfide concentration exceeds 120 µg/L, where there is a notable drop in the percentage of sites with wild rice present. While a small uptick in the proportion of sites with wild rice occurs between 130-150 µg/L, the percentages never return to the 60% or greater that are observed below 120 µg/L. This can be seen with reference to Figure 2 from the TSD.

[12] *Note: Although wild rice was not present at all 96 sites, the MPCA included them in the survey because elevated sulfide could be the reason for the absence of wild rice.*

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 19

Michael Maleska Declaration with Photos taken at Hay Lake on September 7, 2025, and Sketches of Wild Rice Locations at Hay Lake.

MINNESOTA POLLUTION CONTROL AGENCY

Wastewater Permits (NPDES/SDS) for U.S. Steel Corp. Keetac Mining Facility (MN0031879), Keetac Tailings Basin Facility (MN0055948) and Request for Variance	**Declaration of Michael Maleska**

I, MICHAEL MALESKA, in accordance with section 358.116 of Minnesota Statutes and Rule 15 of the Minnesota Rules of General Practice, declare as follows:

1. I am a lifelong resident of Hibbing, Minnesota.

2. After hearing commenters say that wild rice was thick and thriving on Hay Lake at the hearing on September 3, 2025, I asked two friends to come with me to Hay Lake and find out if this was true. I've been to Hay Lake several times in recent years, and these comments were not consistent with what I'd seen in recent years.

3. On the morning of September 7, 2025, we hiked in to Hay Lake from Highway 16 and took pictures from the shore.

4. We found a canoe and paddle on the shore, and my friends borrowed it and took pictures looking for wild rice. After we took pictures, we returned the canoe and paddle to where we'd found them. The pictures in the Maleska Attachment A collection were all taken on September 7, 2025. In my opinion, they show thin, broken, and unhealthy wild rice with few seed heads.

5. Chris Baldwin is my friend and he shared an aerial photo he took of Hay Lake from a small plane on July 1, 2025. I looked at the Hay Lake photo taken by

Chris and circled in red on one copy where we found the wild rice on September 7, 2025. I sketched in black on another copy of that Hay Lake photo the boundary where I remember wild rice growing 50 years ago. The wild rice used to grow from just offshore to the lines shown on my sketch. The photo of Hay Lake taken by Chris Baldwin in July and the copies with my markings are in Maleska Attachment B.

6. From what I know and what I've seen, wild rice is not thick and thriving on Hay Lake. Whatever wild rice remains, or was recently planted, is thin and unhealthy, and has few good seed heads. You could not harvest that rice.

I declare under penalty of perjury that everything I have stated in this document is true and correct.

Dated: September 18, 2025

s/s Michael Maleska
Michael Maleska

ATTACHMENT A



Hay Lake shore, September 7, 2025



Hay Lake algae, lily pads, and wild rice, September 7, 2025



Hay Lake lily pads and wild rice, September 7, 2025



Hay Lake wild rice (close-up) September 7, 2025



Hay Lake lily pads and wild rice, September 7, 2025



Hay Lake shore, September 7, 2025

ATTACHMENT B



Hay Lake from small plane, photo by Chris Baldwin, July 1, 2025



Location of Hay Lake wild rice on September 7, 2025, (red line) by Mike Maleska



Historic location of Hay Lake wild rice (black lines) by Mike Maleska

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 20

Shanai Matteson Declaration with Photos taken at Hay Lake on September 10, 2025.

MINNESOTA POLLUTION CONTROL AGENCY

Wastewater Permits (NPDES/SDS) for U.S. Steel Corp. Keetac Mining Facility (MN0031879), Keetac Tailings Basin Facility (MN0055948) and Request for Variance	**Declaration of Shanai Matteson**

I, SHANAI MATTESON, in accordance with section 358.116 of Minnesota Statutes and Rule 15 of the Minnesota Rules of General Practice, declare as follows:

1. I've lived in rural towns in northern Minnesota most of my life. I grew up in Palisade (Aitkin County) and now live in Itasca County. I harvest wild rice and understand its abundance and value to both Native and non-Native communities. I know what healthy wild rice looks like.

2. I come from a mining family and my grandpa worked in the mines near Keewatin. My grandma told me that they initially lived in a trailer house in Keewatin when my mother was little, but the mine dust was so bad they moved back to Palisade.

3. I was at the hearing on the Keetac permits on September 3, 2025, and heard several commenters say that sulfate pollution wasn't harming wild rice in Hay Lake. Some even said they had riced there this season, and that it was very abundant. I was curious if this talking point was true. I had a dentist appointment in Nashwauk on Wednesday, September 10, 2025, so I decided to visit Hay Lake

and see for myself how the wild rice was doing. I invited a friend to come with me.

4. On September 10, 2025, we hiked in to Hay Lake from Highway 16 and took pictures from the shore and from a canoe.

5. We photographed the wild rice and lily pads from the canoe. The wild rice was thin and looked sick and broken. Up close, we could see that many wild rice stems were cracked or rotten-looking. There were few heads containing seeds and the seeds we found looked dry and unripe. The pictures attached with this declaration were all taken by my friend and me on September 10, 2025.

6. This has been a very good year for harvesting wild rice. I've been to other wild rice beds in Minnesota this year where the rice is beautiful, thick, and abundant. The same day my friend and I took photographs at Hay Lake, we went to the Sandy Lake Flowage in Aitkin County to compare the condition of wild rice at Sandy Lake with wild rice in Hay Lake, downstream of Keetac. The last photograph attached to this declaration is an image of lush, healthy, productive wild rice at the Sandy Lake Flowage on September 10, 2025.

7. Hay Lake wild rice downstream of the Keetac mine and tailings basin sulfate discharge is not healthy or productive. It is sick and broken. I saw no wild rice that would support wildlife and certainly none that people could harvest.

8. I declare under penalty of perjury that everything I have stated in this

document is true and correct.

Dated: September 19th, 2025



Shanai Matteson





Hay Lake wild rice on September 10, 2025



Hay Lake wild rice and lily pads on September 10, 2025



Hay Lake wild rice and lily pads on September 10, 2025



Hay Lake wild rice and lily pads on September 10, 2025

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 21

U.S. Steel Corp., Annual Report Pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934 (Form 10-K) for the fiscal year ended on December 31, 2024.

2024
UNITED STATES
SECURITIES AND EXCHANGE COMMISSION
Washington, D.C. 20549
FORM 10-K

(Mark One)

☒ **ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934**

For the Fiscal Year Ended December 31, 2024
Or

☐ **TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934**

For the transition period from to .

Commission file number 1-16811



United States Steel Corporation
(Exact name of registrant as specified in its charter)

Delaware	**25-1897152**
(State or other jurisdiction of incorporation)	(I.R.S. Employer Identification No.)

600 Grant Street, Pittsburgh, PA 15219-2800
(Address of principal executive offices) (Zip Code)
Registrant's telephone number, including area code: (412) 433-1121
Securities registered pursuant to Section 12(b) of the Act:

Title of Each Class	Trading Symbol(s)	Name of Exchange on which Registered
United States Steel Corporation Common Stock, par value $1.00	**X**	**New York Stock Exchange**
United States Steel Corporation Common Stock, par value $1.00	**X**	**Chicago Stock Exchange**

Securities registered pursuant to Section 12(g) of the Act: None

Indicate by check mark if the registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. Yes ☑ No ☐

Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Act. Yes ☐ No ☑

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15 (d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes ☑ No ☐

Indicate by check mark whether the registrant has submitted electronically every Interactive Data File required to be submitted pursuant to Rule 405 of Regulation S-T (§232.405 of this chapter) during the preceding 12 months (or for such shorter period that the registrant was required to submit such files). Yes ☑ No ☐

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, a smaller reporting company, or an emerging growth company. See the definitions of "large accelerated filer," "accelerated filer," "smaller reporting company," and "emerging growth company" in Rule 12b-2 of the Exchange Act.

Large accelerated filer ☒ Accelerated filer ☐ Non-accelerated filer ☐ Smaller reporting company ☐ Emerging growth company ☐

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act. ☐

Indicate by check mark whether the registrant has filed a report on and attestation to its management's assessment of the effectiveness of its internal control over financial reporting under Section 404(b) of the Sarbanes-Oxley Act (15 U.S.C. 7262(b)) by the registered public accounting firm that prepared or issued its audit report. ☑

If securities are registered pursuant to Section 12(b) of the Act, indicate by check mark whether the financial statements of the registrant included in the filing reflect the correction of an error to previously issued financial statements. ☐

Indicate by check mark whether any of those error corrections are restatements that required a recovery analysis of incentive-based compensation received by any of the registrant's executive officers during the relevant recovery period pursuant to §240.10D-1(b). ☐

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Act). Yes ☐ No ☒

Aggregate market value of Common Stock held by non-affiliates as of June 30, 2024, (the last business day of the registrant's most recently completed second fiscal quarter): $8.5 billion. The amount shown is based on the closing price of the registrant's Common Stock on the New York Stock Exchange composite tape on that date. Shares of Common Stock held by executive officers and directors of the registrant are not included in the computation. However, the registrant has made no determination that such individuals are "affiliates" within the meaning of Rule 405 under the Securities Act of 1933.

There were 225,216,524 shares of United States Steel Corporation Common Stock outstanding as of January 27, 2025.

Documents Incorporated By Reference:

Portions of the Proxy Statement for the 2025 Annual Meeting of Stockholders are incorporated into Part III.

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FORWARD-LOOKING STATEMENTS

This report contains information regarding the Company that may constitute "forward-looking statements," as that term is defined under the Private Securities Litigation Reform Act of 1995 and other securities laws, that are subject to risks and uncertainties. We intend the forward-looking statements to be covered by the safe harbor provisions for forward-looking statements in those sections. Generally, we have identified such forward-looking statements by using the words "believe," "expect," "intend," "estimate," "anticipate," "project," "target," "forecast," "aim," "should," "plan," "goal," "future," "will," "may" and similar expressions or by using future dates in connection with any discussion of, among other things, statements expressing general views about future operating or financial results, operating or financial performance, trends, events or developments that we expect or anticipate will occur in the future, anticipated cost savings, potential capital and operational cash improvements and changes in the global economic environment, anticipated capital expenditures, the construction or operation of new or existing facilities or capabilities and the costs associated with such matters, statements regarding our greenhouse gas emissions reduction goals, as well as statements regarding the merger between the Company and Nippon Steel Corporation (the "Merger"), including the timing of the completion of the Merger. However, the absence of these words or similar expressions does not mean that a statement is not forward-looking. Forward-looking statements include all statements that are not historical facts, but instead represent only the Company's beliefs regarding future goals, plans and expectations about our prospects for the future and other events, many of which, by their nature, are inherently uncertain and outside of the Company's control. It is possible that the Company's actual results and financial condition may differ, possibly materially, from the anticipated results and financial condition indicated in these forward-looking statements. Management of the Company believes that these forward-looking statements are reasonable as of the time made. However, caution should be taken not to place undue reliance on any such forward-looking statements because such statements speak only as of the date when made. In addition, forward looking statements are subject to certain risks and uncertainties that could cause actual results to differ materially from the Company's historical experience and our present expectations or projections. Risks and uncertainties include without limitation: the ability of the parties to consummate the Merger on a timely basis or at all; the occurrence of any event, change or other circumstances that could give rise to the termination of the definitive agreement and plan of merger relating to the Merger (the "Merger Agreement"); risks arising from litigation related to the Merger, either brought by or against the parties; the risk that the parties to the Merger Agreement may not be able to satisfy the conditions to the Merger in a timely manner or at all; risks related to disruption of management time from ongoing business operations due to the Merger and related litigation; certain restrictions during the pendency of the Merger that may impact the Company's ability to pursue certain business opportunities or strategic transactions; the risk that any announcements relating to the Merger could have adverse effects on the market price of the Company's common stock; the risk of any unexpected costs or expenses resulting from the Merger; the risk that the Merger and its announcement could have an adverse effect on the ability of the Company to retain customers and retain and hire key personnel and maintain relationships with customers, suppliers, employees, stockholders and other business relationships and on its operating results and business generally; and the risk the pending Merger could distract management of the Company. The Company directs readers to Item 1A of this Annual Report on Form 10-K, and the other documents it files with the SEC for other risks associated with the Company's future performance. These documents contain and identify important factors that could cause actual results to differ materially from those contained in the forward-looking statements. All information in this report is as of the date above. The Company does not undertake any duty to update any forward-looking statement to conform the statement to actual results or changes in the Company's expectations whether as a result of new information, future events or otherwise, except as required by law.

References in this Annual Report on Form 10-K to (i) "U. S. Steel," "the Company," "we," "us" and "our" refer to United States Steel Corporation and its consolidated subsidiaries unless otherwise indicated by the context, (ii) "Big River Steel" refers to Big River Steel Holdings LLC and its direct and indirect subsidiaries unless otherwise indicated by the context and (iii) "Transtar" refers to Transtar LLC and its direct and indirect subsidiaries unless otherwise indicated by the context.

Non-Generally Accepted Accounting Principles (non-GAAP) Financial Measures

This report contains the non-GAAP financial measure cash conversion cycle. We believe the cash conversion cycle is a useful measure in providing investors with information regarding our cash management performance and is a widely accepted measure of working capital management efficiency. The cash conversion cycle should not be considered in isolation or as an alternative to other Generally Accepted Accounting Principles (GAAP) metrics as an indicator of performance.

PART I

Item 1. BUSINESS

United States Steel Corporation, with operations in the United States of America and Central Europe, is a steelmaker that is pursuing a customer-centric, competitive, Best for All®, differentiated strategy by investing in our competitive advantages. We are executing on our strategy by investing where we have distinct cost and capability advantages so that we are a superior steel solutions provider for our customers. By offering the new steels that our customers are increasingly demanding, we aim to achieve world-competitive positioning in strategic, high-margin end markets and deliver high-quality, value-added products and innovative solutions utilizing a lower carbon footprint than previously available through our traditional integrated steelmaking model.

U. S. Steel has annual raw steel production capability of 25.4 million net tons (20.4 million tons in North America and 5.0 million tons in Europe). U. S. Steel performs a wide range of applied research, development and technical support functions at facilities in Pennsylvania, Michigan, Texas and Slovakia. U. S. Steel supplies customers throughout the world primarily in the automotive, construction, consumer (packaging and appliance), electrical, industrial equipment, service center/distribution, structural tubing and energy (oil country tubular goods (OCTG) and line pipe) markets. According to the worldsteel Association's latest published statistics, U. S. Steel is the third largest U.S. based steel producer and the twenty-fourth largest steel producer in the world. U. S. Steel is a Delaware corporation established in 1901.

Agreement and Plan of Merger with Nippon Steel Corporation

On December 18, 2023, the Company entered into an Agreement and Plan of Merger (such agreement, as it may be amended, modified or supplemented from time to time, the "Merger Agreement") by and among the Company, Nippon Steel North America, Inc., a New York corporation ("Purchaser"), 2023 Merger Subsidiary, Inc., a Delaware corporation and a wholly owned subsidiary of Purchaser ("Merger Sub"), and solely as provided in Section 9.13 therein, Nippon Steel Corporation, a Japanese corporation ("NSC"). Pursuant to the Merger Agreement, and upon the terms and subject to the conditions described therein, Merger Sub will merge with and into the Company, with the Company continuing as the surviving corporation and a wholly owned subsidiary of Purchaser (the "Merger"). On April 12, 2024, the Company obtained the approval of its stockholders required to adopt the Merger Agreement. The Company's stockholders approved the Merger with 98.8% approval of shares voted, satisfying a condition to closing. Subject to the terms and conditions set forth in the Merger Agreement, each share of the Company's common stock, par value $1.00 per share, outstanding immediately prior to the effective time of the Merger (the "Effective Time") will, at the Effective Time, automatically be converted into the right to receive $55.00 per share in cash, without interest, subject to any required tax withholding. The parties have substantially complied with the Second Requests issued on April 3, 2024 and the statutory waiting period under the Hart-Scott-Rodino Antitrust Improvements Act of 1976 has now expired. In addition, all required regulatory approvals outside of the United States related to the Merger have been received. The closing conditions to the Merger include clearance by the Committee on Foreign Investment in the United States ("CFIUS") under the Defense Production Act of 1950, as amended. Following referral of the transaction by CFIUS to the President of the United States, on January 3, 2025, the President of the United States issued an order prohibiting the Merger and requiring the parties to abandon the Merger Agreement within thirty days. On January 10, 2025, CFIUS granted an extension of that deadline to June 18, 2025.

On January 6, 2025, the Company, NSC and Purchaser jointly filed a lawsuit in the United States Court of Appeals for the District of Columbia Circuit alleging that the President's order blocking the Merger was issued for purely political reasons, which are irrelevant to U.S. national security, challenging the decision by the President of the United States and the CFIUS process as violating the constitutional due process rights of the Company, NSC and Purchaser, as well as the applicable statute governing CFIUS and the Administrative Procedure Act, and as an exercise of power that exceeded the authority provided to the President of the United States under the applicable statute. On the same day, the Company, NSC and Purchaser also filed a lawsuit in the United States District Court for the Western District of Pennsylvania against Cleveland-Cliffs Inc. ("Cliffs"), Cliffs' Chief Executive Officer Lourenco Goncalves, and the President of the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union (the "USW"), David McCall, for engaging in a coordinated series of anticompetitive and racketeering activities illegally designed to prevent any party other than Cliffs from acquiring the Company as part of an illegal campaign to monopolize critical domestic steel markets.

Segments

U. S. Steel has four reportable segments: North American Flat-Rolled (Flat-Rolled), Mini Mill, U. S. Steel Europe (USSE) and Tubular Products (Tubular). The Tubular segment includes the electric arc furnace at our Fairfield Tubular Operations in Fairfield, Alabama. The Other category includes the results of our real estate business.

Flat-Rolled

The Flat-Rolled segment includes the operating results of U. S. Steel's integrated steel plants and equity investees in North America involved in the production of slabs, strip mill plates, sheets and tin mill products, as well as all iron ore, direct reduced grade pellets, pig iron, and coke production facilities in the United States. These operations primarily serve North American

customers in the automotive, appliance, construction, container, pipe and tube, sheet converter, solar, industrial equipment and service center markets.

During 2024, Flat-Rolled had aggregate annual raw steel production capability of 13.2 million tons at our Gary Works, Mon Valley Works, and Granite City Works facilities. Raw steel production was 8.4 million tons in 2024, 9.4 million tons in 2023, and 8.8 million tons in 2022. Raw steel production averaged 63 percent of capability in 2024, 71 percent of capability in 2023, and 67 percent of capability in 2022.

Mini Mill

The Mini Mill segment includes the operating results of U. S. Steel's Big River Steel facility and a second mini mill facility, Big River Steel 2 (Big River 2 or BR2), which produced its first coil in October 2024. Both facilities are located in Osceola, Arkansas. The Mini Mill segment produces hot-rolled, cold-rolled, coated sheets and electrical steels. This operation primarily serves North American customers in the automotive, construction, pipe and tube, sheet converter, electrical, solar, industrial equipment and service center markets.

Mini Mill had aggregate annual raw steel production capability of 3.3 million tons at our Big River Steel facility through the third quarter of 2024, which increased to 6.3 million tons at our Big River Steel and BR2 facilities during the fourth quarter of 2024. Raw steel production was 2.8 million tons in 2024, 3.0 million tons in 2023, and 2.7 million tons in 2022. Raw steel production averaged 80 percent of capability in 2024, 89 percent of capability in 2023, and 80 percent of capability in 2022.

European Operations

The USSE segment includes the operating results of U. S. Steel Košice (USSK), U. S. Steel's integrated steel plant and coke production facilities in Slovakia, and its subsidiaries. USSE conducts its business mainly in Central and Western Europe and primarily serves customers in the European transportation (including automotive), construction, container, appliance, electrical, service center, conversion and oil, gas and petrochemical markets. USSE produces and sells slabs, hot-rolled, cold-rolled, hot-dip galvanized, and color-coated coils, electrical steel, strip mill plate, sheet, tin mill products and spiral welded pipe.

USSE has annual raw steel production capability of 5.0 million tons. USSE's raw steel production was 3.8 million tons in 2024, 4.4 million tons in 2023, and 3.8 million tons in 2022. USSE's raw steel production averaged 77 percent of capability in 2024, 88 percent of capability in 2023, and 77 percent of capability in 2022.

Tubular

The Tubular segment includes the operating results of U. S. Steel's tubular production facilities and an equity investee in the United States. These operations can produce and sell rounds, seamless and electric resistance welded (ERW) steel casing and tubing (commonly known as OCTG), and standard and line pipe and mechanical tubing and primarily serve customers in the oil, gas and petrochemical markets. U. S. Steel Tubular Products LLC (USSTP), a wholly owned subsidiary of U. S. Steel, designs and develops a range of premium and semi-premium connections to address our customers' needs. The Tubular segment has annual raw steel production capability of 900 thousand tons. Raw steel production was 575 thousand tons in 2024, 568 thousand tons in 2023, and 634 thousand tons in 2022. Raw steel production averaged 64 percent of capability in 2024, 63 percent of capability in 2023, and 70 percent of capability in 2022. Tubular has total production capability of 1.9 million tons.

For further information, see "Item 7. Management's Discussion and Analysis of Financial Condition and Results of Operations" and Note 4 to the Consolidated Financial Statements.

Steel Shipments by Market and Segment

The following table, except as noted in Footnote 1 below, does not include shipments to end customers by joint ventures and other equity investees of U. S. Steel. Shipments of materials to these entities are included in the "Further Conversion – Joint Ventures" market classification. During 2024, sales to one customer of the Flat-Rolled segment were approximately $2.0 billion which exceeded 10 percent of U. S. Steel's total consolidated net sales. During 2023 and 2022, no single customer accounted for more than 10 percent of U. S. Steel's total consolidated net sales.

(Thousands of Tons)	Flat-Rolled	Mini Mill	USSE	Tubular	Total
Major Market – 2024					
Steel Service Centers	**1,039**	**941**	**877**	**—**	**2,857**
Further Conversion – Trade Customers	**1,709**	**673**	**245**	**—**	**2,627**
– Joint Ventures [1]	**193**	**—**	**—**	**—**	**193**
Transportation and Automotive [1]	**3,389**	**14**	**559**	**—**	**3,962**
Construction and Construction Products	**584**	**591**	**1,224**	**11**	**2,410**
Containers and Packaging	**358**	**6**	**223**	**—**	**587**
Appliances and Electrical Equipment	**441**	**82**	**176**	**—**	**699**
Oil, Gas and Petrochemicals	**—**	**—**	**1**	**465**	**466**
All Other	**132**	**—**	**273**	**—**	**405**
TOTAL	**7,845**	**2,307**	**3,578**	**476**	**14,206**
Major Market – 2023					
Steel Service Centers	1,506	1,116	848	—	3,470
Further Conversion – Trade Customers	1,940	729	293	—	2,962
– Joint Ventures [1]	211	—	—	—	211
Transportation and Automotive [1]	2,876	17	636	—	3,529
Construction and Construction Products	908	483	1,319	31	2,741
Containers and Packaging	570	1	312	—	883
Appliances and Electrical Equipment	429	78	172	—	679
Oil, Gas and Petrochemicals	—	—	—	447	447
All Other	266	—	319	—	585
TOTAL	8,706	2,424	3,899	478	15,507
Major Market – 2022					
Steel Service Centers	1,128	1,080	839	—	3,047
Further Conversion – Trade Customers	2,163	772	289	—	3,224
– Joint Ventures [1]	256	—	—	—	256
Transportation and Automotive [1]	2,611	20	619	—	3,250
Construction and Construction Products	922	310	1,052	30	2,314
Containers and Packaging	693	13	423	—	1,129
Appliances and Electrical Equipment	416	93	225	—	734
Oil, Gas and Petrochemicals	—	—	3	494	497
All Other	183	—	309	—	492
TOTAL	8,372	2,288	3,759	524	14,943

[1] PRO-TEC automotive substrate shipments are included in the Transportation and Automotive category.

Steel Industry Background and Competition

The global steel industry is cyclical, highly competitive and has historically been characterized by global overcapacity.

U. S. Steel's competitive position may be affected by, among other things, differences among U. S. Steel's and its competitors' cost structure, labor costs, environmental remediation and compliance costs, global capacity, achievement of innovations in new technologies and sustainable products and the existence and magnitude of government support.

U. S. Steel competes with many North American and international steel producers. Competitors include 1) integrated producers, which use iron ore and coke as the primary raw materials for steel production, 2) Electric Arc Furnace (EAF) producers, which primarily use steel scrap and other iron-bearing feedstocks as raw materials and 3) slab re-rollers, who purchase mostly imported, but some domestic, semi-finished products and convert them into sheet products. In addition, other materials, such as aluminum, plastics and composites, compete with steel in several applications. According to worldsteel Association, global steel production in 2024 of approximately 1.88 billion metric tons was consistent compared to 2023. Among the top ten steel producing countries, steel production in China, Japan, the United States, and Russia decreased, while production in India, Germany, and Brazil increased. The top five steel producing countries accounted for approximately 74 percent of the world's steel production in 2024.

See "International Trade" below for a discussion of global overcapacity and the Company's efforts to mitigate the competitive impact.

EAF producers typically require lower capital expenditures for construction and operation of facilities and may have lower total employment costs. Some EAF producers utilize thin slab casting technology to produce flat-rolled products and are increasingly able to compete directly with integrated producers in many flat-rolled product applications previously produced only by integrated steelmakers. Slab re-rollers do not incur the cost of melting steel; their input costs are largely driven by the market price of slabs.

U. S. Steel provides defined benefit pension and/or other post-employment benefits to approximately 55,000 current employees, retirees and their beneficiaries. Many of our competitors do not have comparable retiree obligations. Participation in U. S. Steel's main defined benefit pension plan was closed to new entrants on July 1, 2003 and benefit accruals for all non-represented participants were frozen effective December 31, 2015. Participation in U. S. Steel's retiree medical and life insurance programs for USW-represented employees was closed to employees hired or rehired (except in limited circumstances) on or after January 1, 2016. For non-represented employees, retiree medical benefits were eliminated December 31, 2017, and retiree life insurance benefits were eliminated for those who retired after December 31, 2017.

We believe that our major North American and many European integrated steel competitors are confronted with substantially similar environmental regulatory conditions and therefore do not believe that our relative position with regard to such competitors will be materially affected by the impact of environmental laws and regulations. However, if future regulations do not recognize that the integrated steel process involves a series of chemical reactions involving carbon that create carbon dioxide (CO_2) emissions without linking these emissions to steel scrap as well, the competitive position of our integrated operations will be adversely impacted compared to mini mills. Our competitive position compared to producers in developing nations such as China, Russia, Brazil and India will be harmed unless such nations require commensurate reductions in CO_2 emissions or there are policies to adjust for the carbon emissions disparities. Competing materials such as plastics may not be similarly impacted. The specific impact on each competitor will vary depending on a number of factors, including the age and location of its operating facilities and its production methods. U. S. Steel is also responsible for remediation costs related to former and present operating locations and disposal of environmentally sensitive materials. Many of our competitors, including North American producers, or their successors, that have been the subject of bankruptcy relief have no or substantially lower liabilities for such environmental remediation matters.

In 2025, we expect additional steelmaking capacity will enter the domestic steel market as competitors' growth projects come on-line or ramp up to full production in North America throughout the year.

Business Strategy

We are executing on our Best for All® strategy to provide customers with profitable steel solutions for people and planet. Our strategy is focused on developing quality products and customer process solutions by investing where we have distinct cost or capability competitive advantages. We are expanding our competitive advantages in low-cost iron ore, mini mill steelmaking, and best-in-class finishing assets with innovative solutions and commercial acumen. These competitive advantages are built on a foundation of research, innovation and deep customer relationships. In executing our strategy, we aim to enhance our earnings profile, deliver long-term cash flow through industry cycles and reduce our cost, capital, and carbon intensity. By offering the product capabilities, including the more sustainable steels (steels made with lower greenhouse gas emissions), our customers are increasingly demanding, we can achieve more competitive positioning in strategic, high-margin end markets, and deliver high-quality, sustainable, value-added products and innovative solutions.

Our strategy is informed by our critical success factors, which are the bedrock of the Best for All® strategy: (1) Win in Strategic Markets; (2) Move Up the Talent Curve; and (3) Move Down the Cost Curve.

We are focused on strategic markets, where there is the greatest opportunity to provide differentiated, innovative and value-added solutions that will help our customers succeed. We are investing in new technologies to improve our cost position and increase our capabilities, including our mini mill steelmaking and best-in-class finishing capabilities. Beginning in 2021, we began investing nearly $4 billion in the Mini Mill segment to enhance our finishing and EAF capabilities. In 2023, we completed construction of a 200-thousand-ton, non-grain oriented (NGO) electrical steel line at our Big River Steel facility, which produced its first coil in September 2023, and shipped the first prime coil in early 2024. This construction project was completed on-time and on-budget. Construction of BR2 near Osceola, Arkansas continued throughout 2024 and BR2 produced its first coil in October 2024. This new mini mill has about 3 million tons per year of steelmaking capability and combines two state-of-the-art EAFs with differentiated steelmaking and finishing technology, including endless casting and rolling equipment and an advanced high-strength steel (AHSS) finishing line. Total capital spend for BR2 is expected to be approximately $3.6 billion. In addition, the construction of a 325-thousand-ton dual Galvalume®/galvanized coating line at Big River Steel was completed in the second quarter of 2024. We are enhancing our competitive advantage in low-cost iron ore by expanding this advantage to serve our growing fleet of EAF producers. In our Flat-rolled segment, construction of a direct reduced (DR) grade pellet facility at the Company's Keetac ore operations was completed on-time and on-budget in December 2023. We also completed our 500-thousand-ton, pig iron machine at Gary Works in 2022 and ramped to full run-rate production in 2023. Capital expenditures for strategic projects were $1.6 billion during the year ended December 31, 2024.

We know that to accomplish our objectives, we also need to continue to move up the talent curve. We are investing in our employees and providing the training and resources they need to succeed. This will help reinforce our culture of caring, where accountability, fairness and respect are foundational, and high performance and inclusion in all its forms are valued and celebrated. See "Human Capital Management" below for additional information on our talent attraction, development, and retention initiatives.

From time to time, U. S. Steel evaluates potential strategic and organizational opportunities, which may include the acquisition, divestiture or consolidation of assets. Given the cyclicality of our industry, we are focused on strategically deploying our capital, in-line with our capital allocation framework, in order to invest in areas consistent with the execution of our Best for All® strategy and are considering various possibilities, including exiting lines of business and the sale of certain assets, that we believe would ultimately result in greater stockholder value. The Merger Agreement contains customary limitations on U. S. Steel's ability to engage in such transactions without the consent of Purchaser.

As the Company advances and expands its mini mill capability, it seeks to become better, not bigger and will adjust its footprint accordingly by re-evaluating cost and capability advantages within its evolving footprint. In December 2021 and June 2022, the Company permanently idled the steelmaking and ironmaking operations, respectively, at its Great Lakes Works facility. In addition, in March 2022, the Company permanently idled the finishing facilities at its East Chicago Tin operations, which had been idled on a temporary basis during 2019. The coil finishing process at Great Lakes Works continues to operate and remains a component of the Company's operating plans. In December 2022, the Company indefinitely idled the majority of tin operations at our Gary Works facility. In November 2023, the steel and ironmaking production facilities at Granite City Works were indefinitely idled. The plant continues to process slabs to produce hot-rolled, cold-rolled and coated sheets. Production at USS-UPI, LLC (UPI) was indefinitely idled in December 2023.

Commercial Strategy

Our commercial strategy is focused on providing customer-centric solutions with differentiated and value-added steel products, which includes AHSS such as our newer grades of generation 3 (GEN3) steel, coated sheets for the automotive and appliance industries, electrical steel sheets for the manufacture of motors and electrical equipment, a wide variety of bare, laminated and pre-painted corrosion-resistant sheets for construction and related applications, hot rolled coils used in the production of construction and agricultural-related heavy machinery as well as skelp for line pipe used for energy transmission as well as

extraction, tin mill products for the packaging industry and OCTG pipe, connections, accessories and rig site services for use in drilling for oil and gas. In addition, our portfolio of customers serves a variety of different traditional and emerging industries meeting the needs of numerous markets.

U. S. Steel is committed to leveraging our Best for All® strategy to develop and commercialize our low-carbon footprint and high value-add steels for our current and future customers. The Company's current five-year plan includes objectives to develop and commercialize numerous differentiated grades of low-carbon, high rate of recycled-content steels, providing compelling new options for customers in automotive, appliance, industrial equipment, construction, renewable energy and other markets to enhance the sustainability of their products. For example, in April 2021, we announced a new sustainable steel product line, verdeX™, which is made with up to 90% recycled steel content and a reduced carbon footprint - as much as 70-80% less carbon emissions than traditional integrated steelmaking methods. After launching our verdeX™ brand of sustainable steel products in 2021, we have worked closely with customers on their own sustainability goals. In 2022, we achieved our first agreements with customers on the sale of verdeX™ products moving forward, and more agreements have been put in place for use in various industries, setting the stage for increased adoption of verdeX™ in existing and developing steel products produced by our customers. In 2023, with the completion of the NGO electrical steel line at our Big River Steel facility, the Company began production of its InduX™ electrical steel products which have the magnetic properties necessary for electric vehicles as well as generators. InduX™ electrical steel products are wide, ultra-thin, light-weight and infinitely recyclable. In addition, we continue to work with customers in numerous industries to help them implement AHSS solutions in the products they manufacture. While the automotive industry has been most active in the adoption of these products in vehicle platforms, and continues to accelerate the deployment of AHSS solutions in new vehicle launches, U. S. Steel is successfully introducing AHSS in other industries as well. In January 2023, we also enhanced our construction product portfolio by offering a best-in-class warranty of up to 60 years for our Galvalume® products, and in October 2023 launched Coastalume®, the first carbon steel solution designed for use in coastal construction applications, offering a combination of superior corrosion resistance and durability in a more cost-effective product than other widely used options. Most recently, U. S. Steel launched a new coated steel product in September 2024 called ZMAG™, a product designed to offer more strength, corrosion resistance, and sustainable steel benefits in numerous industries, but developed specifically for the growing solar segment.

We are responsive to our customers' changing needs by developing new steel products and uses for steel that meet their evolving markets and regulatory demands. We have research centers in Munhall, Pennsylvania, Košice, Slovakia, and Houston, Texas, as well as an automotive technology center in Troy, Michigan. The focus of these centers is to engineer new products and to co-create innovative solutions that meet our customers' toughest challenges to reduce carbon emissions, increase strength, improve longevity and serve the needs of their customers.

For automotive customers leveraging AHSS, we commissioned a first of its kind GEN3 hot dipped galvanize line at our PRO-TEC Coating Company (PRO-TEC) joint venture in 2020, and have embedded application engineers at original equipment manufacturers (OEMs) to demonstrate how to best utilize the strong, yet highly formable, cost effective material in body design to meet passenger safety requirements while significantly reducing weight to meet future vehicle fuel efficiency standards.

In our tubular markets, we continue development of premium and semi-premium tubular connections designed for our customers that operate in challenging drilling environments. These connections optimize well construction activities and provide outstanding sealing capabilities for onshore and offshore oil and gas drilling in North America. An example is the USS-TALON HTQ™, which was introduced in 2020 for customers that are constructing onshore natural gas and oil wells with long laterals requiring best-in-class torque capacity and optimized well-bore clearances.

Commercial Sales of Product

U. S. Steel characterizes sales as contract sales if sold pursuant to an agreement with a defined volume and pricing and a duration of longer than three months, and as spot if sold without a defined volume and pricing agreement, typically three months or less. In 2024, approximately 76 percent, 56 percent, 50 percent and 82 percent of sales by Flat-Rolled, Mini Mill, USSE and Tubular, respectively, were contract sales. Some contract pricing agreements include fixed prices while others are adjusted periodically based upon published prices of steel products or cost components.

Human Capital Management

At U. S. Steel, we are focused on attracting and retaining the top talent needed to support our strategic transformation and meet our customers' evolving needs as a sustainable steel solutions provider. The support and development of our people is foundational to achieving our Best for All® strategy. We refer to this strategic talent pillar as "Moving Up the Talent Curve."

Our focus on people extends to our current and future employees. We aim to have an engaged workforce and foster an environment that promotes new ideas and innovation, reflects the communities where we operate, and delivers exceptional customer service. To achieve the Best for All® strategy, we must have the "Best from All."

Active Employees as of December 31, 2024	
North America	14,341
Slovakia	7,712
Total	22,053

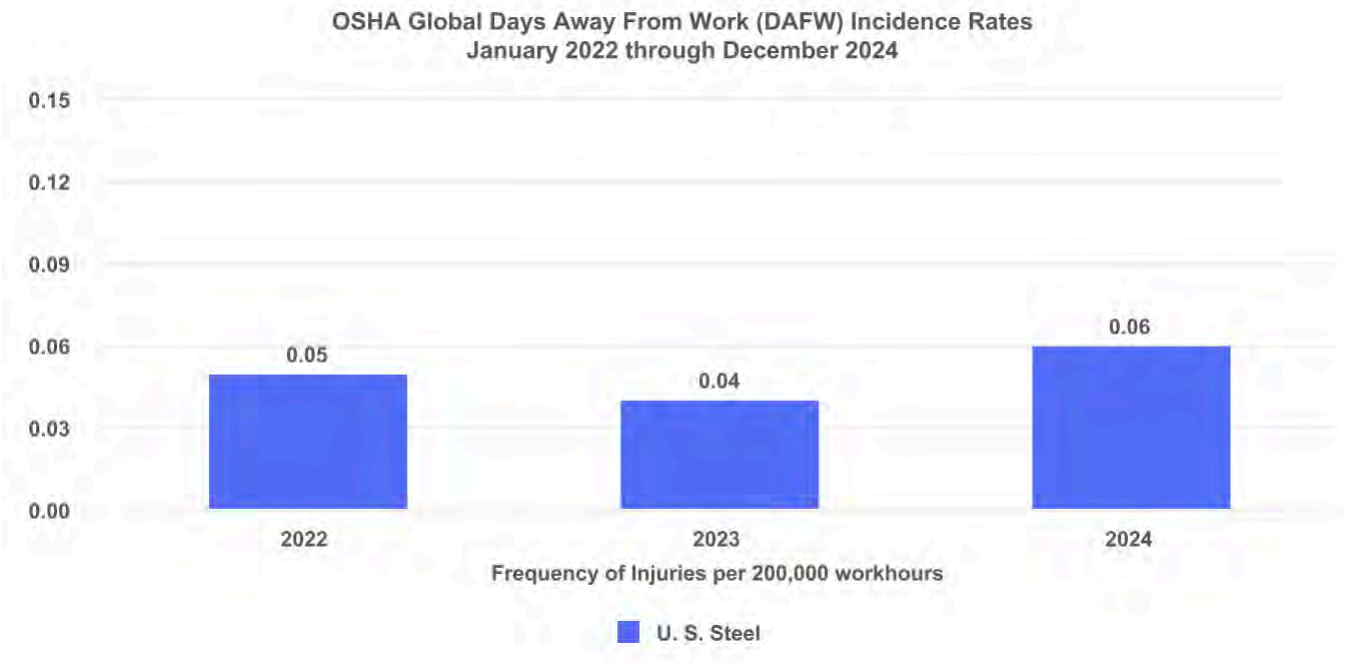
Ethics & Compliance

Our culture is based on our S.T.E.E.L. Principles: **S**afety First; **T**rust and Respect; **E**nvironmental Stewardship; **E**xcellence and Accountability; and **L**awful and Ethical Conduct. We expect our employees and members of our board of directors to take personal responsibility to "do what's right," and our Code of Ethical Business Conduct serves as the foundation for the actions of our employees and directors. To further ensure that employees understand the Company's expectations and all applicable rules, we provide annual formal ethics and compliance training to our employees and have frequent communications with information about key compliance topics, which include messages from senior management underscoring the importance of doing business with integrity. Employees also receive summaries of current events that demonstrate the need to do business lawfully and ethically that include reminders of the Company's expectations for all employees. In addition, through our annual policy certification process, employees of USSK, non-represented employees in the United States, and members of our board of directors certify their ongoing compliance with our Code of Ethical Business Conduct.

Employee Health & Safety

At U. S. Steel, we have a long-standing commitment to the safety and health of every person who works in our facilities. Every employee deserves to return home safely at the end of every day, and we are working to eliminate all injuries and incidents. In addition, the psychological safety of all employees is important to us. We have combined physical safety and psychological safety into the construct of 360° safety. Ensuring a safe workplace also improves productivity, quality, reliability and financial performance. By making safety and health a personal responsibility, our employees are making a daily commitment to follow safe work practices, look out for the safety of co-workers and ensure safe working conditions for everyone. A "Safety First" mindset is as essential to our success as the tools and technologies we rely on to do business.

Our objective is to attain a sustainable zero harm culture supported by leadership and owned by an engaged and highly skilled workforce, empowered with the capabilities and resources needed to assess, reduce and eliminate workplace risks and hazards. In support of these objectives, we have developed an enhanced Safety Management System, initiated new safety communication methods and enhanced contractor safety processes. One of our most important safety protocols is our fatality prevention audit program. These proactive assessments of the processes and protocols we have in place, and adherence to them, to avoid fatalities and severe injuries are conducted annually at the enterprise level and more frequently at each of our facilities. We assess our safety performance through a variety of lagging and leading indicators, including OSHA Days Away From Work (DAFW). This measurement allows us to evaluate the frequency of injuries sustained at our facilities requiring an employee to stay at home for more than one day. U. S. Steel has achieved record-safety performance in this measurement in the last several years, routinely achieving performance better than industry benchmarks.



For 2024, we had a corporate DAFW rate of 0.06, which is 10 times better than the U.S. Bureau of Labor Statistics' Iron and Steel benchmark DAFW rate of 0.60.

Talent Attraction, Development and Retention

Attracting, developing, and retaining a workforce of talented people with unique experiences and skillsets is essential to having high-performing teams that drive results for our Company's stakeholders. As part of our commitment to cultivating a culture of caring, we have inclusive benefits available for our U.S. non-represented workforce, including expanded parental leave, back-up dependent care, infertility coverage and healthcare continuation for the families of employees who suffered work-related or military service fatalities. We also support several employee resource groups (ERGs) to enhance employee engagement and promote a culture of belonging. Our ERGs also provide training and education, mentorship and networking opportunities for their members.

We believe that attraction, development and retention of talent is essential to our success, especially in today's competitive labor market. We offer internship programs, partner with universities, community colleges and technical schools, and collaborate with community employment centers and economic development nonprofit organizations to build strong and diverse internal and external sources of potential employees and opportunities for our existing employees' growth and development.

Once at U. S. Steel, we seek to provide opportunities for continuous learning and development. All of our employees at a director-level and above have a formal professional development plan that is assessed at least annually. In addition, we proactively monitor our attrition rates and take targeted actions to ensure our highest potential and performing employees are motivated to remain with the Company. Over the past five years, our regrettable voluntary turnover rate has been at or below 5.5 percent.

We offer a competitive total rewards package of compensation and benefits that we regularly evaluate and benchmark across the manufacturing industry to ensure that we position U. S. Steel as an employer of choice.

Labor Relations

Approximately 80% of our employees in North America and Slovakia are covered by collective bargaining agreements. We work closely with union representatives to provide safe and productive workplaces that enable our employees to deliver high-quality products and meet the needs of our customers. Our relationship with the USW includes not only a commitment to safety programs, but also a common approach to combating the unfairly traded imports that threaten our industry, our company and ultimately the jobs of our employees.

Certain hourly employees of U. S. Steel's flat-rolled, tubular, cokemaking and iron ore operations in the United States are covered by collective bargaining agreements with the USW entered into effective September 1, 2022 (the 2022 Labor Agreements) that expire on September 1, 2026. The 2022 Labor Agreements include a signing bonus for each eligible USW-represented employee and annual 5% wage increases effective September 1, 2022, 2023, 2024, and 2025. The 2022 Labor Agreements also provide for certain increases to pension and retirement benefits, including increases in our defined benefit pension plan, retiree healthcare account contributions, and to the contribution rate to the Steelworkers Pension Trust from $3.50 to $4.00 per hour, effective January 1, 2023. During the fourth quarter of 2022, U. S. Steel recorded a charge of approximately $67 million for the 2022 Labor Agreements signing bonus and related costs.

In addition, as part of the collective bargaining process, U. S. Steel and the USW agreed to leverage the overfunded Other Post-Employment Benefit (OPEB) plans to support the benefits provided to active represented employees. The OPEB plans were modified to allow the Company to utilize a certain amount of surplus assets to pay additional legally permissible benefits previously paid by the Company. The arrangement permits the Company to utilize a target of $75 million annually for active and retiree employee benefits, with an annual minimum of $50 million, beginning in 2023 and continuing through December 31, 2026. For additional information, see Note 18 to the Consolidated Financial Statements in Part II Item 8 of this Form 10-K.

Capital Structure, Liquidity and Capital Allocation

Our strategy's primary financial goal is to enhance stockholder value by utilizing our capital structure, liquidity and enhanced capital allocation priorities to advance the Company's strategic objectives, generate long-term value and reward stockholders. Our cash deployment strategy is aligned with our corporate strategy and includes executing on strategic projects and portfolio moves, maintaining a strong balance sheet and a healthy pension plan, and delivering sustainable growth with a focus on core values such as safety and environmental stewardship and rewarding stockholders for the continued progress we make. Cash deployment is also performed with a customer-centric focus on improving safety, our environment, quality, delivery and cost.

Our liquidity supports our ability to satisfy short-term obligations, fund working capital requirements and provides a foundation to execute key strategic priorities. We are focused on maintaining a strong balance sheet and may proactively refinance or repay our debt from time to time to protect our capital structure from unforeseen external events and re-financing risks.

In 2024, we repaid approximately $128 million in debt, and we ended the year with $3.62 billion of total liquidity.

On May 18, 2023, U. S. Steel closed on an offering consisting of an aggregate principal amount of $240 million unsecured Arkansas Development Finance Authority environmental improvement revenue bonds, which carry a green bond designation. The bonds, issued through Arkansas Development Finance Authority, have a coupon rate of 5.700% and carry a final maturity of 2053 (2053 ADFA Green Bonds). U. S. Steel received net proceeds of approximately $238 million after fees of approximately $2 million related to the underwriting and third-party expenses and will pay semiannual interest. The net proceeds from the issuance of the 2053 ADFA Green Bonds were used to partially fund work related to the BR2 facility.

The Merger Agreement contains customary limitations on U. S. Steel's ability to incur additional indebtedness without the consent of Purchaser.

On July 25, 2022, following the completion of previously authorized $800 million share repurchase programs, the Board of Directors authorized a share repurchase program for the repurchase of up to $500 million of the Company's outstanding common stock from time to time in the open market or privately negotiated transactions at the discretion of management. The Company's share repurchase program does not obligate it to acquire any specific number of shares.

U. S. Steel repurchased 7.1 million shares of its common stock for approximately $175 million during the year ended December 31, 2023. No share repurchases were completed in 2024, and there is approximately $126 million remaining under the current stock repurchase authorization. We do not expect to utilize the remainder of this authorization. In addition, the Board of Directors declared quarterly dividends of five cents per common share for each of the quarters in 2024. The Merger Agreement contains a customary prohibition on U. S. Steel's ability to engage in additional share repurchases without the consent of Purchaser.

Facilities and Locations as of December 31, 2024

Location Overview

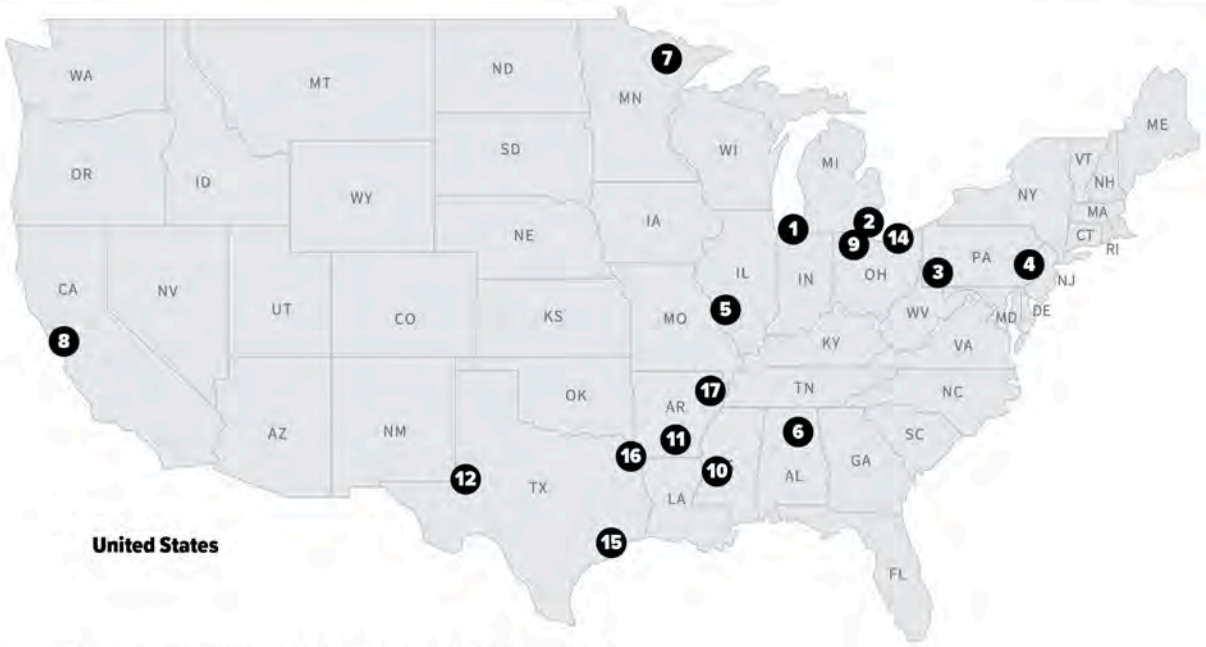
Flat-Rolled Segment
- **1** Gary Works
- **2** Great Lakes Works
- **3 4** Mon Valley Works
- **5** Granite City Works
- **6** Fairfield Sheet
- **7** Minntac
- **7** Keetac
- **7** Hibbing Taconite
- **8** USS-UPI, LLC
- **9** PRO-TEC Coating Company
- **10** Double G Coatings Company
- **1** Chrome Deposit*
- **2** Automotive Center

Mini Mill Segment
- **17** Big River Steel
- **17** Big River Steel 2

Tubular Segment
- **6** Fairfield Tubular
- **14** Lorain Tubular
- **15** Offshore Operations Houston
- **16** Lone Star Tubular
- **11 16** Wheeling Machine Products
- **12** Patriot Premium Threading Services

USSE Segment
- **13** U. S. Steel Košice

Administrative and Research
- **3** Corporate Headquarters
- **3** Research and Technology Center
- **15** U. S. Steel Tubular Products Innovation
- **13** USSE Research



*Chrome Deposit locations are near major steel mills and are not reflected on the map above.



Maps not drawn to scale.

Flat-Rolled

The operating results of all of U. S. Steel's domestic-integrated steel and sheet plants, coke and iron ore operations and ore and sheet production joint ventures are included in Flat-Rolled. Also included within Flat-Rolled is a research and technology center located in Munhall, Pennsylvania (near Pittsburgh) and an automotive technology center in Troy, Michigan. The research and technology center carries out a wide range of applied research, development and technical support functions. The automotive technology center brings automotive sales, service, distribution and logistics services, product technology and applications research into one location and much of U. S. Steel's work in developing new grades of steel to meet the demands of automakers for high-strength, light-weight and formable materials is carried out at this location.

Flat-Rolled Operations Table

Operations, (Property Location)	Annual Production Capability	Principal Products and/or Services
Gary Works, (Gary, Indiana) [a]	7.5 million tons of raw steel which includes 0.5 million tons of pig iron capability	strip mill plate in coil; hot-rolled, cold-rolled and coated sheets; tin mill products and pig iron
Midwest, (Portage, Indiana)	finishing facility	hot-rolled, cold-rolled and coated sheets; tin mill products
Great Lakes Works [b], (Ecorse, River Rouge and Dearborn, Michigan)	finishing facility	cold-rolled and coated sheets
Mon Valley Works [c]: Edgar Thompson, (Braddock, Pennsylvania), Irvin, (West Mifflin, Pennsylvania), Fairless, (Fairless Hills, Pennsylvania), and Clairton, (Clairton, Pennsylvania)	2.9 million tons of raw steel and 3.6 million tons of coke	hot-rolled, cold-rolled and coated sheets; coke and coke by-products
Granite City Works [d], (Granite City, Illinois)	2.8 million tons of raw steel	hot-rolled, cold-rolled and coated sheets
USS-UPI, LLC (UPI) [e], (Pittsburg, California)	finishing facility	cold-rolled and coated sheets; tin mill products
Fairfield Works, (Fairfield, Alabama)	finishing facility	coated sheets
Minnesota Ore Operations: Minntac, (Mt. Iron, Minnesota) and Keetac, (Keewatin, Minnesota)	22.4 million tons of iron ore pellets which includes 4.0 million tons of DR-grade pellet capability	iron ore pellets and DR (direct reduced) grade pellets

[a] The majority of tin operations were indefinitely idled as of December 31, 2022. Pig iron is sold on an intercompany basis to Big River Steel and BR2.

[b] The steel and ironmaking production facilities were permanently idled in December of 2021 and June of 2022, respectively. Great Lakes Works' pickle line, cold mill and CGL continue to operate, while the DESCO and electrolytic galvanizing lines are indefinitely idled.

[c] From time to time, we may swap coke with other domestic steel producers or sell on the open market. Coke by-products are sold to the chemicals and raw materials industries.

[d] In November 2023, the steel and ironmaking production facilities at Granite City Works were indefinitely idled. The plant continues to process slabs to produce hot-rolled, cold-rolled and coated sheets.

[e] In December 2023, production at UPI was indefinitely idled.

Joint Ventures Within Flat-Rolled

U. S. Steel participates in a number of joint ventures that are included in Flat-Rolled, most of which are conducted through subsidiaries. All of these joint ventures are accounted for under the equity method. The significant joint ventures and other investments are described below.

Joint Ventures [a] Within Flat-Rolled Table

Joint Venture, (Property Location)	U. S. Steel's Ownership Percentage	Annual Production Capability
Hibbing Taconite Company (Hibbing); (Hibbing, Minnesota)	14.7%	9.0 million tons of which U. S. Steel's share is 1.3 million tons
PRO-TEC Coating Company (PRO-TEC), (Leipsic, Ohio)	50.0%	2.0 million tons [b]
Double G Coatings Company (Double G) [c]; Jackson, Mississippi	50.0%	315 thousand tons
Chrome Deposit Corporation (CDC), (six locations near major steel plants)	50.0%	not applicable

[a] See further information about our equity investees in Note 12 to the Consolidated Financial Statements.

[b] U. S. Steel's domestic production facilities supply PRO-TEC with cold-rolled sheets and U. S. Steel markets all of PRO-TEC's products.

[c] Each partner supplies its own steel to Double G and markets what is processed by Double G.

Mini Mill

The operations of Big River Steel and Big River Steel 2 are included in Mini Mill. The Big River Steel and BR2 facilities, located in Osceola, Arkansas, are EAF sheet steel production facilities.

Mini Mill Operations Table

Operations, (Property Location)	Annual Production Capability	Principal Products and/or Services
Big River Steel, (Osceola, Arkansas)	3.3 million tons of raw steel	hot-rolled, cold-rolled and coated sheets; electrical steels
Big River Steel 2, (Osceola, Arkansas)	3.0 million tons of raw steel	hot-rolled, cold-rolled and coated sheets; electrical steels

USSE

USSE operates in Košice, Slovakia an integrated facility and a research laboratory, which, in conjunction with our Research and Technology Center, supports efforts in coke making, electrical steels, other value-added products and design and instrumentation.

USSE Operations Table

Operations, (Property Location)	Annual Production Capability	Principal Products and/or Services
U. S. Steel Košice, (Košice, Slovakia)	5.0 million tons of raw steel	coke; slabs; strip mill plate: hot, cold and coated sheets; tin mill products; spiral welded pipe

Tubular

Tubular manufactures seamless and welded OCTG, standard pipe, line pipe and mechanical tubing.

Tubular Operations Table

Operations, (Property Location)	Production Capability	Principal Products and/or Services
Fairfield Tubular Operations, (Fairfield, Alabama)	0.9 million tons of raw steel [(a)] and 750 thousand tons of tubular	seamless tubular pipe
Lorain Tubular Operations [(b)], (Lorain, Ohio)	380 thousand tons of tubular	seamless tubular pipe
Lone Star Tubular [(b)], (Lone Star, Texas)	#1 electric-weld pipe mill (EWPM) 400 thousand tons and #2 EWPM 380 thousand tons of tubular	welded tubular pipe
Wheeling Machine Products [(c)], (Pine Bluff, Arkansas and Hughes Springs, Texas)	not applicable	tubular couplings
Offshore Operations, (Houston, Texas)	not applicable	tubular threading, inspection, accessories and storage services and premium connections
Tubular Processing [(d)], (Houston, Texas)	not applicable	tubular processing

[(a)] Based on the rounds caster capacity which is its constraining production unit.

[(b)] In April 2020, the Lorain Tubular and Lone Star Tubular operations were indefinitely idled.

[(c)] In April 2020, the Wheeling Machine Products at Hughes Springs, Texas was indefinitely idled.

[(d)] Tubular Processing has been indefinitely idled since 2015.

Joint Ventures [(a)] Within Tubular Table

Operations, (Property Location)	U. S. Steel's Ownership Percentage	Production Capability	Principal Products and/or Services
Patriot Premium Threading Services, (Midland, Texas)	50%	not applicable	Tubular threading, accessories and premium connections

[(a)] See further information about our equity investees in Note 12 to the Consolidated Financial Statements.

Other

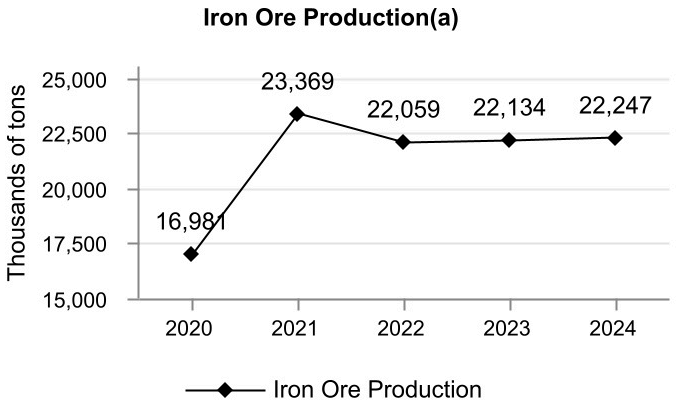
U. S. Steel's Other category includes the operating results relating to our real estate operations. The Company owns approximately 43,000 acres of real estate assets, either held for development or managed, in Alabama, California, Illinois, Michigan, Minnesota, Ohio, Pennsylvania and Texas.

Raw Materials and Energy

As a predominantly integrated producer, U. S. Steel's primary raw materials are iron units in the form of iron ore pellets and sinter ore, carbon units in the form of coal and coke (which is produced from coking coal) and steel scrap. For our EAF production, our primary raw material is scrap. U. S. Steel's raw materials supply strategy consists of acquiring and expanding captive sources of certain primary raw materials and entering into flexible supply contracts for certain other raw materials at competitive market prices that are subject to fluctuations based on market conditions at the time.

The amounts of such raw materials needed to produce a ton of steel will fluctuate based upon the specifications of the final steel products, the quality of raw materials and, to a lesser extent, differences among steel producing equipment. In broad terms, the Company's integrated steel process consumes approximately 1.4 tons of coal to produce one ton of coke and then it consumes approximately 0.3 tons of coke, 0.3 tons of steel scrap (approximately 60 percent of which is internally generated) and 1.3 tons of iron ore pellets to produce one ton of raw steel. In addition, we consume approximately 10 mmbtu's of natural gas per ton produced. Generally, the Company's mini mill operations consume approximately 0.8 tons of steel scrap, 0.3 tons of pig iron, and 0.1 tons of HBI to produce one ton of raw steel. In addition, the mini mill operations consume approximately 0.6 MKWH of electricity per ton of raw steel produced. While we believe that these estimated consumption amounts are useful for planning purposes, and are presented to give a general sense of raw material and energy consumption related to steel production, substantial variations may occur.

Iron Ore



(a) Includes our share of production from Hibbing through December 31, 2024.

The iron ore facilities at Minntac and Keetac contain approximately 900 million short tons of indicated resources and probable reserves and our share of recoverable reserves at the Hibbing joint venture is approximately 4 million short tons. Refer to Mining Properties in Item 2 of this Form 10-K for additional information. Recoverable reserves are defined as the tons of product that can be used internally or delivered to a customer after considering mining and beneficiation or preparation losses. Minntac and Keetac's annual capability and our share of annual capability for the Hibbing joint venture total approximately 23 million tons. We have iron ore pellet production capability that exceeds our steelmaking capability in the U.S.

We historically have sold iron ore pellets to third parties, including in 2024, 2023, and 2022. The Company has agreements to supply iron ore pellets to third-party customers over the next several years.

All of USSE's iron ore requirements are purchased from outside sources, primarily Ukrainian mining companies. Prices are determined in long-term contracts with strategic suppliers or as spot prices negotiated monthly or quarterly. We believe that supplies of iron ore adequate to meet USSE's needs are available at competitive market prices.

During 2024, USSE protected approximately 25 percent of its operation's iron ore purchases with financial swaps to manage exposure to iron ore price fluctuations.

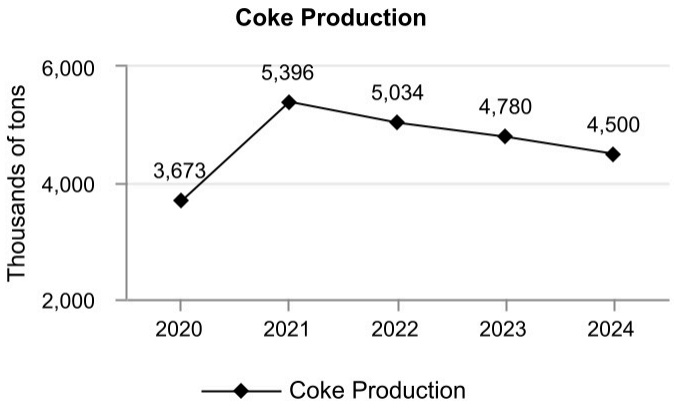
Coking Coal

All of U. S. Steel's coal requirements for our cokemaking facilities are purchased from outside sources. Pricing for Flat-Rolled's coking coal contracts is typically negotiated on a yearly basis, and from time to time we have entered into multi-year agreements for a portion of our coking coal requirements.

Prices for European contracts are negotiated quarterly, annually or determined as index-based prices.

We believe that supplies of coking coal adequate to meet our needs are available from outside sources at competitive market prices. The main source of coking coal for Flat-Rolled is the United States, and sources for USSE include Poland, Ukraine, Canada, Australia and the United States.

Coke



In North America, the Flat-Rolled segment operates a cokemaking facility at the Clairton Plant of Mon Valley Works. At our Granite City Works, we have a coke supply agreement with Gateway that expires on June 30, 2025, with a U. S. Steel option to extend the supply agreement for an additional six months to December 31, 2025. Blast furnace injection of coal, and self-generated coke oven gas is also used to reduce coke usage.

With Flat-Rolled's cokemaking facilities, it has the capability to be nearly self-sufficient with respect to its annual coke requirements at normal operating levels. Coke from time to time has been purchased from, sold to, or swapped with suppliers and other end-users to adjust for production needs and reduce transportation costs.

In Europe, the USSE segment operates cokemaking facilities at USSK. While USSE is self-sufficient for coke at normal operating levels, it periodically purchases coke from Polish and Czech coke producers to meet production needs. Volume and price are negotiated quarterly.

Steel Scrap and Other Materials

We believe that supplies of steel scrap and alloys that are adequate to meet our needs are readily available from outside sources at competitive market prices for the Flat-Rolled, Mini Mill and USSE segments. Generally, approximately 38 percent of our steel scrap requirements were internally generated through normal operations for these segments.

Limestone

All of Flat-Rolled's limestone requirements and USSE's lime and limestone requirements are purchased from outside sources. We believe that supplies of limestone and lime adequate to meet our needs are readily available from outside sources at competitive market prices.

Zinc and Tin

We believe that supplies of zinc and tin required to fulfill the requirements for Flat-Rolled, Mini Mill and USSE are available from outside sources at competitive market prices. For Flat-Rolled and Mini Mill the main sources of zinc are Canada, Mexico and the United States and the main sources of tin are Bolivia, Brazil and Peru. For USSE, the main sources of zinc are Poland and Finland, and the main sources of tin are Peru, Indonesia, and Brazil.

During 2024, Flat-Rolled protected approximately 70 percent of its operation's zinc and tin requirements with financial swap derivatives to manage exposure to zinc and tin price fluctuations. For further information, see Note 16 to the Consolidated Financial Statements.

Natural Gas

All of U. S. Steel's natural gas requirements are purchased from outside sources.

We believe that adequate supplies to meet Flat-Rolled's, Mini Mill's and Tubular's needs are available at competitive market prices. For 2024, approximately 70 percent of our natural gas purchases in Flat-Rolled were based on bids solicited on a monthly basis from various vendors; the remainder were made daily or with term agreements.

We believe that adequate natural gas supplies to meet USSE's needs are available at competitive market prices. During 2024, due to the uncertainty in the energy market, the procurement of natural gas in USSE was based on bids solicited primarily on a quarterly or monthly basis, with the remainder balanced on a daily basis.

Flat-Rolled and USSE use self-generated coke oven and blast furnace gas to reduce consumption of natural gas. USSE uses self-generated coke oven, converter and blast furnace gas to reduce consumption of steam coal that results in lower CO_2 emissions production.

Additionally, Russian supply of natural gas to Europe has decreased significantly in response to enacted sanctions. However, Slovakia has natural gas storage and access to additional supply from other locations including Norway, the U.S. and Africa. Together, these sources are enough to support the country's expected consumption through the 2025 winter season, which includes demand for natural gas for our USSE segment operations.

Industrial Gases

U. S. Steel purchases industrial gas in the U.S. under long-term contracts with various suppliers, with an exception being at our Fairfield Works where the Company's air separation plant provides for the facility's industrial gas needs. USSE owns and operates its own industrial gas facility, but also may purchase industrial gases from time to time from third parties.

International Trade

U. S. Steel continues to face import competition, much of which is unfairly traded and fueled by massive global steel overcapacity, currently estimated to be over 630 million net tons per year—more than six times the entire U.S. steel market and over twenty times total U.S. steel imports. These imports and overcapacity negatively impact the Company's operational and financial performance. U. S. Steel continues to lead efforts to address these challenges that threaten the Company, our workers, our stockholders and our country's national and economic security.

As of the date of this filing, pursuant to a series of Presidential Proclamations issued in accordance with Section 232 of the Trade Expansion Act of 1962, U.S. imports of certain steel products are subject to a 25 percent tariff, except imports from: (1) Argentina, Brazil, and South Korea, which are subject to restrictive quotas; (2) the European Union (EU) that are melted and poured in the EU, within tariff rate quota (TRQ) limits through December 2025; (3) Japan that are melted and poured in Japan within TRQ limits; (4) United Kingdom (UK) that are melted and poured in the UK within TRQ limits; (5) Canada; (6) Mexico, if melted and poured in North America; (7) Ukraine, if melted and poured in Ukraine or the EU, until June 1, 2025; and (8) Australia.

The U.S. Department of Commerce (DOC) is managing a process in which U.S. companies may request and/or oppose temporary product exclusions from the Section 232 tariffs and quotas. U. S. Steel opposes exclusion requests for imported products that are the same as, or substitutes for, products manufactured by U. S. Steel.

Multiple legal challenges to the Section 232 action continue before the U.S. Court of International Trade (CIT) and the U.S. Court of Appeals for the Federal Circuit (CAFC), the latter of which has consistently rejected constitutional and statutory challenges to the Section 232 action. Several challenges to the Section 232 action and retaliation thereto continue at the World Trade Organization (WTO).

Since its implementation in March 2018, the Section 232 action has supported the U.S. steel industry's and U. S. Steel's investments in advanced steel production capabilities, technology, and skills, strengthening U.S. national and economic security. The Company continues to actively defend the Section 232 action.

In February 2019, the European Commission (EC) implemented a definitive safeguard on global steel imports in the form of TRQs that impose 25 percent tariffs on steel imports that exceed the TRQ limit. The EC's safeguard is currently set to expire in June 2026.

Antidumping duties (AD) and countervailing duties (CVD or antisubsidy duties) apply in addition to the Section 232 tariffs, quotas, TRQs and the EC's safeguard, and AD/CVD (antidumping and countervailing duty) orders may continue beyond the Section 232 action and the EC's safeguard. U. S. Steel continues to actively defend and maintain the 69 U.S. AD/CVD orders and 14 EU AD/CVD orders covering U. S. Steel products in multiple proceedings before the DOC, U.S. International Trade Commission (ITC), CIT, CAFC, the EC and European courts, and the WTO.

In May 2024, the ITC voted to continue the AD order on tin mill products from Japan for another five years in the fourth “sunset” review of that order.

Also in May 2024, the EC initiated a new AD investigation on tin plate from China.

In August 2024, the EC initiated new AD investigations on EU imports of hot-rolled steel from Egypt, India, Japan, and Vietnam, with a preliminary decision expected by March 2025.

In September 2024, the DOC initiated new AD/CVD investigations on U.S. imports of corrosion-resistant steel (CORE) from ten countries based on petitions filed by U. S. Steel, Wheeling-Nippon, the USW, Nucor, and Steel Dynamics. On October 18, 2024, the ITC made affirmative preliminary determinations on all ten countries. The DOC will issue preliminary determinations in the first half of 2025.

Additional tariffs of 7.5 to 25 percent continue to apply to certain U.S. imports from China, including certain raw materials used in steel production, semi-finished and finished steel products, and downstream steel-intensive products, pursuant to Section 301 of the Trade Act of 1974. In September 2024, the Office of the United States Trade Representative (USTR) revised certain Section 301 tariffs on U.S. imports from China, including increasing tariffs on steel from 7.5 to 25 percent; batteries from 7.5 to 25 percent; solar cells/modules from 25 to 50 percent; and electric vehicles from 25 to 100 percent.

The United States and EU are currently negotiating a global sustainable steel arrangement to restore market-oriented conditions and address carbon intensity. In June 2023, to inform these ongoing discussions with the EU, USTR requested that the ITC conduct a Section 332 investigation to assess greenhouse gas emissions intensity of steel produced in the United States. The ITC initiated the Section 332 proceeding in July 2023, held a hearing on December 7, 2023, collected information from domestic producers through mid-2024 and will issue a report in the first quarter of 2025. U. S. Steel is actively participating in this Section 332 investigation. In the fourth quarter of 2023, the U.S. agreed to continue the Section 232 TRQs on U.S. imports from Europe through December 2025 and the EU agreed to continue to suspend retaliation on U.S. exports through March 2025.

U. S. Steel will continue to execute a broad, global strategy to maximize opportunities and navigate challenges presented by imports, global steel overcapacity, and international trade law and policy developments.

Environmental Stewardship

U. S. Steel is committed to effective environmental stewardship. We have implemented and continue to develop business practices that are designed to reduce negative environmental impacts of our operations. We believe part of being a good corporate citizen requires a dedicated focus on how our industry affects the environment. We have taken the actions described below in furtherance of that goal. U. S. Steel’s environmental expenditures totaled $354 million in 2024, $345 million in 2023, and $334 million in 2022. Overall, environmental compliance expenditures represented approximately 2 percent of U. S. Steel’s total costs and expenses in 2024, 2023, and 2022. For further information, see “Item 7. Management’s Discussion and Analysis of Financial Condition and Results of Operations – Environmental Matters.”

We continue to work on the promotion of cost-effective environmental strategies by supporting the development of appropriate air, water and waste laws and regulations at the local, state, national and international levels. We are committed to reducing our emissions and are investigating, creating and implementing innovative, best practice solutions throughout our operations to improve our environmental performance and to manage and reduce energy consumption.

U. S. Steel’s North America operations recycled 4.8 million and 4.9 million tons of purchased and produced steel scrap annually in 2024 and 2023, respectively. USSK recycled approximately 787 thousand tons and 895 thousand tons of produced steel scrap in 2024 and 2023, respectively. Because of steel’s physical properties, our products can be recycled at the end of their useful life without loss of quality, contributing to steel’s high recycling rate and affordability. In 2024, our North America operations recycled approximately 2.5 million tons of blast furnace slag, 26 thousand tons of Basic Oxygen Process steel slag, and 114 thousand tons of electric arc furnace slag by selling it for use as aggregate and in highway and other construction. In 2024, USSK recycled approximately 1.0 million tons of blast furnace slag, and 287 thousand tons of Basic Oxygen Process steel slag.

Many of our major production facilities have Environmental Management Systems that are certified to the ISO 14001 Standard. This standard, published by the International Organization for Standardization (ISO), provides the framework for the measurement and improvement of environmental impacts of the certified facility.

In 2019, and in each succeeding year since, we published the Clairton Operating and Environmental Report related to our Clairton Plant of Mon Valley Works. While U. S. Steel agreed to publish an annual report as part of the 2019 Allegheny County Health Department Settlement Order and Agreement, we took the opportunity to enhance the report by including detailed descriptions of our operations, our safety and environmental performance and community involvement in order to provide easily accessible information for the public. The report details battery combustion stack and fugitive emission performance at Clairton and Clairton’s continued commitment to environmental stewardship. In 2021, we published a similar report for the Edgar Thomson facility.

Reduction of Greenhouse Gas Emissions

In 2019, the Company announced its commitment to reduce greenhouse gas emissions intensity across its global footprint by 20 percent, as measured by the rate of CO_2 equivalents emitted per ton of finished steel shipped, by 2030 based on 2018 baseline levels. Then, in 2021, the Company announced its goal to achieve net-zero emissions by 2050, as measured by the rate of CO_2 equivalents emitted per ton of finished steel shipped. These targets apply to U. S. Steel's global operations.

U. S. Steel plans to achieve its greenhouse gas emissions intensity reduction goals through the execution of multiple initiatives. These include the use of EAF steelmaking technology at U. S. Steel's Fairfield Works, at Big River Steel, the first LEED-certified steel mill in the United States and the first steel mill in North America to receive ResponsibleSteel™ site certification, and at Big River Steel 2. EAF steelmaking primarily relies on recycled scrap, rather than iron ore, to produce new steel products, which is a less carbon intensive process and leverages the ability to continuously recycle steel. Further carbon intensity reductions are expected to come from the implementation of ongoing energy efficiency measures, continued use of renewable energy sources and other process improvements to be developed.

The carbon reduction targets reflect our continued commitment to improvement in production efficiency and the manufacture of products that are environmentally friendly. In addition to a commitment to reduce its own greenhouse gas emissions intensity, U. S. Steel is committed to helping its customers achieve their environmental goals. Our industry-leading XG3™ advanced high-strength steel enables automakers to manufacture lighter weight vehicles that meet federal Corporate Average Fuel Economy (CAFE) standards with reduced carbon emissions. As part of our innovation efforts, we continue to look at new steelmaking technologies so that we can produce steels made with low greenhouse gas emissions intensity (green steels) and further reduce carbon emissions.

Environmental Matters, Litigation and Contingencies

Some of U. S. Steel's facilities were in operation before 1900. Although the Company believes that its environmental practices have either led the industry or at least been consistent with prevailing industry practices, hazardous materials have been and may continue to be released at current or former operating sites or delivered to sites operated by third parties.

Our U.S. facilities are subject to environmental laws applicable in the U.S., including the Clean Air Act (CAA), the Clean Water Act (CWA), the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as well as state and local laws and regulations.

U. S. Steel has incurred and will continue to incur substantial capital, operating and maintenance and remediation expenditures as a result of environmental laws and regulations, related to release of hazardous materials, which in recent years have been mainly for process changes to meet CAA obligations and similar obligations in Europe.

EU Environmental Requirements and Slovak Operations

Phase IV of the EU Emissions Trading System (the EU ETS) commenced on January 1, 2021, and will finish on December 31, 2030. The European Commission issued final approval of the updated 2021-2025 Slovak National Allocation table in February 2022. The Slovak Ministry of Environment allocated 6.2 million metric tons of European Union Emission Allowances (EUA) at no charge (free allowances or free allocation) to USSE in March 2024. As of December 31, 2024, we have pre-purchased approximately 2.22 million EUA totaling €161 million (approximately $167 million) via spot purchases or settled forwards to cover the 2024 shortfall of emission allowances and expected shortfall in subsequent years.

The EU's Industrial Emissions Directive requires implementation of EU determined best available techniques (BAT) for Iron and Steel production to reduce environmental impacts as well as compliance with BAT associated emission levels. Total capital expenditures for projects to go beyond BAT requirements were €138 million (approximately $143 million). These costs were partially offset by the EU funding received and may be mitigated over the next measurement periods if USSK complies with certain financial covenants, which are assessed annually. If we are unable to meet these covenants in the future, USSK might be required to provide additional collateral (e.g., bank guarantee) to secure 50 percent of the EU funding received. USSK complied with these covenants as of December 31, 2024, and no additional collateral will be required by the end of June 30, 2025. By this next assessment date, we expect that nine of the fifteen total projects will pass the sustainability monitoring and will be excluded from further assessment to provide additional collateral if the covenants are not met. The last assessment of financial covenants will be performed as of June 30, 2026.

For further discussion of laws applicable in Slovakia and the EU and their impact on USSE, see Note 26 to the Consolidated Financial Statements, "Contingencies and Commitments, Environmental Matters, EU Environmental Requirements."

Minnesota Mining Operations - Water

The State of Minnesota has a sulfate wild rice water quality standard (WQS) set at 10mg/L, which was established in 1973. Since then, industry has been working with the legislature and the Minnesota Pollution Control Agency (MPCA) to reevaluate the environmental protection and science behind the 10 mg/L standard. In 2011, the legislature passed a law requiring MPCA to revise the sulfate standard. MPCA started the process to revise the rulemaking for the sulfate WQS, but it was never completed. During the interim the Keetac National Pollutant Discharge Elimination System (NPDES) permits were issued in November 2011,

with a sulfate standard of 14 mg/L and a compliance schedule. Then in 2015, the Minnesota legislature passed a law that MPCA could not require businesses to expend funds to comply with the sulfate limit until the rulemaking was revised by MPCA as directed by the legislature in 2011. To date the sulfate WQS rulemaking has not been revised.

Keetac has been working to determine the best options to address sulfate. One of the options in process is a site-specific standard (SSS) request to MPCA for Keetac, first applied for in 2014 and then updated in 2022. The SSS presents data specific to the waterbody and explains the actual impact of sulfate. MPCA denied the Keetac SSS based on new agency guidance. U. S. Steel appealed the denial of the SSS and oral argument occurred on January 22, 2025. The United States Environmental Protection Agency (the U.S. EPA) partially rejected the CWA 303(d) list for impaired waters submitted by MPCA for 2021. The MPCA's impaired waters list was in part rejected to add Hay Lake as being impaired for wild rice sulfate. In February 2022, the U.S. EPA Region V sent a letter to MPCA recognizing the conflict between state law and the CWA. In October 2023, MPCA indicated that Dark Lake is now a designated Wild Rice Water, carrying a 10 mg/L sulfate limit. Also in October, MPCA and U. S. Steel entered into a voluntary Sulfate Monitoring Plan related to operational changes with the Keetac DR pellet project. U. S. Steel is currently in discussions with U.S. EPA Region V concerning sulfate compliance at Keetac. This is based upon required monitoring submitted to the MPCA and the interpretation of the WQS for sulfate related to wild rice, even though there is an acknowledged conflict. It is not possible to accurately predict the outcome of this matter at this time.

U. S. Steel is continuing to work to determine the most efficient and effective options to meet the applicable sulfate standards. However, if MPCA does not revise the sulfate standard of 10mg/L for the receiving waters of Keetac or approve the SSS, an impact on mining operations is likely as a result of extensive changes to water collection and treatment that will be required.

New and Emerging Environmental Regulations

United States and European Greenhouse Gas Emissions Regulations

The Phase IV EU ETS period spans 2021-2030 and is divided into two sub periods (2021-2025 and 2026-2030). Currently, the overall EU ETS target is a 40 percent reduction of 1990 emissions by 2030. Free allocation of CO_2 allowances is based on reduced benchmark values and historical levels of production from 2014-2018. Allocations to individual installations may be adjusted annually to reflect relevant increases and decreases in production. The threshold for adjustments is set at 15 percent and is assessed based on a rolling average of two precedent years. In 2023 and 2024, USSK received an allocation for hot metal in the amount corresponding to its historical average, while the allocation for sinter was slightly lower due to lower production.

Lower production in 2019 through 2023 will have an impact on the future free allocation for 2026-2030, where the historical production median for the years 2019-2023 is assessed. During the third quarter of 2024, USSK submitted a request for free allocation for the second sub period 2026-2030 to the European Commission via the Slovak Ministry of Environment. The decision on volume of free allocation is expected at the end of 2025.

In order to achieve the EU political goal of carbon emissions neutrality by 2050, on July 14, 2021, the European Commission released a package of legislative proposals called Fit for 55. The proposals contain significant changes to current EU ETS functions and requirements, including: a new carbon border adjustment mechanism (CBAM) to impose carbon fees on EU imports, further reduction of free CO_2 allowance allocation to heavy industry and measures to strengthen the supply of carbon allowances. The initial phase started on October 1, 2023, with only a reporting obligation without financial impact. The full scale of CBAM will commence on January 1, 2026. CBAM will have an impact on USSK's free allocation starting in 2026 where initial reduction to 97.5% starts until 2035 with no free allocation. Another implication of CBAM is the customs duty that will require USSK to cover all its imports from third parties with CBAM Certificates representing embedded emissions in goods imported. The legislative process is being impacted by the ongoing Russia-Ukraine conflict. The proposals are subject to the EU legislative process, and we cannot predict their future impact.

U. S. Steel continues to monitor emerging regulations on Per- and Polyfluoroalkyl Substances (PFAS). The U.S. EPA has issued regulations on PFAS under several environmental statutes and continues to introduce additional regulations. The Company does not knowingly introduce PFAS in its manufacturing processes, but U. S. Steel continues to review new regulations related to PFAS and their potential impact to the Company.

United States - Air

The CAA imposes stringent limits on air emissions with a federally mandated operating permit program and civil and criminal enforcement sanctions. The CAA requires, among other things, the regulation of hazardous air pollutants through the development and promulgation of National Emission Standards for Hazardous Air Pollutants (NESHAP) and Maximum Achievable Control Technology (MACT) Standards. The U.S. EPA has developed various industry-specific MACT standards pursuant to this requirement. The CAA requires the U.S. EPA to promulgate regulations establishing emission standards for each category of Hazardous Air Pollutants. The U.S. EPA also must conduct risk assessments on each source category that is already subject to MACT standards and determine if additional standards are needed to reduce residual risks.

While our operations are subject to several different CAA rules and categories of NESHAP and MACT standards, the principal impact of these standards on U. S. Steel's operations includes those that are specific to coke making, iron making, steel making

and iron ore processing. The U.S. EPA has several rules under consideration that will impact our operations, as described in the sections below. While many of these rules are not finalized and the impacts are not estimable at this time, the overall cumulative impact could be material.

On July 13, 2020, the U.S. EPA published a Residual Risk and Technology Review rule for the Integrated Iron and Steel MACT category in the Federal Register. Based on the results of the U.S. EPA's risk review, the agency determined that risks due to emissions of air toxics from the Integrated Iron and Steel category are acceptable and that the current regulations provided an ample margin of safety to protect public health. Under the technology review, the U.S. EPA determined that there are no developments in practices, processes or control technologies that necessitate revision of the standards. In September 2020, several petitions for review of the rule, including those filed by the Company, the American Iron and Steel Institute (the AISI), Clean Air Council and others, were filed with the United States Court of Appeals for the D.C. Circuit (D.C. Circuit). The cases were consolidated and are being held in abeyance until the U.S. EPA reviews and responds to administrative petitions for review. The U.S. EPA proposed a revised iron and steel rule on July 31, 2023. U. S. Steel and other entities submitted extensive comments to the U.S. EPA on September 28, 2023. The U.S. EPA signed the final integrated iron and steel rule on March 11, 2024, and it was published in the Federal Register on April 3, 2024. U. S. Steel filed a Petition for Reconsideration with the U.S. EPA and a Petition for Review in the D.C. Circuit challenging the final iron and steel rule on June 6, 2024. U. S. Steel sought a stay of the rule pending the legal challenges. The motion for stay was denied by the D.C. Circuit in November 2024 and parties filed a request for En Banc review on December 6, 2024. Any impacts are not estimable at this time.

For the Taconite Iron Ore Processing category, based on the results of the U.S. EPA's risk review, the agency promulgated a final rule on July 28, 2020, in which the U.S. EPA determined that risks from emissions of air toxics from this source category are acceptable and that the existing standards provide an ample margin of safety. Furthermore, under the technology review, the agency identified no cost-effective developments in controls, practices, or processes to achieve further emissions reductions. Petitions for Review of the rule were filed in the D.C. Circuit, in which the Company and the AISI intervened. The U.S. EPA signed the Taconite Rule on January 31, 2024 and it was published in the Federal Register on March 6, 2024. U. S. Steel filed a Petition for Reconsideration with the U.S. EPA and Petitions for Review with the United States Court of Appeals for the Eighth Circuit and the D.C. Circuit on May 3, 2024, challenging the final Taconite Rule. The Petition for Review is now with the D.C. Circuit and briefing is ongoing. A stay was sought and denied by the D.C. Circuit. Any impacts are not estimable at this time.

The U.S. EPA published the final Coke MACT residual risk and technology rule in the Federal Register on July 5, 2024. The final rule imposes lower emission limits as well as new emission limits and work practices for many emission sources at by-product and heat recovery coke plants. U. S. Steel is reviewing the final version of the rule to determine next steps. On August 30, 2024, the Company, through the American Coke and Coal Chemicals Institute (ACCCI) and Coke Environmental Task Force (COETF), filed a Petition for Review of the coke rule with the D.C. Circuit. On September 3, 2024, the Company separately and jointly with the ACCCI and COETF submitted the Petitions for Reconsideration and Administrative Stay of the final coke rule with the U.S. EPA. The Company through ACCCI and COETF filed a motion to stay the final coke rule with the D.C. Circuit which was denied. Briefing will be in 2025. Any impacts are not estimable at this time.

In response to Court orders that invalidated prior U.S. EPA determinations regarding ozone attainment interference, on April 6, 2022, the U.S. EPA proposed a Federal Implementation Plan (that would replace several pending or disapproved State Implementation Plans) for Regional Ozone Transport for the 2015 Ozone National Ambient Air Quality Standard. The proposed rule would affect electric generating units (EGUs) in 26 states and certain non-EGU industries, including, among several others, coke ovens, taconite production kilns, boilers, blast furnaces, basic oxygen furnaces, reheating furnaces, and annealing furnaces in 23 states, including those where U. S. Steel has operations. The U.S. EPA announced the final rule on March 15, 2023. The final rule only included regulation of boilers and reheat furnaces for the iron and steel industry limiting the potential impacts on the Company. U. S. Steel filed an administrative petition for review and a petition for judicial review to the rule on August 4, 2023. The matter remains before the U.S. EPA Administrator (administrative) and the D.C. Circuit (judicial). While U. S. Steel's and others' petitions to stay the effectiveness of the rule were denied by the D.C. Circuit, the Company, as well as other petitioners, have filed applications to stay the effectiveness of the rule with the Supreme Court of the United States (U.S. Supreme Court). The U.S. Supreme Court granted the stay on June 27, 2024. The effective dates of the rule will be stayed during the pendency of the lower court challenges. Litigation in the D.C. Circuit, in which U. S. Steel is a petitioner, remains ongoing. The U.S. EPA requested the D.C. Circuit remand the administrative record, which was granted, and the record was remanded on December 4, 2024. Any impacts are not estimable at this time.

The CAA also requires the U.S. EPA to develop and implement National Ambient Air Quality Standards (NAAQS) for criteria pollutants, which include, among others, particulate matter (PM) - consisting of PM_{10} and $PM_{2.5}$, lead, carbon monoxide, nitrogen dioxide, sulfur dioxide (SO_2) and ozone.

In October 2015, the U.S. EPA lowered the NAAQS for ozone from 75 parts per billion (ppb) to 70 ppb. On November 6, 2017, the U.S. EPA designated most areas in which we operate as attainment with the 2015 ozone standard. In a separate ruling, on June 4, 2018, the U.S. EPA designated other areas in which we operate as "marginal nonattainment" with the 2015 ozone standard. On December 6, 2018, the U.S. EPA published a final rule regarding implementation of the 2015 ozone standard. Because no state regulatory or permitting actions to bring the ozone nonattainment areas into attainment have yet to be proposed or developed for U. S. Steel facilities, the operational and financial impact of the ozone NAAQS cannot be reasonably estimated at this time. On December 31, 2020, the U.S. EPA published a final rule pursuant to its statutorily required review of

NAAQS that retains the ozone NAAQS at 70 ppb. In January 2021, New York, along with several states and non-governmental organizations, filed petitions for judicial review of the action with the D.C. Circuit. Several other states and industry trade groups intervened in support of the U. S. EPA's action. The case remains in abeyance before the court as the U.S. EPA voluntarily reconsiders the ozone NAAQS. On January 3, 2024, the U.S. EPA filed an unopposed motion to voluntarily remand without vacatur the 2020 rulemaking. In its motion, the U.S. EPA advised the court that it intends to conduct the voluntary remand simultaneously as it conducts an entirely new review of the ozone standard; and that it intends to complete the new review (which is already underway) "as expeditiously as possible". Any impacts related to the U.S. EPA's consideration to revise the ozone NAAQS are not estimable at this time.

On December 18, 2020, the U.S. EPA published a final rule pursuant to its statutorily required review of NAAQS that retains the existing $PM_{2.5}$ standards without revision. In early 2021, several states and non-governmental organizations filed petitions for judicial review of the action with the D.C. Circuit. Several industry trade groups intervened in support of the U.S. EPA's action. The case remains in abeyance before the court as the U.S. EPA voluntarily reconsiders the $PM_{2.5}$ NAAQS. On January 6, 2023, the U.S. EPA proposed to lower the annual $PM_{2.5}$ NAAQS from the current 12 ug/m^3 standard to within the range of 9.0 to 10.0 ug/m^3. On March 6, 2024, the U.S. EPA published a final rule to significantly lower the primary annual $PM_{2.5}$ NAAQS standard from 12 ug/m^3 to 9.0 ug/m^3. In the rule, the U.S. EPA retained the primary 24-hour $PM_{2.5}$ standard at the level of 35 ug/m^3. The rule is being challenged by 24 states as well as trade groups in the D.C. Circuit. Because area designations and State Implementation Plans have not yet been made, any impacts to the Company are not estimable at this time.

Environmental Remediation

For further discussion of relevant environmental matters, including environmental remediation obligations, see "Item 3. Legal Proceedings, Environmental Proceedings."

Property, Plant and Equipment Additions

For property, plant and equipment additions, including finance leases, see "Item 7. Management's Discussion and Analysis of Financial Condition and Results of Operations – Liquidity and Capital Resources" and Note 13 to the Consolidated Financial Statements.

Available Information

U. S. Steel's Internet address is ***www.ussteel.com***. We post our Annual Report on Form 10-K, our quarterly reports on Form 10-Q, our proxy statement, our current reports on Form 8-K, amendments to those reports and our interactive data files to our website free of charge as soon as reasonably practicable after such reports are filed with, or furnished to, the Securities and Exchange Commission (SEC). We also post all press releases and earnings releases to our website.

All other filings with the SEC are available via a direct link on the U. S. Steel website to the SEC's website, *www.sec.gov*.

Also available on the U. S. Steel website are U. S. Steel's Corporate Governance Principles, Code of Ethical Business Conduct and the charters of the Audit Committee, the Compensation & Organization Committee and the Corporate Governance & Sustainability Committee of the Board of Directors. These documents and the Annual Report on Form 10-K and proxy statement are also available in print to any stockholder who requests them. Such requests should be sent to the Office of the Corporate Secretary, United States Steel Corporation, 600 Grant Street, Suite 1844, Pittsburgh, Pennsylvania, 15219-2800 (telephone: 412-433-1121).

U. S. Steel does not incorporate into this document the contents of any website or the documents referred to in the immediately preceding paragraphs.

Other Information

Information on net sales, depreciation, capital expenditures, earnings (loss) before interest, taxes, depreciation and amortization and assets by reportable segment and for business in the Other category and on net sales and assets by geographic area are set forth in Note 4 to the Consolidated Financial Statements.

For significant operating data for U. S. Steel for each of the last five years, see "Five-Year Operating Summary (Unaudited)" within this document.

Item 1A. RISK FACTORS

Merger-Related Risk Factors

Failure to complete the Merger on a timely basis, or at all, would negatively impact our business and financial condition, as well as the price of our common stock.

We may not be able to complete the Merger on a timely basis, or at all, including due to the failure to receive required regulatory approvals. The closing conditions to the Merger include clearance by CFIUS. Following referral of the transaction by CFIUS to the President of the United States, on January 3, 2025, the President of the United States issued an order prohibiting the Merger and requiring the parties to abandon the Merger Agreement within thirty days. On January 10, 2025, CFIUS granted an extension of that deadline to June 18, 2025.

The Company, NSC and Purchaser jointly filed a lawsuit in the United States Court of Appeals for the District of Columbia Circuit alleging that the President's order blocking the Merger was issued for purely political reasons, which are irrelevant to U.S. national security, challenging the decision by the President of the United States and the CFIUS process as violating the constitutional due process rights of the Company, NSC and Purchaser, as well as the applicable statute governing CFIUS and the Administrative Procedure Act, and as an exercise of power that exceeded the authority provided to the President of the United States under the applicable statute. There is no assurance that this lawsuit will be successful, or will ultimately permit the Merger to be consummated. The Company, NSC and Purchaser also filed a lawsuit in the U.S. District Court for the Western District of Pennsylvania against Cliffs, Cliffs' Chief Executive Officer Lourenco Goncalves, and the President of the USW, David McCall, for engaging in a coordinated series of anticompetitive and racketeering activities illegally designed to prevent any party other than Cliffs from acquiring the Company as part of an illegal campaign to monopolize critical domestic steel markets. There is no assurance that this lawsuit will be successful.

If the Merger is not completed, our ongoing business may be adversely affected as follows: (i) we may experience negative reactions from the financial markets, including negative impacts on the market price of our common stock; (ii) some of management's attention will have been directed to the Merger instead of being directed to our own operations and the pursuit of other opportunities that could have been beneficial to us; (iii) the manner in which customers, suppliers and other third parties perceive us may be negatively impacted, which in turn could affect our ability to compete for business; (iv) we may experience negative reactions from employees and there may be further negative impact on the relationship with the leadership of the USW; (v) we will have expended time and resources that could otherwise have been spent on our business; and (vi) we will not obtain the benefits of NSC's commitments to the Company, including the commitments to invest at least $2.7 billion of capital and to share technology to protect and grow the Company. In addition, further delay in consummating the Merger could have an adverse effect on our operating results and adversely affect our relationships with customers and suppliers and would likely lead to a significant diversion of management and employee attention.

Additionally, in approving the Merger Agreement, the Board of Directors considered a number of factors and potential benefits, including the fact that the merger consideration to be received by holders of common stock represented a significant premium over the unaffected trading price, including a premium of 142% to the Company's unaffected closing stock price of $22.72 on August 11, 2023, the last trading day before the Company's announcement of the strategic alternatives review process and a premium of 40% to the Company's closing stock price of $39.33 on December 15, 2023, the last trading day before public announcement of the Merger Agreement. If the Merger is not completed, neither the Company nor the holders of our common stock will realize this benefit of the Merger. Moreover, we would also have nevertheless incurred substantial transaction-related fees and costs and the loss of management time and resources.

Expenses related to the pending Merger are significant and will adversely affect our operating results.

We have incurred and expect to continue to incur significant expenses in connection with the pending Merger, including legal and investment banking fees and fees incurred in connection with the Merger-related litigation. We expect these costs to have an adverse effect on our operating results.

We are subject to business uncertainties and contractual restrictions while the Merger is pending, which could adversely affect our business.

The Merger Agreement requires us to operate in the ordinary course of business and restricts us, without the consent of Purchaser, from taking certain specified actions agreed by the parties to be outside the ordinary course of business until the pending Merger occurs or the Merger Agreement terminates. These restrictions may prevent us from pursuing otherwise attractive business opportunities and making other changes to our business before completion of the Merger or, if the Merger is not completed, termination of the Merger Agreement. In addition, matters relating to the Merger (including integration planning) will require substantial commitments of time and resources by our management, which could divert their time and attention.

Litigation and union grievances and disputes could result in substantial costs or other negative impacts on the Company.

In connection with the Merger, we (along with our directors and officers) may face lawsuits, disputes and/or other actions (including union grievances or actions), in addition to the lawsuits jointly filed by the Company, NSC and Purchaser described above. We may face additional lawsuits, disputes and/or other actions, including those brought by stockholders of the Company or those arising from the Merger-related litigation filed by the Company and NSC, which may seek to enjoin, prevent, and/or delay us from consummating the Merger or may seek damages or other relief from the Company.

One of the conditions to the closing of the Merger is the absence of any injunction or similar order issued by any government entity in the U.S. or other specified jurisdiction or law in the U.S. or other specified jurisdiction that has the effect of prohibiting the consummation of the Merger or that makes consummation of the Merger illegal. Accordingly, if any plaintiff is successful in obtaining an injunction prohibiting the consummation of the Merger, then such injunction may prevent the Merger from becoming effective, or delay its becoming effective within the expected time frame. The ultimate resolution of any such proceedings cannot be predicted, and defending against such claims, even those without merit, could result in substantial costs (including costs in connection with the defense or settlement of stockholder litigation in connection with the Merger and costs associated with our indemnification obligations to our directors and officers), delay, and diversion of management's time and resources, which may negatively impact our financial condition and adversely affect our business and results of operations. We may also file actions to assert our rights in connection with the Merger.

The announcement and pendency of the Merger may adversely affect our business, financial condition and results of operations.

Whether or not the Merger is consummated, the Merger may disrupt our current plans and operations, which could have an adverse effect on our business and financial results. We cannot predict how our customers, distributors, suppliers and strategic partners will view or react to the pendency of the Merger or any of the actions being taken in pursuit of consummating the Merger. If we are unable to reassure our customers, distributors, suppliers and strategic partners to continue transacting business with us, our sales, financial condition, results of operations, cash flows and stock price may be adversely affected.

In addition, uncertainty about the effect of the Merger on our employees may have an adverse effect on our business. These uncertainties may impair our ability to attract, retain and motivate key personnel until the Merger is completed and for a period of time thereafter. Employee retention may be particularly challenging during the pendency of the Merger. If key employees depart and as we face additional uncertainties relating to the Merger, our business relationships may be subject to disruption as customers, suppliers and other third parties attempt to negotiate changes in existing business relationships or consider entering into business relationships with parties other than the Company. If key employees depart or if our existing business relationships suffer, our results of operations may be adversely affected. The adverse effects of such disruptions could be exacerbated by further delay in the completion of the Merger.

The Merger Agreement contains provisions that eliminate our ability to consider alternative transaction proposals.

The Merger Agreement contains non-solicitation provisions that, subject to limited exceptions which applied prior to obtaining the requisite stockholder approval of the Merger, restrict our ability to solicit, initiate, or knowingly encourage or induce competing third-party proposals (or engage in, continue or otherwise participate in negotiations or discussions regarding such third-party proposals) for the acquisition of our stock or assets.

While the Merger Agreement remains in effect, these provisions would prevent us from being able to consider, negotiate or accept a transaction with a potential third-party acquirer that might have an interest in acquiring all or a significant portion of us, even if the acquirer was prepared to pay consideration with a higher per share cash or market value than the market value proposed to be received or realized in the Merger.

If the Merger Agreement is terminated and we decide to seek another business combination, we may not be able to negotiate or consummate a transaction with another party on terms comparable to, or better than, the terms of the Merger Agreement.

All of the matters described above, alone or in combination, could materially and adversely affect our business, financial condition, results of operations and stock price.

Economic and Market Risk Factors

The changing global economic climate is having adverse impacts on our business, which may create new risks and exacerbate certain other risks set forth below.

Changes in the global economic environment, inflation, elevated interest rates, recessions or prolonged periods of slow economic growth, and global instability and actual and threatened geopolitical conflict, could have an adverse effect on our industry and business, as well as those of our customers and suppliers.

Overall economic conditions in the U.S. and globally, including in Europe, including adverse factors such as inflation, rising or sustained elevated interest rates, supply chain disruptions and geopolitical conflicts, including the impacts of the war in Ukraine, significantly impact our business. Periods of economic downturn or continued uncertainty could result in difficulty increasing or maintaining our level of sales or profitability and we may experience an adverse effect on our business, results of operations, financial condition and cash flows.

Our U.S. operations are subject to economic conditions, including credit and capital market conditions, inflation, prevailing interest rates, and political factors, which if changed could negatively affect our results of operations, cash flows and liquidity. Political factors include, but are not limited to, changes to tax laws and regulations resulting in increased income tax liability,

changes in administration resulting in increased or newly imposed tariffs, increased regulation, such as carbon emissions limitations or trading mechanisms, limitations on exports of energy and raw materials, and trade remedies. Actions taken by the U.S. government could affect our results of operations, cash flows and liquidity.

USSE is subject to economic conditions and political factors associated with the EU, Slovakia and neighboring countries, and the euro currency. Changes in any of these economic conditions or political factors could negatively affect our results of operations, cash flows and liquidity. Political factors include, but are not limited to, taxation, nationalization, inflation, government instability, regional conflict, civil unrest, increased regulation and quotas, tariffs, sanctions and other market-distorting measures. Continued uncertainty and economic downturn in the European market throughout 2024, as well as the ongoing war in Ukraine, have had a broad range of adverse impacts on global economic conditions, many of which have had and are likely to continue to have adverse impacts on our USSE business, including increased raw material and energy costs, softer customer demand and lower steel prices, which led to the temporary idling of a portion of USSE's raw steel capability at the end of 2024 until the demand environment improves. These uncertain conditions in the European market could lead to adverse effects on the valuation of USSE's long-lived assets, which could negatively affect our results of operations through potential impairment charges. USSE also purchases a significant portion of its iron ore and coal from suppliers based in Ukraine.

Additionally, we are also exposed to risks associated with the business success and creditworthiness of our suppliers and customers. If our customers or suppliers are negatively impacted by a slowdown in economic markets, we may face the reduction, delay or cancellation of customer orders, delays or interruptions of the supply of raw materials, and increased risk of insolvency and other credit related issues of customers or suppliers, which could delay payments from customers, result in increased customer defaults and cause our suppliers to delay filling, or to be unable to fill, our needs at all or on a timely or cost-effective basis. The occurrence of any of these events may adversely affect our business, results of operations, financial condition and cash flows.

The steel industry, as well as the industries of our customers and suppliers upon whom we are reliant, is highly cyclical, which may have an adverse effect on our customer demand and results of operations.

Steel consumption is highly cyclical and generally follows economic and industrial conditions both worldwide and in regional markets. Price fluctuations are impacted by the timing, magnitude and duration of these cycles, and are difficult to predict. This volatility makes it difficult to balance the procurement of raw materials and energy with global steel prices, our steel production and customer product demand. U. S. Steel has implemented strategic initiatives to produce more stable and consistent results, even during periods of economic and market downturns, but this may not be enough to mitigate the effect that the volatility inherent in the steel industry has on our results of operations.

Additionally, our business is reliant on certain other industries that are cyclical in nature. We sell to the automotive, service center, converter, energy and appliance and construction-related industries. Some of these industries are highly sensitive to general economic conditions and may also face meaningful fluctuations in demand based on a number of factors outside of our control, including regulatory factors, supply chain disruptions, changing customer demand, economic conditions and raw material and energy costs. As a result, downturns or volatility in any of the markets we serve could adversely affect our financial position, results of operations and cash flows.

U. S. Steel has been and continues to be adversely affected by unfairly traded imports and global overcapacity, which may cause downward pricing pressure, lost sales and revenue and decreased market share, production, investment, and profitability.

Currently, global steel production capacity significantly exceeds global steel demand, which adversely affects U.S. and global steel prices. Global overcapacity continues to result in high levels of dumped and subsidized steel imports into the markets we serve. Domestic and international trade laws provide mechanisms to address the injury caused by such imports to domestic industries. Excessive steel imports have resulted and may continue to result in downward pricing pressure and lost sales and revenue, which adversely impacts our business, operations, financial condition and cash flows.

Although U. S. Steel currently benefits from 69 U.S. AD and CVD or anti-subsidy duty orders and 14 EU AD/CVD orders, petitions for trade relief are not always successful or effective. When implemented, such relief is generally subject to periodic reviews and challenges, which can result in revocation of AD/CVD orders or reduction of effective duty rates. There can be no assurance that any relief will be obtained or continued in the future or that such relief will adequately combat unfairly traded imports.

As of the date of this filing, pursuant to a series of Presidential Proclamations issued in accordance with Section 232 of the Trade Expansion Act of 1962, U.S. imports of certain steel products are subject to a 25 percent tariff, except imports from: (1) Argentina, Brazil, and South Korea, which are subject to restrictive quotas; (2) the European Union (EU) that are melted and poured in the EU, within TRQ limits through December 2025; (3) Japan that are melted and poured in Japan within TRQ limits; (4) United Kingdom (UK) that are melted and poured in the UK within TRQ limits; (5) Canada; (6) Mexico, if melted and poured in North America; (7) Ukraine, if melted and poured in Ukraine or the EU, until June 1, 2025; and (8) Australia. The Section 232 national security action on steel imports currently provides U. S. Steel and other domestic steel producers critical relief from imports. With no scheduled end date, the future coverage and duration of the Section 232 action is not known. Further, the U.S.

government may negotiate alternatives to the Section 232 tariffs for certain countries, similar to TRQ agreements with the EU, Japan, and the UK.

USTR's review of additional tariffs of 7.5 to 25 percent on certain U.S. imports from China, including certain raw materials used in steel production, semi-finished and finished steel products, and downstream steel-intensive products, pursuant to Section 301 of the Trade Act of 1974 could change the coverage and levels of such tariffs. In September 2024, USTR revised certain Section 301 tariffs on U.S. imports from China, including increasing tariffs on steel from 7.5 to 25 percent; batteries from 7.5 to 25 percent; solar cells/modules from 25 to 50 percent; and electric vehicles from 25 to 100 percent.

In February 2019, the EC implemented a definitive safeguard on global steel imports in the form of TRQs. The TRQs, which impose 25 percent tariffs on steel imports that exceed the TRQ limit, are currently effective through June 2026.

All of the above factors present a degree of uncertainty to our financial and operational performance, our customers, and overall economic conditions, all of which could impact steel demand and our performance. Faced with significant import competition and overcapacity in various markets, we will continue to evaluate potential strategic and organizational opportunities, which may include exiting lines of business and the sale of certain assets, temporary shutdowns or closures of facilities.

Shortages of skilled labor, increased labor costs or our failure to attract and retain other highly qualified personnel in the future could disrupt our operations and adversely affect our financial results.

We depend on skilled labor for the manufacture of our products. Some of our facilities are located in areas where demand for skilled labor often exceeds supply. Shortages of some types of skilled labor, such as electricians and qualified maintenance technicians, could restrict our ability to maintain or increase production rates, lead to production inefficiencies and increase our labor costs. Our strategic investments also require a set of job skills that is different from our prior needs. Our continued success executing on our strategy, and constructing and commercializing depends on the active participation of our key employees and ability to attract employees with different skills. We have recently observed an overall tightening and increasingly competitive labor market. The competitive nature of the labor markets in which we operate, the cyclical nature of the steel industry and our resulting needs for skilled employees increase our risk of not being able to recruit, train and retain the employees we require at efficient costs and on reasonable terms, and could lead to increased costs, such as increased overtime to meet demand and increased compensation to attract and retain employees. In addition, many companies, including U. S. Steel, have had employee layoffs as a result of reduced business activities during industry downturns. The loss of our key people or our inability to attract new key employees could adversely affect our operations. Additionally, layoffs or other adverse actions could result in an adverse relationship with our workforce or third-party labor providers. If we are unable to recruit, train and retain adequate numbers of qualified employees and third-party labor providers on a timely basis or at a reasonable cost or on reasonable terms, our business and results of operations could be adversely affected. Additionally, an overall labor shortage, lack of skilled labor, increased turnover, labor strikes or labor inflation as a result of general macroeconomic factors that affect our customers or suppliers could have a material adverse impact on the Company's operations, results of operations, liquidity or cash flows.

Strategic Risk Factors

Commercialization of our strategic investments in new technologies and products may not be fully successful.

Execution of our Best for All® strategy depends, in part, on the successful commercialization of a number of investments we have made in new facilities, technologies and products and successfully transitioning our footprint to a lower-cost, carbon and capital intensive model. Our Best for All® strategy is centered around expanding our competitive advantages in low-cost iron ore, mini mill steelmaking, and best-in-class finishing capabilities. These competitive advantages are built on a foundation of research, innovation and deep customer relationships. We have expanded our low-cost iron ore competitive advantage by investing in ways to translate the advantage to feed our growing EAF footprint. This includes investments in a pig iron caster at the Gary Works facility in the fourth quarter of 2022, and DR-grade pellet capabilities in Keetac, Minnesota, completed in December 2023. We have expanded our mini mill steelmaking capabilities through the construction of a second mini mill facility in Osceola, Arkansas, which produced its first coil in October 2024. We also expanded our best-in-class finishing capabilities through investments in a non-grain oriented electrical steel line and galvanizing construction line at Big River Steel. In executing our strategy, we aim to enhance our earnings profile, deliver long-term cash flow through industry cycles and reduce our cost, capital, and carbon intensity. By offering the product capabilities, including the more sustainable steels our customers are increasingly demanding, we believe that we can achieve more competitive positioning in strategic, high-margin end markets, and deliver high-quality, sustainable, value-added products and innovative solutions.

Successful commercialization of our strategic investments and execution of our strategy are subject to changing market conditions and demand for our new products, capability and cost performance, and customer adoption of new technologies. New product development or modification is costly, may be restricted by regulatory requirements, involves significant research, development, time, expense and human capital and may not necessarily result in the successful commercialization of new products, customer adoption of new technologies or products or new technologies may not perform as intended or expected. Unsuccessful commercialization and execution of these strategic investments, underperformance of any of these assets, failure of new products to gain market acceptance, delays or inability to achieve customer qualification standards, or limited or reduced demand in the marketplace could adversely affect our business, results of operations and financial condition and may limit the benefits of our stockholder value creation strategy.

From time to time, we engage in acquisitions, divestitures and joint ventures and may encounter difficulties in integrating and separating these businesses and therefore we may not realize the anticipated benefits.

As we pursue our Best for All® strategy, we may seek growth opportunities through strategic acquisitions as well as evaluate our portfolio for potential divestitures to optimize our business footprint and portfolio. The success of these transactions will depend on our ability to integrate or separate, as applicable, assets and personnel in these transactions and to cooperate with our strategic partners. We may encounter difficulties in integrating acquisitions with our operations as well as separating divested businesses, and in managing strategic investments. Furthermore, we may not realize the degree, or timing, of benefits we anticipate when we first enter into a transaction.

Additionally, we seek opportunities to monetize non-core and excess iron assets, including through real estate sales, third party agreements and option agreements. These opportunities may not materialize or generate the financial benefits expected. For example, Stelco Inc. (Stelco), a subsidiary of Cliffs, holds an option (Option) to acquire an undivided 25 percent interest in a to-be-formed entity that will own the Company's current iron ore mine located in Mt. Iron, Minnesota. There is a possibility that Stelco may not exercise its Option in the anticipated timeframe or at all. If the proposed joint venture with Stelco is not successful, fails to provide the benefits we expect, or is not created at all, we may in the future have more iron ore than we need to support the business. Additionally, the existence of the Option may deter future potential opportunities to monetize the iron ore assets. Any of the foregoing could adversely affect our business and results of operations.

Operational and Commercial Risk Factors

Our operational footprint, unplanned equipment outages and other unforeseen disruptions may adversely impact our results of operations or result in idle facility costs or impairment charges.

U. S. Steel has adjusted its operating configuration to advance its Best for All® strategy, in response to market conditions, including global economic volatility, declining steel prices, oil and gas industry disruption, global overcapacity and unfairly traded imports, and to optimize capability and cost performance, by idling and restarting production at certain facilities. Due to our existing operational footprint, the Company may not be able to respond in an efficient manner to fully realize the benefits from changing market conditions that are favorable to integrated steel producers or most efficiently mitigate the negative impacts of such changes. Our decisions concerning which facilities to operate and at what levels are made based upon execution of our Best for All® strategy, market conditions, our customers' orders for products as well as the capabilities and cost performance of our locations. We may concentrate production operations at several plant locations and not operate others, and as a result we may incur idle facility costs or impairment charges.

Our steel production depends on the operation of critical structures and pieces of equipment, such as blast furnaces, electric arc furnaces, steel shops, casters, hot strip mills and various structures and operations, including information technology systems, that support them, as well as finishing lines at our facilities and certain of our joint ventures. While we invested in operational and reliability enhancements to our assets through the asset revitalization program, launched in 2017, and continue to implement initiatives focused on proactive maintenance of key machinery and equipment at our production facilities, we may experience prolonged periods of reduced production and increased maintenance and repair costs due to equipment failures at our facilities or those of our key suppliers.

It is also possible that operations may be disrupted due to other unforeseen circumstances such as power outages, explosions, fires, floods, earthquakes, pandemics, terrorism, accidents, severe weather conditions, changes in U.S., European Union and other foreign tariffs, free trade agreements, trade regulations, laws and policies. We are also exposed to similar risks involving major customers and suppliers such as force majeure events of raw materials suppliers that have occurred and may occur in the future. Availability of raw materials and delivery of products to customers could be affected by logistical disruptions, such as shortages of barges, ocean vessels, rail cars or trucks or unavailability of rail lines or of the locks on the Great Lakes or other bodies of water. To the extent that lost production could not be compensated for at unaffected facilities and depending on the length of the outage, our sales and our unit production costs could be adversely affected.

We are subject to outbreaks of infectious disease, such as risks related to the global COVID-19 pandemic, which had adverse impacts on economic and market conditions and our business. Public health crises, including COVID-19, have created and may create significant volatility, uncertainty and economic disruption in the regions in which we operate.

The physical impacts of climate change may also have a material adverse effect on our results of operations. Climate change may be associated with increased occurrence of extreme weather conditions, which could include, among other things, increased risk of flooding, extreme cold or potential heat stress at facilities and other natural disasters that may lead our customers to curtail or shut down production or to supply chain and operational disruptions.

We face increased competition within our industry and from alternative materials and risks concerning innovation, new technologies, products and increasing customer demand for lower-carbon products.

As a result of increasingly stringent regulatory requirements and increased market and technological changes driven by broader trends such as decarbonization and electrification efforts in response to climate change, designers, engineers and industrial manufacturers, especially those in the automotive industry, are increasing their use of lighter weight, less carbon intense and alternative materials, such as aluminum, composites, plastics and carbon fiber. Use of such materials could reduce the demand for our steel products or steel products generally, which may reduce our profitability and cash flow. Additionally, the trend toward light weighting in the automotive industry, which requires lighter gauges of steel at higher strengths, could result in lower steel volumes required by that industry over time.

Additionally, technologies such as direct iron reduction, oxygen-coal injection and experimental technologies such as molten oxide electrolysis and hydrogen flash smelting may be more cost effective than our current production methods. However, we may not have sufficient capital to invest in such technologies and may incur difficulties adapting and fully integrating these technologies into our existing operations. We may also encounter production restrictions, or not realize the cost benefit from such capital intensive technology adaptations to our current production processes.

Finally, we may face increased competition due to the rapid development and rising use of digital, artificial intelligence (AI) and machine learning technologies. Failure to early adopt and incorporate such technologies to improve productivity, yields, manufacturing technology or support functional teams may put us at a long-term competitive disadvantage.

Limited availability, or volatility in prices of raw materials, scrap and energy may constrain operating levels and reduce profit margins.

U. S. Steel and other steel producers have periodically faced problems obtaining sufficient raw materials and energy in a timely manner due to delays, defaults, severe weather conditions, or force majeure events, shortages or transportation problems (such as shortages of barges, ore vessels, rail cars or trucks, or disruption of rail lines, waterways, or natural gas transmission lines), resulting in production curtailments. As a result, we may be exposed to risks concerning pricing and availability of raw materials and energy resources from third parties as well as logistics constraints moving our own raw materials and scrap to our plants. USSE purchases substantially all of its iron ore and coking coal requirements from outside sources. Any curtailments or escalated costs may further reduce profit margins.

U. S. Steel has agreed, and may continue to agree, to purchase raw materials and energy at prices that have been, and may be, above future market prices or in greater volumes than required in the future. Additionally, any future decreases in iron ore, scrap, natural gas, electricity and oil prices may place downward pressure on steel prices. If steel prices decline, our profit margins on indexed contracts and spot business could be reduced.

A failure of our information technology infrastructure and cybersecurity threats may adversely affect our business operations.

Despite efforts to protect confidential business information, personally identifiable information (PII), and the control systems of manufacturing plants, U. S. Steel systems and those of our joint ventures and third-party service providers have been and may be subject to cyberattacks or system breaches. System breaches can lead to theft, unauthorized disclosure, modification or destruction of proprietary business data, PII, or other sensitive information, to defective products, production downtime and damage to production assets, and the inaccessibility of key systems, with a resulting impact to our reputation, competitiveness and operations. We have experienced cybersecurity attacks that have resulted in unauthorized persons gaining access to our information technology systems and networks, and we could in the future experience similar attacks. To date, no cybersecurity attack has had a material impact on our financial condition, results of operations or liquidity.

While the Company continually works to safeguard our systems and mitigate potential risks, there can be no assurance that such actions will be sufficient to prevent cyberattacks or security breaches or mitigate all potential risks to our systems, networks and data, particularly with the recent proliferation and sophistication of cyberattacks and cyber intrusions around the world. The number of threats and events has increased substantially every year, which is expected to continue, particularly as the use of artificial intelligence makes these attempts look more legitimate. The potential consequences of a material cybersecurity attack include reputational damage, investigations and/or adverse proceedings with government regulators or enforcement agencies, litigation with third parties, disruption to our systems, including production capabilities, unauthorized release of confidential, personally identifiable or otherwise protected information, corruption of data, diminution in the value of our investment in research, development and engineering and increased cybersecurity protection and remediation costs, which in turn could adversely affect our competitiveness, results of operations and financial condition. The amount of insurance coverage we maintain may be inadequate to cover claims or liabilities resulting from a cybersecurity attack.

We depend on third parties for transportation services and increases in costs or the availability of transportation may adversely affect our business and operations.

Our business depends on the transportation of a large number of products, both domestically and internationally. We rely primarily on third parties, including the divested Transtar business, for transportation of the products we manufacture as well as delivery of our raw materials. Any increase in the cost of the transportation of our raw materials or products, as a result of increases in fuel or labor costs, higher demand for logistics services, consolidation in the transportation industry or otherwise, may adversely affect our results of operations as we may not be able to pass such cost increases on to our customers.

Our transportation service providers may face disruptions due to weather conditions or events, strikes, labor shortages or other constraints. If any of these providers were to fail to deliver raw materials to us or deliver our products in a timely manner, we may be unable to manufacture and deliver our products in response to customer demand. In addition, if any of these third parties were to cease operations or cease doing business with us, we may be unable to replace them at a reasonable cost. Such failure of a third-party transportation provider could harm our reputation, negatively affect our customer relationships and have a material adverse effect on our financial position and results of operations.

Our 2022 Labor Agreements with the USW contain provisions that may impact certain business activities.

Our 2022 Labor Agreements with the USW contain provisions that grant the USW a limited right to bid on the Company's sale of a facility (or sale of a controlling interest in an entity owning a facility) covered by the 2022 Labor Agreements, excluding public equity offerings and/or the transfer of assets between U. S. Steel and its wholly owned subsidiaries. The 2022 Labor Agreements also require a minimum level of capital expenditures (subject to approval of the Board of Directors) to maintain the competitive status of the covered facilities, and place certain limited restrictions on our ability to replace product produced at a covered facility with product produced at other than Company facilities or affiliates or U.S. or Canadian facilities with employee protections similar to the protections found in the 2022 Labor Agreements when the Company is operating covered facilities below capacity. The provisions in the 2022 Labor Agreements, as well as current or future proposed labor legislation or regulations, could unfavorably impact certain business activities including pricing, operating costs, margins and/or our competitiveness in the marketplace.

Financial Risk Factors

Our business and execution of our strategy require substantial expenditures for capital investments, debt service obligations, operating leases and maintenance that we may be unable to fund, which may require other actions to satisfy our obligations under our debt.

We have approximately $4.1 billion of long-term debt (see Note 17 to the Consolidated Financial Statements). If our cash flows and capital resources are insufficient to fund our planned capital expenditures or debt service obligations, we may face substantial liquidity problems and may be forced to reduce or delay investments and capital expenditures, terminate strategic projects, or to dispose of material assets or operations or issue additional debt or equity. We may not be able to take such actions, if necessary, on commercially reasonable terms or at all. The Credit Facility Agreement, the documents governing the USSK Credit Facility, the documents governing the Big River Steel ABL (Asset Based Loan) Facility and Big River Steel notes, and the indentures governing our existing senior unsecured notes may restrict our ability to dispose of assets and may also restrict our ability to raise debt or equity capital to be used to repay other debt when it becomes due. We may not be able to consummate those dispositions or to obtain proceeds in an amount sufficient to meet any debt service obligations then due. Our inability to generate sufficient cash flows to satisfy our debt obligations, or to refinance our indebtedness on commercially reasonable terms or at all, would materially and adversely affect our financial position and results of operations and may place us at a competitive disadvantage with competitors who may have less indebtedness and other obligations or greater access to financing. In addition, the availability under our Credit Facility Agreement and Big River ABL Facility may be reduced if we have insufficient collateral, or if we do not meet a fixed charge coverage ratio test. Availability under the USSK Credit Agreement could be limited if USSK does not meet certain financial covenants.

Our ability to service or refinance our debt or fund investments and capital expenditures required to maintain or expand our business operations depends on our financial condition and operating performance, which are subject to prevailing economic and competitive conditions and to certain financial, business, legislative, regulatory and other factors beyond our control, such as supply and demand conditions, inflation, prevailing interest rates, supply chain disruptions and the impacts of the war in Ukraine. We may not be able to maintain a level of cash flows from operating activities sufficient to permit us to satisfy our liquidity needs. In addition, the availability under certain of our debt instruments may be limited if we do not meet certain financial covenants. Furthermore, the agreements governing the BRS (Big River Steel) ABL Facility and other outstanding indebtedness of Big River Steel LLC and its subsidiaries limit their ability, subject to certain exceptions, to pay dividends or distributions or make other restricted payments, such that we may not be able to access the cash generated by these subsidiaries to fund our other expenditures.

If we cannot make scheduled payments on our debt, we will be in default and holders of our senior unsecured notes could declare all outstanding principal and interest to be due and payable, the lenders under the Sixth Amended and Restated Credit

Agreement, the USSK Credit Facility and the Export Credit Agreement could terminate their commitments to loan money, accelerate full repayment of any or all amounts outstanding (which may result in the cross acceleration of certain of our other debt obligations) and the lenders could foreclose against the assets securing their borrowings and we could be forced into bankruptcy or liquidation. All of these events would materially and adversely affect our financial position and results of operations.

Furthermore, ratings agencies could downgrade our ratings either due to factors specific to our business, a prolonged cyclical downturn in the steel industry, macroeconomic trends such as global or regional recessions and trends in credit and capital markets more generally. Ratings agencies also may lower, suspend or withdraw ratings on the outstanding securities of U. S. Steel or Big River Steel. Any lowering, suspension or withdrawal of such ratings may have an adverse effect on the market prices of such securities.

Any decline in our operating results or downgrades in our credit ratings may make raising capital or entering into any business transaction more difficult, lead to reductions in the availability of credit or increased cost of credit, adversely affect the terms of future borrowings, may limit our ability to take advantage of potential business opportunities, may have an adverse effect on the terms under which we purchase goods and services, and lead to reductions in the availability of credit.

We have significant retiree health care, retiree life insurance and pension plan costs, which may negatively affect our results of operations and cash flows.

We maintain retiree health care and life insurance and defined benefit pension plans covering many of our domestic employees and former employees upon their retirement. Some of these benefit plans are not fully funded, and thus will require cash funding in future years. Minimum contributions to domestic qualified pension plans (other than contributions to the Steelworkers Pension Trust (SPT) described below) are regulated under the Employee Retirement Income Security Act of 1974 (ERISA) and the Pension Protection Act of 2006 (PPA).

The level of cash funding for our defined benefit pension plans in future years depends upon various factors, including voluntary contributions that we may make, future pension plan asset performance, actual interest rates under the law, the impact of business acquisitions or divestitures, union negotiated benefit changes and future government regulations, many of which are not within our control. In addition, assets held by the trusts for our pension plan and our trust for retiree health care and life insurance benefits are subject to the risks, uncertainties and variability of the financial markets. Future funding requirements could also be materially affected by differences between expected and actual returns on plan assets, actuarial data and assumptions relating to plan participants, the discount rate used to measure the pension obligations and changes to regulatory funding requirements. See “Item 7. Management’s Discussion and Analysis of Financial Condition and Results of Operations” and Note 18 to the Consolidated Financial Statements for a discussion of assumptions and further information associated with these benefit plans.

U. S. Steel contributes to a domestic multiemployer defined benefit pension plan, the SPT, for USW-represented employees formerly employed by National Steel and represented employees hired after May 2003. We have legal requirements for future funding of this plan should the SPT become significantly underfunded or we decide to withdraw from the plan. Either of these scenarios may negatively impact our future cash flows. The 2022 Labor Agreements increased the contribution rate for most steelworker employees. Collectively bargained company contributions to the plan could increase further as a result of future changes agreed to by the Company and the USW.

The accounting treatment of goodwill, equity method investments and other long-lived assets could result in future asset impairments, which would reduce our earnings.

We periodically test our goodwill, equity method investments and other long-lived assets to determine whether their estimated fair value is less than their value recorded on our balance sheet. The results of this testing for potential impairment may be adversely affected by uncertain market conditions for the global steel industry and general economic conditions. If we determine that the fair value of any of these assets is less than the value recorded on our balance sheet, and, in the case of equity method investments the decline is other than temporary, we would likely incur a non-cash impairment loss that would negatively impact our results of operations. We have incurred asset impairment charges in recent years, including during the year ended December 31, 2024, and there can be no assurances that continued market dynamics or other factors may not result in future impairment charges.

We are subject to foreign currency risks, which may negatively impact our profitability and cash flows.

The financial condition and results of operations of USSE are reported in euros and then translated into U.S. dollars at the applicable exchange rate for inclusion in our financial statements. The appreciation of the U.S. dollar against the euro negatively affects our Consolidated Results of Operations. International cash requirements have been and in the future may be funded by intercompany loans, which may create intercompany monetary assets and liabilities in currencies other than the functional currencies of the entities involved, which can have a non-cash impact on income when they are remeasured at the end of each period. Procurement of equipment of announced strategic projects may be denominated in foreign currencies, which could adversely affect the costs of these projects.

In addition, foreign producers, including foreign producers of subsidized or unfairly traded steel with foreign currency denominated costs may gain additional competitive advantages or target our home markets if the U.S. dollar or euro exchange rates strengthen relative to those producers' currencies. Volatility in the markets and exchange rates for foreign currencies and contracts in foreign currencies could have a significant impact on our reported financial results and condition.

Financial regulatory frameworks introduced by U.S. and EU regulators may limit our financial flexibility or increase our costs.

We use swaps, forward contracts and similar agreements to mitigate our exposure to volatility, which entails a variety of risks. The Commodity Future Trading Commission's Dodd Frank and the EU's European Market Infrastructure Regulation and other government agencies' regulatory frameworks can limit the Company's ability to hedge interest rate, foreign exchange (FX), or commodity pricing exposures, which could expose us to increased economic risk. These frameworks may introduce additional compliance costs or liquidity requirements. Some counterparties may cease hedging as a result of increased regulatory cost burdens, which in turn may reduce U. S. Steel's ability to hedge its interest rate, FX or commodity exposures.

We are a party to various legal proceedings, the resolution of which could negatively affect our profitability and cash flows in a particular period.

We are involved at any given time in various litigation matters, including administrative and regulatory proceedings, governmental investigations, environmental matters and commercial disputes. Our profitability and cash flows in a particular period could be negatively affected by an adverse ruling or settlement in any legal proceeding or investigation. While we believe that we have taken appropriate actions to mitigate and effectively manage these risks, due to the nature of our operations, these risks will continue to exist and additional legal proceedings or investigations may arise from time to time.

Additionally, we may be subject to product liability claims that may have an adverse effect on our financial position, results of operations and cash flows. Events such as well failures, line pipe leaks, blowouts, bursts, fires and product recalls could result in claims that our products or services were defective and caused death, personal injury, property damage or environmental pollution. The insurance we maintain may not be adequate, available to protect us in the event of a claim, or its coverage may be limited, canceled or otherwise terminated, or the amount of our insurance may be less than the related impact on our enterprise value after a loss. We establish reserves based on our assessment of contingencies, including contingencies for claims asserted against us in connection with litigation, arbitrations and environmental issues. Adverse developments in litigation, arbitrations, environmental issues or other legal proceedings may affect our assessment and estimates of the loss contingency recorded as a reserve and require us to make payments in excess of our reserves, which could negatively affect our operations, financial results and cash flows. See "Item 3. Legal Proceedings" and Note 26 to the Consolidated Financial Statements for further details.

Regulatory Risk Factors

Compliance with existing and new environmental regulations, environmental permitting and approval requirements may result in delays or other adverse impacts on planned projects, our results of operations and cash flows.

Steel producers in the U.S., along with their customers and suppliers, are subject to numerous federal, state and local laws and regulations relating to the protection of the environment. These laws and regulations concern the generation, storage, transportation, treatment, disposal, release, emission or discharge of pollutants, contaminants, petroleum, and hazardous substances into the environment, the reporting of such matters, and the general protection of public health and safety, natural resources, wildlife and the environment. Steel producers in the EU are subject to similar laws. These laws and regulations continue to evolve and are becoming increasingly stringent. For example, the U.S. EPA has proposed to lower the NAAQS for fine particulate matter ($PM_{2.5}$), which would result in stringent and costly requirements to control emissions from existing operations and restrictions on new projects. The ultimate impact of complying with such laws and regulations is not always clearly known or determinable because regulations under some of these laws have not yet been promulgated, and the subject of ongoing litigation or are undergoing revision, and new versions or interpretations of existing laws may take effect. Additionally, compliance with certain of these laws and regulations, such as the CAA and state and local requirements governing air emissions, could result in substantially increased capital requirements and operating costs and could require changes to the equipment or facilities we operate. Compliance with current or future laws and regulations could entail substantial costs and could have a negative impact on our results of operations and cash flows. The amount and timing of environmental expenditures is difficult to predict.

In addition, the Company must obtain, maintain and comply with numerous permits, leases, approvals, consents and certificates from various governmental authorities in connection with the construction and operation of new production facilities or modifications to existing facilities. In connection with such activities, the Company may need to make significant capital and operating expenditures to detect, repair and/or control air emissions, to control water discharges or to perform certain corrective actions to meet the conditions of the permits issued pursuant to applicable environmental laws and regulations.

There can be no assurance that future approvals, licenses and permits will be granted or that we will be able to maintain and renew the approvals, licenses and permits we currently hold. Failure to do so could have a material adverse effect on our results of operations and cash flows. Furthermore, compliance with environmental permitting and approval requirements may be costly and time consuming and could result in delays or other adverse impacts on planned projects, our results of operations and cash flows.

Failure to comply with legal requirements, including permits, leases, approvals, consents and certificates, may result in administrative, civil and criminal penalties, and revocation of permits and our authority to conduct business or construct certain facilities, substantial fines or sanctions, or citizens' suits or enforcement actions (including orders limiting our operations or requiring corrective measures), among other consequences.

We have significant environmental remediation costs that negatively affect our results of operations and cash flows.

Various environmental laws impose liability on a current or former owner or operator of real property for investigation or cleanup of hazardous substances or petroleum products at, on, under or migrating from our currently or formerly owned or leased real property. Some of U. S. Steel's current and former facilities were in operation before such environmental regulations were in place. Hazardous materials associated with those facilities have been and may continue to be encountered at current or former operating sites or delivered to sites operated by third parties. In some cases, liability may be imposed without regard to contribution or to whether we knew of, or caused, the release of hazardous substances. Liability under these laws may be joint and several, meaning that we could be required to bear 100% of the liability even if other parties are also liable. U. S. Steel is involved in numerous remediation projects at currently operating facilities, facilities that have been closed or sold to unrelated parties and other sites where material generated by U. S. Steel was deposited. In addition, there are numerous other former operating or disposal sites that could become subject to remediation, which may negatively affect our results of operations and cash flows. Contamination at our current properties could result in limitations on or interruptions to our operations and liens in favor of the government for costs the government incurs in cleaning up contamination. In addition, we may be liable for the costs of investigating or remediating contamination at off-site waste facilities where we have arranged for the disposal, or treatment of hazardous substances, without regard to whether we complied with environmental laws in doing so.

Reducing greenhouse gas (GHG) emissions from steelmaking operations to meet corporate targets or comply with new regulations as well as stakeholder expectations and mitigate potential physical impacts of climate change could significantly increase costs to manufacture future materials or reduce the amount of materials being manufactured.

Iron and steel producers around the world are facing mounting pressure to reduce greenhouse gas emissions from operations. The majority of greenhouse gas emissions from the production of iron and steel are caused by the combustion of fossil fuels, the use of electrical energy, and the use of coal, lime, and iron ore as feedstock. The two main production processes are the integrated route of blast furnace ironmaking in combination with basic oxygen furnace steelmaking (BOF) and the alternative route of electric arc furnace steelmaking. Both routes generate greenhouse gas emissions with the latter process, involving the electric arc melting of a majority of steel scrap, generating less than half that of the traditional integrated steelmaking process.

Federal, state and local governmental agencies within the United States may introduce regulatory changes in response to the potential impacts of climate change, including the introduction of carbon emissions limitations or trading mechanisms, and changes in U.S. administration may result in new or significantly different regulations than those currently impacting or likely to impact the Company. Any such regulation regarding climate change and GHG emissions could impose significant costs on our operations and on the operations of our customers and suppliers, including increased energy, capital equipment, emissions controls, environmental monitoring and reporting and other costs in order to comply with current or future laws or regulations concerning climate change and GHG emissions. Any adopted future climate change and GHG regulations could negatively impact our ability, and that of our customers and suppliers, to compete with companies situated in areas not subject to or not complying with such limitations. Inconsistency of regulations may also change the attractiveness of the locations of some of the Company's assets and investments. In addition, changes in certain environmental regulations, including those that may impose output limitations or higher costs associated with climate change or greenhouse gas emissions, could substantially increase the cost of manufacturing and raw materials to us and other steel producers. For additional details, see "Part I – Item 1, Business – New and Emerging Environmental Regulations – United States and European Greenhouse Gas Emissions Regulations" above.

Additionally, the European Union has established aggressive CO_2 reduction targets of 40 percent by 2030, against a 1990 baseline, and full carbon neutrality by 2050. As part of the European Green Deal the Commission proposed in September 2020 to raise the 2030 reduction target to at least 55 percent compared to 1990. The new target has since been endorsed by the European Parliament. An emission trading system (ETS) was established to encourage compliance with set emissions reduction targets. These aggressive targets require drastic measures within the steel industry to comply. The transition to EAF technology, as well as incremental gains in energy reduction, use of renewable energy, hydrogen-based steelmaking and continued asset and process improvements are expected to reduce our GHG footprint. However, the development of breakthrough technologies is likely required to continue the path of low to no carbon footprint in the steel industry. Implementation of new technologies will most likely require significant amounts of capital and an abundant source of low-cost hydrogen and/or green power, most likely leading to an increase in the cost of future steelmaking. In addition, the cost of emission allowances is forecast to increase, along with the number of allowances decreasing in the next several years. The price of CO_2 emission allowances was 71 euro per metric ton as of December 31, 2024, and forecasts call for potential prices exceeding 100 euro per metric ton in future years.

Environmental, social and governance matters may impact our business and reputation.

In addition to the changing rules and regulations related to environmental, social and governance (ESG) matters imposed by governmental and self-regulatory organizations such as the SEC and the New York Stock Exchange, a variety of third-party organizations, institutional investors and customers evaluate the performance of companies on ESG topics, and the results of these assessments are widely publicized. These changing rules, regulations and stakeholder expectations have resulted in, and are likely to continue to result in, increased general and administrative expenses and increased management time and attention spent complying with or meeting such regulations and expectations. Reduced access to or increased cost of capital may occur as financial institutions and investors increase expectations related to ESG matters.

Developing and acting on initiatives within the scope of ESG, and collecting, measuring and reporting ESG-related information and metrics can be costly, difficult and time consuming and is subject to evolving reporting standards. We may also communicate certain initiatives and goals, regarding environmental matters, diversity, social investments and other ESG-related matters, in our SEC filings or in other public disclosures. These initiatives and goals within the scope of ESG could be difficult and expensive to implement, the technologies needed to implement them may not be cost effective and may not advance at a sufficient pace, and we could be criticized for the accuracy, adequacy or completeness of the disclosure. Furthermore, statements about our ESG-related initiatives and goals, and progress against those goals, may be based on standards for measuring progress that are still developing, internal controls and processes that continue to evolve and assumptions that are subject to change in the future. In addition, we could be criticized for the scope or nature of such initiatives or goals, or for any revisions to these goals. If our ESG-related data, processes and reporting are incomplete or inaccurate, or if we fail to achieve progress with respect to our goals, including our previously announced commitments to reduce greenhouse gas emissions, within the scope of ESG on a timely basis, or at all, our reputation, business, financial performance and growth could be adversely affected. In addition, in recent years “anti-ESG” sentiment has gained momentum across the U.S., with several states and Congress having proposed or enacted “anti-ESG” policies, legislation, or initiatives or issued related legal opinions, and the President having recently issued an executive order opposing diversity equity and inclusion (“DEI”) initiatives in the private sector. Such anti-ESG and anti-DEI-related policies, legislation, initiatives, litigation, legal opinions, and scrutiny could result in U. S. Steel facing additional compliance obligations, becoming the subject of investigations and enforcement actions, or sustaining reputational harm.

New and changing data privacy laws and cross-border transfer requirements could have a negative impact on our business and operations.

Our business depends on the processing and transfer of data between our affiliated entities, to and from our business partners, and with third-party service providers, and of our employees, which may be subject to data privacy laws and/or cross-border transfer restrictions. In North America and Europe, new legislation and changes to the requirements or applicability of existing laws, as well as evolving standards and judicial and regulatory interpretations of such laws, may impact U. S. Steel’s ability to effectively process and transfer data both within the United States and across borders in support of our business operations and/or keep pace with specific requirements regarding processing and safeguarding personal information. While U. S. Steel takes steps to comply with these legal requirements, non-compliance could lead to possible administrative, civil, or criminal liability, as well as reputational harm to the Company and its employees. The costs of compliance with privacy laws and the potential for fines and penalties in the event of a breach may have a negative impact on our business and operations.

Item 1B. UNRESOLVED STAFF COMMENTS

None.

Item 1C. CYBERSECURITY

Risk Management and Strategy

U. S. Steel maintains robust processes for identifying, assessing, and managing material risks from cybersecurity threats. U. S. Steel’s cybersecurity program is based on the National Institute of Standards and Technology (“NIST”) Cybersecurity Framework, and the risk of cybersecurity threats is integrated into the Company’s Enterprise Risk Management (“ERM”) program, led by the Chief Risk Officer. The ERM program includes an annual risk prioritization process to identify key enterprise risks. Each key risk is assigned risk owners to establish action plans and implement risk mitigation strategies. The cybersecurity threat risk action plan is managed at the enterprise level by the Senior Vice President – Business Development and President, USSE, the Vice President & Chief Information Officer (the “CIO”) and the Chief Information Security Officer (the “CISO”). Each quarter, the risk owners review and update the cybersecurity threat risk action plan to provide the status on specific risk mitigation actions and to identify new threats. U. S. Steel works closely with its internal and external auditors to assess, plan for, prevent and mitigate cybersecurity risks.

The Company maintains a Cybersecurity Incident Response Plan (CSIRP), which establishes an organizational framework and guidelines intended to facilitate an effective response and handling of cybersecurity incidents that could jeopardize the availability, integrity, or confidentiality of U. S. Steel’s assets. The CSIRP outlines roles and responsibilities, criteria for measuring the severity of a cybersecurity incident, and an escalation framework. The CSIRP also addresses senior management responsibility with respect to disclosure determinations related to a cybersecurity incident and provides for Audit Committee and Board briefings as appropriate. Along with the CSIRP, management sustains numerous programs and processes to stay

informed about and monitor the prevention, detection, mitigation and remediation of cybersecurity incidents. The list of cybersecurity programs and processes described below is not meant to be exhaustive, but to provide examples of such programs and processes.

The Company engages with third party cybersecurity specialists to provide an independent assessment of U. S. Steel's cybersecurity programs and to prepare a 5-year plan to maintain compliance and operational excellence. Management periodically reviews the 5-year plan and modifies it in response to changes in the threat landscape and otherwise as needed. Management employs in-depth defense mechanisms throughout the enterprise, including, but not limited to, employee training, vulnerability management, multi-factor authentication, cybersecurity insurance and table top exercises to mitigate and/or prevent cybersecurity incidents. The Company conducts security assessments of certain third party providers before and periodically throughout their engagement and has established procedures intended to mitigate risks related to security incidents originating from third parties. For example, management assesses the cybersecurity proficiency of potential third party cloud suppliers before utilizing their services. The assessment identifies cybersecurity-related risks and makes recommendations to enhance the security of new cloud computing services.

A cybersecurity incident may be detected in a number of ways, including, but not limited to, through automated reporting mechanisms, network and system indicators, intrusion detection systems, internal investigations, employee reports, law enforcement reports, or other third party notification. To oversee and identify cybersecurity threat risks on a day-to-day basis, including from third party service providers, the Company maintains a security operations center with round-the-clock monitoring, and the CIO receives regular reports on industry activity.

Upon receiving notification of a cybersecurity incident, the cybersecurity operations team acts to isolate and contain the threat. The CISO, along with the Chief Safety & Security Officer, will consult and determine the incident severity level, which determines whether the incident should be escalated. Critical and high severity incidents must be reported to the General Counsel. The Company may engage third party experts for assistance with crisis management, including forensic investigations, ransom negotiation, or crisis communication. During this process, the cybersecurity operations team will take steps to preserve evidence as soon as possible, including, but not limited to, memory dumps, log preservation and forensic hard drive collection. In addition, the General Counsel, in consultation with the CISO and others as necessary and appropriate, will promptly evaluate whether the incident requires legal notifications or disclosure, including whether the incident requires disclosure under the U. S. securities laws.

Following a cybersecurity incident, the General Counsel will direct the development of documentation regarding lessons learned in the response, including evaluation of preparedness capability, to continuously strengthen the cybersecurity posture of the Corporation.

Management has not identified risks from cybersecurity threats, including as a result of any previous cybersecurity incidents, that have materially affected or are reasonably likely to materially affect U. S. Steel, including its business strategy, results of operations or financial condition. See "Item 1A. Risk Factors, *A failure of our information technology infrastructure and cybersecurity threats may adversely affect our business operations.*" above for more information. While we continually work to safeguard the information systems we use, and the proprietary, confidential and personal information residing therein, and mitigate potential risks, there can be no assurance that such actions will be sufficient to prevent cybersecurity incidents or mitigate all potential risks to such systems, networks and data or those of our third party providers.

Governance

The Board of Directors is responsible for overseeing the assessment and management of enterprise-level risks that may impact U. S. Steel. The Audit Committee has primary responsibility for overseeing risk management, including oversight of risks from cybersecurity threats. Management, including the CIO and CISO, reports on cybersecurity matters regularly to the Board, primarily through the Audit Committee, including an annual report regarding specific risks and mitigation efforts within U. S. Steel and a 5-year cybersecurity threat assessment conducted by third party experts. Management provides benchmarking information and updates on key operational and compliance metrics to the Board. In addition, cybersecurity training is provided to the full Board of Directors, including training by third party experts, to educate directors on the current cybersecurity threat environment and measures companies can take to mitigate risk and impact of cyberattacks.

As described above, management is actively involved in assessing and managing U. S. Steel's material cybersecurity risks. The CIO and the CISO primarily lead these efforts. The CIO is responsible for the oversight of U. S. Steel's entire global IT operation, including the cybersecurity program, and holds a Bachelor of Science in operations research and industrial engineering and a Bachelor of Arts in economics from Cornell University, as well as a Master of Science in engineering and Master of Business Administration from Massachusetts Institute of Technology. The CIO's previous work experience includes holding the position of CIO at a $25 billion manufacturing conglomerate and a $7 billion energy company. The CISO reports directly to the CIO and has responsibility for leadership of U. S. Steel's global cybersecurity program. She holds a bachelor's degree in Information Systems Management, a master's degree in Internet Information Systems, and a doctorate in Instructional Management and Leadership. The CISO also completed the Chief Information Security Officer Certificate program at Carnegie Mellon University, where she now serves as a coach for the program, and holds a Certified Information Systems Security Professional (CISSP) certification.

She is an active member of the Greater Pittsburgh CISO Group and the Steel City OTSEC Information Sharing Group, and serves on the Editorial Review Board for two peer-reviewed journals (International Journal of Cyber Research and International Journal of Information and Communication Technology Education).

Item 2. PROPERTIES

See Item 1. Business, Facilities and Locations for listings of U. S. Steel's main properties, their locations and their products and services.

U. S. Steel and its predecessors have owned their properties for many years with no material adverse title claims asserted. In the case of Great Lakes Works, Granite City Works, the Midwest Plant and Keetac iron ore operations, U. S. Steel or its subsidiaries are the beneficiaries of bankruptcy laws and orders providing that properties are held free and clear of past liens and liabilities. In addition, U. S. Steel or its predecessors obtained title insurance, local counsel opinions or similar protections when significant properties were initially acquired or since acquisition.

At the Midwest Plant in Indiana, U. S. Steel has a supply agreement for various utility services with a company that owns a cogeneration facility located on U. S. Steel property. The Midwest Plant agreement expires in 2028.

U. S. Steel leases its headquarters office space in Pittsburgh, Pennsylvania.

For property, plant and equipment additions, including finance leases, see "Item 7. Management's Discussion and Analysis of Financial Condition and Results of Operations, Liquidity and Capital Resources" and Note 13 to the Consolidated Financial Statements.

Mining Properties

Summary Overview of Mining Operations

U. S. Steel operates two surface iron ore mining complexes in Minnesota consisting of the Minntac Mine and Pellet Plant and the Keetac Mine and Pellet Plant, which are wholly owned by the Company. As of December 31, 2024, U. S. Steel owns a minority interest in the iron ore mining assets of Hibbing Taconite Company.

The following table provides a summary of the net book value of the land and PP&E at the Minntac and Keetac mines as of December 31, 2024:

(in millions)	Gross Value	Accumulated Depreciation	Net Book Value
Minntac Mine and Pellet Plant			
Land	$ 35	$ —	$ 35
Other property, plant and equipment	1,780	1,359	421
Total	**$ 1,815**	**$ 1,359**	**$ 456**
Keetac Mine and Pellet Plant			
Land	$ 7	$ —	$ 7
Other property, plant and equipment	505	224	281
Total	**$ 512**	**$ 224**	**$ 288**

The following table provides a summary of our mineral production by mining complex for each reportable period:

Iron Ore Pellets	Production		
(Millions of short tons)	**2024**	**2023**	**2022**
Iron Ore Pellets			
Minntac Mine and Pellet Plant	**15.5**	15.5	15.1
Keetac Mine and Pellet Plant	**5.8**	5.5	5.9
Hibbing Taconite Company [(1)]	**0.9**	1.1	0.9
Total	**22.2**	22.1	21.9

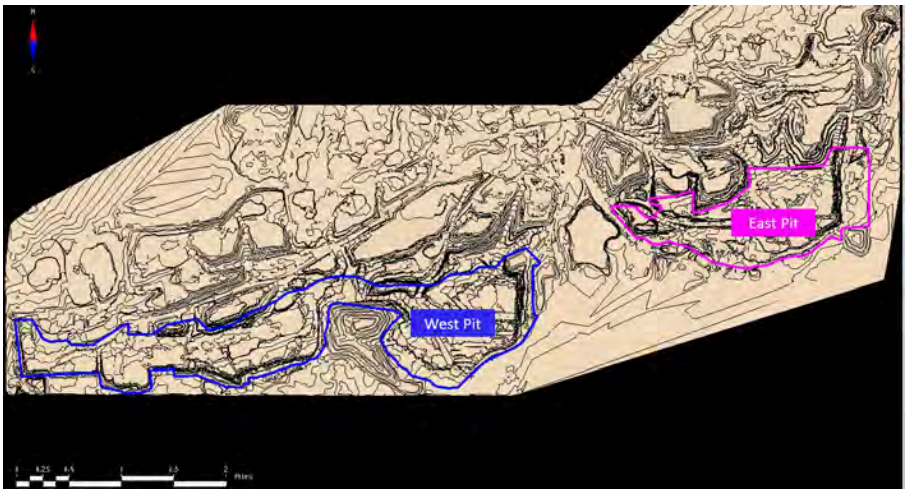
[(1)] Represents U. S. Steel's proportionate share of production as these investments are unconsolidated equity affiliates.

We engaged DRA Global and Barr Engineering Co. ("DRA") to provide feasibility studies and technical report summaries for our material mining operations at Minntac and Keetac in 2023. Indicated and inferred mineral resources and probable mineral reserve information for the Minntac and Keetac mines were updated based on those DRA estimations. Changes as a result of this study were due to improved resource and reserve estimation methodology. The majority shareholders of the Hibbing Taconite Company separately engaged qualified persons to perform the same procedures at the Hibbing Taconite Mine in 2024. Accordingly, the figures below for the Hibbing Taconite Mine were provided by the majority shareholders using the reports provided by the qualified persons. The tables showing resources and reserves by mining property were prepared using the results of the procedures performed by the qualified persons designated by each organization, which have no affiliation with or interest in our material mining properties.

Item 302 of Regulation S-K requires registrants to file the technical report summary as an exhibit to the Form 10-K filing when disclosing for the first time mineral reserves or resources or when there has been a material change in the mineral reserves or resources since the last technical report summary filed for the properties. The Company did not have material changes to its reserves or resources during 2024, nor is it disclosing mineral reserves or resources for the first time. Accordingly, the technical report summary is not filed as an exhibit with this Form 10-K.

Minntac Mine and Pellet Plant

The Minntac Mine and Pellet Plant is located in Mountain Iron, Minnesota and is wholly owned and operated by U. S. Steel. On April 30, 2020, the Company granted Stelco Inc. (Stelco), a subsidiary of Cleveland-Cliffs Inc., a purchase option to acquire a 25 percent interest in the Minntac mining operations. The option can be exercised at any time before January 31, 2027. For more information regarding the purchase option, please see Note 20 to the Consolidated Financial Statements. The Minntac Mine has 25,420 acres of surface rights. The surface mine is in the production stage whereby taconite iron ore is mined using the Truck-Shovel method. The mine is approximately 57 years old and has been operated by U. S. Steel since 1967. For discussions regarding encumbrances, violations, fines, etc. related to the Minntac Mine, see Item 3. Legal Proceedings.



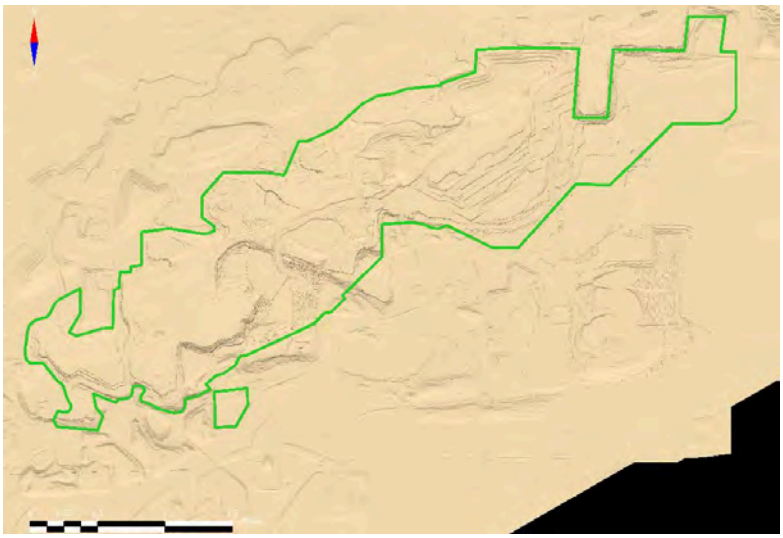
The following table provides details of our iron ore resources and reserves at Minntac as of December 31, 2024, and December 31, 2023. Resources below are stated exclusive of reserves.

Minntac Mine and Pellet Plant

	Amount			Grades/Qualities		Cut-off Grades		Metallurgical Recovery
(Millions of short tons)	Pellets 2024	Pellets 2023	Change (%)	MagFe%	Concentrate Silica %	Min MagFe %	Max Concentrate Silica %	Weight Recovery %
Measured mineral resources	—	—	— %	—	—	—	—	—
Indicated mineral resources	234.2	234.2	— %	18.19	5.82	14.00	9.99	26.98
Measured + indicated mineral resources	**234.2**	**234.2**	**— %**	**18.19**	**5.82**	**14.00**	**9.99**	**26.98**
Inferred mineral resources	96.7	96.7	— %	18.29	6.22	14.00	9.99	27.31
Proven mineral reserves	—	—	— %	—	—	—	—	—
Probable mineral reserves	265.0	280.5	(6)%	19.11	6.20	14.00	9.99	28.55
Total mineral reserves	**265.0**	**280.5**	**(6)%**	**19.11**	**6.20**	**14.00**	**9.99**	**28.55**

Keetac Mine and Pellet Plant

The Keetac Mine and Pellet Plant is located in Keewatin, Minnesota and is wholly owned and operated by U. S. Steel. The Keetac Mine has 18,020 acres of surface rights. The surface mine is in the production stage whereby taconite iron ore is mined using the Truck-Shovel method. The mine is approximately 57 years old and has been operated by U. S. Steel since 2003, when it was acquired as part of the Company's purchase of National Steel Corporation. For discussions regarding encumbrances, violations, fines, etc. related to the Keetac Mine, see Item 3. Legal Proceedings.



The following table provides details of our iron ore resources and reserves at Keetac as of December 31, 2024, and December 31, 2023. Resources below are stated exclusive of reserves.

Keetac Mine and Pellet Plant

	Amount					Grades/Qualities		Cut-off Grades		Metallurgical Recovery
(Millions of short tons)	DR Grade Pellets 2024	DR Grade Pellets 2023	Pellets 2024	Pellets 2023	Change (%)	MagFe%	Concentrate Silica %	Min MagFe %	Max Concentrate Silica %	Weight Recovery %
Measured mineral resources	—	—	—	—	— %	—	—	—	—	—
Indicated mineral resources	153.3	153.3	214.7	214.7	— %	18.88	3.45	14.00	9.99	27.31
Measured + indicated mineral resources	**153.3**	**153.3**	**214.7**	**214.7**	**— %**	**18.88**	**3.45**	**14.00**	**9.99**	**27.31**
Inferred mineral resources	108.9	108.9	163.2	163.2	— %	18.39	4.37	14.00	9.99	26.83
Proven mineral reserves	—	—	—	—	— %	—	—	—	—	—
Probable mineral reserves	125.9	126.4	175.3	180.6	(2)%	19.36	3.82	14.00	9.99	28.00
Total mineral reserves	**125.9**	**126.4**	**175.3**	**180.6**	**(2)%**	**19.36**	**3.82**	**14.00**	**9.99**	**28.00**

Hibbing Taconite Mine

U. S. Steel maintains a minority interest in the Hibbing Taconite Mine, which is majority-owned by Cleveland-Cliffs Inc. and located in Hibbing, Minnesota. The Hibbing Mine has 30,705 acres of surface rights, of which 1,150 acres are associated with mineral leases. The majority of the mineral rights are leased. The property is comprised of 7,417 acres of mineral leases expiring between 2025 and 2056. The taconite iron ore mine is currently in the production stage.

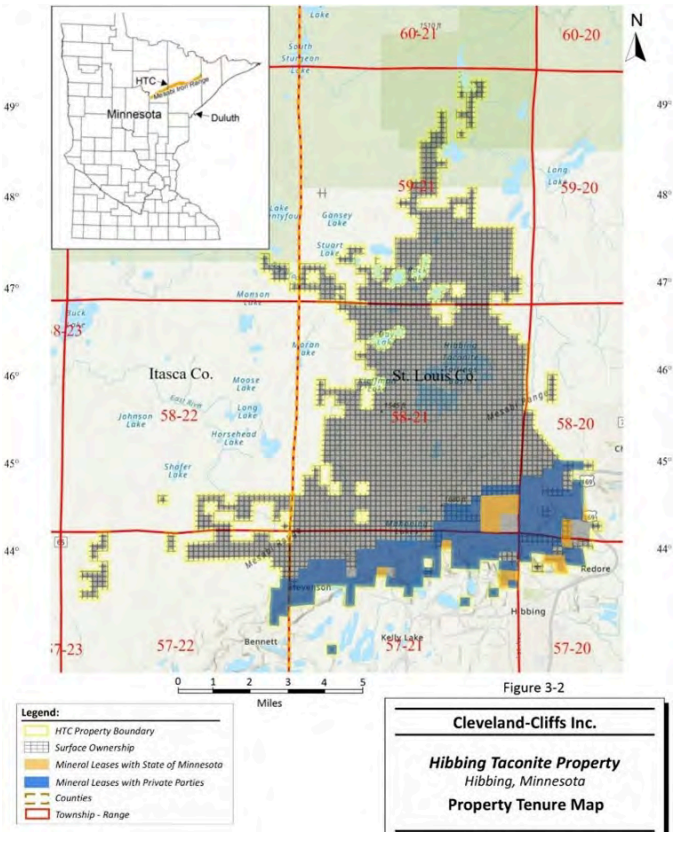


Figure 3-2

The following table provides details of our proportionate share of iron ore pellet resources and reserves at Hibbing as of December 31, 2024, and December 31, 2023. Resources below are stated exclusive of reserves.

Hibbing Taconite Company [1]

	Amount			Grades/Qualities
(Millions of short tons)	**Pellets 2024**	**Pellets 2023**	**Change (%)**	**MagFe%**
Measured mineral resources	0.4	0.4	— %	19.20
Indicated mineral resources	—	—	— %	18.70
Measured + indicated mineral resources	**0.4**	**0.4**	**— %**	**19.20**
Inferred mineral resources	—	—	— %	—
Proven mineral reserves	3.1	2.2	40.91 %	18.96
Probable mineral reserves	0.2	0.4	(50.00)%	18.96
Total mineral reserves	**3.3**	**2.6**	**26.92 %**	**18.96**

[1] Represents U. S. Steel's proportionate share of proven and probable reserves and production as these investments are unconsolidated equity affiliates.

Internal Controls

U. S. Steel estimates its iron ore resources and reserves using exploration drill holes, physical inspections, sampling, laboratory testing, 3-D computer models, economic pit analysis and fully-developed pit designs for its operating mines. Estimates for our share of unconsolidated equity affiliates are based upon information supplied by the joint ventures. Refer to sections 2 and 3 of the technical report summaries filed as Exhibit 96.1 to the 2023 Form 10-K for further details.

Item 3. LEGAL PROCEEDINGS

On January 6, 2025, the Company, NSC and Purchaser jointly filed lawsuits related to the Merger. A Petition for Review was filed in the United States Court of Appeals for the District of Columbia Circuit alleging that the President's order blocking the Merger was issued for purely political reasons, which are irrelevant to U.S. national security, challenging the decision by the President of the United States and the CFIUS process as violating the constitutional due process rights of the Company, NSC and Purchaser, as well as the applicable statute governing CFIUS and the Administrative Procedure Act, and as an exercise of power that exceeded the authority provided to the President of the United States under the applicable statute. The Petition names as respondents Joseph R. Biden, in his official capacity as President of the United States, CFIUS, Janet L. Yellen, in her official capacity as Secretary of the Treasury and Chairperson of CFIUS, and Merrick B. Garland, in his official capacity as United States Attorney General. The Petition asks the Court to set aside the unlawful CFIUS review process and the President's accompanying order, and to instruct CFIUS to conduct a new review of the Merger that is consistent with the petitioners' due process rights and its own statutory obligations. Also on January 6, 2025, the Company, NSC and Purchaser jointly filed a Complaint and motion for a preliminary injunction and for an expedited hearing in the United States District Court for the Western District of Pennsylvania against Cliffs, Cliffs' Chief Executive Officer Lourenco Goncalves, and the President of the USW, David McCall, for engaging in a coordinated series of anticompetitive and racketeering activities illegally designed to prevent any party other than Cliffs from acquiring the Company as part of an illegal campaign to monopolize critical domestic steel markets. This suit asserts antitrust claims under Sections 1 and 2 of the Sherman Act, violations of the Racketeer Influenced and Corrupt Organizations (RICO) Act, and tortious interference claims and seeks an injunction preventing Cliffs, Mr. Goncalves, and Mr. McCall from engaging in further collusive and anticompetitive behavior, and to impose substantial monetary damages for their conduct.

Following announcement of the Merger, the Company received eleven demand letters from putative stockholders (collectively, the "Demand Letters") alleging that the disclosures contained in the preliminary proxy statement, as amended, and/or the definitive proxy statement, in each case filed with the Securities and Exchange Commission in connection with a special meeting of stockholders to consider the Merger, were deficient and demanding that certain corrective disclosures be made. The Company believes that the Demand Letters are without merit; however solely in order to mitigate any risk of the Demand Letters delaying or otherwise adversely affecting the consummation of the Merger and to minimize any costs, risks, and uncertainties inherent in any potential litigation related thereto, and without admitting any liability or wrongdoing, voluntarily made supplemental disclosures on a Form 8-K.

General Litigation

On June 8, 2021, JSW Steel (USA) Inc. and JSW Steel USA Ohio, Inc. (collectively, JSW), U.S. based subsidiaries of Indian steelmaker JSW Steel, filed suit in the United States District Court for the Southern District of Texas against Nucor, U. S. Steel, AK Steel Holding Group and Cleveland-Cliffs Inc. (collectively, the JSW Defendants) alleging that the Defendants operated as a cartel and formed a conspiracy to boycott JSW from obtaining semi-finished steel slabs. JSW alleges that the JSW Defendants acted in violation of Section 1 of the Sherman Act and the Clayton Act (federal antitrust), and violation of the Texas Free Enterprise and Antitrust Act. JSW also alleges that the JSW Defendants formed a civil conspiracy in violation of Texas common law, and that the JSW Defendants tortiously interfered with JSW's business relationships. The basis for JSW's allegations relate to the JSW Defendants' participation in the DOC's Section 232 process, including the JSW Defendants' support of the enactment of the President's Section 232 proclamation, statements made by the JSW Defendants after the enactment of Section 232, and the JSW Defendants' participation in the Section 232 exclusion process. Plaintiffs seek monetary damages including $45 million for payment of Section 232 tariffs and unspecified amounts for financial penalties, termination fees and lost profits as well as other damages. U. S. Steel, along with the other JSW Defendants, filed a Motion to Dismiss the case on August 17, 2021. On February 17, 2022, the Court issued an opinion dismissing JSW's antitrust complaint with prejudice. JSW filed a timely notice of appeal with the United States Court of Appeals for the Fifth Circuit. The Fifth Circuit held oral argument on the appeal on February 6, 2023, and we are awaiting a ruling from the Court. The Company continues to vigorously defend the matter.

On December 24, 2018, U. S. Steel's Clairton Plant experienced a fire, affecting portions of the facility involved in desulfurization of the coke oven gas generated during the coking process. With the desulfurization process out of operation as a result of the fire, U. S. Steel was not able to certify compliance with Clairton Plant's Title V permit levels for sulfur emissions. U. S. Steel promptly notified ACHD (Allegheny County Health Department), which has regulatory jurisdiction for the Title V permit, and updated the ACHD regularly on efforts to mitigate any potential environmental impacts until the desulfurization process was returned to normal operations. Of the approximately 2,400 hours between the date of the fire and April 4, 2019, when the Company resumed desulfurization, there were ten intermittent hours where average SO_2 emissions exceeded the hourly NAAQS for SO_2 at the Allegheny County regional air quality monitors located in Liberty and North Braddock boroughs, which are near U. S. Steel's Mon Valley Works facilities. On April 29, 2019, PennEnvironment and Clean Air Council, both environmental, non-governmental organizations, filed a Complaint in Federal Court in the Western District of Pennsylvania. The ACHD was subsequently granted intervenor status. The parties entered into a Consent Decree that was authorized by the U.S. Department of Justice and U.S. EPA and subsequently approved by the Court on March 26, 2024 that resolved all claims in the suit. The Consent Decree required the Company to undertake operational improvements at Clairton Works, permanently idle Coke Battery #15, pay a $500,000 penalty to the ACHD, fund community-beneficial projects throughout the Mon Valley over a period of five years through contributions which total $4.5 million and pay counsel fees in the amount of $3.0 million. The Consent Decree also established a new H2S Coke Oven Gas standard for Clairton Works. Separately, a class action has been filed in the Court of Common Pleas of Allegheny County on behalf of approximately 123,000 persons who claim that the impacts from the fire created

a nuisance and seek damages for loss of use and enjoyment of properties. That action has been certified as a class action and the Company continues to vigorously defend against it.

Asbestos Litigation

See Note 26 to our Consolidated Financial Statements, Contingencies and Commitments for a description of our asbestos litigation.

ENVIRONMENTAL PROCEEDINGS

The following is a summary of the proceedings of U. S. Steel that were pending or contemplated as of December 31, 2024, under federal and state environmental laws, and which U. S. Steel reasonably believes may result in monetary sanctions of at least $1 million (the threshold chosen by U. S. Steel as permitted by Item 103 of Regulation S-K). Information about specific sites where U. S. Steel is or has been engaged in significant clean up or remediation activities is also summarized below. Except as described herein, it is not possible to accurately predict the ultimate outcome of these matters.

CERCLA Remediation Sites

Claims under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) have been raised with respect to the cleanup of various waste disposal and other sites. Under CERCLA, potentially responsible parties (each, a PRP) for a site include current owners and operators, past owners and operators at the time of disposal, persons who arranged for disposal of a hazardous substance at a site and persons who transported a hazardous substance to a site. CERCLA imposes strict and joint and several liabilities. Because of various factors, including the ambiguity of the regulations, the difficulty of identifying the responsible parties for any particular site, the complexity of determining the relative liability among them, the uncertainty as to the most desirable remediation techniques, and the amount of damages and cleanup costs and the time period during which such costs may be incurred, we are unable to reasonably estimate U. S. Steel's ultimate liabilities under CERCLA.

As of December 31, 2024, U. S. Steel has received information requests or been identified as a PRP at a total of four CERCLA sites, three of which have liabilities that have not been resolved. Based on currently available information, which is in many cases preliminary and incomplete, management believes that U. S. Steel's liability for CERCLA cleanup and remediation costs at one of the other sites will be over $5 million as described below.

Duluth Works

The former U. S. Steel Duluth Works site was placed on the National Priorities List under CERCLA in 1983 and on the State of Minnesota's Superfund list in 1984. Liability for environmental remediation at the site is governed by a Response Order by Consent executed with the MPCA in 1985 and a Record of Decision signed by MPCA in 1989. U. S. Steel has partnered with the Great Lakes National Program Office (GLNPO) of the U.S. EPA Region 5 to address contaminated sediments in the St. Louis River Estuary and several other operable units that could impact the estuary if not addressed. An amendment to the Project Agreement between U. S. Steel and GLNPO was executed during the second quarter of 2018 to recognize the initial costs associated with implementing the first two phases of the proposed remedial plan at the site.

Remediation contracts were issued by both U. S. Steel and GLNPO for the first phase of the remedial work at the site during the fourth quarter of 2020. U. S. Steel and GLNPO have completed the second phase of work at the site which extended through early 2022. The final phase of the remedial design has been defined and another amendment to the Project Agreement between U. S. Steel and GLNPO was executed in December 2021. Execution of this final phase is in progress and is expected to extend through mid-2025 for habitat restoration. U. S. Steel's portion of additional design, oversight costs, and implementation of all three phases of the preferred remedial alternative on the upland property and Estuary are currently estimated as of December 31, 2024, at approximately $6 million.

Resource Conservation Recovery Act and Other Remediation Sites

U. S. Steel may be liable for remediation costs under other environmental statutes, both federal and state, or where private parties are seeking to impose liability on U. S. Steel for remediation costs through discussions or litigation. There are nine such sites where remediation is being sought involving amounts in excess of $1 million. Based on currently available information, which is in many cases preliminary and incomplete, management believes that liability for cleanup and remediation costs in connection with four sites may involve remediation costs between $1 million and $5 million per site and five sites are estimated to, or could have, costs for remediation, investigation, restoration or compensation in excess of $5 million per site.

For more information on the status of remediation activities at U. S. Steel's significant sites, see the discussions below.

Gary Works

On October 23, 1998, the U.S. EPA issued a final Administrative Order on Consent (Order) addressing Corrective Action for Solid Waste Management Units (SWMU) throughout Gary Works. This Order requires U. S. Steel to perform an RCRA Facility

Investigation, a Corrective Measures Study and Corrective Measure Implementation. Evaluations are underway at six groundwater areas on the east side of the facility. A remedial groundwater treatment system has been operating at one of the six areas since 2021. An Interim Stabilization Measure work plan was approved by the U.S. EPA for a second area where installation and start-up of the remedial system was completed in 2023. Until the remaining Phase I work and Phase II field investigations are completed, it is not possible to assess what additional expenditures will be necessary for Corrective Action projects at Gary Works. In total, the accrued liability for Corrective Action projects is approximately $23 million as of December 31, 2024, based on our current estimate of known remaining costs.

Geneva Works

At U. S. Steel's former Geneva Works, liability for environmental remediation, including the closure of three hazardous waste impoundments and facility-wide corrective action, has been allocated between U. S. Steel and the current property owner pursuant to an agreement and a permit issued by the Utah Department of Environmental Quality (UDEQ). Having completed the investigation on a majority of the remaining areas identified in the permit, U. S. Steel had determined the most effective means to address the remaining impacted material was to manage those materials in a previously approved on-site Corrective Action Management Unit (CAMU). U. S. Steel awarded a contract for the implementation of the CAMU project during the fourth quarter of 2018. Construction, waste stabilization and placement, along with closure of the CAMU, were substantially completed in the fourth quarter of 2020. Work at the site is now focused on addressing groundwater impacts in discrete areas. U. S. Steel has an accrued liability of approximately $17 million as of December 31, 2024 for our estimated share of the remaining costs of remediation at the site.

USS-UPI LLC

In February 2020, U. S. Steel purchased the remaining 50 percent interest in USS-POSCO Industries, a former joint venture that is located in Pittsburg, California between subsidiaries of U. S. Steel and POSCO, now known as USS-UPI, LLC. Prior to formation of the joint venture, UPI's facilities were previously owned and operated solely by U. S. Steel, which assumed responsibility for the existing environmental conditions. U. S. Steel continues to monitor the impacts of the remedial plan implemented in 2016 to address groundwater impacts from trichloroethylene at SWMU 4. Work began in early 2024 to complete removal of hazardous materials and decommission the northwest portion of Building A (SWMU 4.1) and the 54" and 66" Pickle Lines. Additionally, evaluations continue for the SWMUs, known as the Northern Boundary Group, and it is likely that corrective measures will be required, but it is not possible at this time to define a scope or estimate costs for what may be required by the California Department of Toxic Substances Control. As such, there has been no material change in the status of the project during the year ended December 31, 2024. As of December 31, 2024, approximately $6 million has been accrued for ongoing remediation, environmental studies, investigations, and remedial monitoring. Significant additional costs associated with this site are possible and are referenced in Note 26 to the Consolidated Financial Statements "Contingencies and Commitments - Environmental Matters - Remediation Projects - Projects with Ongoing Study and Scope Development."

Fairfield Works

A consent decree was signed by U. S. Steel, the U.S. EPA and the U.S. Department of Justice and filed with the United States District Court for the Northern District of Alabama (United States of America v. USX Corporation) in December 1997. In accordance with the consent decree, U. S. Steel initiated a RCRA corrective action program at the Fairfield Works facility. The Alabama Department of Environmental Management (ADEM), with the approval of the U.S. EPA, assumed primary responsibility for regulation and oversight of the RCRA corrective action program at Fairfield Works. Corrective Measure Implementation Plans (CMIPs) have been submitted to and approved by ADEM for the last two areas on site where impacts to soil and sediments are required to be addressed. Plans are being finalized for contracting the work required under the CMIPs. U. S. Steel has an accrued liability of approximately $8 million at December 31, 2024 for the estimated remaining costs of remediation at the site.

South Works

On August 29, 2017, U. S. Steel was notified by the U.S. Coast Guard of a sheen on the water in the North Vessel Slip at our former South Works in Chicago, Illinois. U. S. Steel has been working with the Illinois Environmental Protection Agency (IEPA) under their voluntary Site Remediation Program since 1993 to evaluate the condition of the property including the North Vessel Slip. The result of this cooperative effort has been the issuance of a series of "No Further Remediation" (NFR) notices to U. S. Steel including one specific to the North Vessel Slip. Following the discovery of the sheen, U. S. Steel notified the IEPA of the changed condition and has since been working closely with the IEPA and the U.S. EPA to determine the source and extent of the sheen as well as options to address the issue. U. S. Steel has also filed a claim against an existing insurance policy at the site and is working closely with the insurers to address the issue. U. S. Steel has an accrued liability of approximately $1 million as of December 31, 2024. Significant additional costs associated with this site are possible and are referenced in Note 26 to the Consolidated Financial Statements "Contingencies and Commitments - Environmental Matters - Remediation Projects - Projects with Ongoing Study and Scope Development."

Air Related Matters

Granite City Works

In October 2015, Granite City Works received a Notice of Violation (NOV) from the IEPA alleging that U. S. Steel violated the emission limits for nitrogen oxides (NOx) and volatile organic compounds from the Basic Oxygen Furnace Electrostatic Precipitator Stack. In addition, the IEPA alleges that U. S. Steel exceeded its natural gas usage limit at its CoGeneration Boiler. U. S. Steel continues to negotiate resolution of the NOV with the IEPA.

Although discussions with the IEPA regarding the foregoing alleged violations are ongoing and the resolution of these matters is uncertain at this time, it is not anticipated that the result of those discussions will be material to U. S. Steel.

Minnesota Ore Operations

On February 6, 2013, the U.S. EPA published a Federal Implementation Plan (FIP) that applies to taconite facilities in Minnesota. The FIP establishes and requires emission limits and the use of low NOx reduction technology on indurating furnaces as Best Available Retrofit Technology (BART). While U. S. Steel installed low NOx burners on three furnaces at Minntac and is currently obligated to install low NOx burners on the two other furnaces at Minntac pursuant to existing agreements and permits, the rule would require the installation of a low NOx burner on the one furnace at Keetac for which U. S. Steel did not have an otherwise existing obligation. U. S. Steel estimates expenditures associated with the installation of low NOx burners of as much as $25 million to $30 million. In 2013, U. S. Steel filed a petition for administrative reconsideration to the U.S. EPA and a petition for judicial review of the 2013 FIP and denial of the Minnesota state implementation plan (SIP) to the Eighth Circuit. In April 2016, the U.S. EPA promulgated a revised FIP with the same substantive requirements for U. S. Steel. In June 2016, U. S. Steel filed a petition for administrative reconsideration of the 2016 FIP to the U.S. EPA and a petition for judicial review of the 2016 FIP before the Eighth Circuit Court of Appeals. While the proceedings regarding the petition for judicial review of the 2013 FIP remained stayed, oral arguments regarding the petition for judicial review of the 2016 FIP were heard by the Eighth Circuit Court of Appeals on November 15, 2017. Thus, both petitions for judicial review remain with the Eighth Circuit. On December 4, 2017, the U.S. EPA published a notification in the Federal Register in which the U.S. EPA denied U. S. Steel's administrative petitions for reconsideration and stay of the 2013 FIP and 2016 FIP. On February 1, 2018, U. S. Steel filed a petition for judicial review of the U.S. EPA's denial of the administrative petitions for reconsideration to the Eighth Circuit Court of Appeals. The U.S. EPA and U. S. Steel reached a settlement regarding the five indurating lines at Minntac. After proposing a revised FIP and responding to public comments, on March 2, 2021, the U.S. EPA promulgated a final revised FIP incorporating the conditions and limits for Minntac to which the parties agreed. U. S. Steel and the U.S. EPA reached a tentative settlement agreement to revise BART limits for Keetac. The proposed settlement agreement was subject to a 30-day public comment period as provided in the April 23, 2024 Federal Register. Per the terms of the proposed settlement agreement, the U.S. EPA will sign a proposed rule to revise the FIP consistent with the settlement agreement by April 23, 2025.

Mon Valley Works

On March 7, 2022, the Company received an enforcement order from the ACHD that includes a civil penalty demand for $1.8 million. In the Order, the ACHD alleges that the Company's Clairton plant is solely and entirely culpable for 153 alleged exceedances of the Pennsylvania hydrogen sulfide ambient air standard that are reported to have occurred during January 1, 2020 through March 1, 2022. On April 5, 2022, the Company appealed the Order and is vigorously defending the matter. On December 29, 2023, the Company received an enforcement order from the ACHD that includes a civil penalty demand for $2.2 million. In the Order, the ACHD alleges that the Company's Clairton plant was the cause for 159 alleged exceedances of the Pennsylvania hydrogen sulfide ambient air standard that are reported to have occurred from March 2, 2022 through November 30, 2023. The Company appealed the Order and consolidated the case with the Order from March 7, 2022. On September 27, 2024, the Company filed a Motion for Summary Judgment which is currently pending. Due to the ACHD not currently having a Hearing Officer, this matter is stayed.

On March 24, 2022, the Company received an enforcement order from the ACHD that includes a civil penalty demand for $4.6 million for alleged air permit violations occurring between January 1, 2020 through March 15, 2022 regarding the Company's Clairton plant's coke oven pushing emission control systems. The Company has appealed the Order. On February 26, 2024, the Company received an enforcement order from the ACHD that includes a civil penalty demand for $2.0 million for alleged air permit violations occurring from March 16, 2022 through December 31, 2023 regarding the Company's Clairton plant's coke oven pushing emission control systems. The Company has appealed the Order. The appeals of the 2022 and 2024 Orders have been consolidated. Due to the ACHD not currently having a Hearing Officer, this matter is stayed.

Item 4. MINE SAFETY DISCLOSURE

The information concerning mine safety violations and other regulatory matters required by Section 1503(a) of the Dodd-Frank Wall Street Reform and Consumer Protection Act and Item 104 of Regulation S-K is included in Exhibit 95 to this Form 10-K.

INFORMATION ABOUT OUR EXECUTIVE OFFICERS

The executive officers of U. S. Steel and their ages as of January 30, 2025, are as follows:

Name	Age	Title	Executive Officer Since
Daniel R. Brown	52	Senior Vice President - Advanced Technology Steelmaking & Chief Operating Officer, Big River Steel	February 1, 2022
James E. Bruno	59	Senior Vice President - Business Development and President, USSE	December 1, 2014
Scott D. Buckiso	57	Senior Vice President and Chief Manufacturing Officer North American Flat-Rolled	May 31, 2015
David B. Burritt	69	President & Chief Executive Officer	September 1, 2013
Jessica T. Graziano	51	Senior Vice President & Chief Financial Officer	August 8, 2022
Manpreet S. Grewal	45	Vice President, Controller & Chief Accounting Officer	March 30, 2020
Duane D. Holloway	52	Senior Vice President, General Counsel and Chief Ethics & Compliance Officer	April 16, 2018

Messrs. Brown, Bruno, Buckiso, Burritt, and Holloway have held responsible management or professional positions with U. S. Steel or its subsidiaries for more than the past five years. Prior to joining U. S. Steel in 2022, Ms. Graziano spent eight years with United Rentals, Inc., culminating in her position as Executive Vice President and Chief Financial Officer. Prior to her work with United Rentals, Ms. Graziano spent five years at Revlon, Inc. where she advanced through positions of increasing responsibility culminating in her being named Senior Vice President, Chief Accounting Officer and Corporate Controller. Prior to joining U. S. Steel in 2020, Mr. Grewal served as vice president, business finance, controller and chief accounting officer at Covanta since February 2017. Prior to Covanta, Mr. Grewal spent fourteen years at Johnson Controls Incorporated (formerly Tyco International) in increasingly responsible roles, including internal audit, accounting, controllership, and financial planning and analysis.

PART II

Item 5. MARKET FOR REGISTRANT'S COMMON EQUITY, RELATED STOCKHOLDER MATTERS AND ISSUER PURCHASES OF EQUITY SECURITIES

Common Stock Information

The principal market on which United States Steel Corporation (U. S. Steel) common stock is traded is the New York Stock Exchange, where the common stock trades under trading symbol "X". U. S. Steel common stock is also traded on the Chicago Stock Exchange under the symbol "X".

As of January 27, 2025, there were 9,505 registered holders of U. S. Steel common stock.

The Board of Directors currently intends to declare and pay dividends on shares of U. S. Steel common stock based on the financial condition and results of operations of U. S. Steel out of legally available funds and in accordance with the requirements set forth by applicable law. Quarterly dividends were declared by U. S. Steel in 2024 and 2023 in the amount of five cents per share.

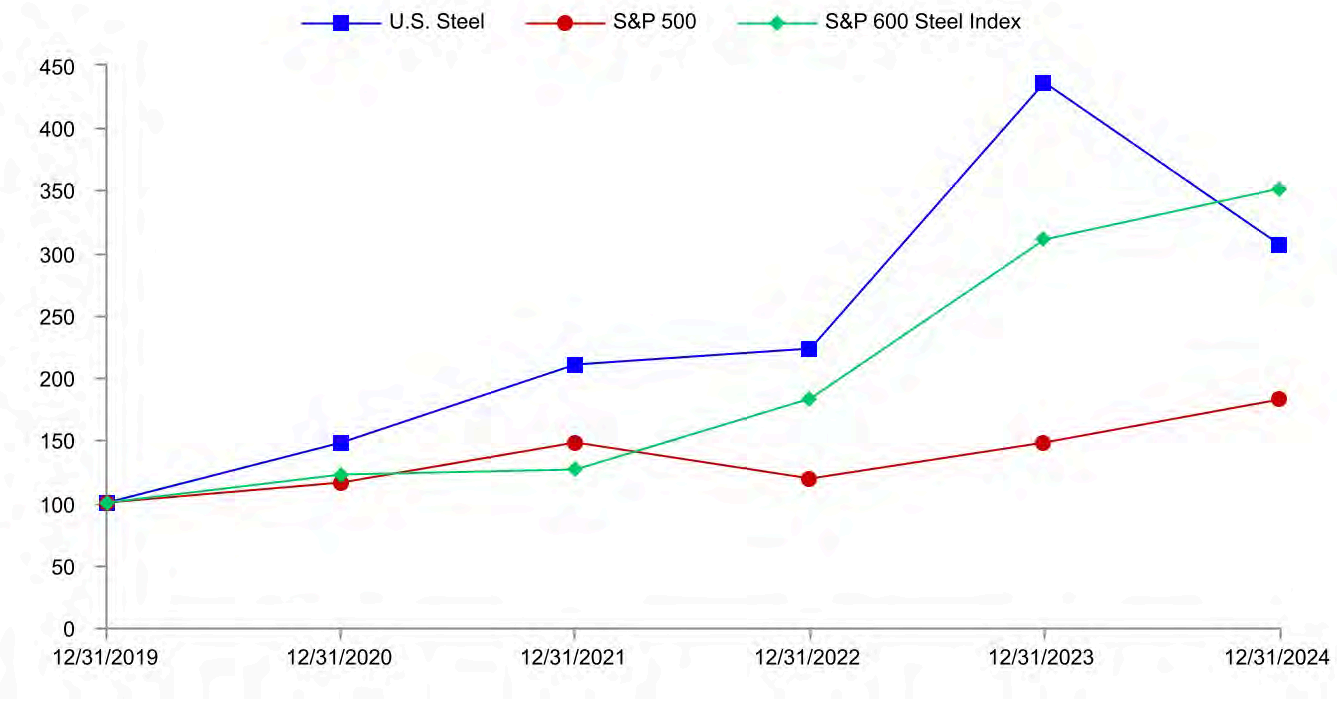
Purchases of Equity Securities by the Issuer and the Affiliated Purchasers

There were no share repurchases in fiscal 2024.

Stockholder Return Performance

The graph below assumes $100 invested on December 31, 2019, and compares the yearly change in cumulative total stockholder return of our common stock with the cumulative total return of the Standard & Poor's (S&P) 500 Stock Index and the S&P 600 Steel Index, and assumes that all dividends were reinvested. U. S. Steel is not included in either the S&P 500 Stock Index or S&P 600 Steel Index as to provide a clearer comparison to the selected indices.

Comparison of Cumulative Total Return
on $100 Invested in U. S. Steel Stock on December 31, 2019
vs
S&P 500 and S&P 600 Steel Index



For information on securities authorized for issuance under our equity compensation plans, see "Item 12. Security Ownership of Certain Beneficial Owners and Management and Related Stockholder Matters."

Unregistered Sales of Equity Securities

U. S. Steel had no sales of unregistered equity securities during the period covered by this report.

Item 6. RESERVED

Item 7. MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL CONDITION AND RESULTS OF OPERATIONS

The following discussion should be read in conjunction with the Consolidated Financial Statements and the related Notes that appear elsewhere in this document. Please refer to Item 7 of our 2023 Form 10-K for further discussion and analysis of our 2022 financial condition and results of operations.

Overview

Business Update

As previously disclosed, on December 18, 2023, the Company entered into the Merger Agreement by and among the Company, Purchaser, Merger Sub, and solely as provided in Section 9.13 therein, NSC. Pursuant to the Merger Agreement, and upon the

terms and subject to the conditions described therein, Merger Sub will merge with and into the Company, with the Company continuing as the surviving corporation and a wholly owned subsidiary of Purchaser (the "Merger").

The parties have substantially complied with the Second Requests issued on April 3, 2024 and the statutory waiting period under the Hart-Scott-Rodino Antitrust Improvements Act of 1976 has now expired. In addition, all required regulatory approvals outside of the United States related to the Merger have been received. The closing conditions to the Merger include clearance by the Committee on Foreign Investment in the United States ("CFIUS") under the Defense Production Act of 1950, as amended. Following referral of the transaction by CFIUS to the President of the United States, on January 3, 2025, the President of the United States issued an order prohibiting the Merger and requiring the parties to abandon the Merger Agreement within thirty days. On January 10, 2025, CFIUS granted an extension of that deadline to June 18, 2025.

On January 6, 2025, the Company, NSC and Purchaser jointly filed a lawsuit in the United States Court of Appeals for the District of Columbia Circuit alleging that the President's order blocking the Merger was issued for purely political reasons, which are irrelevant to U.S. national security, challenging the decision by the President of the United States and the CFIUS process as violating the constitutional due process rights of the Company, NSC and Purchaser, as well as the applicable statute governing CFIUS and the Administrative Procedure Act, and as an exercise of power that exceeded the authority provided to the President of the United States under the applicable statute. On the same day, the Company, NSC and Purchaser also filed a lawsuit in the United States District Court for the Western District of Pennsylvania against Cleveland-Cliffs Inc. ("Cliffs"), Cliffs' Chief Executive Officer Lourenco Goncalves, and the President of the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union (the "USW"), David McCall, for engaging in a coordinated series of anticompetitive and racketeering activities illegally designed to prevent any party other than Cliffs from acquiring the Company as part of an illegal campaign to monopolize critical domestic steel markets.

Segments Update

In 2024, the Company continued to execute on its strategy by investing in and completing its key strategic projects. U. S. Steel's results in 2024 decreased compared to the previous year for the four reportable segments due to the following factors:

- **North American Flat-Rolled:** Flat-Rolled results decreased primarily due to lower sales volume across most products and lower sales price across most products.
- **Mini Mill:** Mini Mill results decreased primarily due to lower sales volume across most products and lower sales price across all products.
- **U. S. Steel Europe:** USSE results decreased primarily due to lower sales volume across most products and lower sales price across all products.
- **Tubular:** Tubular results decreased primarily due to lower sales price.

Fluctuations in the market price of raw materials and other inflationary impacts have affected the results of each of our reportable segments, and fluctuations going-forward are reasonably likely to have a material impact on future results. We anticipate inflation related headwinds for certain raw materials and other costs, and sales prices and sales volumes may continue to have an adverse effect on our results.

Critical Accounting Estimates

Management's discussion and analysis of U. S. Steel's financial condition and results of operations is based upon U. S. Steel's financial statements, which have been prepared in accordance with accounting standards generally accepted in the United States (U.S. GAAP). The preparation of these financial statements requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities, the disclosure of contingent assets and liabilities at year-end and the reported amount of revenues and expenses during the year. Management regularly evaluates these estimates, including those related to employee benefits liabilities and assets held in trust relating to such liabilities; the carrying value of property, plant and equipment; intangible assets; valuation allowances for receivables, inventories and deferred income tax assets; liabilities for deferred income taxes; potential tax deficiencies; environmental obligations; potential litigation claims and settlements and put and call option assets and liabilities. Management's estimates are based on historical experience, current business and market conditions, and various other assumptions that are believed to be reasonable under the circumstances, the results of which form the basis for making judgments about the carrying values of assets and liabilities that are not readily apparent from other sources. Actual results may differ materially from current expectations under different assumptions or conditions.

Management believes that the following are the more significant judgments and estimates used in the preparation of the financial statements.

Goodwill and intangible assets – Goodwill represents the excess of the cost over the fair value of acquired identifiable tangible and intangible assets and liabilities assumed from businesses acquired. Goodwill and intangible assets deemed to have indefinite lives are not amortized, but are subject to impairment testing annually, or more frequently if events or changes in

circumstances indicate the asset might be impaired. We perform our annual goodwill impairment test as of October 1 and monitor for interim triggering events on an ongoing basis. Application of the goodwill impairment test requires judgment.

We review goodwill for impairment utilizing either a qualitative assessment or a quantitative goodwill impairment test. If we choose to perform a qualitative assessment and we determine that the fair value of the reporting unit more likely than not exceeds the carrying value, no further evaluation is necessary. For reporting units where we perform the quantitative goodwill impairment test, we compare the fair value of each reporting unit, which we primarily determine using an income approach based on the present value of discounted cash flows, to the respective carrying value, which includes goodwill. If the fair value of the reporting unit exceeds its carrying value, we do not consider the goodwill impaired. If the carrying value is higher than the fair value, we recognize the difference as an impairment loss.

A quantitative goodwill impairment testing process requires valuation of the respective reporting unit, which we primarily determine using an income approach based on a discounted cash flow forecast covering discrete periods of time including a terminal value. We compute the terminal value using the constant growth method, which values the forecasted cash flows in perpetuity. The assumptions about future cash flows and growth rates are based on the respective reporting unit's long-term forecast and are subject to review and approval by senior management. A reporting unit's discount rate is a significant assumption and is a risk-adjusted weighted average cost of capital, which we believe approximates the rate from a market participant's perspective. The estimated fair value could be impacted by changes in market conditions, interest rates, growth rates, tax rates, costs, pricing and capital expenditures. We categorize the fair value determination as Level 3 in the fair value hierarchy due to its use of internal projections and unobservable measurement inputs.

Our Mini Mill reporting unit holds the goodwill recognized as a result of the Company's acquisition of Big River Steel and currently is our only reporting unit that has a significant amount of goodwill. This goodwill is primarily attributable to Big River Steel's operational abilities, workforce and the anticipated benefits from their recent expansion. U. S. Steel completed its annual goodwill impairment test using a qualitative assessment during the fourth quarter of 2024 and determined there was no impairment of goodwill.

Intangible assets with indefinite lives are also subject to at least annual impairment testing, which compares the fair value of the intangible assets with their carrying amounts. U. S. Steel has determined that certain of its acquired intangible assets have indefinite useful lives. These assets are also reviewed for impairment annually in the fourth quarter and whenever events or circumstances indicate the carrying value may not be recoverable. U. S. Steel completed its annual evaluation of its indefinite-lived water rights using a qualitative assessment and determined there was no indication of impairment. Key assumptions included in this test relate to the relevant market rate of an acre foot of water.

If business conditions deteriorate or other factors have an adverse effect on our qualitative and quantitative estimates, inclusive of discounted future cash flows or assumed growth rates, or if we experience a sustained decline in our market capitalization, future assessments of goodwill for impairment may result in impairment charges.

Finite-lived intangible assets are amortized on a straight-line basis over their estimated useful lives and are tested for impairment when events occur that indicate that the net book value will not be recovered over future cash flows.

Business combinations – We account for business combinations under the acquisition method of accounting in accordance with Accounting Standards Codification (ASC) Topic 805, *Business Combinations,* which requires an allocation of the consideration we paid to the identifiable assets, intangible assets and liabilities based on the estimated fair values as of the closing date of the acquisition. The excess of the fair value of the purchase price over the fair values of these identifiable assets, intangible assets and liabilities is recorded as goodwill.

Purchased intangibles are initially recognized at fair value and amortized over their useful lives unless those lives are determined to be indefinite. The valuation of acquired assets will impact future operating results. The fair value of identifiable intangible assets is determined using an income approach on an individual asset basis. Specifically, we use the multi-period excess earnings method to estimate the fair value of the customer relationships intangible asset. Determining the fair value of the customer relationships intangible asset involves significant judgments and assumptions, including expected realized price, base year metallic costs, contributory asset charges, and customer attrition rate.

Inventories – Inventories are carried at the lower of cost or market for last-in, first-out (LIFO), moving average and first-in, first-out (FIFO) method inventories. The predominant method of inventory costing for Flat-Rolled and Tubular is LIFO. The Mini Mill segment uses FIFO for raw materials and a moving average costing method to account for semi-finished and finished products. FIFO is the predominant inventory costing method used by the USSE segment. The LIFO method of inventory costing was used on 53 percent of consolidated inventories at both December 31, 2024, and December 31, 2023. Since the LIFO inventory valuation methodology is an annual calculation, interim estimates of the annual LIFO valuation are required. We recognize the effects of the LIFO inventory valuation method on an interim basis by estimating the year-end inventory amounts. The projections of annual LIFO inventory amounts are updated quarterly. Changes in U.S. GAAP rules or tax law, such as the elimination of the LIFO method of accounting for inventories, could negatively affect our profitability and cash flow.

Pensions and Other Benefits – The recording of net periodic benefit costs for defined benefit pensions and Other Benefits is based on, among other things, assumptions of the expected annual return on plan assets, discount rate, mortality, escalation or other changes in retiree health care costs and plan participation levels. Changes in the assumptions or differences between actual and expected changes in the present value of liabilities or assets of U. S. Steel's plans could cause net periodic benefit costs to increase or decrease materially from year to year as discussed below.

U. S. Steel's investment strategy for its U.S. pension and Other Benefits plan assets provides for a diversified mix of high-quality bonds, public equities and selected smaller investments in private equities and private credit. For its U.S. pension, U. S. Steel has a target allocation for plan assets of 68 percent in fixed income investments. The balance is invested in equity securities, private equity and real estate partnerships. U. S. Steel believes that returns on equities over the long term will be higher than returns from fixed-income securities as actual historical returns from U. S. Steel's trusts have shown. Returns on bonds tend to offset some of the short-term volatility of stocks. Both equity and fixed-income investments are made across a broad range of industries and companies (both domestic and foreign) to provide protection against the impact of volatility in any single industry as well as company specific developments. U. S. Steel will use a 6.90 percent assumed rate of return on assets for the development of net periodic cost for the main defined benefit pension plan in 2025. Actual returns since the inception of the plan have exceeded this 6.90 percent rate and while recent annual returns have been volatile, it is U. S. Steel's expectation that rates will achieve this level in future periods.

For its Other Benefits plan, U. S. Steel is employing a liability driven investment strategy. The plan assets are allocated to match the plan cash flows with maturing investments. To achieve this strategy, U. S. Steel has a target allocation for plan assets of 78 percent in fixed income and private credit. The balance is primarily invested in equity securities, private equity and real estate partnerships. U. S. Steel will use a 6.00 percent assumed rate of return on assets for the development of net periodic cost for its Other Benefits plan for 2025.

The expected long-term rate of return on plan assets is applied to the market value of assets as of the beginning of the period less expected benefit payments and considering any planned contributions.

To determine the discount rate used to measure our pension and Other Benefit obligations for U.S. plans we utilize a bond matching approach to select specific bonds that would satisfy our projected benefit payments. At December 31, 2024, the weighted average discount rate used for our pension and Other Benefit obligations was determined to be 5.90 percent and 5.90 percent, respectively, compared to the weighted average discount rate used of 5.49 percent and 5.58 percent, respectively, at December 31, 2023. The discount rate reflects the current rate at which we estimate the pension and Other Benefits liabilities could be effectively settled at the measurement date.

U. S. Steel reviews its actual historical rate experience and expectations of future health care cost trends to determine the escalation of per capita health care costs under U. S. Steel's benefit plans. Approximately 85 percent of our costs for the domestic United Steelworkers participants' retiree health benefits in the Company's main domestic benefit plan are limited to a per capita dollar maximum calculation based on 2006 base year actual costs incurred under the main U. S. Steel benefit plan for USW participants (cost cap). The full effect of the cost cap is expected to be realized around 2031. After 2031, the Company's costs for a majority of USW retirees and their dependents are expected to remain fixed and as a result, the cost impact of health care escalation for the Company is projected to be limited for this group (see Note 18 to the Consolidated Financial Statements). For measurement of its domestic retiree medical plans where health care cost escalation is applicable, U. S. Steel has assumed an initial escalation rate of 5.80 percent for 2025. This rate is assumed to decrease gradually to an ultimate rate of 4.50 percent in 2038 and remain at that level thereafter.

Net periodic pension benefit cost (credit), including multiemployer plans, is expected to total approximately $139 million in 2025 compared to $82 million in 2024. The increase in net periodic pension benefit cost in 2025 is primarily due to a decrease in expected asset return and an increase in amortized actuarial losses. Net periodic other benefit (credit) in 2025 is expected to be approximately $(44) million, compared to $(102) million in 2024. The expected decrease in the 2025 net periodic other benefit (credit) is primarily due to decreases in prior service credits and amortized actuarial gains. See Note 18 to the Consolidated Financial Statements, "Pensions and Other Benefits."

The table below projects the incremental effect of a hypothetical one percentage point change in significant assumptions used in determining the funded status and net periodic benefit cost for pension and other benefits:

	Hypothetical Rate Change Increase (Decrease)	
(In millions)	**1%**	**(1)%**
Expected return on plan assets		
Incremental (decrease) increase in:		
Net periodic pension and other benefits costs for 2025	$ (49)	$ 49
Discount rate		
Incremental (decrease) increase in:		
Net periodic pension and other benefits costs for 2025	$ (24)	$ (1)
Pension & other benefits obligations at December 31, 2024	$ (344)	$ 400

Changes in the assumptions for expected annual return on plan assets and the discount rate used for accounting purposes do not impact the funding calculations used to derive minimum funding requirements for the pension plan. However, the discount rate required for minimum funding purposes is also based on corporate bond related indices and as such, the same general sensitivity concepts as above can be applied to increases or decreases to the funding obligations of the plans assuming the same hypothetical rate changes. See Note 18 to the Consolidated Financial Statements for a discussion regarding legislation enacted in March of 2021 that impacts the discount rate used for funding purposes. For further cash flow discussion see “Item 7. Management’s Discussion and Analysis of Financial Condition and Results of Operations, Liquidity and Capital Resources.”

Long-lived assets – U. S. Steel evaluates long-lived assets, primarily property, plant and equipment for impairment whenever changes in circumstances indicate that the carrying amounts of those productive assets exceed their recoverable amount as determined by the asset group’s projected undiscounted cash flows. We evaluate long-lived assets for potential impairment at the asset group level. Our primary asset groups are flat-rolled, mini mill, USSE, welded tubular and seamless tubular.

In 2024, the Company recognized impairment charges of approximately $19 million for certain indefinitely idled assets at Granite City Works and certain permanently idled assets at Clairton Works. In 2023, the Company recognized charges of approximately $123 million for impairment of indefinitely idled iron and steel making assets at Granite City Works. Impairment charges of approximately $151 million were recognized for the write-off of iron making and steel making assets at Great Lakes Works in 2022. The coil finishing processes at Granite City Works and Great Lakes Works continue to operate and remain components of the Company’s operating plans. These impairment charges were the result of actions impacting specific, identifiable assets and were not significantly adverse to the flat-rolled long-lived asset group. No triggering events that required an impairment evaluation of our long-lived asset groups were identified during the years ended December 31, 2024, 2023 and 2022.

Taxes – U. S. Steel records a valuation allowance, related to certain state and foreign net operating losses, state and foreign tax credits and unused capital losses, to reduce deferred tax assets to the amount that is more likely than not to be realized. A valuation allowance is recorded if, based on the weight of all available positive and negative evidence, it is more likely than not that some portion, or all, of a deferred tax asset will not be realized. Each quarter U. S. Steel analyzes the likelihood that our deferred tax assets will be realized. In the future, if we determine that it is more likely than not that we will be able to realize all or a portion of our deferred tax assets, the valuation allowance will be reduced, and we will record a non-cash net benefit to earnings.

At the end of both 2024 and 2023, U. S. Steel did not have any undistributed foreign earnings and profits for which U.S. deferred taxes have not been provided.

For further information on income taxes see Note 11 to the Consolidated Financial Statements.

Environmental remediation – U. S. Steel has been identified as a PRP at four sites under the CERCLA as of December 31, 2024. Of these, there are three sites where information requests have been received or there are other indications that U. S. Steel may be a PRP under CERCLA, but where sufficient information is not presently available to confirm the existence of liability or to make a reasonable estimate with respect to any potential liabilities. There are also nine additional sites where U. S. Steel may be liable for remediation costs in excess of $1 million under other environmental statutes, both federal and state, or where private parties are seeking to impose liability on U. S. Steel for remediation costs through discussions or litigation. At many of these sites, U. S. Steel is one of a number of parties involved and the total cost of remediation, as well as U. S. Steel’s share, is frequently dependent upon the outcome of ongoing investigations and remedial studies. U. S. Steel accrues for environmental remediation activities when the responsibility to remediate is probable and the amount of associated costs is reasonably determinable. As environmental remediation matters proceed toward ultimate resolution or as remediation obligations arise, charges in excess of those previously accrued may be required.

U. S. Steel's accrual for environmental liabilities for U.S. and international facilities as of December 31, 2024, and 2023 was $108 million and $107 million, respectively. These amounts exclude liabilities related to asset retirement obligations, disclosed in Note 19 to the Consolidated Financial Statements.

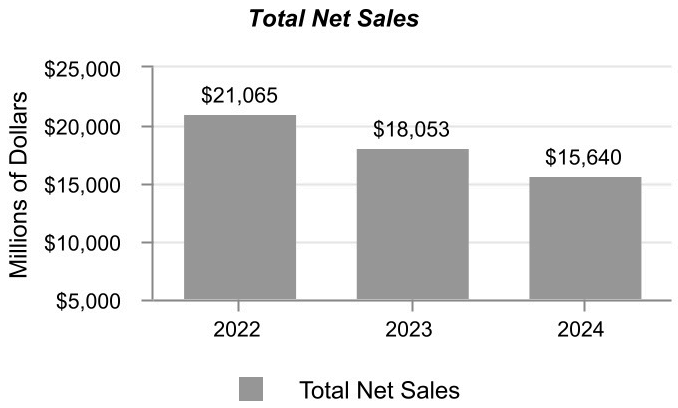
U. S. Steel is the subject of, or a party to, a number of pending or threatened legal actions, contingencies and commitments involving a variety of matters, including laws and regulations relating to the environment. The ultimate resolution of these contingencies could, individually or in the aggregate, be material to the Consolidated Financial Statements.

For discussion of relevant environmental items, see "Part I. Item 3. Legal Proceedings—Environmental Proceedings."

Segments

U. S. Steel has four reportable segments: North American Flat-Rolled, Mini Mill, USSE and Tubular Products. For further description of segment operations and information see Item 1. Business—Segments and Note 4 to the Consolidated Financial Statements, respectively.

Net Sales



Net Sales by Segment

Net sales by segment for the years ended December 31, 2024, and 2023 are set forth in the following table:

(Dollars in millions, excluding intersegment sales)	Years Ended December 31, 2024	2023	% Change
Flat-Rolled	**$ 9,604**	$ 10,744	(11)%
Mini Mill	**2,070**	2,223	(7)%
USSE	**2,983**	3,525	(15)%
Tubular	**970**	1,551	(37)%
Total sales from reportable segments	**15,627**	18,043	(13)%
Other	**13**	10	30 %
Net Sales	**$ 15,640**	$ 18,053	(13)%

Management's analysis of the percentage change in net sales for U. S. Steel's reportable business segments is set forth in the following table:

Year Ended December 31, 2024 versus Year Ended December 31, 2023	Steel Products[a] Volume	Price	Mix	FX[b]	Other[C]	Net Change
Flat-Rolled	(8)%	(2)%	— %	— %	(1)%	(11)%
Mini Mill	(5)%	(3)%	1 %	— %	— %	(7)%
USSE	(8)%	(7)%	— %	— %	— %	(15)%
Tubular	— %	(30)%	(7)%	— %	— %	(37)%

[a] Excludes intersegment sales.

[b] Foreign currency translation effects.

[c] Primarily consists of sales of raw material and coke making by-products.

Net sales for the year ended December 31, 2024, compared to the same period in 2023 were $15,640 million and $18,053 million, respectively.

- For the Flat-Rolled segment, the decrease in sales primarily resulted from decreased shipments (861 thousand tons) across most products and lower average realized prices ($17 per ton) across most products.
- For the Mini Mill segment, the decrease in sales primarily resulted from decreased shipments (117 thousand tons) from lower value products and lower average realized prices ($18 per ton) across all products.
- For the USSE segment, the decrease in sales primarily resulted from decreased shipments (321 thousand tons) across most products and lower average realized prices ($69 per ton) across all products.
- For the Tubular segment, the decrease in sales primarily resulted from lower average realized prices ($1,232 per ton) and mix changes to lower value products.

Operating Expenses

Union profit-sharing costs

(Dollars in millions)	Year Ended December 31, 2024	2023
Allocated to segment results	$ 57	$ 149

The amounts above represent profit-sharing amounts paid to active USW-represented employees and are included in cost of sales on the Consolidated Statements of Operations.

Profit-based amounts are calculated and paid on a quarterly basis as a percentage of consolidated earnings before interest and income taxes based on 7.5 percent of profit between $10 and $50 per ton and 15 percent of profit above $50 per ton.

Net periodic pension and other benefits costs

Pension and other benefit costs (other than service cost) are reflected within net interest and other financial (benefits) costs and the service cost component is reflected within cost of sales in the Consolidated Statements of Operations.

Defined benefit and multiemployer pension plan costs included in cost of sales totaled $108 million in 2024 and $116 million in 2023.

Other benefit service cost included in cost of sales totaled $4 million in 2024 and $6 million in 2023.

Costs related to defined contribution plans totaled $48 million in 2024 and $50 million in 2023.

Selling, general and administrative expenses

Selling, general and administrative expenses were $435 million and $501 million for the years ended December 31, 2024, and December 31, 2023, respectively. The change between periods was primarily due to decreased costs related to pension and OPEB benefits and variable compensation.

Operating configuration adjustments

The Company adjusts its operating configuration in response to changes in market conditions, global overcapacity, import competition arising from unfair trade practices, and changes in customer demand. These operating configuration adjustments can include indefinitely and temporarily idling certain of its facilities as well as restarting production at certain of its facilities.

Idled Operations

In December 2024, the Company temporarily idled Blast Furnace #3 at USSE until demand improves. It is expected that Blast Furnace #3 will be restarted in the first quarter of 2025 based on market conditions.

In 2023, the Company indefinitely idled its subsidiary in Pittsburg, California, USS-UPI, LLC (UPI), resulting in restructuring and other charges of $3 million and $30 million in 2023 and 2022, respectively. Also, in 2023, the Company indefinitely idled the iron and steel making assets at Granite City Works which resulted in a non-cash asset impairment of $123 million and additional charges of $107 million primarily for take-or-pay commitments and employee-related costs. The hot-strip mill, cold mill and coating lines at Granite City Works continue to operate.

In 2023, the Company completed the previously announced permanent shutdown of coke batteries numbers 1 through 3 at the Mon Valley Works.

In 2022, U. S. Steel indefinitely idled the majority of the tin mill operations at Gary Works. This included the Tin Line #5 and the Tin Line #6. As of December 31, 2024, the carrying value of the indefinitely idled tin mill operations assets at Gary Works is $65 million. Tin mill operations continue to operate at the Midwest plant.

At Great Lakes Works, the Company permanently idled the ironmaking operations in 2022, which resulted in non-cash impairment of $151 million. The coil finishing process at Great Lakes Works continues to operate and remains a component of the Company's operating plans.

The Company's Lorain Tubular Operations, Lone Star Tubular Operations and the Wheeling Machine Products coupling production facility at Hughes Springs, Texas were initially idled in 2020 and remained indefinitely idled as of December 31, 2024. The carrying value of the Lorain Tubular Operations assets is $50 million as of December 31, 2024.

Depreciation, depletion and amortization

Depreciation, depletion and amortization expenses were $913 million in 2024 and $916 million in 2023.

Earnings from investees

Earnings from investees were $112 million in 2024 compared to $115 million in 2023. The decrease in 2024 from the prior year is primarily due to decreased earnings from Hibbing Development Company and Patriot Premium Threading Services, partially offset by our PRO-TEC joint venture.

Restructuring and other charges

During 2024, the Company recorded restructuring and other charges of $8 million, which related primarily to idling of certain coke-making facilities. Charges for restructuring and ongoing cost reduction initiatives are recorded in the period U. S. Steel commits to a restructuring or cost reduction plan, or executes specific actions contemplated by the plan and all criteria for liability recognition have been met. Charges related to restructuring and cost reductions are reported in Restructuring and other charges in the Consolidated Statements of Operations.

Earnings (loss) before interest, taxes, depreciation and amortization by segment

Segment performance is measured primarily on the basis of segment level earnings (loss) before interest, taxes, depreciation and amortization (EBITDA). EBITDA for reportable segments and the Other category does not include net interest and other financial costs (income), income taxes, and certain other items that management believes are not indicative of future results.

Earnings (loss) before interest, taxes, depreciation and amortization by segment [(a)]	Year Ended December 31,	
(Dollars in Millions)	**2024**	**2023**
Flat-Rolled	**$ 934**	$ 1,023
Mini Mill	**233**	383
USSE	**71**	98
Tubular	**135**	638
Other loss before interest, taxes, depreciation and amortization	**(7)**	(3)
Depreciation, depletion and amortization	**(913)**	(916)
Segment earnings before interest and income taxes	**453**	1,223
Other items not allocated to segments:		
Restructuring and other charges [(b)]	**(8)**	(36)
Stock-based compensation expense	**(51)**	(51)
Asset impairment charges [(c)]	**(19)**	(127)
Environmental remediation charges	**(18)**	(11)
Strategic alternatives review process costs	**(90)**	(79)
Granite City idling costs	**(11)**	(121)
Other charges, net	**(16)**	1
Total earnings before interest and income taxes	**$ 240**	$ 799

[(a)] See Note 4 to the Consolidated Financial Statements for reconciliations and other details.

[(b)] Included in restructuring and other charges on the Consolidated Statements of Operations. See Note 25 to the Consolidated Financial Statements for further details.

[(c)] See Note 1 to the Consolidated Financial Statements for further details.

Segment results for Flat-Rolled

	Year Ended December 31,		%
(Dollars in Millions)	**2024**	**2023**	**Change**
Earnings before interest, taxes, depreciation and amortization (EBITDA)	**$ 934**	$ 1,023	(9)%
Depreciation, depletion and amortization	**535**	605	(12)%
Earnings before interest and income taxes	**$ 399**	$ 418	(5)%
Gross margin	**11 %**	11 %	— %
Raw steel production (mnt)	**8,389**	9,399	(11)%
Capability utilization	**63 %**	71 %	(8)%
Steel shipments (mnt)	**7,845**	8,706	(10)%
Average realized steel price per ton	**1,013**	1,030	(2)%

The decrease in Flat-Rolled EBITDA for 2024 compared to 2023 was primarily due to:

- lower average realized prices, including mix (approximately $50 million)
- decreased shipments (approximately $220 million)
- lower other sales (approximately $70 million)
- higher operating costs (approximately $110 million),

these changes were partially offset by:

- lower raw material costs, including inventory revaluations (approximately $90 million)
- lower energy costs (approximately $105 million)
- favorable equity affiliate income (approximately $70 million)
- lower other costs, primarily profit-based payments (approximately $95 million).

Gross margin for 2024 as compared to 2023 was unchanged.

Segment results for Mini Mill

(Dollars in Millions)	Year Ended December 31, 2024	2023	% Change
Earnings before interest, taxes, depreciation and amortization (EBITDA)	**$ 233**	$ 383	(39)%
Depreciation, depletion and amortization	**203**	168	21 %
Earnings before interest and income taxes	**$ 30**	$ 215	(86)%
Gross margin	**17 %**	19 %	(2)%
Raw steel production (mnt)	**2,838**	2,953	(4)%
Capability utilization	**80 %**	89 %	(9)%
Steel shipments (mnt)	**2,307**	2,424	(5)%
Average realized steel price per ton	**857**	875	(2)%

The decrease in Mini Mill EBITDA results for 2024 compared to 2023 was primarily due to:
- lower average realized prices, including mix (approximately $55 million)
- decreased shipments (approximately $140 million)
- higher other costs, primarily strategic projects startup costs (approximately $105 million),

these changes were partially offset by:
- lower raw material costs (approximately $150 million).

Gross margin for 2024 as compared to 2023 decreased primarily due to lower sales volume and price.

Segment results for USSE

(Dollars in Millions)	Year Ended December 31, 2024	2023	% Change
Earnings before interest, taxes, depreciation and amortization (EBITDA)	**$ 71**	$ 98	(28)%
Depreciation, depletion and amortization	**125**	94	33 %
(Loss) earnings before interest and income taxes	**$ (54)**	$ 4	(1,450)%
Gross margin	**4 %**	4 %	— %
Raw steel production (mnt)	**3,832**	4,395	(13)%
Capability utilization	**77 %**	88 %	(11)%
Steel shipments (mnt)	**3,578**	3,899	(8)%
Average realized steel price per ton	**805**	873	(8)%

The decrease in USSE EBITDA results for 2024 compared to 2023 was primarily due to:
- lower average realized prices, including mix (approximately $220 million)
- decreased shipments, including volume inefficiencies (approximately $70 million)
- lower other sales (approximately $5 million)
- higher operating costs (approximately $40 million),

these changes were partially offset by:
- lower raw material costs, including inventory revaluations and CO_2 accrual adjustments (approximately $215 million)
- lower energy costs (approximately $85 million)
- lower other costs (approximately $5 million)
- strengthening of the U.S. dollar versus the Euro (approximately $5 million).

Gross margin for 2024 as compared to 2023 was unchanged.

Segment results for Tubular

(Dollars in Millions)	Year ended December 31, 2024	2023	% Change
Earnings before interest, taxes, depreciation and amortization (EBITDA)	**$ 135**	$ 638	(79)%
Depreciation, depletion and amortization	**50**	49	2 %
Earnings before interest and income taxes	**$ 85**	$ 589	(86)%
Gross margin	**14 %**	40 %	(26)%
Raw steel production (mnt)	**575**	568	1 %
Capability utilization	**64 %**	63 %	1 %
Steel shipments (mnt)	**476**	478	— %
Average realized steel price per ton	**1,905**	3,137	(39)%

The decrease in Tubular EBITDA results for 2024 compared to 2023 was primarily due to:

- lower average realized prices (approximately $520 million)
- decreased shipments (approximately $35 million),

these changes were partially offset by:

- lower raw material costs (approximately $20 million)
- lower other costs, primarily variable compensation (approximately $30 million).

Gross margin for 2024 as compared to 2023 decreased primarily as a result of lower average realized prices.

Results for Other

The Other category had a loss before interest, taxes, depreciation and amortization of $7 million for the year ended December 31, 2024, compared to a loss before interest, taxes, depreciation and amortization of $3 million for the year ended December 31, 2023.

Net Interest and Other Financial Costs

(Dollars in millions)	Year Ended December 31, 2024	2023
Interest expense	**24**	72
Interest income	**(96)**	(141)
Loss on debt extinguishment	**2**	—
Other financial costs	**29**	18
Net periodic benefit income	**(132)**	(154)
Net gain from investments related to active employee benefits	**(25)**	(43)
Net interest and other financial benefits	**$ (198)**	$ (248)

Net interest and other financial benefits declined in 2024 compared to 2023 primarily due to reduced net periodic benefit income from increases in actuarial losses, reduced investment gains related to active employee benefits from lower 2024 asset performance, and decreased interest income from a lower cash balance. These were partially offset by lower interest expense as a result of increased capitalized interest. For additional information on U. S. Steel indebtedness see Note 17 to the Consolidated Financial Statements.

For additional information on U. S. Steel's foreign currency exchange activity see Note 16 to the Consolidated Financial Statements and Item 7A. "Quantitative and Qualitative Disclosures about Market Risk – Foreign Currency Exchange Rate Risk."

Income Tax

The income tax expense for the year ended December 31, 2024, was $54 million compared to an income tax expense of $152 million in 2023. The change from the prior year period was primarily due to a decrease in earnings before taxes. In addition, the current year period includes a benefit of $59 million related to the 2023 federal and state income tax returns.

For further information on income taxes see Note 11 to the Consolidated Financial Statements.

Net earnings attributable to U. S. Steel

Net earnings attributable to U. S. Steel in 2024 were $384 million compared to net earnings of $895 million in 2023. The decrease was primarily attributable to the factors discussed above.

Liquidity and Capital Resources

Cash Flows and Capital Requirements

Net Cash Provided by Operating Activities

Net cash provided by operating activities was $919 million in 2024 compared to $2,100 million in 2023. The decrease in 2024 compared to 2023 was primarily due to lower net earnings and changes in working capital. Changes in working capital can vary significantly depending on factors such as the timing of inventory production and purchases, which is affected by the length of our business cycles as well as our captive raw materials position, customer payments of accounts receivable and payments to vendors in the regular course of business.

Our cash conversion cycle increased by 7 days in the fourth quarter of 2024 from the fourth quarter of 2023 as shown below:

Cash Conversion Cycle	2024		2023	
	$ millions	Days	$ millions	Days
Accounts receivable, net [a]	$ 1,398	40	$ 1,549	34
+ Inventories [b]	$ 2,168	58	$ 2,128	53
- Accounts Payable and Other Accrued Liabilities [c]	$ 2,601	72	$ 2,867	68
= Cash Conversion Cycle [d]		26		19

[a] Calculated as Average Accounts Receivable, net divided by total Net Sales multiplied by the number of days in the period.
[b] Calculated as Average Inventory divided by total Cost of Sales multiplied by the number of days in the period.
[c] Calculated as Average Accounts Payable and Other Accrued Liabilities less bank checks outstanding and other current liabilities divided by total Cost of Sales multiplied by the number of days in the period.
[d] Calculated as Accounts Receivable Days plus Inventory Days less Accounts Payable Days.

The cash conversion cycle is a non-GAAP financial measure. We believe the cash conversion cycle is a useful measure in providing investors with information regarding our cash management performance and is a widely accepted measure of working capital management efficiency. The cash conversion cycle should not be considered in isolation or as an alternative to other GAAP metrics as an indicator of performance.

The days in our cash conversion cycle in comparison to the prior year increased primarily from higher inventory levels in our Mini Mill segment due to the BR2 start-up and lower net sales in the fourth quarter of the current year compared to the same period in the prior year.

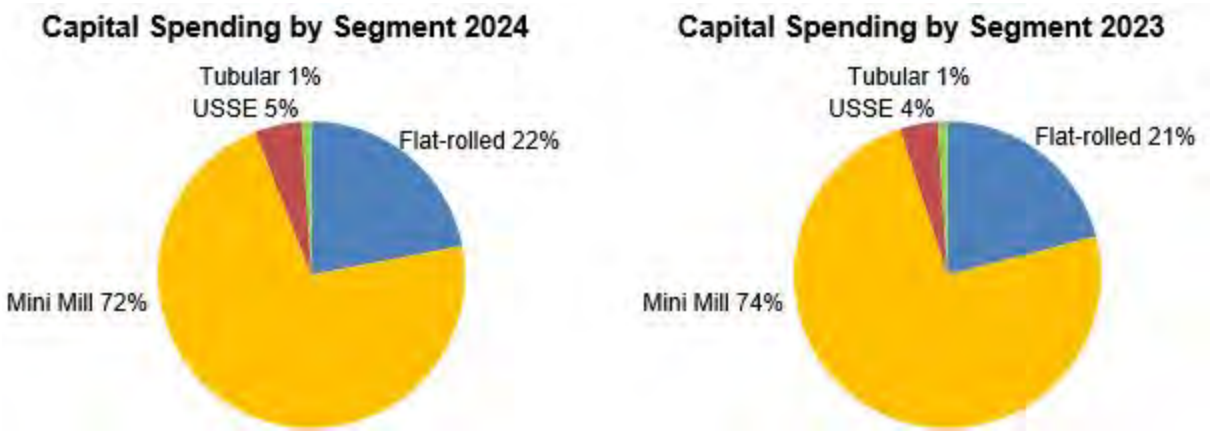
The LIFO inventory method is the predominant method of inventory costing for our Flat-Rolled and Tubular segments. The FIFO and moving average methods are the predominant inventory costing methods for our Mini Mill segment and the FIFO method is the predominant inventory costing method for our USSE segment. In the U.S., management monitors the inventory realizability by comparing the LIFO cost of inventory with the replacement cost of inventory. To the extent the replacement cost (i.e., market value) of inventory is lower than the LIFO cost of inventory, management will write the inventory down. As of December 31, 2024, and 2023, the replacement cost of the LIFO inventory was higher by approximately $1,143 million and $1,248 million, respectively.

Net cash provided by operating activities for 2024 and 2023 reflects employee benefits payments as shown in the following table.

Benefits Payments for Employees	Year Ended December 31,	
(Dollars in millions)	**2024**	2023
Other employee benefits payments not funded by trusts	**32**	40
Payments to a multiemployer pension plan	**79**	84
Pension related payments not funded by trusts	**1**	3
Reductions in cash flows from operating activities	**$ 112**	$ 127

Net Cash Used in Investing Activities

Net cash used in investing activities was $2,276 million in 2024 compared to $2,568 million in 2023. The decrease in net cash used in investing activities was primarily due to decreased capital expenditures (discussed in more detail below).



Capital expenditures in 2024 were $2,287 million compared to $2,576 million in 2023. Mini Mill capital expenditures were $1,641 million and included $1,368 million for BR2, exclusive of the air separation unit, which began operations during the fourth quarter, as well as spending for the dual Galvalume®/galvanized coating and color coating lines at the existing Big River Steel facility. Flat-Rolled capital expenditures were $495 million which includes spending for the DR grade pellet facility at Keetac, as well as for mining equipment, blast furnace repairs and a stove rebuild at Gary Works, and other infrastructure and environmental projects across the Flat-Rolled footprint. USSE capital expenditures were $118 million and included spending for the blast furnace stove repairs and upgrades, enterprise resource planning (ERP) project, 5-stand control system upgrades, and various other projects. Tubular capital expenditures were $33 million and included spending to support steelmaking, infrastructure, and environmental projects within the Tubular footprint. Other businesses had no capital expenditures.

Net Cash used in Financing Activities

Net cash used in financing activities was $199 million for the twelve months ended December 31, 2024, compared to net cash used in financing activities of $98 million for the same period in 2023. The period over period change in financing activities was primarily due to the absence of proceeds received from the issuance of long-term debt in the current year period, partially offset by the absence of repurchases of common stock in the current year period.

In 2023, U. S. Steel received net proceeds of approximately $238 million after closing on an aggregate principal amount of $240 million unsecured Arkansas Development Finance Authority environmental improvement revenue bonds with a coupon rate of 5.700% and a final maturity of 2053.

Certain of our credit facilities, including the Credit Facility Agreement, the Big River Steel ABL Facility, the USSK Credit Agreement and the Export Credit Agreement, contain standard terms and conditions including customary material adverse change clauses. If a material adverse change was to occur, our ability to fund future operating and capital requirements could be negatively impacted. The €150 million (approximately $156 million) USSK Credit Agreement contains certain USSK specific financial covenants. The USSK Credit Agreement requires USSK to maintain a net debt to EBITDA ratio of less than 3.50:1 (the “EBITDA Ratio Covenant”), as measured on a rolling twelve month basis on June 30th and December 31st of each year. As of December 31, 2024 USSK was in compliance with the EBITDA Ratio Covenant. There are currently no amounts outstanding under the facility.

We use surety bonds, trusts and letters of credit to provide financial assurance for certain transactions and business activities. The use of some forms of financial assurance and cash collateral have a negative impact on liquidity. U. S. Steel has committed $192 million of liquidity sources for financial assurance purposes as of December 31, 2024. Increases in certain of these commitments which use collateral are reflected within cash, cash equivalents and restricted cash on the Consolidated Statement of Cash Flows.

The maximum guarantees of the indebtedness of unconsolidated entities of U. S. Steel totaled $7 million at December 31, 2024. If any default related to the guaranteed indebtedness occurs, U. S. Steel has access to its interest in the assets of the investees to reduce its potential losses under the guarantees.

We may from time to time seek to retire or repurchase our outstanding long-term debt through open market purchases, privately negotiated transactions, exchange transactions, redemptions or otherwise. Such purchases or exchanges, if any, will depend on prevailing market conditions, our liquidity requirements and other factors and may be commenced or suspended at any time. The amounts involved may be material. See Note 17 to the Consolidated Financial Statements for further details regarding U. S. Steel’s debt.

Share Repurchases

In the third quarter of 2022, the Board of Directors authorized a share repurchase program that allows for the repurchase of up to $500 million of our outstanding common stock from time to time in the open market or privately negotiated transactions at the discretion of management. The Company's share repurchase program does not obligate it to acquire any specific number of shares. In the twelve months ended December 31, 2024 no common stock was repurchased under our share repurchase program. We do not expect to utilize the remainder of this authorization as the Merger Agreement contains a customary prohibition on our ability to engage in additional share repurchases without the consent of Purchaser. See Note 27 to the Consolidated Financial Statements, "Common Stock Repurchased" for further details.

Capital Requirements

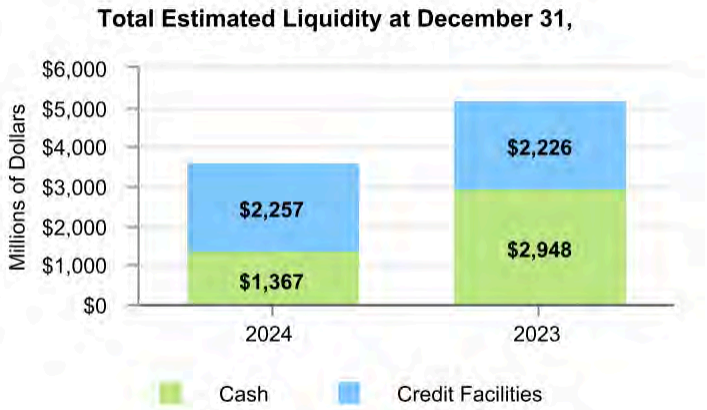
Capital expenditures for 2025 are expected to total approximately $1.0 billion and are significantly lower than 2024 due to the on time completion of several strategic projects as well as the nearing completion and commissioning of the remaining strategic projects to expand our competitive advantages in low-cost iron ore, mini mill steelmaking and best-in-class finishing capabilities.

U. S. Steel's contractual commitments to acquire property, plant and equipment at December 31, 2024, totaled $683 million.

Liquidity

The following table summarizes U. S. Steel's liquidity as of December 31, 2024:

(Dollars in millions)		
Cash and cash equivalents	$	1,367
Amount available under Credit Facility Agreement		1,746
Amount available under Big River Steel - Revolving Line of Credit		340
Amounts available under USSK Credit Agreement and USSK Credit Facility		171
Total estimated liquidity	$	3,624



As of December 31, 2024, $171 million of the total cash and cash equivalents was held by our foreign subsidiaries. Substantially all of the liquidity attributable to our foreign subsidiaries can be accessed without the imposition of income taxes as a result of the election effective December 31, 2013, to liquidate for U.S. income tax purposes a foreign subsidiary that holds most of our international operations.

We expect that our estimated liquidity requirements will consist primarily of our 2025 planned strategic capital expenditures, working capital requirements, debt service, and operating costs and employee benefits for our operations. Our available liquidity at December 31, 2024, consists principally of our cash and cash equivalents and available borrowings under the Credit Facility Agreement, Big River Steel ABL Facility, USSK Credit Agreement and the USSK Credit Facility.

Management continues to evaluate market conditions in our industry and our global liquidity position, and may consider additional actions to further strengthen our balance sheet and optimize liquidity, including but not limited to the repayment or refinancing of outstanding debt and the incurrence of additional debt to opportunistically finance strategic projects.

U. S. Steel management believes that U. S. Steel's liquidity will be adequate to satisfy our cash requirements and obligations for the next twelve months and for the foreseeable future, including obligations to complete currently authorized capital spending programs. Future requirements for U. S. Steel's business needs, including the funding of capital expenditures, scheduled debt maturities, repurchase of debt, dividends, contributions to employee benefit plans and any amounts that may ultimately be paid

in connection with contingencies, are expected to be funded by a combination of internally generated funds (including asset sales), borrowings, refinancings and other external financing sources.

The Company has a supply chain finance (SCF) arrangement with a third-party administrator which allows participating suppliers, at their sole discretion, to make offers to sell payment obligations of the Company prior to their scheduled due dates at a discounted price to a participating financial institution. The third-party administrator entered into a separate agreement with the Export Import Bank of the United States to guarantee 90 percent of supplier obligations sold for up to $95 million. No guarantees or collateral are provided by the Company or any of its subsidiaries under the SCF program.

The Company's goal is to capture overall supplier savings and improve working capital efficiency. The agreements facilitate the suppliers' ability to sell payment obligations, while providing them with greater working capital flexibility. The Company has no economic interest in the sale of the suppliers' receivables and no direct financial relationship with the financial institution concerning these services. The Company's obligations to its suppliers, including amounts due and scheduled payment dates, are not impacted by suppliers' decisions to sell amounts under the arrangements. The SCF program requires the Company to pay the third-party administrator the stated amount of the confirmed participating supplier invoices. The payment terms for confirmed invoices range from 45 to 90 days after the end of the month in which the invoice was issued.

The underlying costs from suppliers that elected to participate in the SCF program are generally recorded in cost of sales in the Company's Consolidated Statements of Operations. Amounts due to suppliers who participate in the SCF program are reflected in accounts payable and accrued expenses on the Company's Consolidated Balance Sheets and payments on the obligations by our suppliers are included in cash used in operating activities in the Consolidated Statements of Cash Flows. As of December 31, 2024, accounts payable and accrued expenses included $62 million of outstanding payment obligations which suppliers elected to sell to participating financial institutions.

The following table summarizes the Company's contractual obligations at December 31, 2024, and the effect such obligations are expected to have on our liquidity and cash flows in future periods.

(Dollars in millions)

		Payments Due by Period			
Contractual Obligations	**Total**	**2025**	**2026 through 2027**	**2028 through 2029**	**Beyond 2029**
Debt (including interest) and finance leases[a]	$ 7,077	$ 338	$ 1,133	$ 1,573	$ 4,033
Operating leases[b]	88	39	39	8	2
Contractual purchase commitments[c]	7,720	5,386	1,286	386	662
Capital commitments[d]	683	518	165	—	—
Environmental commitments[d]	108	26	—	—	82
Steelworkers Pension Trust[e]	411	79	163	169	—
Employee related benefits[f]	138	31	55	52	—
Total contractual obligations	$ 16,225	$ 6,417	$ 2,841	$ 2,188	$ 4,779

(a) See Note 17 to the Consolidated Financial Statements.
(b) See Note 24 to the Consolidated Financial Statements.
(c) Reflects estimated contractual purchase commitments under purchase orders and "take or pay" arrangements. "Take or pay" arrangements are primarily for purchases of gases and certain energy and utility services.
(d) See Note 26 to the Consolidated Financial Statements.
(e) While it is difficult to make a prediction of cash requirements beyond the term of the 2022 Labor Agreements with the USW, which expire on September 1, 2026, projected amounts shown through 2028 assume the contribution rate per hour included in the 2022 Labor Agreements of $4.00 per hour worked.
(f) The amounts reflect corporate cash outlays for expected benefit payments to be paid by the Company. (See Note 18 to the Consolidated Financial Statements.) The accuracy of this forecast of future cash flows depends on future medical health care escalation rates and restrictions related to our trusts for retiree healthcare and life insurance (VEBA) that impact the timing of the use of trust assets. Projected amounts have been reduced to reflect withdrawals from the USW VEBA trust available under its agreements with the USW. Due to these factors, it is not possible to reliably estimate cash requirements beyond five years and actual amounts experienced may differ significantly from those shown.

Other Commercial Commitments

The following table summarizes U. S. Steel's commercial commitments at December 31, 2024, and the effect such commitments could have on our liquidity and cash flows in future periods.

(Dollars in millions)

Commercial Commitments	Total	Scheduled Reductions by Period 2025	2026 through 2027	2028 through 2029	Beyond 2029	
Standby letters of credit[a]	$ 60	$ 43	$ —	$ —	$ 17	[b]
Surety bonds[a]	98	—	—	—	98	[b]
Funded Trusts[a]	35	—	—	—	35	[b]
Total commercial commitments	$ 193	$ 43	$ —	$ —	$ 150	

(a) Reflects a commitment or guarantee for which future cash outflow is not considered likely.
(b) Timing of potential cash outflows is not determinable.

Off-Balance Sheet Arrangements

U. S. Steel has invested in several joint ventures that are reported as equity investments. Several of these investments involved a transfer of assets in exchange for an equity interest. U. S. Steel has supply arrangements with several of these joint ventures.

U. S. Steel's other off-balance sheet arrangements include guarantees, indemnifications, unconditional purchase obligations, surety bonds, trusts and letters of credit disclosed in Note 26 to the Consolidated Financial Statements.

Derivative Instruments

See "Item 7A. Quantitative and Qualitative Disclosures About Market Risk" for discussion of derivative instruments and associated market risk for U. S. Steel.

Environmental Matters

U. S. Steel's environmental expenditures were as follows:

(Dollars in millions)

	2024	2023	2022
North America:			
Capital	**$ 80**	$ 60	$ 38
Compliance			
Operating & maintenance	**247**	243	255
Remediation[a]	**10**	15	18
Total North America	**$ 337**	$ 318	$ 311
USSE:			
Capital	**$ 3**	$ 10	$ 6
Compliance			
Operating & maintenance	**10**	12	11
Remediation[a]	**4**	5	6
Total USSE	**$ 17**	$ 27	$ 23
Total U. S. Steel	**$ 354**	$ 345	$ 334

[a] These amounts include spending charged against remediation reserves, net of recoveries where permissible, but do not include non-cash provisions recorded for environmental remediation.

U. S. Steel's environmental capital expenditures accounted for 4 percent of total capital expenditures in 2024, 3 percent in 2023 and 2 percent in 2022.

Environmental compliance expenditures represented 2 percent of U. S. Steel's total costs and expenses in 2024, 2023, and 2022. Remediation spending during 2022 through 2024 was mainly related to remediation activities at former and present operating locations.

For discussion of other relevant environmental items see "Part I, Item 3. Legal Proceedings – Environmental Proceedings."

The following table shows activity with respect to environmental remediation liabilities for the years ended December 31, 2024, and December 31, 2023. These amounts exclude liabilities related to asset retirement obligations accounted for in accordance with ASC Topic 410. See Note 19 to the Consolidated Financial Statements.

(Dollars in millions)	2024	2023
Beginning Balance	**$ 107**	$ 126
Plus: Additions	**18**	15
Adjustments for changes in estimates	**—**	(11)
Less: Obligations settled	**(17)**	(23)
Ending Balance	**$ 108**	$ 107

New or expanded environmental requirements, which could increase U. S. Steel's environmental costs, may arise in the future. U. S. Steel intends to comply with all legal requirements regarding the environment, but since many of them are not fixed or presently determinable (even under existing legislation) and may be affected by future legislation, it is not possible to predict accurately the ultimate cost of compliance, including remediation costs which may be incurred and penalties which may be imposed. U. S. Steel's environmental capital expenditures are expected to be approximately $156 million in 2025, $6 million of which is related to projects at USSE. U. S. Steel's environmental expenditures for 2025 for operating and maintenance and for remediation projects are expected to be approximately $273 million and $65 million, respectively, of which approximately $14 million and $5 million for operating and maintenance and remediation, respectively, is related to USSE. Although the outcome of pending environmental matters is not estimable at this time, it is reasonably possible that U. S. Steel's environmental capital and operating and maintenance expenditures could materially increase as a result of the future resolution of these matters. Predictions of future environmental expenditures beyond 2025 can only be broad-based estimates, which have varied, and will continue to vary, due to the ongoing evolution of specific regulatory requirements, the possible imposition of more stringent requirements and the availability of new technologies to remediate sites, among other factors.

Accounting Standards

See Notes 2 and 3 to the Consolidated Financial Statements in Part II Item 8 of this Form 10-K.

Item 7A. QUANTITATIVE AND QUALITATIVE DISCLOSURES ABOUT MARKET RISK

U. S. Steel is exposed to certain risks related to its ongoing business operations, including financial, market, political, and economic risks. The following discussion provides information regarding U. S. Steel's exposure to the risks of changing foreign currency exchange rates, commodity prices and interest rates.

U. S. Steel may enter into derivative financial instrument transactions in order to manage or reduce these market risks. The use of derivative instruments is subject to our corporate governance policies. These instruments are used solely to mitigate market exposure and are not used for trading or speculative purposes.

U. S. Steel may elect to use hedge accounting for certain commodity or currency transactions. For those transactions, the impact of the hedging instrument will be recognized in other comprehensive income until the transaction is settled. Once the transaction is settled, the effect of the hedged item will be recognized in income. For further information regarding derivative instruments see Notes 1 and 16 to the Consolidated Financial Statements.

Foreign Currency Exchange Rate Risk

U. S. Steel is subject to the risk of price fluctuations due to the effects of exchange rates on revenues and operating costs, firm commitments for capital expenditures and existing assets or liabilities denominated in currencies other than the U.S. dollar, particularly the euro. U. S. Steel historically has made limited use of forward currency contracts to manage exposure to certain currency price fluctuations. U. S. Steel elected cash flow hedge accounting for foreign exchange forwards and had no material open forward exchange contracts that were subject to mark-to-market accounting as of December 31, 2024.

The fair value of our derivatives is determined using Level 2 inputs, which are defined as "significant other observable" inputs. The inputs used include quotes from counterparties that are corroborated with market sources.

Volatility in the foreign currency markets could have significant implications for U. S. Steel as a result of foreign currency transaction effects. Future foreign currency impacts will depend upon changes in currencies and the extent to which we engage in derivatives transactions. For additional information on U. S. Steel's foreign currency exchange activity, see Note 16 to the Consolidated Financial Statements.

Commodity Price Risk and Related Risks

In the normal course of our business, U. S. Steel is exposed to market risk or price fluctuations related to the purchase, production or sale of steel products. U. S. Steel is also exposed to price risk related to the purchase, production or sale of coal, coke, natural gas, steel scrap, iron ore and pellets, and zinc, tin and other nonferrous metals used as raw materials. U. S. Steel is also subject to market price risk for the purchase of a portion of its electricity at certain facilities. See Note 16 to the Consolidated Financial Statements for further details on U. S. Steel's derivatives.

U. S. Steel's market risk strategy has generally been to obtain competitive prices for our products and services and allow operating results to reflect market price movements dictated by supply and demand; however, from time to time U. S. Steel has made forward physical purchases to manage exposure to price risk related to the purchases of natural gas and certain non-ferrous metals used in the production process. As of December 31, 2024, U. S. Steel did not have forward buy contracts for natural gas or any of the other significant raw materials used in the domestic production process.

Interest Rate Risk

U. S. Steel is subject to the effects of interest rate fluctuations on the fair value of certain of our non-derivative financial instruments. A sensitivity analysis of the projected incremental effect of a hypothetical 10 percent increase/decrease in year-end 2024 and 2023 interest rates on the fair value of U. S. Steel's non-derivative financial instruments is provided in the following table:

(Dollars in millions)	**2024**		**2023**	
Non-Derivative Financial Instruments[a]	**Fair Value[b]**	**Change in Fair Value[c]**	Fair Value[b]	Change in Fair Value[c]
Financial liabilities:				
Debt[d][e]	**$ 4,243**	**$ 256**	$ 4,797	$ 325

(a) Fair values of cash and cash equivalents, current accounts and notes receivable, accounts payable, bank checks outstanding and accrued interest approximate carrying value and are relatively insensitive to changes in interest rates due to the short-term maturity of the instruments. Accordingly, these instruments are excluded from the table.

(b) See Note 20 to the Consolidated Financial Statements for carrying value of instruments.

(c) Reflects, by class of financial instrument, the estimated incremental effect of a hypothetical 10 percent change in interest rates at December 31, 2024, and 2023, on the fair value of U. S. Steel's non-derivative financial instruments. For financial liabilities, this assumes a 10 percent decrease in the weighted average yield to maturity of U. S. Steel's long-term debt at December 31, 2024, and December 31, 2023.

(d) Excludes finance lease obligations.

(e) Fair value was determined using Level 2 inputs which were derived from quoted market prices and is based on the yield on public debt where available or current borrowing rates available for financings with similar terms and maturities.

U. S. Steel's sensitivity to interest rate declines and corresponding increases in the fair value of our debt portfolio would unfavorably affect our results and cash flows only to the extent that we elected to repurchase or otherwise retire all or a portion of our fixed-rate debt portfolio at prices above carrying value.

Item 8. CONSOLIDATED FINANCIAL STATEMENTS AND SUPPLEMENTARY DATA

The information required by this item is set forth in our Consolidated Financial Statement contained in this Annual Report on Form 10-K. Specific financial statements can be found at the page listed below:

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REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM (PCAOB ID 238)	66
CONSOLIDATED STATEMENTS OF OPERATIONS FOR THE YEARS ENDED DECEMBER 31, 2024, 2023, AND 2022	68
CONSOLIDATED STATEMENTS OF COMPREHENSIVE INCOME (LOSS) FOR THE YEARS ENDED DECEMBER 31, 2024, 2023, AND 2022	69
CONSOLIDATED BALANCE SHEETS AS OF DECEMBER 31, 2024, AND 2023	70
CONSOLIDATED STATEMENTS OF CASH FLOWS FOR THE YEARS ENDED DECEMBER 31, 2024, 2023, AND 2022	71
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MANAGEMENT'S REPORT TO STOCKHOLDERS

January 31, 2025

To the Stockholders of United States Steel Corporation:

Financial Statements and Practices

The accompanying consolidated financial statements of United States Steel Corporation are the responsibility of and have been prepared by United States Steel Corporation in conformity with accounting principles generally accepted in the United States of America. They necessarily include some amounts that are based on our best judgments and estimates. United States Steel Corporation's financial information displayed in other sections of this report is consistent with these financial statements.

United States Steel Corporation seeks to assure the objectivity and integrity of its financial records by careful selection of its managers, by organizational arrangements that provide an appropriate division of responsibility and by communication programs aimed at assuring that its policies, procedures and methods are understood throughout the organization.

United States Steel Corporation has a comprehensive, formalized system of internal controls designed to provide reasonable assurance that assets are safeguarded, that financial records are reliable and that information required to be disclosed in reports filed with or submitted to the Securities and Exchange Commission is recorded, processed, summarized and reported within the required time limits. Appropriate management monitors the system for compliance and evaluates it for effectiveness, and the independent registered public accounting firm measures its effectiveness and recommends possible improvements thereto.

The Board of Directors exercises its oversight role in the area of financial reporting and internal control over financial reporting through its Audit Committee. This committee, composed solely of independent directors, regularly meets (jointly and separately) with the independent registered public accounting firm, management, internal audit and other executives to monitor the proper discharge by each of their responsibilities relative to internal control over financial reporting and United States Steel Corporation's financial statements.

Internal Control Over Financial Reporting

United States Steel Corporation's management is responsible for establishing and maintaining adequate internal control over financial reporting, as defined in Exchange Act Rule 13a-15(f). Under the supervision and with the participation of United States Steel Corporation's management, including the Chief Executive Officer and Chief Financial Officer, United States Steel Corporation conducted an evaluation of the effectiveness of its internal control over financial reporting based on the framework in *Internal Control – Integrated Framework (2013)* issued by the Committee of Sponsoring Organizations of the Treadway Commission.

Based on this evaluation, United States Steel Corporation's management concluded that United States Steel Corporation's internal control over financial reporting was effective as of December 31, 2024.

The effectiveness of United States Steel Corporation's internal control over financial reporting as of December 31, 2024, has been audited by PricewaterhouseCoopers LLP, an independent registered public accounting firm, as stated in their report which is included herein.

/s/ David B. Burritt
David B. Burritt
President and
Chief Executive Officer

/s/ Jessica T. Graziano
Jessica T. Graziano
Senior Vice President and
Chief Financial Officer

/s/ Manpreet S. Grewal
Manpreet S. Grewal
Vice President, Controller
& Chief Accounting Officer

Report of Independent Registered Public Accounting Firm

To the Board of Directors and Stockholders of United States Steel Corporation

Opinions on the Financial Statements and Internal Control over Financial Reporting

We have audited the accompanying consolidated balance sheets of United States Steel Corporation and its subsidiaries (the "Company") as of December 31, 2024 and 2023, and the related consolidated statements of operations, of comprehensive income (loss), of stockholders' equity and of cash flows for each of the three years in the period ended December 31, 2024, including the related notes and financial statement schedule listed in the index appearing under Item 15(a)(2) (collectively referred to as the "consolidated financial statements"). We also have audited the Company's internal control over financial reporting as of December 31, 2024, based on criteria established in *Internal Control - Integrated Framework* (2013) issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO).

In our opinion, the consolidated financial statements referred to above present fairly, in all material respects, the financial position of the Company as of December 31, 2024 and 2023, and the results of its operations and its cash flows for each of the three years in the period ended December 31, 2024 in conformity with accounting principles generally accepted in the United States of America. Also in our opinion, the Company maintained, in all material respects, effective internal control over financial reporting as of December 31, 2024, based on criteria established in *Internal Control - Integrated Framework* (2013) issued by the COSO.

Basis for Opinions

The Company's management is responsible for these consolidated financial statements, for maintaining effective internal control over financial reporting, and for its assessment of the effectiveness of internal control over financial reporting, included in the accompanying Management's Report to Stockholders on Internal Control Over Financial Reporting. Our responsibility is to express opinions on the Company's consolidated financial statements and on the Company's internal control over financial reporting based on our audits. We are a public accounting firm registered with the Public Company Accounting Oversight Board (United States) (PCAOB) and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audits to obtain reasonable assurance about whether the consolidated financial statements are free of material misstatement, whether due to error or fraud, and whether effective internal control over financial reporting was maintained in all material respects.

Our audits of the consolidated financial statements included performing procedures to assess the risks of material misstatement of the consolidated financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the consolidated financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the consolidated financial statements. Our audit of internal control over financial reporting included obtaining an understanding of internal control over financial reporting, assessing the risk that a material weakness exists, and testing and evaluating the design and operating effectiveness of internal control based on the assessed risk. Our audits also included performing such other procedures as we considered necessary in the circumstances. We believe that our audits provide a reasonable basis for our opinions.

Definition and Limitations of Internal Control over Financial Reporting

A company's internal control over financial reporting is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A company's internal control over financial reporting includes those policies and procedures that (i) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (ii) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and (iii) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company's assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Also, projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

Critical Audit Matters

The critical audit matter communicated below is a matter arising from the current period audit of the consolidated financial statements that was communicated or required to be communicated to the audit committee and that (i) relates to accounts or

disclosures that are material to the consolidated financial statements and (ii) involved our especially challenging, subjective, or complex judgments. The communication of critical audit matters does not alter in any way our opinion on the consolidated financial statements, taken as a whole, and we are not, by communicating the critical audit matter below, providing a separate opinion on the critical audit matter or on the accounts or disclosures to which it relates.

Sales Recognition

As described in Notes 1 and 6 to the consolidated financial statements, revenue is generated primarily from contracts to produce, ship and deliver steel products, and to a lesser extent, raw materials such as iron ore pellets and coke by-products. Sales are recognized when the Company's performance obligations are satisfied. Generally, the Company's performance obligations are satisfied, control of products is transferred, and revenue is recognized at a single point in time, when title transfers to customers for products shipped. For the year ended December 31, 2024, the Company's net sales were $15.6 billion.

The principal consideration for our determination that performing procedures relating to sales recognition is a critical audit matter is a high degree of auditor effort in performing procedures related to the Company's sales recognition.

Addressing the matter involved performing procedures and evaluating audit evidence in connection with forming our overall opinion on the consolidated financial statements. These procedures included testing the effectiveness of controls relating to the sales recognition process. These procedures also included, among others, for certain components (i) evaluating revenue transactions by testing the issuance and settlement of invoices and credit memos (ii) tracing transactions not settled to a detailed listing of accounts receivable, (iii) testing the completeness and accuracy of data provided by management, and (iv) confirming a sample of outstanding customer invoice balances as of December 31, 2024 and, for confirmations not returned, obtaining and inspecting source documents, such as invoices, delivery documents, and subsequent cash receipts. For other components, these procedures included testing the revenue recognized for a sample of revenue transactions by obtaining and inspecting source documents, such as evidence of customer arrangement, invoices, proof of shipment, and subsequent cash receipts.

/s/ PricewaterhouseCoopers LLP
Pittsburgh, Pennsylvania
January 31, 2025

We have served as the Company's auditor since 1903.

UNITED STATES STEEL CORPORATION
CONSOLIDATED STATEMENTS OF OPERATIONS

(Dollars in millions, except per share amounts)	Year Ended December 31, 2024	2023	2022
Net sales:			
Net sales	**$ 13,135**	$ 16,038	$ 19,123
Net sales to related parties (Note 23)	**2,505**	2,015	1,942
Total (Note 6)	**15,640**	18,053	21,065
Operating expenses (income):			
Cost of sales (excludes items shown below)	**14,060**	15,803	16,777
Selling, general and administrative expenses	**435**	501	422
Depreciation, depletion and amortization (Notes 13 and 14)	**913**	916	791
Earnings from investees (Note 12)	**(112)**	(115)	(243)
Asset impairment charges (Note 1)	**19**	129	163
Restructuring and other charges (Note 25)	**8**	36	48
Gain on equity investee transactions (Note 12)	**—**	—	(6)
Other losses (gains), net	**77**	(16)	(47)
Total	**15,400**	17,254	17,905
Earnings before interest and income taxes	**240**	799	3,160
Interest expense	**24**	72	159
Interest income	**(96)**	(141)	(44)
Loss on debt extinguishment (Note 7)	**2**	—	—
Other financial costs	**29**	18	32
Net periodic benefit income	**(132)**	(154)	(246)
Net gain from investments related to active employee benefits (Note 20)	**(25)**	(43)	—
Net interest and other financial (benefits) costs (Note 7)	**(198)**	(248)	(99)
Earnings before income taxes	**438**	1,047	3,259
Income tax expense (Note 11)	**54**	152	735
Net earnings	**384**	895	2,524
Less: Net earnings attributable to noncontrolling interests	**—**	—	—
Net earnings attributable to United States Steel Corporation	**$ 384**	$ 895	$ 2,524
Earnings per common share (Note 8)			
Earnings per share attributable to United States Steel Corporation stockholders:			
— Basic	**$ 1.71**	$ 3.98	$ 10.22
— Diluted	**$ 1.57**	$ 3.56	$ 9.16

The accompanying notes are an integral part of these Consolidated Financial Statements.

UNITED STATES STEEL CORPORATION
CONSOLIDATED STATEMENTS OF COMPREHENSIVE INCOME (LOSS)

(Dollars in millions)	Year Ended December 31, 2024	2023	2022
Net earnings	**$ 384**	$ 895	$ 2,524
Other comprehensive income (loss), net of tax:			
Changes in foreign currency translation adjustments [(a)]	**(70)**	54	(91)
Changes in pension and other employee benefit accounts [(a)]	**(77)**	81	(297)
Changes in derivative financial instruments [(a)]	**80**	(9)	(28)
Changes in fair value of active employee benefit investments [(a)]	**—**	5	—
Total other comprehensive income (loss), net of tax	**(67)**	131	(416)
Comprehensive income including noncontrolling interest	**317**	1,026	2,108
Comprehensive income attributable to noncontrolling interest	**—**	—	—
Comprehensive income attributable to United States Steel Corporation	**$ 317**	$ 1,026	$ 2,108

[(a)] Related income tax (provision) benefit:

Foreign currency translation adjustments	**$ 28**	$ (3)	$ 24
Pension and other benefits adjustments	**23**	(24)	95
Derivative adjustments	**(26)**	3	9
Active employee benefit investments	**—**	(2)	—

The accompanying notes are an integral part of these Consolidated Financial Statements.

UNITED STATES STEEL CORPORATION
CONSOLIDATED BALANCE SHEETS

(Dollars in millions)	December 31, 2024	2023
Assets		
Current assets:		
Cash and cash equivalents (Note 9)	**$ 1,367**	$ 2,948
Receivables, less allowance of $26 and $38	**1,236**	1,390
Receivables from related parties (Note 23)	**162**	158
Inventories (Note 10)	**2,168**	2,128
Other current assets	**299**	319
Total current assets	**5,232**	6,943
Long-term restricted cash (Note 9)	**35**	32
Investments and long-term receivables, less allowance of $3 in both periods (Note 12)	**757**	761
Operating lease assets (Note 24)	**72**	109
Property, plant and equipment, net (Note 13)	**11,973**	10,393
Intangibles, net (Note 14)	**416**	436
Deferred income tax benefits (Note 11)	**—**	19
Goodwill (Note 14)	**920**	920
Other noncurrent assets	**830**	838
Total assets	**$ 20,235**	$ 20,451
Liabilities		
Current liabilities:		
Accounts payable and other accrued liabilities	**$ 2,601**	$ 2,889
Accounts payable to related parties (Note 23)	**146**	139
Payroll and benefits payable	**295**	442
Accrued taxes	**131**	222
Accrued interest	**70**	70
Current operating lease liabilities (Note 24)	**35**	44
Short-term debt and current maturities of long-term debt (Note 17)	**95**	142
Total current liabilities	**3,373**	3,948
Noncurrent operating lease liabilities (Note 24)	**44**	73
Long-term debt, less unamortized discount and debt issuance costs (Note 17)	**4,078**	4,080
Employee benefits (Note 18)	**117**	126
Deferred income tax liabilities (Note 11)	**657**	587
Deferred credits and other noncurrent liabilities	**526**	497
Total liabilities	**8,795**	9,311
Contingencies and commitments (Note 26)		
Stockholders' Equity		
Common stock issued — 288,088,141 and 285,959,739 shares issued (par value $1 per share, authorized 400,000,000 shares) (Note 8)	**288**	286
Treasury stock, at cost (62,907,930 shares and 62,288,523 shares)	**(1,446)**	(1,418)
Additional paid-in capital	**5,307**	5,253
Retained earnings	**7,219**	6,880
Accumulated other comprehensive (loss) income (Note 21)	**(21)**	46
Total United States Steel Corporation stockholders' equity	**11,347**	11,047
Noncontrolling interests	**93**	93
Total liabilities and stockholders' equity	**$ 20,235**	$ 20,451

The accompanying notes are an integral part of these Consolidated Financial Statements.

UNITED STATES STEEL CORPORATION
CONSOLIDATED STATEMENTS OF CASH FLOWS

(Dollars in millions)	Year Ended December 31, 2024	2023	2022
Increase (decrease) in cash and cash equivalents			
Operating activities:			
Net earnings	**$ 384**	$ 895	$ 2,524
Adjustments to reconcile net cash provided by operating activities:			
Depreciation, depletion and amortization (Notes 13 and 14)	**913**	916	791
Asset impairment charges (Note 1)	**19**	129	163
Gain on equity investee transactions (Note 12)	**—**	—	(6)
Restructuring and other charges (Note 25)	**8**	36	48
Loss on debt extinguishment (Note 7)	**2**	—	—
Pensions and other post-employment benefits	**(133)**	(157)	(213)
Active employee benefit investments	**65**	32	—
Deferred income taxes (Note 11)	**113**	97	501
Net gain on sale of assets	**(5)**	(6)	(12)
Equity investees earnings, net of distributions received	**(3)**	(1)	(215)
Changes in:			
Current receivables	**174**	103	370
Inventories	**(71)**	257	(222)
Current accounts payable and accrued expenses	**(285)**	25	(180)
Income taxes receivable/payable	**(126)**	(27)	(15)
All other, net	**(136)**	(199)	(29)
Net cash provided by operating activities	**919**	2,100	3,505
Investing activities:			
Capital expenditures	**(2,287)**	(2,576)	(1,769)
Proceeds from cost reimbursement government grants (Note 26)	**—**	—	54
Proceeds from sale of assets	**5**	8	32
Proceeds from sale of ownership interests in equity investees (Note 12)	**—**	—	12
Other investing activities	**6**	—	(8)
Net cash used in investing activities	**(2,276)**	(2,568)	(1,679)
Financing activities:			
Issuance of long-term debt, net of financing costs (Note 17)	**—**	241	343
Repayment of long-term debt (Note 17)	**(128)**	(89)	(382)
Common stock repurchased (Note 27)	**—**	(175)	(849)
Proceeds from government incentives (Note 26)	**—**	—	82
Other financing activities	**(71)**	(75)	(62)
Net cash used in financing activities	**(199)**	(98)	(868)
Effect of exchange rate changes on cash	**(19)**	15	(19)
Net (decrease) increase in cash, cash equivalents and restricted cash	**(1,575)**	(551)	939
Cash, cash equivalents and restricted cash at beginning of year (Note 9)	**2,988**	3,539	2,600
Cash, cash equivalents and restricted cash at end of year (Note 9)	**$ 1,413**	$ 2,988	$ 3,539

See Note 22 for supplemental cash flow information.

The accompanying notes are an integral part of these Consolidated Financial Statements.

UNITED STATES STEEL CORPORATION
CONSOLIDATED STATEMENTS OF STOCKHOLDERS' EQUITY

	Dollars in Millions			Shares in Thousands		
	2024	**2023**	**2022**	**2024**	**2023**	**2022**
Common stock:						
Balance at beginning of year	**$ 286**	$ 283	$ 280	**285,960**	282,487	279,522
Common stock issued	**2**	3	3	**2,128**	3,473	2,965
Balance at end of year	**$ 288**	$ 286	$ 283	**288,088**	285,960	282,487
Treasury stock:						
Balance at beginning of year	**$ (1,418)**	$ (1,204)	$ (334)	**(62,289)**	(54,090)	(15,709)
Common stock repurchased	**—**	(175)	(849)	**—**	(7,092)	(37,559)
Excise tax on common stock repurchased	**—**	(1)	—	**—**	—	—
Common stock repurchased for employee/non-employee director stock plans	**(28)**	(38)	(21)	**(619)**	(1,107)	(822)
Balance at end of year	**$ (1,446)**	$ (1,418)	$ (1,204)	**(62,908)**	(62,289)	(54,090)
Additional paid-in capital:						
Balance at beginning of year	**$ 5,253**	$ 5,194	$ 5,199			
Employee stock plans	**54**	59	72			
Cumulative effect upon adoption of Accounting Standards Update 2020-06	**—**	—	(77)			
Balance at end of year	**$ 5,307**	$ 5,253	$ 5,194			

The accompanying notes are an integral part of these Consolidated Financial Statements.

UNITED STATES STEEL CORPORATION
CONSOLIDATED STATEMENTS OF STOCKHOLDERS' EQUITY

(Continued)

(Dollars in millions)	2024	2023	2022	Comprehensive Income (Loss) 2024	2023	2022
Retained earnings:						
Balance at beginning of year	**$ 6,880**	$ 6,030	$ 3,534			
Net earnings attributable to United States Steel Corporation	**384**	895	2,524	**$ 384**	$ 895	$ 2,524
Dividends on common stock	**(46)**	(45)	(50)			
Cumulative effect upon adoption of Accounting Standards Update 2020-06	**—**	—	22			
Other	**1**	—	—			
Balance at end of year	**$ 7,219**	$ 6,880	$ 6,030			
Accumulated other comprehensive (loss) income:						
Pension and other benefit adjustments (Note 18):						
Balance at beginning of year	**$ (241)**	$ (322)	$ (25)			
Changes during year, net of taxes [a]	**(77)**	79	(304)	**(77)**	79	(304)
Changes during year, equity investee net of taxes [a]	**—**	2	7	**—**	2	7
Balance at end of year	**$ (318)**	$ (241)	$ (322)			
Foreign currency translation adjustments:						
Balance at beginning of year	**$ 334**	$ 280	$ 371			
Changes during year, net of taxes [a]	**(70)**	54	(91)	**(70)**	54	(91)
Balance at end of year	**$ 264**	$ 334	$ 280			
Derivative financial instruments:						
Balance at beginning of year	**$ (52)**	$ (43)	$ (15)			
Changes during year, net of taxes [a]	**80**	(9)	(28)	**80**	(9)	(28)
Balance at end of year	**$ 28**	$ (52)	$ (43)			
Fair value of active employee benefit investments						
Balance at beginning of year	**$ 5**	$ —	$ —			
Changes during year, net of taxes [a]	**—**	5	—	**—**	5	—
Balance at end of year	**$ 5**	$ 5	$ —			
Total balances at end of year	**$ (21)**	$ 46	$ (85)			
Total stockholders' equity	**$ 11,347**	$ 11,047	$ 10,218			
Noncontrolling interests:						
Balance at beginning of year	**$ 93**	$ 93	$ 93			
Net loss	**—**	—	—	**—**	—	—
Balance at end of year	**$ 93**	$ 93	$ 93			
Total comprehensive income				**$ 317**	$ 1,026	$ 2,108

[a] Related income tax (provision) benefit:

Foreign currency translation adjustments	**$ 28**	$ (3)	$ 24
Pension and other benefits adjustments	**23**	(24)	95
Derivative adjustments	**(26)**	3	9
Active employee benefit investments	**—**	(2)	—

The accompanying notes are an integral part of these Consolidated Financial Statements.

1. Nature of Business and Significant Accounting Policies

Nature of Business

U. S. Steel produces and sells steel products, including flat-rolled and tubular products, in North America and Europe. Operations in the United States also include iron ore and coke production facilities and real estate operations. Operations in Europe also include coke production facilities.

Agreement and Plan of Merger with Nippon Steel Corporation

On December 18, 2023, the Company entered into an Agreement and Plan of Merger (such agreement, as it may be amended, modified or supplemented from time to time, the "Merger Agreement") by and among the Company, Nippon Steel North America, Inc., a New York corporation ("Purchaser"), 2023 Merger Subsidiary, Inc., a Delaware corporation and a wholly owned subsidiary of Purchaser ("Merger Sub"), and solely as provided in Section 9.13 therein, Nippon Steel Corporation, a Japanese corporation ("NSC"). Pursuant to the Merger Agreement, and upon the terms and subject to the conditions described therein, Merger Sub will merge with and into the Company, with the Company continuing as the surviving corporation and a wholly owned subsidiary of Purchaser (the "Merger"). On April 12, 2024, the Company obtained the approval of its stockholders required to adopt the Merger Agreement. U. S. Steel stockholders approved the Merger with 98.8% approval of shares voted, satisfying a condition to closing. Subject to the terms and conditions set forth in the Merger Agreement, each share of the Company's common stock, par value $1.00 per share, outstanding immediately prior to the effective time of the Merger (the "Effective Time") will, at the Effective Time, automatically be converted into the right to receive $55.00 per share in cash, without interest, subject to any required tax withholding. The parties have substantially complied with the Second Requests issued on April 3, 2024 and the statutory waiting period under the Hart-Scott-Rodino Antitrust Improvements Act of 1976 has now expired. In addition, all required regulatory approvals outside of the United States related to the Merger have been received. The closing conditions to the Merger include clearance by the Committee on Foreign Investment in the United States ("CFIUS") under the Defense Production Act of 1950, as amended. Following referral of the transaction by CFIUS to the President of the United States, on January 3, 2025, the President of the United States issued an order prohibiting the Merger and requiring the parties to abandon the Merger Agreement within thirty days. On January 10, 2025, CFIUS granted an extension of that deadline to June 18, 2025.

On January 6, 2025, the Company, NSC and Purchaser jointly filed a lawsuit in the United States Court of Appeals for the District of Columbia Circuit alleging that the President's order blocking the Merger was issued for purely political reasons, which are irrelevant to U.S. national security, challenging the decision by the President of the United States and the CFIUS process as violating the constitutional due process rights of the Company, NSC and Purchaser, as well as the applicable statute governing CFIUS and the Administrative Procedure Act, and as an exercise of power that exceeded the authority provided to the President of the United States under the applicable statute. The Company, NSC and Purchaser also filed a lawsuit in the United States District Court for the Western District of Pennsylvania against Cleveland-Cliffs Inc. ("Cliffs"), Cliffs' Chief Executive Officer Lourenco Goncalves, and the President of the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union (the "USW"), David McCall, for engaging in a coordinated series of anticompetitive and racketeering activities illegally designed to prevent any party other than Cliffs from acquiring the Company as part of an illegal campaign to monopolize critical domestic steel markets.

The Merger Agreement requires us to operate in the ordinary course of business and restricts us, without the consent of Purchaser, from taking certain specified actions agreed by the parties to be outside the ordinary course of business until the pending Merger occurs or the Merger Agreement terminates.

Significant Accounting Policies

Principles applied in consolidation

These financial statements include the accounts of U. S. Steel and its majority-owned subsidiaries. Additionally, variable interest entities for which U. S. Steel is the primary beneficiary are included in the Consolidated Financial Statements, and their impacts are either partially or completely offset by noncontrolling interests. Intercompany accounts, transactions and profits have been eliminated in consolidation.

Investments in entities over which U. S. Steel has significant influence are accounted for using the equity method of accounting and are carried at U. S. Steel's share of net assets plus loans, advances and our share of earnings less distributions.

Earnings or loss from investees includes U. S. Steel's share of earnings or loss from equity method investments (and any amortization of basis differences), which are generally recorded a month in arrears.

Use of estimates

Generally accepted accounting principles require management to make estimates and assumptions that affect the reported amounts of assets and liabilities, the disclosure of contingent assets and liabilities at year-end and the reported amounts of revenues and expenses during the year. Significant items subject to such estimates and assumptions include the carrying value of property, plant and equipment; intangible assets; the fair value of assets or liabilities acquired in a business combination; valuation allowances for receivables, inventories and deferred income tax assets and liabilities;

environmental liabilities; liabilities for potential tax deficiencies; potential litigation claims and settlements; assets and obligations related to employee benefits; and restructuring and other charges. Actual results could differ materially from the estimates and assumptions used.

The preparation of the financial statements includes an assessment of certain accounting matters using all available information including consideration of forecasted financial information in context with other information reasonably available to us. However, our future assessment of current expectations could result in material impacts to our consolidated financial statements in future reporting periods. All such adjustments are of a normal recurring nature unless disclosed otherwise.

Sales recognition

Sales are recognized when U. S. Steel's performance obligations are satisfied. Generally, U. S. Steel's performance obligations are satisfied, control of our products is transferred, and revenue is recognized at a single point in time, when title transfers to our customer for product shipped or when services are provided. Revenues are recorded net of any sales incentives. Shipping and other transportation costs charged to customers are treated as fulfillment activities and are recorded as additional net sales and cost of sales at the time control is transferred to the customer. See Note 6 for further details on U. S. Steel's revenue.

Inventories

Inventories are carried at the lower of cost or net realizable value. Fixed costs related to abnormal production capacity are expensed in the period incurred rather than capitalized into inventory.

LIFO is the predominant method of inventory costing for inventories held by the Flat-Rolled and Tubular segments. The Mini Mill segment uses a moving average costing method to account for semi-finished and finished products and FIFO to account for raw materials. FIFO is the predominant method used by the USSE segment. The LIFO method of inventory costing was used on 53 percent of consolidated inventories at both December 31, 2024, and December 31, 2023.

Derivative instruments

From time to time, U. S. Steel may use fixed price forward physical purchase contracts to partially manage our exposure to price risk. Generally, forward physical purchase contracts qualify for the normal purchase normal sales exclusion in Accounting Standards Codification (ASC) 815, *Derivatives and Hedging*, and are not subject to mark-to-market accounting. U. S. Steel also uses derivatives such as commodity-based financial swaps and foreign currency exchange forward contracts to manage its exposure to purchase and sale price fluctuations and foreign currency exchange rate risk. The USSE and Flat-Rolled segments elect hedge accounting for some of their derivatives. Under hedge accounting, fluctuations in the value of the derivative are recognized in Accumulated other comprehensive (loss) income (AOCI) until the associated underlying is recognized in earnings. When the associated underlying is recognized in earnings, the value of the derivative is reclassified to earnings from AOCI. The Mini Mill segment has not elected hedge accounting. Therefore, the changes in fair value of the Mini Mill segment's foreign exchange forwards, as well as fair value changes for other derivatives where hedge accounting has not been elected, are recognized immediately in earnings. In accordance with the guidance in ASC Topic 820 on fair value measurements and disclosures, the fair value of our foreign exchange forwards, commodity purchase swaps and sales swaps was determined using Level 2 inputs, which are defined as "significant other observable" inputs. The inputs used are from market sources that aggregate data based upon market transactions. See Note 16 for further details on U. S. Steel's derivatives.

Property, plant and equipment

Property, plant and equipment is carried at cost less accumulated depreciation and is depreciated on a straight-line basis over the estimated useful lives of the assets.

Depletion of mineral properties is based on rates which are expected to amortize cost over the estimated tonnage of minerals to be removed.

When property, plant and equipment is sold or otherwise disposed of, any gains or losses are reflected in income. If a loss on disposal is expected, such losses are recognized when the assets are reclassified as assets held for sale or when impaired as part of an asset group's impairment.

Asset Impairment

U. S. Steel evaluates impairment of its property, plant and equipment whenever circumstances indicate that the carrying value may not be recoverable. We evaluate the impairment of long-lived assets at the asset group level. Our asset groups are flat-rolled, mini mill, USSE, welded tubular and seamless tubular. Asset impairments are recognized when the carrying value of an asset group exceeds its recoverable amount as determined by the asset group's aggregate projected undiscounted cash flows.

In 2024, the Company recognized impairment charges of approximately $19 million for certain indefinitely idled assets at Granite City Works and certain permanently idled assets at Clairton Works. In 2023, the Company recognized charges of approximately $123 million for impairment of indefinitely idled iron and steel making assets at Granite City Works. In 2022,

impairment charges of approximately $151 million were recognized for the write-off of iron making and steel making assets at Great Lakes Works. The coil finishing processes at Granite City Works and Great Lakes Works continue to operate and remain components of the Company's operating plans. These impairment charges were the result of actions impacting specific, identifiable assets and were not significantly adverse to the flat-rolled long-lived asset group.

No triggering events that required an impairment evaluation of our long-lived asset groups were identified during the years ended December 31, 2024, 2023, and 2022.

Goodwill and identifiable intangible assets

Goodwill represents the excess of the cost over the fair value of acquired identifiable tangible and intangible assets and liabilities assumed from businesses acquired. Goodwill and intangible assets deemed to have indefinite lives are not amortized, but are subject to impairment testing annually, or more frequently if events or changes in circumstances indicate the asset might be impaired. We perform our annual goodwill impairment test as of October 1 and monitor for interim triggering events on an ongoing basis.

We review goodwill for impairment utilizing either a qualitative assessment or a quantitative goodwill impairment test. If we choose to perform a qualitative assessment and we determine that the fair value of the reporting unit more likely than not exceeds the carrying value, no further evaluation is necessary. For reporting units where we perform the quantitative goodwill impairment test, we compare the fair value of each reporting unit, which we primarily determine using an income approach based on the present value of discounted cash flows, to the respective carrying value, which includes goodwill. If the fair value of the reporting unit exceeds its carrying value, we do not consider the goodwill impaired. If the carrying value is higher than the fair value, we recognize the difference as an impairment loss.

A quantitative goodwill impairment testing process requires valuation of the respective reporting unit, which we primarily determine using an income approach based on a discounted cash flow forecast covering discrete periods of time including a terminal value. We compute the terminal value using the constant growth method, which values the forecasted cash flows in perpetuity. The assumptions about future cash flows and growth rates are based on the respective reporting unit's long-term forecast and are subject to review and approval by senior management. A reporting unit's discount rate is a significant assumption and is a risk-adjusted weighted average cost of capital, which we believe approximates the rate from a market participant's perspective. The estimated fair value could be impacted by changes in market conditions, interest rates, growth rates, tax rates, costs, pricing and capital expenditures. We categorize the fair value determination as Level 3 in the fair value hierarchy due to its use of internal projections and unobservable measurement inputs.

Our Mini Mill reporting unit holds the goodwill recognized as a result of the Company's acquisition of Big River Steel and currently is our only reporting unit that has a significant amount of goodwill. This goodwill is primarily attributable to Big River Steel's operational abilities, workforce and the anticipated benefits from their recent expansion. U. S. Steel completed its annual goodwill impairment test using a qualitative assessment during the fourth quarter of 2024 and determined there was no impairment of goodwill.

Intangible assets with indefinite lives are also subject to at least annual impairment testing, which compares the fair value of the intangible assets with their carrying amounts. U. S. Steel has determined that certain of its acquired intangible assets have indefinite useful lives. These assets are also reviewed for impairment annually in the fourth quarter and whenever events or circumstances indicate the carrying value may not be recoverable. U. S. Steel completed its annual evaluation of its indefinite-lived water rights using a qualitative assessment and determined there was no indication of impairment.

Finite-lived intangible assets are amortized on a straight-line basis over their estimated useful lives and are tested for impairment when events occur that indicate that the net book value will not be recovered over future cash flows.

Environmental remediation

Environmental expenditures are capitalized if the costs mitigate or prevent future contamination or if the costs improve existing assets' environmental safety or efficiency. U. S. Steel provides for remediation costs and penalties when the responsibility to remediate is probable and the amount of associated costs is reasonably estimable. The timing of remediation accruals typically coincides with completion of studies defining the scope of work to be undertaken or when it is probable that a formal plan of action will be approved by the oversight agency. Remediation liabilities are accrued based on estimates of believed environmental exposure and are discounted if the amount and timing of the cash disbursements are readily determinable.

Asset retirement obligations

Asset retirement obligations (AROs) are initially recorded at fair value and are capitalized as part of the cost of the related long-lived asset and depreciated in accordance with U. S. Steel's depreciation policies for property, plant and equipment. The fair value of the obligation is determined as the discounted value of expected future cash flows. Accretion expense is recorded each month to increase this discounted obligation over time. Certain AROs related to disposal costs of the majority of assets at our integrated steel facilities are not recorded because they have an indeterminate settlement date.

These AROs will be initially recognized in the period in which sufficient information exists to estimate their fair value. See Note 19 for further details on U. S. Steel's AROs.

Pensions and other post-employment benefits

U. S. Steel has defined contribution plans or multiemployer arrangements for pension benefits for more than 85 percent of its employees in the United States and defined benefit pension plans covering the remaining employees. For hires before January 1, 2016, U. S. Steel has defined benefit retiree health care and life insurance plans (Other Benefits) that cover its represented employees in North America upon their retirement. Government-sponsored programs into which U. S. Steel makes required contributions cover U. S. Steel's European employees. For more details regarding pension and other post-employment benefits see Note 18 of the Consolidated Financial Statements.

The pension and Other Benefits obligations and the related net periodic benefit costs are based on, among other things, assumptions regarding the discount rate, estimated return on plan assets, salary increases, the projected mortality of participants and the current level and future escalation of health care costs. Additionally, U. S. Steel recognizes an obligation to provide post-employment benefits for disability-related claims covering indemnity and medical payments for certain employees in North America. The obligation for these claims and the related periodic costs are measured using actuarial techniques and assumptions. Actuarial gains and losses occur when actual experience differs from any of the many assumptions used to value the benefit plans, or when assumptions change. For pension and Other Benefits, the Company recognizes into income on an annual basis a portion of unrecognized actuarial net gains or losses that exceed 10 percent of the larger of projected benefit obligations or plan assets (the corridor). These unrecognized amounts in excess of the corridor are amortized over the plan participants' average life expectancy or average future service, depending on the demographics of the plan. Unrecognized actuarial net gains and losses for disability-related claims are immediately recognized into income.

Deferred taxes

Deferred tax assets and liabilities are recognized for the estimated future tax consequences attributable to differences between the financial statement carrying amounts of existing assets and liabilities and their respective tax basis. The realization of deferred tax assets is assessed quarterly based on several interrelated factors. These factors include U. S. Steel's expectation to generate sufficient future taxable income and the projected time period over which these deferred tax assets will be realized. U. S. Steel records a valuation allowance when necessary to reduce deferred tax assets to the amount that will more likely than not be realized. See Note 11 for further details of deferred taxes.

2. New Accounting Standards

During the year ended December 31, 2024, there were no new accounting standards and interpretations issued which are expected to have a material impact on the Company's financial position, operations or cash flows.

In November 2024, the Financial Accounting Standards Board (FASB) issued Accounting Standards Update 2024-03, *Disaggregation of Income Statement Expenses* (ASU 2024-03). ASU 2024-03 includes requirements that an entity disclose in the notes to the financial statements specified information about certain costs and expenses, including the amounts of (a) purchases of inventory, (b) employee compensation, (c) depreciation, (d) intangible asset amortization, and (e) other amounts of depletion expense included in each relevant expense caption presented on the statement of operations. The standard also requires disclosure of a qualitative description of the amounts remaining in relevant expense captions that are not separately disaggregated quantitatively, as well as the total amount of selling expenses and an entity's definition of selling expenses. ASU 2024-03 is effective for annual periods beginning after December 15, 2026, and interim periods beginning after December 15, 2027. U. S. Steel is currently assessing the impact of ASU 2024-03 on its disclosures.

In March 2024, the SEC adopted final rules that would require certain climate related disclosures. Certain disclosures would be required in the notes to the financial statements beginning in fiscal year 2025. The audited financial statement disclosures include capitalized costs and expenses related to severe weather events and other natural conditions subject to certain materiality thresholds. Beginning in annual disclosures for fiscal year 2026, certain greenhouse gas emission disclosures would also be required. In April 2024, the SEC issued a stay on the rules until legal challenges to the rule are addressed. U. S. Steel is monitoring the legal challenges and assessing the impact of the rules on its disclosures.

In December 2023, the FASB issued Accounting Standards Update 2023-09, *Improvements to Income Tax Disclosures* (ASU 2023-09). ASU 2023-09 includes requirements that an entity disclose specific categories in the rate reconciliation and provide additional information for reconciling items that are greater than five percent of the amount computed by multiplying pretax income (or loss) by the applicable statutory income tax rate. The standard also requires that entities disclose income (or loss) from continuing operations before income tax expense (or benefit) and income tax expense (or benefit) each disaggregated between domestic and foreign. In addition, the standard also requires disclosure of payment amounts disaggregated by federal, state, and foreign, as well as by major jurisdiction. ASU 2023-09 is effective for annual periods beginning after December 15, 2024. U. S. Steel is currently assessing the impact of ASU 2023-09 on its disclosures.

3. Recently Adopted Accounting Standards

In November 2023, the FASB issued Accounting Standards Update 2023-07, *Improvements to Reportable Segment Disclosures* (ASU 2023-07). ASU 2023-07 includes requirements that an entity disclose the title of the chief operating decision maker (CODM) and on an interim and annual basis, significant segment expenses and the composition of other segment items for each segment's reported profit. The standard also permits disclosure of additional measures of segment profit. ASU 2023-07 is effective for fiscal years beginning after December 15, 2023, and interim periods within fiscal years beginning after December 15, 2024. U. S. Steel adopted this guidance effective January 1, 2024 for annual reporting and applied the amendments retrospectively to all prior periods presented in the Consolidated Financial Statements. The amendments for interim periods will be adopted in our fiscal year beginning on January 1, 2025. See Note 4 for further details on segment information.

In September 2022, the FASB issued Accounting Standards Update 2022-04, *Disclosure of Supplier Finance Program Obligations* (ASU 2022-04). ASU 2022-04 requires that an entity disclose certain information about supplier finance programs used in connection with the purchase of goods and services. ASU 2022-04 is effective for all entities with fiscal years beginning after December 15, 2022, and interim periods within those fiscal years, except for the amendment on roll-forward information, which is effective for fiscal years beginning after December 15, 2023. U. S. Steel adopted this guidance effective January 1, 2023, with the exception of the amendment on roll-forward information, which was adopted in our fiscal year beginning on January 1, 2024 and applied prospectively.

The Company has a SCF arrangement with a third-party administrator which allows participating suppliers, at their sole discretion, to make offers to sell payment obligations of the Company prior to their scheduled due dates at a discounted price to a participating financial institution. The third-party administrator entered into a separate agreement with the Export Import Bank of the United States to guarantee 90 percent of supplier obligations sold for up to $95 million. No guarantees or collateral are provided by the Company or any of its subsidiaries under the SCF program, and the Company does not benefit from any preferential payment terms or discounts as a result of supplier participation.

The Company's goal is to capture overall supplier savings and improve working capital efficiency. The agreements facilitate the suppliers' ability to sell payment obligations, while providing them with greater working capital flexibility. The Company has no economic interest in the sale of the suppliers' receivables and no direct financial relationship with the financial institution concerning these services. The Company's obligations to its suppliers, including amounts due and scheduled payment dates, are not impacted by suppliers' decisions to sell amounts under the arrangements. The SCF program requires the Company to pay the third-party administrator the stated amount of the confirmed participating supplier invoices. The payment terms for confirmed invoices range from 45 to 90 days after the end of the month in which the invoice was issued.

The underlying costs from suppliers that elected to participate in the SCF program are generally recorded in cost of sales in the Company's Consolidated Statements of Operations. Amounts due to suppliers who participate in the SCF program are reflected in accounts payable and accrued expenses on the Company's Consolidated Balance Sheets and payments on the obligations by our suppliers are included in cash used in operating activities in the Consolidated Statements of Cash Flows. As of December 31, 2024 and 2023, accounts payable and accrued expenses included $62 million and $84 million, respectively, of outstanding payment obligations which suppliers elected to sell to participating financial institutions.

The roll-forward of the Company's outstanding obligations confirmed as valid under its SCF program for the year ended December 31, 2024 is as follows:

(in millions)	**2024**
Confirmed obligations outstanding at beginning of year	$197
Invoices confirmed	936
Invoices paid	(935)
Confirmed obligations outstanding at end of year	$198

4. Segment Information

U. S. Steel has four reportable segments: North American Flat-Rolled, Mini Mill, USSE and Tubular Products. The results of our real estate business are disclosed in the Other category. The majority of U. S. Steel's customers are located in North America and Europe. During 2024, sales to one customer of the Flat-Rolled segment were approximately $2.0 billion which exceeded 10 percent of U. S. Steel's total consolidated net sales. During 2023 and 2022, no single customer accounted for more than 10 percent of U. S. Steel's total consolidated net sales.

The Flat-Rolled segment includes the operating results of U. S. Steel's integrated steel plants and equity investees in the United States involved in the production of slabs, strip mill plates, sheets and tin mill products, as well as all pig iron, iron

ore and coke production facilities in the United States. These operations primarily serve North American customers in the service center, conversion, transportation (including automotive), construction, container and appliance and electrical markets.

The Mini Mill segment includes the operating results of Big River Steel and BR2 steel plants in Osceola, Arkansas involved in the production of sheets and electrical products. These operations primarily serve North American customers in the service center, conversion, transportation (including automotive), construction, container and appliance and electrical markets.

The USSE segment includes the operating results of USSK, U. S. Steel's integrated steel plant and coke production facilities in Slovakia, and its subsidiaries. USSE conducts its business mainly in Central and Western Europe and primarily serves customers in the European transportation (including automotive), construction, container, appliance, electrical, service center, conversion and oil, gas and petrochemical markets. USSE produces and sells slabs, hot-rolled, cold-rolled, hot-dip galvanized, and color-coated coils, electrical steel, strip mill plate, sheet, tin mill products and spiral welded pipe.

The Tubular segment includes the operating results of U. S. Steel's tubular production facilities and an equity investee in the United States. These operations produce and sell rounds, seamless and electric resistance welded (welded) steel casing and tubing (commonly known as oil country tubular goods or OCTG), standard and line pipe and mechanical tubing and primarily serve customers in the oil, gas and petrochemical markets. The Tubular segment includes the electric arc furnace at our Fairfield Tubular Operations in Fairfield, Alabama.

The chief operating decision maker (CODM), which is the chief executive officer, evaluates segment performance and determines resource allocations based on a number of factors, the primary measure being earnings (loss) before interest, taxes, depreciation and amortization (EBITDA). EBITDA for reportable segments and the Other category does not include net interest and other financial costs (income), income taxes, and certain other items that management believes are not indicative of future results. For all of the segments, the CODM uses segment EBITDA in the Annual Operating Plan (AOP) and monthly performance review processes. The CODM considers AOP-to-actual EBITDA variances on a monthly, quarter-to-date, and year-to-date basis for evaluating performance of each segment and making decisions about resource allocations to each segment.

The accounting principles applied at the operating segment level in determining earnings (loss) before interest, taxes, depreciation and amortization are generally the same as those applied at the consolidated financial statement level. Intersegment sales and transfers are accounted for at market-based prices and are eliminated at the corporate consolidation level. Corporate-level selling, general and administrative expenses and costs related to certain former businesses are allocated to the reportable segments and Other based on measures of activity that management believes are reasonable.

The results of segment operations are as follows:

(In millions)	Flat-Rolled	Mini Mill	USSE	Tubular	Total
2024					
Customer sales	$ 9,604	$ 2,070	$ 2,983	$ 970	$ 15,627
Intersegment sales	211	347	24	7	589
Net sales	9,815	2,417	3,007	977	16,216
Other net sales [a]					13
Elimination of intersegment sales					(589)
Total net sales					$ 15,640
Less: [b]					
Cost of sales	8,775	2,063	2,898	843	14,579
Earnings from investees	(90)	—	—	(22)	(112)
Other segment items [c]	196	121	38	21	376
Segment earnings before interest, taxes, depreciation and amortization	934	233	71	135	$ 1,373
Other loss before interest, taxes, depreciation and amortization [a]					(7)
Depreciation, depletion and amortization					(913)
Items not allocated to segments:					
Restructuring and other charges (Note 25)					(8)
Stock-based compensation expense (Note 15)					(51)
Asset impairment charges					(19)
Environmental remediation charges					(18)
Strategic alternatives review process costs					(90)
Granite City idling costs					(11)
Other charges, net					(16)
Earnings before interest and income taxes					$ 240
Net interest and other financial benefits					(198)
Earnings before income taxes					$ 438
Capital expenditures [d]	495	1,641	118	33	2,287
Segment depreciation, depletion and amortization	(535)	(203)	(125)	(50)	(913)
Other depreciation, depletion and amortization [a]					—
Total depreciation, depletion and amortization					$ (913)
Assets [d]	7,266	9,339	1,904	975	19,484
Other assets [a]					127
Corporate, reconciling items, and eliminations [e]					624
Total assets					$ 20,235

[a] The results of our real estate business are disclosed in the Other category.

[b] The significant expense (income) categories and amounts align with the segment-level information that is regularly provided to the CODM. Intersegment expenses are included within the amounts shown.

[c] Other segment items primarily include selling, general and administrative expenses, BRS recycling tax credit revenue and BR2 startup costs.

[d] Mini Mill includes capital expenditures and assets related to BR2 of $1.4 billion and $4.7 billion, respectively.

[e] The majority of Corporate, reconciling items, and eliminations total assets is comprised of cash and the elimination of intersegment amounts.

(In millions)	Flat-Rolled	Mini Mill	USSE	Tubular	Total
2023					
Customer sales	$ 10,744	$ 2,223	$ 3,525	$ 1,551	$ 18,043
Intersegment sales	365	455	25	1	846
Net sales	11,109	2,678	3,550	1,552	18,889
Other net sales [a]					10
Elimination of intersegment sales					(846)
Total net sales					$ 18,053
Less: [b]					
Cost of sales	9,899	2,259	3,413	931	16,502
Earnings from investees	(72)	—	—	(43)	(115)
Other segment items [c]	259	36	39	26	360
Segment earnings before interest, taxes, depreciation and amortization	1,023	383	98	638	$ 2,142
Other loss before interest, taxes, depreciation and amortization [a]					(3)
Depreciation, depletion and amortization					(916)
Items not allocated to segments:					
Restructuring and other charges (Note 25)					(36)
Stock-based compensation expense (Note 15)					(51)
Asset impairment charges					(127)
Environmental remediation charges					(11)
Strategic alternatives review process costs					(79)
Granite City idling costs					(121)
Other charges, net					1
Earnings before interest and income taxes					$ 799
Net interest and other financial benefits					(248)
Earnings before income taxes					$ 1,047
Capital expenditures [d]	536	1,899	109	32	2,576
Segment depreciation, depletion and amortization	(605)	(168)	(94)	(49)	(916)
Other depreciation, depletion and amortization [a]					—
Total depreciation, depletion and amortization					$ (916)
Assets [d]	7,546	7,569	2,229	1,002	18,346
Other assets [a]					140
Corporate, reconciling items, and eliminations [e]					1,965
Total assets					$ 20,451

[a] The results of our real estate business are disclosed in the Other category.

[b] The significant expense (income) categories and amounts align with the segment-level information that is regularly provided to the CODM. Intersegment expenses are included within the amounts shown.

[c] Other segment items primarily include selling, general and administrative expenses, BRS recycling tax credit revenue and BR2 startup costs.

[d] Mini Mill includes capital expenditures and assets related to BR2 of $1.5 billion and $3.0 billion, respectively.

[e] The majority of Corporate, reconciling items, and eliminations total assets is comprised of cash and the elimination of intersegment amounts.

(In millions)	Flat-Rolled	Mini Mill	USSE	Tubular	Total
2022					
Customer sales	$ 12,522	$ 2,681	$ 4,243	$ 1,611	$ 21,057
Intersegment sales	350	366	13	5	734
Net sales	12,872	3,047	4,256	1,616	21,791
Other net sales [a]					9
Elimination of intersegment sales					(735)
Total net sales					$ 21,065
Less: [b]					
Cost of sales	10,357	2,381	3,696	1,024	17,458
Earnings from investees	(220)	—	—	(23)	(243)
Other segment items [c]	228	27	31	23	309
Segment earnings before interest, taxes, depreciation and amortization	2,507	639	529	592	$ 4,267
Other earnings before interest, taxes, depreciation and amortization [a]					23
Depreciation, depletion and amortization					(791)
Items not allocated to segments:					
Restructuring and other charges (Note 25)					(48)
Stock-based compensation expense (Note 15)					(57)
Asset impairment charges					(163)
Environmental remediation charges					(13)
United Steelworkers labor agreement signing bonus and related costs					(64)
Gains on assets sold & previously held investments					6
Earnings before interest and income taxes					$ 3,160
Net interest and other financial benefits					(99)
Earnings before income taxes					$ 3,259
Capital expenditures [d]	503	1,159	90	17	1,769
Segment depreciation, depletion and amortization	(499)	(158)	(85)	(48)	(790)
Other depreciation, depletion and amortization [a]					(1)
Total depreciation, depletion and amortization					$ (791)
Assets [d]	7,936	5,787	2,175	1,140	17,038
Other assets [a]					141
Corporate, reconciling items, and eliminations [e]					2,279
Total assets					$ 19,458

[a] The results of our real estate business are disclosed in the Other category.

[b] The significant expense (income) categories and amounts align with the segment-level information that is regularly provided to the CODM. Intersegment expenses are included within the amounts shown.

[c] Other segment items primarily include selling, general and administrative expenses, BRS recycling tax credit revenue and adjustments in electricity purchase agreements.

[d] Mini Mill includes capital expenditures and assets related to BR2 of $0.8 billion and $1.4 billion, respectively.

[e] The majority of Corporate, reconciling items, and eliminations total assets is comprised of cash and the elimination of intersegment amounts.

Geographic Area:
The information below summarizes external sales, property, plant and equipment and equity method investments based on the location of the operating segment to which they relate.

(In millions)	Year	External Sales	Assets
North America	**2024**	**$ 12,657**	**$ 11,853** [(a)]
	2023	14,528	10,223 [(a)]
	2022	16,822	8,459 [(a)]
Europe	**2024**	**2,983**	**854**
	2023	3,525	910
	2022	4,243	843
Total	**2024**	**15,640**	**12,707**
	2023	18,053	11,133
	2022	21,065	9,302

[(a)] Assets with a book value of $11,853 million, $10,223 million, and $8,459 million were located in the United States at December 31, 2024, 2023, and 2022, respectively.

5. Dispositions

Real Property, South Works Disposition
In July 2024, the Company entered into a purchase and sale agreement with a third party for the sale of substantially all of the Company's former South Works real property. The Company will convey title of the property to the buyer for expected proceeds of approximately $70 million. This transaction is expected to close within the next 12 months.

USS-UPI, LLC Disposition
In December 2023, production at USS-UPI, LLC (UPI) was indefinitely idled. The Company has accrued a total of $44 million and $108 million for severance, exit costs and employee benefits as of December 31, 2024 and 2023, respectively. Payments of $59 million for these items were made during the year ended December 31, 2024. The Company has previously committed to, and continues to intend to, pursue the disposition of certain assets related to the UPI facility.

As of December 31, 2024, the South Works property and the UPI facility are recorded as assets held-for-sale which are recorded in Other current assets on the Consolidated Balance Sheet.

6. Revenue

Revenue is generated primarily from contracts to produce, ship and deliver steel products, and to a lesser extent, raw materials sales such as iron ore pellets and coke by-products and real estate sales. Generally, U. S. Steel's performance obligations are satisfied and revenue is recognized when title transfers to our customer for product shipped or services are provided. Revenues are recorded net of any sales incentives. Shipping and other transportation costs charged to customers are treated as fulfillment activities and are recorded in both revenue and cost of sales at the time control to the related good being shipped is transferred to the customer. Costs related to obtaining sales contracts are incidental and are expensed when incurred. Because customers are invoiced at the time title transfers and U. S. Steel's right to consideration is unconditional at that time, U. S. Steel does not maintain contract asset balances. Additionally, U. S. Steel does not maintain contract liability balances, as performance obligations are satisfied prior to customer payment for product. U. S. Steel offers industry standard payment terms.

The following tables disaggregate our revenue by product for each of our reportable business segments for the years ended December 31, 2024, 2023, and 2022, respectively (Net Sales by Product, excluding intersegment sales, in millions):

Year Ended December 31, 2024	**Flat-Rolled**	**Mini Mill**	**USSE**	**Tubular**	**Other**	**Total**
Semi-finished	**$ 84**	**$ —**	**$ 78**	**$ 35**	**$ —**	**$ 197**
Hot-rolled sheets	**1,566**	**1,039**	**1,468**	**—**	**—**	**4,073**
Cold-rolled sheets	**3,665**	**325**	**229**	**—**	**—**	**4,219**
Coated sheets	**2,899**	**701**	**1,052**	**—**	**—**	**4,652**
Tubular products	**—**	**—**	**51**	**913**	**—**	**964**
All other [(a)]	**1,390**	**5**	**105**	**22**	**13**	**1,535**
Total	**$ 9,604**	**$ 2,070**	**$ 2,983**	**$ 970**	**$ 13**	**$ 15,640**

[(a)] Consists primarily of sales of raw materials and coke making by-products

Year Ended December 31, 2023	Flat-Rolled	Mini Mill	USSE	Tubular	Other	Total
Semi-finished	$ 242	$ —	$ 168	$ —	$ —	$ 410
Hot-rolled sheets	1,926	1,215	1,637	—	—	4,778
Cold-rolled sheets	3,568	365	269	—	—	4,202
Coated sheets	3,484	639	1,278	—	—	5,401
Tubular products	—	—	52	1,528	—	1,580
All other [(a)]	1,524	4	121	23	10	1,682
Total	$ 10,744	$ 2,223	$ 3,525	$ 1,551	$ 10	$ 18,053

[(a)] Consists primarily of sales of raw materials and coke making by-products.

Year Ended December 31, 2022	Flat-Rolled	Mini Mill	USSE	Tubular	Other	Total
Semi-finished	$ 193	$ —	$ 103	$ —	$ —	$ 296
Hot-rolled sheets	2,338	1,570	1,919	—	—	5,827
Cold-rolled sheets	3,898	356	385	—	—	4,639
Coated sheets	4,461	745	1,622	—	—	6,828
Tubular products	—	—	68	1,594	—	1,662
All other [(a)]	1,632	10	146	17	8	1,813
Total	$ 12,522	$ 2,681	$ 4,243	$ 1,611	$ 8	$ 21,065

[(a)] Consists primarily of sales of raw materials and coke making by-products.

7. Net Interest and Other Financial Costs

(In millions)	2024	2023	2022
Interest income:			
Interest income	**$ (96)**	$ (141)	$ (44)
Interest expense and other financial costs:			
Interest incurred	**237**	234	218
Less interest capitalized	**213**	162	59
Total interest expense	**24**	72	159
Loss on debt extinguishment [(a)]	**2**	—	—
Net periodic benefit income	**(132)**	(154)	(246)
Net gain from investments related to active employee benefits	**(25)**	(43)	—
Foreign currency net loss (gain) [(b)]	**6**	(5)	11
Financial costs on:			
Amended Credit Agreement	**5**	5	5
USSK Credit Facility	**2**	4	3
Other	**7**	5	4
Amortization of discounts and deferred financing costs	**9**	9	9
Total other financial costs	**29**	18	32
Net interest and other financial (benefits) costs	**$ (198)**	$ (248)	$ (99)

[(a)] Represents a net pretax charge of $2 million during 2024 related to the repayments of the 2026 Senior Convertible Notes.
[(b)] The functional currency for USSE is the euro. Foreign currency net loss (gain) is a result of transactions denominated in currencies other than the euro.

8. Earnings and Dividends Per Common Share

Earnings per Share Attributable to United States Steel Corporation Stockholders
Basic earnings per common share is based on the weighted average number of common shares outstanding during the period.

Diluted earnings per common share assumes the exercise of stock options, the vesting of restricted stock units and performance awards, provided in each case the effect is dilutive. The “if-converted” method is used to calculate the dilutive effect of the Senior Convertible Notes due in 2026 as a result of ASU 2020-06.

The computations for basic and diluted earnings per common share from continuing operations are as follows:

(Dollars in millions, except per share amounts)	2024	2023	2022
Net earnings attributable to United States Steel Corporation stockholders			
Basic	**$ 384**	$ 895	$ 2,524
Interest expense on Senior Convertible Notes, net of tax	**13**	13	13
Diluted	**$ 397**	$ 908	$ 2,537
Weighted-average shares outstanding (in thousands):			
Basic	**224,817**	224,761	246,986
Effect of Senior Convertible notes	**26,159**	26,194	26,194
Effect of stock options, restricted stock units and performance awards	**3,028**	4,405	3,783
Diluted	**254,004**	255,360	276,963
Net earnings per share attributable to United States Steel Corporation stockholders:			
Basic	**$ 1.71**	$ 3.98	$ 10.22
Diluted	**$ 1.57**	$ 3.56	$ 9.16

The following table summarizes the securities that were antidilutive, and therefore, were not included in the computation of diluted earnings per common share:

(In thousands)	2024	2023	2022
Securities granted under the 2016 Omnibus Incentive Compensation Plan, as amended and restated	**125**	475	960

Dividends Paid per Share
Quarterly dividends on common stock were five cents per share for each quarter in 2024, 2023, and 2022.

9. Cash, Cash Equivalents and Restricted Cash

The following table provides a reconciliation of cash, cash equivalents and restricted cash reported within U. S. Steel's Consolidated Balance Sheets that sum to the total of the same amounts shown in the Consolidated Statements of Cash Flows:

	December 31,		
(In millions)	2024	2023	2022
Cash and cash equivalents	**$ 1,367**	$ 2,948	$ 3,504
Restricted cash in other current assets	**11**	8	4
Long-term restricted cash	**35**	32	31
Total cash, cash equivalents and restricted cash	**$ 1,413**	$ 2,988	$ 3,539

Amounts included in restricted cash represent cash balances which are legally or contractually restricted, primarily for insurance purposes, environmental liabilities and other capital projects.

10. Inventories

(In millions)	December 31, 2024	December 31, 2023
Raw materials	**$ 959**	$ 773
Semi-finished products	**828**	877
Finished products	**331**	428
Supplies and sundry items	**50**	50
Total	**$ 2,168**	$ 2,128

Current acquisition costs for LIFO inventories were estimated to exceed the above inventory values at December 31 by $1.1 billion in 2024 and $1.2 billion in 2023. As a result of the liquidation of LIFO inventories, cost of sales increased and earnings before interest and income taxes decreased by $3 million in 2024. Cost of sales decreased and earnings before interest and income taxes increased by $43 million and $44 million in 2023 and 2022, respectively.

11. Income Taxes

Components of earnings before income taxes:

(In millions)	2024	2023	2022
United States	**$ 499**	$ 1,041	$ 2,847
Foreign	**(61)**	6	412
Earnings before income taxes	**$ 438**	$ 1,047	$ 3,259

At the end of 2024, 2023, and 2022, U. S. Steel does not have any undistributed foreign earnings and profits for which U.S. deferred taxes have not been provided.

Income tax provision (benefit):

	2024			2023			2022		
(In millions)	Current	Deferred	Total	Current	Deferred	Total	Current	Deferred	Total
Federal	**$ (53)**	**$ 60**	**$ 7**	$ 56	$ 116	$ 172	$ 101	$ 451	$ 552
State and local	**(6)**	**24**	**18**	(3)	(14)	(17)	54	43	97
Foreign	**—**	**29**	**29**	2	(5)	(3)	79	7	86
Total	**$ (59)**	**$ 113**	**$ 54**	$ 55	$ 97	$ 152	$ 234	$ 501	$ 735

A reconciliation of the federal statutory tax rate of 21 percent to total provision follows:

(In millions)	2024	2023	2022
Statutory rate applied to earnings before income taxes	**$ 92**	$ 220	$ 684
Valuation allowance	**47**	(14)	(38)
Excess percentage depletion	**(23)**	(18)	(48)
Capitalized transaction costs	**13**	10	—
State and local income taxes after federal income tax effects	**8**	(1)	97
Effects of foreign operations	**(12)**	(3)	85
U.S. impact of foreign operations	**(29)**	(19)	6
Impact of tax credits	**(11)**	(7)	(83)
Adjustment of prior years' federal income taxes	**(42)**	(34)	40
Unrecognized tax benefits	**12**	2	—
Stock compensation	**(7)**	(5)	(3)
Nondeductible executive compensation	**5**	16	6
Other	**1**	5	(11)
Total provision	**$ 54**	$ 152	$ 735

Included in the 2024 provision is a benefit of $59 million related to the 2023 federal and state income tax returns.

In March 2022, the Company and the Arkansas Economic Development Commission entered into the Recycling Tax Credit Incentive Agreement, whereby the Company may earn state income tax credits in an amount equal to 30 percent of the cost of waste reduction, reuse, or recycling equipment, subject to meeting the requirements of the Arkansas Code Ann. Section 26-51-506, for the Company's BR2 facility near Osceola, Arkansas. Documentation supporting the Company's investment in qualifying equipment must be submitted as part of an application for certification expected to be completed in 2025. In March 2022, the Company received a lump-sum payment of approximately $82 million as proceeds from the sale of a portion of expected future tax credits to be earned by the Company (see Note 26 for additional information). The Company estimates that it could earn tax credits in excess of $700 million, exclusive of the amount sold in March 2022, which the Company will recognize in the year it meets the requirements of Arkansas Code Ann. Section 26-51-506. Any unused tax credit that cannot be claimed in a tax year may be carried forward indefinitely by the Company and applied to its future state tax liability.

On August 16, 2022, H.R. 5376 (commonly called the Inflation Reduction Act of 2022) was signed into law, which, among other things, implemented a corporate alternative minimum tax (CAMT) of 15 percent on net book income of certain large corporations adjusted for certain items prescribed by the legislation.

The Organization for Economic Co-operation and Development (the "OECD"), an international association of 38 countries including the U.S., has proposed changes to numerous long-standing tax principles, including a global minimum tax initiative. On December 12, 2022, the European Union member states agreed to implement the OECD's Pillar 2 global

corporate minimum tax rate of 15 percent on companies with revenues of at least €750 million, which went into effect in 2024. The law on minimum top-up tax for multinational enterprise groups and large-scale domestic groups in Slovakia was approved by the parliament on December 8, 2023 and signed by the President on December 21, 2023, with an effective date of December 31, 2023.

The Company analyzed the 2024 tax effects of CAMT and Pillar 2, which were not material to the Consolidated Financial Statements.

Included in the 2023 provision is a benefit of $43 million related to the 2022 federal and state income tax returns, as well as an additional benefit of $12 million related to the adjustment of prior years' federal income taxes. Also included in the 2023 provision is a benefit of $23 million related to the recognition of a deferred tax asset on unrecognized currency losses in branch operations pursuant to proposed regulations under Internal Revenue Code Section 987.

Deferred taxes

Deferred tax assets and liabilities resulted from the following:

	December 31,	
(In millions)	**2024**	**2023**
Deferred tax assets:		
Federal tax loss carryforwards (no expiration)	**$ 213**	$ 1
Federal capital loss carryforwards (expiring in 2026)	**69**	69
State tax credit carryforwards (expiring in 2027 through 2038)	**17**	14
State tax loss carryforwards (expiring in 2026 through 2044)	**91**	80
State capital loss carryforwards (expiring in 2026 through 2036)	**21**	23
General business credit carryforwards (expiring in 2044)	**9**	—
Foreign tax loss and credit carryforwards (expiring in 2027 through 2034)	**26**	8
Operating lease liabilities	**19**	28
Capitalized research and development	**76**	69
Receivables, payables and debt	**149**	140
Inventory	**48**	57
Other temporary differences	**71**	41
Valuation allowance	**(149)**	(101)
Total deferred tax assets	**$ 660**	$ 429
Deferred tax liabilities:		
Property, plant and equipment	**$ 589**	$ 642
Operating right-of-use assets	**17**	26
Investments in subsidiaries and equity investees	**557**	184
Employee benefits	**109**	72
Contingencies and accrued liabilities	**45**	73
Total deferred tax liabilities	**$ 1,317**	$ 997
Net deferred tax liability	**$ (657)**	$ (568)

U. S. Steel recognizes deferred tax assets and liabilities for the estimated future tax consequences attributable to differences between the financial statement carrying amounts of existing assets and liabilities and their respective tax basis. The realization of deferred tax assets is assessed quarterly based on several interrelated factors. These factors include U. S. Steel's expectation to generate sufficient future taxable income and the projected time period over which these deferred tax assets will be realized.

Each quarter U. S. Steel analyzes the likelihood that our deferred tax assets will be realized. A valuation allowance is recorded if, based on the weight of all available positive and negative evidence, it is more likely than not that some portion, or all, of a deferred tax asset will not be realized.

At December 31, 2024, the net domestic deferred tax liability was $619 million, net of an established valuation allowance of $103 million. At December 31, 2023, the net domestic deferred tax liability was $566 million, net of an established valuation allowance of $98 million.

At December 31, 2024, the net foreign deferred tax liability was $38 million, net of an established valuation allowance of $46 million. At December 31, 2023, the net foreign deferred tax liability was $2 million, net of an established valuation allowance of $3 million. The net foreign deferred tax asset will fluctuate as the value of the U.S. dollar changes with respect to the euro.

U. S. Steel will continue to monitor the realizability of its deferred tax assets on a quarterly basis. In the future, if we determine that realization is more likely than not for a deferred tax asset with a valuation allowance, the related valuation allowance will be reduced, and we will record a non-cash benefit to earnings.

Unrecognized tax benefits

Unrecognized tax benefits are the differences between a tax position taken, or expected to be taken, in a tax return and the benefit recognized for accounting purposes pursuant to the guidance in ASC Topic 740 on income taxes. The total amount of gross unrecognized tax benefits was $18 million, $4 million, and $2 million as of December 31, 2024, 2023, and 2022, respectively.

The total amount of net unrecognized tax benefits that, if recognized, would affect the effective tax rate was $18 million and $4 million as of December 31, 2024, and 2023, respectively.

U. S. Steel records interest related to uncertain tax positions as a part of net interest and other financial costs in the Consolidated Statements of Operations. Any penalties are recognized as part of selling, general and administrative expenses. U. S. Steel had accrued liabilities for interest and penalties related to uncertain tax positions of less than $1 million and $2 million as of December 31, 2024, and 2023, respectively.

A tabular reconciliation of unrecognized tax benefits follows:

(In millions)	2024	2023	2022
Unrecognized tax benefits, beginning of year	**$ 4**	$ 2	$ 3
Increases – tax positions taken in prior years	**16**	—	—
Increases – current tax positions	**—**	2	—
Lapse of statute of limitations	**(2)**	—	(1)
Unrecognized tax benefits, end of year	**$ 18**	$ 4	$ 2

Tax years subject to examination

Below is a summary of the tax years open to examination by major tax jurisdiction:

U.S. Federal – 2021 and forward
U.S. States – 2017 and forward
Slovakia – 2013 and forward

Status of Internal Revenue Service (IRS) examinations

The IRS completed its audit of the Company's 2017-2018 federal consolidated tax returns in 2023.

12. Investments, Long-Term Receivables and Equity Investee Transactions

	December 31,	
(In millions)	2024	2023
Equity method investments	**$ 734**	$ 740
Receivables due after one year, less allowance of $3 in both periods	**21**	19
Other	**2**	2
Total	**$ 757**	$ 761

Summarized financial information of all investees accounted for by the equity method of accounting is as follows (amounts represent 100% of investee financial information):

(In millions)	2024	2023	2022
Income data – year ended December 31:			
Net Sales	**$ 3,184**	$ 3,335	$ 3,222
Operating income	**245**	342	492
Net earnings	**220**	319	462
Balance sheet date – December 31:			
Current Assets	**$ 847**	$ 876	$ 1,085
Noncurrent Assets	**788**	844	974
Current liabilities	**226**	255	314
Noncurrent Liabilities	**392**	398	513

U. S. Steel's portion of the income (loss) from investees reflected on the Consolidated Statements of Operations was $112 million, $115 million, and $243 million for the years ended December 31, 2024, 2023, and 2022, respectively.

All of our significant investees are located in the U.S. Investees accounted for using the equity method include:

Investee	December 31, 2024 Interest
Chrome Deposit Corporation	50 %
Double G Coatings Company, Inc.	50 %
Hibbing Development Company	24.1 %
Hibbing Taconite Company[(a)]	14.7 %
Patriot Premium Threading Services, LLC	50 %
PRO-TEC Coating Company, LLC	50 %

[(a)] Hibbing Taconite Company (Hibbing) is an unincorporated joint venture that is owned, in part, by Hibbing Development Company (HDC), which is accounted for using the equity method. Through HDC we are able to influence the activities of Hibbing, and as such, its activities are accounted for using the equity method.

In 2022, the Company recognized pre-tax gains on equity investee transactions of approximately $6 million from Worthington Specialty Processing pertaining to the sale of the former joint venture's facilities and subsequent distribution to the investors. The joint venture is expected to be dissolved in the future and is expected to result in an immaterial distribution to the Company.

Dividends or partnership distributions received from equity investees were $109 million, $114 million and $28 million in 2024, 2023 and 2022, respectively.

U. S. Steel evaluates impairment of its equity method investments whenever circumstances indicate that a decline in value below carrying value is other than temporary. Under these circumstances, we would adjust the investment down to its estimated fair value, which then becomes its new carrying value.

We supply substrate to certain of our equity method investees and from time to time will extend the payment terms for their trade receivables. For discussion of transactions and related receivable and payable balances between U. S. Steel and its investees, see Note 23.

13. Property, Plant and Equipment

(In millions)	Useful Lives	December 31, 2024	2023
Land and depletable property	—	**$ 257**	$ 216
Buildings	35-40 years	**2,883**	1,854
Machinery and equipment			
Steel producing	2-30 years	**19,790**	16,806
Other	5-30 years	**102**	97
Information technology	5-15 years	**857**	829
Assets under finance lease	5-15 years	**379**	302
Construction in process	—	**1,971**	3,871
Total		**26,239**	23,975
Less accumulated depreciation and depletion		**14,266**	13,582
Net		**$ 11,973**	$ 10,393

Amounts in accumulated depreciation and depletion for assets acquired under finance leases were $182 million and $126 million at December 31, 2024, and 2023, respectively.

14. Goodwill and Intangible Assets

Intangible assets are being amortized on a straight-line basis over their estimated useful lives and are detailed below:

(In millions)	Useful Lives	As of December 31, 2024 Gross Carrying Amount	Accumulated Amortization	Net Amount	As of December 31, 2023 Gross Carrying Amount	Accumulated Amortization	Net Amount
Customer relationships	22 Years	**$ 413**	**$ 75**	**$ 338**	$ 413	$ 56	$ 357
Patents	5-15 Years	**17**	**14**	**3**	17	13	4
Energy Contract	2 Years	**—**	**—**	**—**	54	54	—
Total amortizable intangible assets		**$ 430**	**$ 89**	**$ 341**	$ 484	$ 123	$ 361

Amortization expense was $20 million and $42 million for years ended December 31, 2024, and December 31, 2023, respectively. We expect approximately $97 million in total amortization expense from 2025 through 2029 and approximately $244 million in remaining amortization expense thereafter.

The carrying amount of acquired water rights with indefinite lives as of December 31, 2024, and December 31, 2023, totaled $75 million.

Below is a summary of goodwill by segment for the twelve months ended December 31, 2024:

(In millions)	Flat-Rolled	Mini Mill	USSE	Tubular	Total
Balance at December 31, 2023	$ —	$ 916	$ 4	$ —	$ 920
Additions	**—**	**—**	**—**	**—**	**—**
Balance at December 31, 2024	**$ —**	**$ 916**	**$ 4**	**$ —**	**$ 920**

15. Stock-Based Compensation Plans

U. S. Steel has outstanding stock-based compensation awards that were granted by the Compensation & Organization Committee of the Board of Directors (the Committee), or its designee, under the 2005 Stock Incentive Plan (the 2005 Plan) and the 2016 Omnibus Incentive Compensation Plan, as amended and restated (the Omnibus Plan) (collectively the Plans). On April 26, 2016, the Company's stockholders approved the Omnibus Plan and authorized the Company to issue up to 7,200,000 shares of U. S. Steel common stock under the Omnibus Plan. The Company's stockholders authorized the issuance of an additional 6,300,000 shares under the Omnibus Plan on April 25, 2017, an additional 4,700,000 shares under the Omnibus Plan on April 28, 2020, and an additional 14,500,000 shares under the Omnibus Plan on April 27, 2021. While awards that were previously granted under the 2005 Plan remain outstanding, all future awards will be granted under the Omnibus Plan. As of December 31, 2024, there were 4,084,130 shares available for future grants under the Omnibus Plan.

Generally, a share issued under the Omnibus Plan pursuant to an award other than a stock option will reduce the number of shares available under the Stock Plan by 1.78 shares. Shares related to awards under either plan (i) that are forfeited, (ii) that terminate without shares having been issued or (iii) for which payment is made in cash or property other than shares, are again available for awards under the Omnibus Plan. Shares delivered to U. S. Steel or withheld for purposes of satisfying the exercise price or tax withholding obligations are not available for future awards. The purpose of the Plans is to attract, reward and retain employees and non-employee directors who create long-term value for our stockholders by delivering on objectives that support our long-term strategy. The Committee administers the Plans, and under the Omnibus Plan may make grants of stock options, restricted stock units (RSUs), performance awards, and other stock-based awards.

The following table summarizes the total stock-based compensation awards granted during the years 2024, 2023, and 2022:

	Restricted Stock Units	TSR Performance Awards	ROCE Performance Awards	Performance-Based Restricted Stock Units
2024	**801,540**	**—**	**230,350**	**—**
2023	2,126,020	185,120	357,020	—
2022	1,249,830	236,520	408,870	83,951

Stock-based compensation expense
The following table summarizes the total compensation expense recognized for stock-based compensation awards:

(In millions, except per share amounts)	Year Ended December 31, 2024	Year Ended December 31, 2023	Year Ended December 31, 2022
Stock-based compensation expense recognized:			
Cost of sales	**$ 20**	$ 16	$ 15
Selling, general and administrative expenses	**32**	35	42
Total	**52**	51	57
Related deferred income tax benefit	**12**	12	14
Decrease in net income	**40**	39	43
Decrease in basic earnings per share	**0.18**	0.17	0.18
Decrease in diluted earnings per share	**0.16**	0.15	0.16

As of December 31, 2024, total future compensation cost related to nonvested stock-based compensation arrangements was $43 million and the average period over which this cost is expected to be recognized is approximately 21 months.

Stock options
Compensation expense for stock options is recorded over the vesting period based on the fair value on the date of grant, as calculated by U. S. Steel using the Black-Scholes model and the assumptions listed below. Awards generally vest ratably over a three-year service period and have a term of ten years. Stock options are generally issued at the average market price of the underlying stock on the date of the grant. Upon exercise of stock options, shares of U. S. Steel stock are issued from treasury stock or from authorized, but unissued common stock. There were 171,000 performance-based stock options granted in 2021. There were no stock options granted in 2024, 2023, and 2022.

The 171,000 performance-based stock options granted in December 2021 do not become vested and exercisable until the Company's 20-trading day average closing stock price meets or exceeds the following stock price hurdles during the seven-year period beginning on the grant date, as follows:

20-trading day Average Closing Stock Price Achievement During 7-Year Period Beginning on Grant Date [(a)]	Percentage of Performance-Based Stock Options Exercisable
$ 35.00	33.33 %
$ 45.00	33.33 %
$ 55.00	33.34 %

[(a)] The $35.00 tranche vested in April 2022 and the $45.00 tranche vested in January 2024.

The following table shows a summary of the status and activity of stock options for the year ended December 31, 2024:

	Shares	Weighted-Average Exercise Price (per share)	Weighted-Average Remaining Contractual Term (in years)	Aggregate Intrinsic Value (in millions)
Outstanding at January 1, 2024	760,238	$ 27.98		
Granted	—	$ —		
Exercised	(158,908)	$ 24.90		
Forfeited or expired	(13,057)	$ 37.33		
Outstanding at December 31, 2024	588,273	$ 28.60	2.11	$ 4
Exercisable at December 31, 2024	531,273	$ 29.15	1.91	$ 4
Exercisable and expected to vest at December 31, 2024	588,273	$ 28.60	2.11	$ 4

The aggregate intrinsic value in the table above represents the total pretax intrinsic value (difference between our closing stock price on the last trading day of 2024 and the exercise price, multiplied by the number of in-the-money options). Intrinsic value changes are a function of the fair market value of our stock.

The total intrinsic value of stock options exercised (i.e., the difference between the market price at exercise and the price paid by the employee to exercise the option) was $3 million, $4 million, and $5 million during the years ended December 31, 2024, December 31, 2023, and December 31, 2022, respectively. The total amount of cash received by U. S. Steel from the exercise of options was $4 million and $10 million during the years ended December 31, 2024, and

December 31, 2023, respectively. The related net tax benefit realized from the exercise of these options was immaterial in 2024 and 2023.

Stock awards
Compensation expense for nonvested stock awards is recorded over the vesting period based on the fair value at the date of grant.

RSUs awarded as part of annual grants generally vest ratably over three years. Their fair value is the average market price of the underlying common stock on the date of grant. RSUs granted in connection with new-hire or retention awards generally cliff vest three years from the date of the grant.

Total shareholder return (TSR) performance awards may vest at varying levels at the end of a three-year performance period if U. S. Steel's total shareholder return compared to the total shareholder return of a peer group of companies meets performance criteria during the three-year performance period. TSR is calculated as follows: 20 percent for each year in the three-year performance period and 40 percent for the full three-year period. TSR performance awards may vest and pay out 50 percent at the threshold level, 100 percent at the target level and 200 percent at the maximum level. Payment for performance in between the threshold percentages will be interpolated. The fair value of the performance awards is calculated using a Monte-Carlo simulation.

Performance awards based on the return on capital employed (ROCE) metric will be measured based on the Company's consolidated worldwide earnings (loss) before interest and income taxes, as adjusted, divided by consolidated worldwide capital employed, as adjusted, over a three year period.

ROCE is calculated based on the ROCE achieved in the first, second and third years of the performance period, weighted at 20 percent for each year in the three-year performance period and 40 percent for the full three-year period. The ROCE awards will pay out 50 percent at the threshold level, 100 percent at the target level and 200 percent at the maximum level. Payment for performance in between the threshold percentages will be interpolated.

Compensation expense associated with the ROCE awards will be contingent based upon the achievement of the specified ROCE performance goals and will be adjusted on a quarterly basis to reflect the probability of achieving the ROCE metric.

ROCE performance awards may vest at the end of a three-year performance period contingent upon meeting ROCE performance goals approved by the Committee. The fair value of the ROCE performance awards is the average market price of the underlying common stock on the date of grant.

In December 2021 and August 2022, special performance-based restricted stock unit awards (PSUs) were granted to members of the Company's executive leadership team. Shares are earned based on the achievement of certain pre-set quantitative performance criteria during the four-year performance period, January 1, 2022, through December 31, 2025. Shares may vest following the expiration of the Performance Period if the Company satisfies the performance criteria.

The Chief Executive Officer was granted PSUs that vest with the following, equally weighted, performance metrics: (i) EBITDA margin expansion, (ii) greenhouse gas emissions intensity reduction, (iii) asset portfolio optimization, (iv) leverage metrics and (v) corporate relative valuation. Other members of the executive leadership team were granted PSUs that vest with performance criteria related to: (i) on time and on budget completion of the second mini mill (30% of the grant), (ii) EBITDA margin expansion (40% of the grant) and (iii) greenhouse gas emissions intensity reduction (30% of the grant).

For the PSU awards, a payout is achievable at threshold (50% of target), target (100% of target) or maximum (200% of target) performance achievement. Pay out amounts will be interpolated between the threshold, target and maximum amounts.

The following table shows a summary of the performance awards outstanding as of December 31, 2024, and their fair market value on the respective grant date:

Performance Period		Fair Value (in millions)	Minimum Shares	Target Shares	Maximum Shares
2024 - 2026	$	10	—	219,770	439,540
2023 - 2025	$	16	—	495,852	991,704
2022 - 2024	$	15	—	595,662	1,191,324
2021 - 2025	$	13	—	574,168	1,148,336

The following table shows a summary of the status and activity of nonvested stock awards for the year ended December 31, 2024:

	Restricted Stock Units	TSR Performance Awards [a]	ROCE Performance Awards [a]	Performance-Based Restricted Stock Units [a]	Total	Weighted-Average Grant-Date Fair Value
Nonvested at January 1, 2024	3,432,338	728,570	952,969	697,485	5,811,362	$ 26.95
Granted	801,540	—	230,350	—	1,031,890	47.22
Vested	(1,332,529)	(192,040)	(404,952)	—	(1,929,521)	23.00
Performance adjustment factor [b]	—	(114,890)	202,476	—	87,586	15.89
Forfeited or expired	(139,826)	(32,612)	(58,587)	(123,317)	(354,342)	29.60
Nonvested at December 31, 2024	2,761,523	389,028	922,256	574,168	4,646,975	$ 32.68

[a] The number of shares shown for the performance awards is based on the target number of share awards.
[b] Consists of adjustments to vested performance awards to reflect actual performance.

The following table presents information on RSUs and performance awards granted:

	2024	2023	2022
Number of awards granted	**1,031,890**	2,668,160	1,979,171
Weighted-average grant-date fair value per share	**$ 47.22**	$ 31.68	$ 24.52

During the years ended December 31, 2024, 2023, and 2022, the total fair value of shares vested was $44 million, $45 million, and $45 million, respectively.

16. Derivative Instruments

U. S. Steel is exposed to foreign currency exchange rate risks in our European operations. USSE's revenues are primarily in euros and costs are primarily in euros and U.S. dollars. U. S. Steel uses foreign exchange forward sales contracts (foreign exchange forwards) with maturities up to 12 months to manage our currency requirements and exposure to foreign currency exchange rate fluctuations. Derivative instruments are required to be recognized at fair value in the Consolidated Balance Sheet. The USSE and Flat-Rolled segments use hedge accounting for their foreign exchange forwards.

U. S. Steel also uses financial swaps to mitigate commodity price risks related to the procurement of natural gas, zinc, tin, electricity, and iron ore (commodity purchase swaps). We have elected cash flow hedge accounting for these commodity purchase swaps, which have maturities of up to 15 months.

U. S. Steel has entered into financial swaps that are used to partially manage the sales price risk of certain hot-rolled coil sales and iron ore sales (sales swaps). The sales swaps are accounted for using hedge accounting and have maturities of up to 12 months.

Generally, forward physical purchase contracts qualify for the normal purchase and normal sales exceptions described in ASC Topic 815 and are not subject to mark-to-market accounting. In accordance with the guidance in ASC Topic 820 on fair value measurements and disclosures, the fair value of our foreign exchange forwards, commodity purchase swaps and sales swaps was determined using Level 2 inputs, which are defined as "significant other observable" inputs. The inputs used are from market sources that aggregate data based upon market transactions.

The table below shows the outstanding swap quantities used to hedge forecasted purchases and sales as of December 31, 2024, and December 31, 2023:

Hedge Contracts	Classification	December 31, 2024	December 31, 2023
Natural gas (in mmbtus)	Commodity purchase swaps	**20,706,000**	20,625,000
Tin (in metric tons)	Commodity purchase swaps	**—**	5
Zinc (in metric tons)	Commodity purchase swaps	**9,300**	26,148
Electricity (in megawatt hours)	Commodity purchase swaps	**16,400**	183,288
Iron ore pellets (in metric tons)	Commodity purchase swaps	**2,880,000**	0
Iron ore pellets (in metric tons)	Sales swaps	**300,900**	120,834
Hot-rolled coils (in tons)	Sales swaps	**236,000**	261,000
Foreign currency (in millions of euros)	Foreign exchange forwards	**€ 368**	€ 452
Foreign currency (in millions of dollars)	Foreign exchange forwards	**$ —**	$ 37

The following summarizes the fair value amounts included in our Consolidated Balance Sheets as of December 31, 2024, and December 31, 2023:

Balance Sheet Location (in millions)	December 31, 2024	December 31, 2023
Designated as Hedging Instruments		
Accounts receivable	**$ 41**	$ 4
Accounts payable	**8**	81
Investments and long-term receivables	**1**	—
Other long-term liabilities	**1**	2

The table below summarizes the effect of hedge accounting on AOCI and amounts reclassified from AOCI into earnings for 2024, 2023, and 2022:

	Gain (Loss) on Derivatives in AOCI				Amount of Gain (Loss) Recognized in Income		
(In millions)	2024	2023	2022	Location of Reclassification from AOCI	2024	2023	2022
Sales swaps	**$ 58**	$ (41)	$ 14	Net sales	**$ 8**	$ (15)	$ (18)
Commodity purchase swaps	**20**	34	(35)	Cost of sales [(a)]	**(40)**	(105)	103
Foreign exchange forwards	**28**	(5)	(16)	Cost of sales	**7**	(1)	44

[(a)] Costs for commodity purchase swaps are recognized in cost of sales as products are sold.

The table below summarizes the impact of derivative activity where hedge accounting has not been elected on our Consolidated Statements of Operations for 2024, 2023, and 2022:

		Amount of Gain (Loss) Recognized in Income		
(In millions)	Consolidated Statements of Operations Location	2024	2023	2022
Commodity purchase swaps	Cost of sales	**$ —**	$ (13)	$ 18
Foreign exchange forwards	Other financial costs	**(1)**	1	(7)

At current contract values, $22 million in AOCI as of December 31, 2024, will be recognized as a decrease in cost of sales over the next year, and $12 million in AOCI as of December 31, 2024, will be recognized as an increase in net sales over the next year.

17. Debt

(In millions)	Issuer/Borrower	Interest Rates %	Maturity	December 31, 2024	2023
2037 Senior Notes	U. S. Steel	6.650	2037	**$ 274**	$ 274
2026 Senior Convertible Notes	U. S. Steel	5.000	2026	**349**	350
2029 Senior Notes	U. S. Steel	6.875	2029	**475**	475
2029 Senior Secured Notes	Big River Steel	6.625	2029	**720**	720
Environmental Revenue Bonds	U. S. Steel	4.125 - 6.750	2026 - 2053	**1,104**	1,164
Environmental Revenue Bonds	Big River Steel	4.500 - 4.750	2049	**752**	752
Finance leases and all other obligations	U. S. Steel	Various	2025 - 2029	**189**	157
Finance leases and all other obligations	Big River Steel	Various	2025 - 2027	**162**	167
ECA Credit Agreement	U. S. Steel	Variable	2031	**84**	97
Credit Facility Agreement	U. S. Steel	Variable	2027	**—**	—
Big River Steel ABL Facility	Big River Steel	Variable	2026	**—**	—
USSK Credit Agreement	U. S. Steel Kosice	Variable	2026	**—**	—
USSK Credit Facility	U. S. Steel Kosice	Variable	2027	**—**	—
Total debt				**4,109**	4,156
Less unamortized discount, premium and debt issuance costs				**(64)**	(66)
Less short-term debt, long-term debt due within one year, and short-term issuance costs				**95**	142
Long-term debt				**$ 4,078**	$ 4,080

Arkansas Development Finance Authority Environmental Improvement Revenue Bonds, Series 2023 (United States Steel Corporation Project) (Green Bonds)

On May 18, 2023, U. S. Steel closed on an offering consisting of an aggregate principal amount of $240 million unsecured Arkansas Development Finance Authority environmental improvement revenue bonds, which carry a green bond designation. The bonds, issued through Arkansas Development Finance Authority, have a coupon rate of 5.700% and a final maturity of 2053 (2053 ADFA Green Bonds). U. S. Steel received net proceeds of approximately $238 million after fees of approximately $2 million related to the underwriting and third-party expenses, and will pay semiannual interest. The net proceeds from the issuance of the 2053 ADFA Green Bonds were used to partially fund work related to the BR2 facility near Osceola, Arkansas.

On and after May 1, 2026, the Company may redeem the 2053 ADFA Green Bonds at its option, at any time in whole or from time to time in part at the redemption prices (expressed in percentages of principal amount) listed below, plus accrued and unpaid interest on the 2053 ADFA Green Bonds, if any, to, but excluding, the applicable redemption date, if redeemed during the twelve-month period beginning on May 1 of each of the years indicated below.

Year	Redemption Price
2026	105.000 %
2027	104.000 %
2028	103.000 %
2029	102.000 %
2030	101.000 %
2031 and thereafter	100.000 %

At any time prior to May 1, 2026, U. S. Steel may also redeem the 2053 ADFA Green Bonds, at our option, in whole or in part, or from time to time, at a price equal to the greater of 100 percent of the principal amount of the 2053 ADFA Green Bonds plus accrued and unpaid interest, if any, or the sum of the present value of the redemption price of the 2053 ADFA Green Bonds if they were redeemed on May 1, 2026, plus interest payments due through May 1, 2026, discounted to the date of redemption on a semi-annual basis at the applicable tax-exempt municipal bond rate, plus accrued and unpaid interest, if any.

2026 Senior Convertible Notes
In October 2019, U. S. Steel issued $350 million of 5.00% Senior Convertible Notes due November 1, 2026 (2026 Senior Convertible Notes). Interest on the 2026 Senior Convertible Notes is payable semi-annually on May 1 and November 1 of each year. The initial conversion rate for the 2026 Senior Convertible Notes is 74.8391 shares of U. S. Steel common stock per $1,000 principal amount, equivalent to an initial conversion price of approximately $13.36 per share of common stock, subject to adjustment pursuant to the 2026 Senior Convertible Notes indenture. Based on the initial conversion rate, the 2026 Senior Convertible Notes are convertible into 26,155,592 shares of U. S. Steel common stock and we reserved for the possible issuance of 33,348,361 shares, which is the maximum amount that could be issued upon conversion. Prior to August 1, 2026, holders of notes may convert all or a portion of their notes at their option only upon the satisfaction of specified conditions and during certain periods. On or after August 1, 2026, holders may convert all or a portion of their notes prior to the maturity date. Upon conversion, we will satisfy the obligation with cash, common stock, or a combination thereof, at our election. Anytime prior to August 1, 2026, if the price per share of U. S. Steel's common stock has been at least 130% of the conversion price for specified periods, U. S. Steel may redeem all or a portion of the 2026 Senior Convertible Notes at a cash redemption price of 100% of the principal amount, plus accrued and unpaid interest.

If U. S. Steel undergoes a fundamental change, as defined in the 2026 Senior Convertible Notes, holders may require us to repurchase the 2026 Senior Convertible Notes in whole or in part for cash at a price equal to 100% of the principal amount of the 2026 Senior Convertible Notes to be purchased plus any accrued and unpaid interest up to, but excluding the repurchase date.

Big River Steel — Sustainability Linked ABL Facility
Big River Steel's amended senior secured asset-based revolving credit facility (Big River Steel ABL Facility) matures on July 23, 2026. The facility is secured by first-priority liens on accounts receivable and inventory and certain other assets and second priority liens on most tangible and intangible assets of Big River Steel in each case subject to permitted liens. Additionally, the amendment includes sustainability targets related to greenhouse gas emissions intensity reduction, safety performance and facility certification by ResponsibleSteel™.

The Big River Steel ABL Facility provides for borrowings for working capital and general corporate purposes in an amount equal up to the lesser of (a) $350 million and (b) a borrowing base calculated based on specified percentages of eligible accounts receivables and inventory, subject to certain adjustments and reserves.

Big River Steel LLC must maintain a fixed charge coverage ratio of at least 1.00 to 1.00 for the most recent twelve consecutive months when availability under the Big River Steel ABL Facility is less than the greater of ten percent of the borrowing base availability and $13 million. Based on the most recent four quarters as of December 31, 2024, Big River Steel would have met the fixed charge coverage ratio test. The facility includes affirmative and negative covenants and events of default that are customary for facilities of this type.

There were no loans outstanding under the Big River Steel ABL Facility at December 31, 2024. Availability under the Big River Steel ABL Facility, pursuant to the available borrowing base, was $340 million at December 31, 2024.

U. S. Steel — Sustainability Linked Credit Facility Agreement
On May 27, 2022, U. S. Steel entered into the Sixth Amended and Restated Credit Facility Agreement (Credit Facility Agreement) to replace the existing Fifth Amended and Restated Credit Facility Agreement (Fifth Credit Facility Agreement). The Credit Facility Agreement has substantially the same terms as the Fifth Credit Facility Agreement, except the Credit Facility Agreement references the Secured Overnight Financing Rate instead of the London Interbank Offered Rate, adjusts the individual lenders' commitments, and renews the five-year maturity to May 27, 2027. The Credit Facility Agreement also adjusts the threshold for the fixed charge coverage ratio. The total availability under the facility remained the same at $1,750 million, and the financial impact from replacing the Fifth Credit Facility Agreement was immaterial. Consistent with the Fifth Credit Facility Agreement, the Credit Facility Agreement is secured by first-priority liens on certain accounts receivable and inventory and includes targets related to greenhouse gas emissions intensity reduction, safety performance and facility certification by ResponsibleSteel™.

The Credit Facility Agreement provides for borrowings for working capital and general corporate purchases in an amount equal to the lesser of (a) $1,750 million or (b) a borrowing base calculated based on specified percentages of eligible accounts receivable and inventory, subject to certain adjustments and reserves. As of December 31, 2024, there were approximately $4 million of letters of credit issued and no loans drawn under the Credit Facility Agreement. U. S. Steel must maintain a fixed charge coverage ratio of at least 1.00 to 1.00 for the most recent four consecutive quarters when availability under the Credit Facility Agreement is less than the greater of ten percent of the maximum facility availability and $140 million. Based on the most recent four quarters as of December 31, 2024, the Company would have met the fixed charge coverage ratio test.

USSK Credit Facilities
On September 28, 2023, the Company elected to reduce the size of the USSK Credit Agreement from €300 million to €150 million (approximately $156 million). The reduced credit facility size supports USSK's liquidity needs and is consistent with efforts to optimize costs and the global liquidity position. The USSK Credit Agreement matures in 2026 and contains sustainability targets related to greenhouse gas emissions intensity reduction, safety performance and facility certification by ResponsibleSteel™.

Under the USSK Credit Agreement, USSK is required to maintain a net debt to EBITDA ratio of less than 3.50:1.00 (the "EBITDA Ratio Covenant"), as measured on a rolling twelve month basis on June 30th and December 31st of each year. As of December 31, 2024, USSK met the EBITDA Ratio Covenant, and the USSK Credit Agreement was undrawn and fully available.

During the first quarter of 2023, USSK increased the size of its €20 million credit facility to €30 million (approximately $31 million) (the USSK Credit Facility). On September 13th, 2024, the Company amended the USSK Credit Facility to extend the term by three years, maturing in 2027. At December 31, 2024, USSK had no borrowings under the USSK Credit Facility, and the availability was approximately $15 million due to approximately $16 million of customs and other guarantees outstanding.

Debt Maturities – Aggregate maturities of debt are as follows (in millions):

2025	2026	2027	2028	2029	Later Years	Total
$ 99	$ 562	$ 130	$ 41	$ 1,216	$ 2,061	$ 4,109

18. Pensions and Other Benefits

U. S. Steel has defined contribution plans or multiemployer retirement benefits for more than 85 percent of its employees in the United States and non-contributory defined benefit pension plans covering the remaining employees. Benefits under the defined benefit pension plans are based upon years of service and final average pensionable earnings, with a minimum benefit based upon years of service. In addition, pension benefits for most non-represented employees under these plans are based upon a percent of total career pensionable earnings. Effective December 31, 2015, non-represented participants in the defined benefit plan no longer accrue additional benefits under the plan. For most non-represented employees without defined benefit coverage (the defined benefit pension plan was closed to new participants in 2003) and those for which the defined benefit plan was frozen, the Company also provides in the defined contribution plans (401(k) plans) a retirement account benefit based on salary and attained age. Most non-represented employees also participate in the 401(k) plans whereby the Company matches a certain percentage of salary based on the amount contributed by the participant. As of December 31, 2024, approximately 80 percent of U. S. Steel's represented employees in the United States are covered by the SPT, a multiemployer pension plan, to which U. S. Steel contributes on the basis of a fixed dollar amount for each hour worked.

Certain hourly employees of U. S. Steel's flat-rolled, tubular, cokemaking and iron ore operations in the United States are covered by collective bargaining agreements with the USW entered into effective September 1, 2022 (the 2022 Labor Agreements) that expire on September 1, 2026. The 2022 Labor Agreements include a signing bonus for each eligible USW-represented employee and annual 5% wage increases effective September 1, 2022, 2023, 2024, and 2025. Additionally, the 2022 Labor Agreements provide for increases to our pension and retirement benefits, including increases to our defined benefit pension plan, and to the contribution rate to the SPT from $3.50 to $4.00 per hour effective January 1, 2023. During the fourth quarter of 2022, U. S. Steel recorded a charge of approximately $67 million for the 2022 Labor Agreements signing bonus and related costs which was recognized primarily as a component of Cost of sales on the Consolidated Statements of Operations.

In addition, as part of the collective bargaining process, U. S. Steel and the USW agreed to leverage the overfunded OPEB plans to support the benefits provided to active represented employees. Beginning January 1, 2023, this agreement allows the Company to use a certain amount of surplus VEBA assets (the surplus amount) to pay for legally permissible benefits under Section 501(c)(9) of the Internal Revenue Code for active employees and retirees of the USW. The surplus amount represented a one-time transfer of VEBA assets to a subaccount to be used for these employees and retirees, which took place in the first quarter of 2023. The surplus amount of $595 million was determined as of December 31, 2022, (after merger of the UPI VEBA) and is the balance of VEBA assets in excess of 135% of the retiree obligation. The Company is permitted to withdraw a target of $75 million annually, with a guaranteed annual minimum of $50 million, and which may be in excess of $75 million in certain circumstances, on a quarterly pro rata basis, from the subaccount to cover the cost of the permissible benefits for active USW employees and USW retirees. As a result of its designation for this purpose, the surplus amount is presented as $75 million in Other current assets and $430 million in Other noncurrent assets on the Consolidated Balance Sheet as of December 31, 2024. Pursuant to the agreement with the USW, the Company merged the United States Steel Corporation Plan for Active Employee Insurance Benefits with and into the United States Steel Corporation Plan for Retiree Insurance Benefits effective January 1, 2023. Upon the one-time transfer from the VEBA to the subaccount, the surplus assets were no longer accounted for under ASC 715, *Compensation-Retirement Benefits*, and are instead accounted for primarily under the provisions of ASC 825 *Financial Instruments,* resulting in the portfolio being accounted for on a fair value basis, with gains and losses recognized in earnings, and reported as activity in Other financial costs (benefits) on the Company's Consolidated Statements of Operations.

On November 8, 2021, U. S. Steel entered into a commitment agreement with Banner Life Insurance Company and William Penn Life Insurance Company of New York (the "Insurers") and State Street Global Advisors Trust Company, as

independent fiduciary to the United States Steel Corporation Plan for Employee Pension Benefits (Revision of 2003), for the plan to purchase group annuity contracts and transfer approximately $284 million of its pension plan obligations to the Insurers. The purchase of the group annuity contracts was funded directly by the assets of the pension plan. The purchase resulted in the transfer of administrative and benefit-paying responsibilities for approximately 17,800 U.S. retirees and beneficiaries to the Insurers. The Insurers began paying benefits for certain retirees and beneficiaries in the Plan on January 1, 2022. There was no change to the pension benefits for any retirees and beneficiaries as a result of the transaction.

On October 26, 2022, U. S. Steel entered into an agreement with Pacific Life Insurance Company (the Insurer) and State Street Global Advisors Trust Company, as independent fiduciary to the UPI Pension Plan, for the plan to purchase group annuity contracts and transfer approximately $115 million of its pension plan obligations to the Insurer. The purchase of the group annuity contracts was completed on November 1, 2022, and funded directly by the assets of the pension plan. The purchase resulted in the transfer of the administrative and benefit-paying responsibilities for approximately 850 U.S. retirees and beneficiaries to the Insurer. The Insurer began paying benefits for certain retirees and beneficiaries in the Plan on January 1, 2023. There was no change to the pension benefits for any retirees and beneficiaries as a result of the transaction. As a result of the transaction, the Corporation recognized a non-cash pension settlement credit of approximately $3 million. This amount was reclassified to earnings through Net interest and other financial costs from accumulated other comprehensive loss.

Effective as of December 15, 2022, the UPI Pension Plan was merged into the U. S. Steel pension plan.

U. S. Steel's defined benefit retiree health care and life insurance plans (Other Benefits) cover the majority of its represented employees in the United States upon their retirement. Health care benefits are provided for Medicare and pre-Medicare retirees, with Medicare retirees largely enrolled in Medicare Advantage Plans. Both are subject to various cost sharing features, and in most cases domestically, an employer cap on total costs. The Other Benefits plan was closed to represented employees hired or rehired under certain conditions on or after January 1, 2016.

The retiree medical and retiree life insurance plans, for non-represented employees were amended to eliminate retiree medical benefits effective December 31, 2017, and to eliminate retiree life insurance benefits for employees who retired after December 31, 2017.

The majority of U. S. Steel's European employees are covered by government-sponsored programs into which U. S. Steel makes required contributions. Also, U. S. Steel sponsors defined benefit plans for most European employees covering benefit payments due to employees upon their retirement, some of which are government mandated. These same employees receive service awards throughout their careers based on stipulated service and, in some cases, age and service.

U. S. Steel uses a December 31 measurement date for its plans and may have an interim measurement date if significant events occur. Details relating to pension benefits and Other Benefits are below.

	Pension Benefits		Other Benefits	
(In millions)	**2024**	**2023**	**2024**	**2023**
Change in benefit obligations				
Benefit obligations at January 1	**$ 4,071**	$ 4,186	**$ 1,119**	$ 1,236
Service cost	**29**	33	**4**	6
Interest cost	**212**	220	**60**	67
Actuarial losses (gains)	**(118)**	24	**(18)**	(77)
Exchange rate gain	**(1)**	(1)	**—**	—
Settlements, curtailments and termination benefits	**—**	12	**—**	—
Benefits paid	**(411)**	(403)	**(103)**	(113)
Benefit obligations at December 31	**$ 3,782**	$ 4,071	**$ 1,062**	$ 1,119
Change in plan assets				
Fair value of plan at January 1	**$ 4,174**	$ 4,170	**$ 1,172**	$ 1,151
Actual return on plan assets	**148**	406	**18**	98
Asset reversion	**—**	—	**(10)**	(2)
Benefits paid from plan assets	**(410)**	(402)	**(71)**	(75)
Fair value of plan assets at December 31	**$ 3,912**	$ 4,174	**$ 1,109**	$ 1,172
Funded status of plans at December 31	**130**	103	**47**	53

For pension benefits, the largest contributor to the actuarial gain in 2024 was the increase in the discount rate from 5.49% at December 31, 2023, to 5.90% at December 31, 2024. In 2023, the largest contributor of actuarial loss was the decrease in the discount rate from 5.55% at December 31, 2022, to 5.49% at December 31, 2023.

For Other Benefits, the largest contributor to the actuarial gain in 2024 was the increase in the discount rate from 5.58% at December 31, 2023, to 5.90% at December 31, 2024. In 2023, the largest contributor to the actuarial gain was attributable to reductions in future health care costs.

Amounts recognized in accumulated other comprehensive loss:

		2024		
(In millions)	12/31/2023	Amortization	Activity	12/31/2024
Pensions				
Prior Service Cost	$ 113	$ (17)	$ —	**$ 96**
Actuarial Losses	1,409	(43)	31	**1,397**
Other Benefits				
Prior Service Credit	(18)	27	—	**9**
Actuarial Gains	(664)	65	38	**(561)**

As of December 31, 2024, and 2023, the following amounts were recognized in the Consolidated Balance Sheets:

	Pension Benefits		Other Benefits	
(In millions)	2024	2023	2024	2023
Noncurrent assets	**$ 154**	$ 131	**$ 51**	$ 57
Current liabilities	**(2)**	(2)	**(1)**	(1)
Noncurrent liabilities	**(22)**	(26)	**(3)**	(3)
Accumulated other comprehensive loss [(a)]	**1,493**	1,522	**(552)**	(682)
Net amount recognized	**$ 1,623**	$ 1,625	**$ (505)**	$ (629)

[(a)] Accumulated other comprehensive loss effects associated with accounting for pensions and other benefits in accordance with ASC Topic 715 at December 31, 2024, and December 31, 2023, respectively, are reflected net of tax of $626 million and $602 million respectively, on the Consolidated Statements of Stockholders' Equity.

The Accumulated Benefit Obligation (ABO) for all defined benefit pension plans was $3,679 million and $3,956 million at December 31, 2024, and 2023, respectively.

	December 31,	
(In millions)	2024	2023
Information for pension plans with an accumulated benefit obligation in excess of plan assets:		
Aggregate accumulated benefit obligations (ABO)	**$ (18)**	$ (21)
Aggregate projected benefit obligations (PBO)	**(24)**	(28)
Aggregate fair value of plan assets	**—**	—

The aggregate PBO in excess of plan assets reflected above is included in the payroll and benefits payable and employee benefits lines on the Consolidated Balance Sheets.

Following are the details of net periodic benefit costs (credits) related to Pension and Other Benefits:

	Pension Benefits			Other Benefits		
(In millions)	**2024**	**2023**	**2022**	**2024**	**2023**	**2022**
Components of net periodic benefit cost (credits):						
Service cost	**$ 29**	$ 33	$ 45	**$ 4**	$ 6	$ 9
Interest cost	**212**	220	157	**60**	67	49
Expected return on plan assets	**(298)**	(328)	(357)	**(74)**	(61)	(91)
Amortization - prior service costs (credits)	**17**	17	2	**(27)**	(23)	(24)
- actuarial losses (gains)	**43**	13	73	**(65)**	(72)	(53)
Net periodic benefit cost (credits), excluding below	**3**	(45)	(80)	**(102)**	(83)	(110)
Multiemployer plans [(a)]	**79**	83	74	**—**	—	—
Settlement, termination and curtailment losses	**—**	13	12	**—**	—	2
Net periodic benefit cost (credits)	**$ 82**	$ 51	$ 6	**$ (102)**	$ (83)	$ (108)

(a) Primarily represents pension expense for the SPT covering USW employees hired from National Steel Corporation and new USW employees hired after May 21, 2003.

Net periodic benefit expense (credits) for pensions and Other Benefits is projected to be approximately $139 million and approximately $(44) million, respectively, in 2025. The pension cost projection includes approximately $79 million of contributions to the SPT.

Weighted average assumptions used to determine the benefit obligation at December 31 and net periodic benefit cost for the year ended December 31 are detailed below.

	Pension Benefits		Other Benefits	
	2024	**2023**	**2024**	**2023**
	U.S. and Europe	**U.S. and Europe**	**U.S.**	**U.S.**
Actuarial assumptions used to determine benefit obligations at December 31:				
Discount rate	**5.90 %**	5.49 %	**5.90 %**	5.58 %
Increase in compensation rate	**3.15 %**	3.15 %	**N/A**	N/A

	Pension Benefits			Other Benefits		
	2024	**2023**	**2022**	**2024**	**2023**	**2022**
	U.S. and Europe	**U.S. and Europe**	**U.S. and Europe**	**U.S.**	**U.S.**	**U.S.**
Actuarial assumptions used to determine net periodic benefit cost for the year ended December 31:						
Discount rate	**5.49 %**	5.55 %	3.01 %	**5.58 %**	5.66 %	3.11 %
Expected annual return on plan assets	**6.90 %**	6.90 %	6.82 %	**6.00 %**	4.50 %	4.50 %
Increase in compensation rate	**3.15 %**	3.15 %	2.60 %	**N/A**	N/A	N/A

The discount rate reflects the current rate at which the pension and Other Benefit liabilities could be effectively settled at the measurement date. In 2017, we refined our discount rate determination process for our U.S. plans by using a bond matching approach to select specific bonds that would satisfy our projected benefit payments. We believe the bond matching approach more closely reflects the process we would employ to settle our pension and other benefits obligations. For our European pension plan, the discount rate is determined using data published by European Central Bank and underlying data provided by EuroMTS Ltd. The discount rate assumptions are updated annually.

	2024	**2023**
Assumed health care cost trend rates at December 31:	**U.S.**	**U.S.**
Health care cost trend rate assumed for next year	**5.80%**	5.90%
Rate to which the cost trend rate is assumed to decline (the ultimate trend rate)	**4.50%**	4.50%
Year that the rate reaches the ultimate trend rate	**2038**	2038

U. S. Steel reviews its actual historical rate experience and expectations of future health care cost trends to determine the escalation of per capita health care costs under U. S. Steel's benefit plans. About 85 percent of our costs for the domestic USW participants' retiree health benefits in the Company's main domestic benefit plan are limited to a per capita dollar maximum calculation based on 2006 base year actual costs incurred under the main U. S. Steel benefit plan for USW participants (cost cap). The full effect of the cost cap is expected to be realized around 2031. After 2031, the Company's costs for a majority of USW retirees and their dependents are expected to remain fixed and as a result, the cost impact of health care escalation for the Company is projected to be limited for this group.

Plan Assets

ASC Topic 820 establishes a single definition of fair value, creates a three-tier hierarchy as a framework for measuring fair value based on inputs used to value the Plan's investments, and requires additional disclosure about fair value. The hierarchy gives the highest priority to unadjusted quoted prices in active markets for identical assets or liabilities (level 1) and the lowest priority to unobservable inputs (level 3). The three levels of the fair value hierarchy are summarized below:

- Level 1 – Inputs to the valuation methodology are unadjusted quoted prices for identical assets or liabilities in active markets that the Plan has the ability to access.
- Level 2 – Inputs to the valuation methodology include:
  - Quoted prices for similar assets or liabilities in active markets;
  - Quoted prices for identical or similar assets or liabilities in inactive markets;
  - Inputs other than quoted prices that are observable for the asset or liability;
  - Inputs that are derived principally from or corroborated by observable market data by correlation or other means

  If the asset or liability has a specified (contractual) term, the level 2 input must be observable for substantially the full term of the asset or liability.

- Level 3 – Inputs to the valuation methodology are unobservable and significant to the fair value measurement.

An instrument's level is based on the lowest level of any input that is significant to the fair value measurement. Valuation techniques maximize the use of relevant observable inputs and minimize the use of unobservable inputs. The following is a description of the valuation methodologies used for assets measured at fair value. There have been no changes in the methodologies used at December 31, 2024, and 2023.

Short-term investments are valued at amortized cost which approximates fair value due to the short-term maturity of the instruments. Equity securities - U.S. & International are valued at the closing price reported on the active exchange on which the individual securities are traded. U.S. and Non U.S. government bonds are valued using pricing models maximizing the use of observable inputs for similar securities. Corporate U.S. & Non U.S. bonds are also valued using pricing models maximizing the use of observable inputs for similar securities, which includes basing value on yields currently available on comparable securities of issuers with similar credit ratings. When quoted prices are not available for identical or similar bonds, the bond is valued under a discounted cash flow approach that maximizes observable inputs, such as current yields of similar instruments, but includes adjustments for certain risks that may not be observable, such as credit and liquidity risks. Mortgage and asset-backed securities are valued using quotes from a broker dealer. Private equities and real estate are valued using information provided by external managers for each individual investment held in the fund or using NAV (net asset value) as a practical expedient. Timberland investments are valued at their appraised value. Mineral Interests and other alternatives are valued at the present value of estimated future cash flows discounted at estimated market rates for assets of similar quality and duration.

The fair value of U. S. Steel's pension plan assets by asset category at December 31 was as follows (in millions):

	2024					2023				
	Level 1	Level 2	Level 3	measured at NAV [a]	Total	Level 1	Level 2	Level 3	measured at NAV [a]	Total
Asset Category										
Equity										
U. S. companies	$ 295	$ —	$ —	$ —	$ 295	$ 332	$ —	$ —	$ —	$ 332
International companies	419	—	—	—	419	433	—	—	—	433
Derivative financial instruments	38	—	—	—	38	—	7	—	—	7
Total equity	752	—	—	—	752	765	7	—	—	772
Fixed Income										
Corporate Bonds - U.S.	—	706	—	—	706	—	654	—	—	654
Corporate Bonds - Non-U.S.	—	116	—	—	116	—	129	—	—	129
U.S. government and agencies	—	178	—	—	178	—	197	—	—	197
Non-U.S. government	—	66	—	—	66	—	43	—	—	43
Mortgage and asset-backed securities	—	6	—	—	6	—	9	—	—	9
Derivative financial instruments	2	2	—	—	4	—	6	—	—	6
Total fixed income	2	1,074	—	—	1,076	—	1,038	—	—	1,038
Alternatives										
Timberlands	—	—	—	1	1	—	—	—	21	21
Mineral Interests and other alternatives	—	—	—	348	348	—	—	—	239	239
Private equity	—	—		210	210	—	—	—	235	235
Real estate	—	—	—	251	251	—	—	—	245	245
Total alternatives	—	—	—	810	810	—	—	—	740	740
Commingled Funds	—	—	—	1,154	1,154	—	—	—	1,499	1,499
Short-Term Investments	55	36	—	—	91	106	5	—	—	111
Other [b]	29	—	—	—	29	14	—	—	—	14
Total assets at fair value	$ 838	$ 1,110	$ —	$ 1,964	$ 3,912	$ 885	$ 1,050	$ —	$ 2,239	$ 4,174

[a] In accordance with ASC Topic 820, certain investments that were measured at net asset value per share (or its equivalent) have not been classified in the fair value hierarchy.

[b] Includes cash, accrued income, and miscellaneous payables.

The following table sets forth a summary of changes in the fair value of U. S. Steel's Pension plan Level 3 assets for the years ended December 31, 2024, and 2023:

	Level 3 assets only	
(In millions)	2024	2023
Balance at beginning of period	$ —	$ 89
Transfers in and/or out of Level 3	—	(89)
Actual return on plan assets:		
Realized gain	—	—
Net unrealized gain	—	—
Purchases, sales, issuances and settlements:		
Purchases	—	—
Sales	—	—
Balance at end of period	$ —	$ —

The fair value of U. S. Steel's Other Benefits plan assets by asset category at December 31 was as follows (in millions):

	2024					2023				
	Level 1	Level 2	Level 3	measured at NAV [a]	Total	Level 1	Level 2	Level 3	measured at NAV [a]	Total
Asset Category										
Equity										
U. S. companies	$ 64	$ —	$ —	$ —	$ 64	$ 65	$ —	$ —	$ —	$ 65
International companies	24	—	—	—	24	31	—	—	—	31
Total equity	88	—	—	—	88	96	—	—	—	96
Fixed Income										
Corporate Bonds - U.S.	—	435	—	—	435	—	476	—	—	476
Corporate Bonds - Non-U.S.	—	78	—	—	78	—	108	—	—	108
U.S. government and agencies	—	89	—	—	89	—	105	—	—	105
Non-U.S. government	—	15	—	—	15	—	14	—	—	14
Mortgage and asset-backed securities	—	11	—	—	11	—	11	—	—	11
Total fixed income	—	628	—	—	628	—	714	—	—	714
Alternatives										
Timberlands	—	—	—	—	—	—	—	—	3	3
Other alternatives	—	—	29	70	99	—	—	—	41	41
Private equity	—	—	—	50	50	—	—	—	54	54
Real estate	—	—	—	20	20	—	—	—	30	30
Total alternatives	—	—	29	140	169	—	—	—	128	128
Commingled Funds	—	—	—	177	177	—	—	—	190	190
Short-Term Investments	19	10	—	—	29	13	1	—	—	14
Other [b]	18	—	—	—	18	30	—	—	—	30
Total assets at fair value	$ 125	$ 638	$ 29	$ 317	$ 1,109	$ 139	$ 715	$ —	$ 318	$ 1,172

[a] In accordance with ASC Topic 820, certain investments that were measured at net asset value per share (or its equivalent) have not been classified in the fair value hierarchy.
[b] Includes cash, accrued income, and miscellaneous payables.

The following table sets forth a summary of changes in the fair value of U. S. Steel's Other Benefits plan Level 3 assets for the years ended December 31, 2024, and 2023:

	Level 3 assets only	
(In millions)	**2024**	**2023**
Balance at beginning of period	$ —	$ 47
Transfers in and/or out of Level 3	—	(47)
Actual return on plan assets:		
Realized gain	—	—
Net unrealized loss	—	—
Purchases, sales, issuances and settlements:		
Purchases	29	—
Sales	—	—
Balance at end of period	$ 29	$ —

U. S. Steel's investment strategy for its U.S. pension and Other Benefits plan assets provides for a diversified mix of high quality bonds, public equities and selected smaller investments in private equities and private credit. For its U.S. pension, U. S. Steel has a target allocation for plan assets of 68 percent in corporate bonds, government bonds and mortgage, private credit, and asset-backed securities. The balance is invested in equity securities, timber, private equity and real estate partnerships. U. S. Steel believes that returns on equities over the long term will be higher than returns from fixed-income securities as actual historical returns from U. S. Steel's trusts have shown. Returns on bonds tend to offset some of the short-term volatility of stocks. Both equity and fixed-income investments are made across a broad range of industries and companies (both domestic and foreign) to provide protection against the impact of volatility in any single industry as well as company specific developments. U. S. Steel will use a 6.90 percent assumed rate of return on assets for the development of net periodic cost for the main defined benefit pension plan in 2025. Actual returns since the inception of the plan have exceeded this 6.90 percent rate and while recent annual returns have been volatile, it is U. S. Steel's expectation that rates will achieve this level in future periods.

For its Other Benefits plan, U. S. Steel is employing a liability driven investment strategy. The plan assets are allocated to match the plan cash flows with maturing investments. To achieve this strategy, U. S. Steel has a target allocation for plan assets of 78 percent in fixed income and private credit. The balance is primarily invested in equity securities, private equity and real estate partnerships. U. S. Steel will use a 6.00 percent assumed rate of return on assets for the development of net periodic cost for its Other Benefit plans for 2025.

Steelworkers Pension Trust

For most bargaining unit employees participating in the SPT, U. S. Steel contributed to the SPT a fixed dollar amount for each hour worked of $4.00 through December 31, 2024. SPT contributions increased from $3.50 to $4.00 per hour effective January 1, 2023. U. S. Steel's contributions to the SPT represented greater than 30% of the total combined contributions of all employers participating in the plan for the years ended December 31, 2024, 2023, and 2022.

Participation in a multiemployer pension plan agreed to under the terms of a collective bargaining agreement differ from a traditional qualified single employer defined benefit pension plan. The SPT shares risks associated with the plan in the following respects:

a. Contributions to the SPT by U. S. Steel may be used to provide benefits to employees of other participating employers;

b. If a participating employer stops contributing to the SPT, the unfunded obligations of the plan may be borne by the remaining participating employers; and

c. If U. S. Steel chooses to stop participating in the SPT, U. S. Steel may be required to pay an amount based on the underfunded status of the plan, referred to as a withdrawal liability.

On March 21, 2011, the Board of Trustees of the SPT elected funding relief which has the effect of decreasing the amount of required minimum contributions in near-term years, but will increase the minimum funding requirements during later plan years. As a result of the election of funding relief, the SPT's zone funding under the Pension Protection Act may be impacted.

In addition to the funding relief election, the Board of Trustees also elected a special amortization rule, which allows the SPT to separately amortize investment losses incurred during the SPT's December 31, 2008 plan year-end over a 29 year period, whereas they were previously required to be amortized over a 15 year period.

U. S. Steel's participation in the SPT for the annual periods ended December 31, 2024, 2023, and 2022 is outlined in the table below.

Pension Fund	Employer Identification Number/ Pension Plan Number	Pension Protection Act Zone Status as of December 31 [a]		FIP/RP Status Pending/Implemented[b]	U. S. Steel Contributions (in millions)			Surcharge Imposed[c]		Expiration Date of Collective Bargaining Agreement
		2024	2023		2024	2023	2022	2024	2023	
Steelworkers Pension Trust	23-6648508/499	Green	Green	No	$ 83	$ 82	$ 74	No	No	September 1, 2026

[a] The zone status is based on information that U. S. Steel received from the plan and is certified by the plan's actuary. Among other factors, plans in the green zone are at least 80 percent funded, while plans in the yellow zone are less than 80 percent funded and plans in the red zone are less than 65 percent funded.
[b] Indicates if a financial improvement plan (FIP) or a rehabilitation plan (RP) is either pending or has been implemented.
[c] Indicates whether there were charges to U. S. Steel from the plan.

Cash Flows

The following information is in addition to the contributions to the SPT noted in the table above.

Employer Contributions – U. S. Steel did not make any voluntary or mandatory contributions to the U. S. Steel Retirement Plan Trust in 2024 or 2023. The U. S. Steel Retirement Plan Trust is the funding vehicle for the Company's main defined benefit pension plan.

For pension plans not funded by trusts, U. S. Steel made $1 million, $3 million, and $2 million of pension payments in 2024, 2023, and 2022, respectively.

Cash payments totaling $32 million, $40 million, and $32 million were made for other post-employment benefit payments not funded by trusts in 2024, 2023, and 2022, respectively. In 2024, 2023, and 2022, U. S. Steel continued to use assets from our VEBA trust for represented retiree health care and life insurance benefits to pay USW post-employment benefit claims.

Estimated Future Benefit Payments – The following benefit payments, which reflect expected future service as appropriate, are expected to be paid from U. S. Steel's defined benefit plans:

(In millions)	Pension Benefits	Other Benefits
2025	$ 1,043	$ 102
2026	1,043	109
2027	1,154	111
2028	1,182	114
2029	1,451	117
Years 2030 - 2034	9,904	437

Defined contribution plans

U. S. Steel also contributes to two defined contribution plans for its salaried employees. Most non-represented salaried employees in North America receive pension benefits in the form of a separate retirement account through a defined contribution plan with contribution percentages based upon age, for which company contributions totaled $19 million, $21 million, and $21 million in 2024, 2023, and 2022, respectively. U. S. Steel's matching contributions to the salaried employees' defined contribution plans, which for most non-represented salaried employees are 100 percent of the employees' contributions up to six percent of their eligible salary, totaled $20 million, $20 million, and $19 million in 2024, 2023, and 2022, respectively. U. S. Steel also maintains non-qualified defined contribution plans to provide benefits which are otherwise limited by the terms of the qualified plan or the Internal Revenue Code. U. S. Steel's contributions under these defined contribution plans were less than $1 million in 2024, $2 million in 2023, and less than $1 million in 2022.

Most represented employees are eligible to participate in a defined contribution plan where there is no company match on savings or separate retirement account except for certain Tubular hourly employees. Effective with the 2015 Labor Agreement, represented employees hired on or after January 1, 2016, are eligible for a $0.50 per hour savings account contribution. As a result of the 2018 Labor Agreements, the retiree healthcare account contribution for each hour worked increased to $0.55 effective January 1, 2019, $0.60 effective January 1, 2020, and $0.65 effective January 1, 2021. As a result of the 2022 Labor Agreements, the retiree healthcare account contribution for each hour worked increased to $0.75 effective January 1, 2023. These Company contributions for represented employees totaled $7 million, $7 million, and $5 million in 2024, 2023, and 2022, respectively.

Other post-employment benefits

The Company provides benefits to former or inactive employees after employment but before retirement. Certain benefits including workers' compensation and black lung benefits represent material obligations to the Company and under the guidance for nonretirement post-employment benefits, have historically been treated as accrued benefit obligations. Liabilities for these benefits recorded at December 31, 2024, totaled $81 million as compared to $91 million at December 31, 2023. Liability amounts were developed assuming a discount rate of 5.76% and 5.66% at December 31, 2024, and 2023. Net periodic benefit cost for these benefits is projected to be $15 million in 2025 compared to $9 million in 2024 and $24 million in 2023.

Pension Funding

In March 2021, the American Rescue Plan Act (ARPA - H.R. 1319) further extended the pension relief interest rate corridor used to measure defined benefit pension obligations for calculating minimum annual contributions. The new interest rate formula results in higher interest rates for minimum funding calculations as compared to prior law over the next few years, which will improve the funded status of our main defined benefit pension plan and reduce minimum required contributions.

U. S. Steel will monitor the funded status of the plan to determine when voluntary contributions may be prudent in order to mitigate potentially larger mandatory contributions in later years.

19. Asset Retirement Obligations

U. S. Steel's asset retirement obligations (AROs) primarily relate to mine, landfill closure and post-closure costs. The following table reflects changes in the carrying values of AROs for the years ended December 31, 2024, and 2023:

	December 31,	
(In millions)	**2024**	**2023**
Balance at beginning of year	**$ 79**	$ 66
Additional obligations incurred	**—**	12
Obligations settled	**(4)**	(1)
Change in estimate of obligations	**(1)**	—
Foreign currency translation effects	**(1)**	—
Accretion expense	**4**	2
Balance at end of period	**$ 77**	$ 79

Certain AROs related to disposal costs of the majority of fixed assets at our integrated steel facilities have not been recorded because they have an indeterminate settlement date. These AROs will be initially recognized in the period in which sufficient information exists to estimate their fair value.

20. Fair Value of Financial Instruments

The carrying value of cash and cash equivalents, current accounts and notes receivable, accounts payable and accrued interest included in the Consolidated Balance Sheets approximate fair value. See Note 16 for disclosure of U. S. Steel's derivative instruments, which are accounted for at fair value on a recurring basis.

Stelco Option for Minntac Mine Interest
On April 30, 2020, the Company entered into an Option Agreement with Stelco, a subsidiary of Cleveland-Cliffs Inc., that grants Stelco the option to purchase a 25 percent interest (the Option Interest) in a to-be-formed entity (the Joint Venture) that will own the Company's current iron ore mine located in Mt. Iron, Minnesota (the Minntac Mine). As consideration for the option, Stelco paid the Company an aggregate amount of $100 million in five $20 million installments during the year ended December 31, 2020, which are recorded net of transaction costs in the Consolidated Balance Sheet. The option can be exercised any time before January 31, 2027, and in the event Stelco exercises the option, Stelco will contribute an additional $500 million to the Joint Venture, which amount shall be remitted solely to U. S. Steel in the form of a one-time special distribution, and the parties will engage in good faith negotiations to finalize the master agreement (pursuant to which Stelco will acquire the Option Interest) and the limited liability company agreement of the Joint Venture.

Surplus VEBA assets
During the fourth quarter 2022, U. S. Steel and the USW agreed to utilize the overfunded OPEB plans to support the benefits provided to active represented employees. Beginning January 1, 2023, this agreement allows the Company to use a certain amount of surplus VEBA assets (the surplus amount) to pay for legally permissible benefits under Section 501(c)(9) of the Internal Revenue Code for active employees and retirees of the USW. The surplus amount of $595 million was determined as of December 31, 2022, and was the balance of VEBA assets in excess of 135% of the retiree obligation at that time. On January 1, 2023, a subaccount was created and consisted of a pro-rata share of the existing trust. On February 1, 2023, using January 31, 2023 asset values, a new investment strategy was implemented and comprised of existing investments from the VEBA trust and cash. On February 1, 2023, certain assets were transferred from the VEBA to the subaccount. The Company is permitted to withdraw a target of $75 million annually, with a guaranteed annual minimum of $50 million, on a quarterly pro rata basis, from the subaccount to cover the cost of the permissible benefits for active USW employees and USW retirees. If after the annual withdrawal of $75 million, the subaccount value decreases by less than $40 million annually (defined as the "Threshold Surplus"), the Company may withdraw the excess above the Threshold Surplus. Based on the value of the subaccount as of December 31, 2023, approximately $15 million was withdrawn from the subaccount in January 2024 to pay for permissible benefits. The surplus VEBA assets subaccount portfolio consists of fixed income securities including corporate bonds, U.S. government bonds, and U.S. Treasury notes, in addition to alternatives including investments in private credit partnerships and real estate funds. A portion of the corporate bonds are classified as available-for-sale debt securities, with unrealized gains and losses reported in Accumulated other comprehensive (loss) income. Upon sale, realized gains and losses are reported in earnings. All other investments in the subaccount are financial instruments measured at fair value or net asset value, with gains and losses recognized through net earnings and are reported as Net gain from investments related to active employee benefits on the Company's Consolidated Statements of Operations

As of December 31, 2024, the fair value of the surplus VEBA assets subaccount portfolio was $505 million, with $75 million in Other current assets and $430 million in Other noncurrent assets on the Consolidated Balance Sheet.

As of December 31, 2023, the fair value of the surplus VEBA assets subaccount portfolio was $570 million, with $89 million in Other current assets and $481 million in Other noncurrent assets on the Consolidated Balance Sheet.

The value of corporate bonds classified as available-for-sale debt securities was $131 million and $208 million as of December 31, 2024, and 2023, respectively. A total pretax net gain related to available-for-sale securities of $7 million was included in Accumulated other comprehensive (loss) income as of both December 31, 2024, and 2023.

During 2024, pretax net gains of $25 million were recognized in Net gain from investments related to active employee benefits. During 2024, immaterial pretax net gains were recognized in Accumulated other comprehensive (loss) income.

During 2023, pretax net gains of $43 million and $7 million were recognized in Net gain from investments related to active employee benefits and in Accumulated other comprehensive (loss) income, respectively.

The fair value of the subaccount portfolio by asset category as of December 31, 2024 and 2023 was as follows (in millions):

	December 31, 2024					December 31, 2023				
	Level 1	Level 2	Level 3	measured at NAV [a]	Total	Level 1	Level 2	Level 3	measured at NAV [a]	Total
Asset Category										
Fixed Income										
Corporate bonds - U.S.	—	129	—	—	129	—	191	—	—	191
Corporate bonds - Non-U.S.	—	46	—	—	46	—	56	—	—	56
U.S. government bonds	—	43	—	—	43	—	86	—	—	86
Mortgage and asset-backed securities	—	14	—	—	14	—	12	—	—	12
Total fixed income	$ —	$ 232	$ —	$ —	$ 232	$ —	$ 345	$ —	$ —	$ 345
Alternatives										
Private credit partnerships	—	—	29	157	186	—	—	58	64	122
Other alternatives	—	—	—	19	19	—	—	—	18	18
Total alternatives	$ —	$ —	$ 29	$ 176	$ 205	$ —	$ —	$ 58	$ 82	$ 140
Commingled Funds	—	—	—	5	5	—	—	—	61	61
Other [b]	63	—	—	—	63	25	—	(1)	—	24
Total assets at fair value	$ 63	$ 232	$ 29	$ 181	$ 505	$ 25	$ 345	$ 57	$ 143	$ 570

[a] In accordance with ASC Topic 820, certain investments that were measured at net asset value per share (or its equivalent) have not been classified in the fair value hierarchy.

[b] Includes cash, accrued income, and miscellaneous payables.

The following table summarizes U. S. Steel's financial assets and liabilities that were not carried at fair value at December 31, 2024, and 2023.

	December 31, 2024		December 31, 2023	
(In millions)	Fair Value	Carrying Amount	Fair Value	Carrying Amount
Financial liabilities:				
Long-term debt [a]	**$ 4,243**	**$ 3,822**	$ 4,797	$ 3,899

[a] Excludes finance lease obligations.

The fair value of long-term debt was determined using Level 2 inputs which were derived from quoted market prices.

Fair value of the financial assets and liabilities disclosed herein is not necessarily representative of the amount that could be realized or settled, nor does the fair value amount consider the tax consequences of realization or settlement.
Financial guarantees are U. S. Steel's only unrecognized financial instrument. For details relating to financial guarantees see Note 26.

21. Reclassifications from Accumulated Other Comprehensive Income (AOCI)

(In millions)	Pension and Other Benefit Items	Foreign Currency Items	Unrealized (Loss) Gain on Derivatives	Active Employee Benefit Investments	Total
Balance at December 31, 2022	$ (322)	$ 280	$ (43)	$ —	$ (85)
Other comprehensive income (loss) before reclassifications	131	54	(77)	6	114
Amounts reclassified from AOCI [a]	(50)	—	68	(1)	17
Net current-period other comprehensive income (loss)	81	54	(9)	5	131
Balance at December 31, 2023	$ (241)	$ 334	$ (52)	$ 5	$ 46
Other comprehensive (loss) income before reclassifications	**(52)**	**(70)**	**72**	**3**	**(47)**
Amounts reclassified from AOCI [a]	**(25)**	**—**	**8**	**(3)**	**(20)**
Net current-period other comprehensive (loss) income	**(77)**	**(70)**	**80**	**—**	**(67)**
Balance at December 31, 2024	**$ (318)**	**$ 264**	**$ 28**	**$ 5**	**$ (21)**

[a] See table below for further details.

Details about AOCI components [a]	**Amount reclassified from AOCI**		
(In millions)	**2024**	**2023**	**2022**
Amortization of pension and other benefit items			
Prior service credits [a]	**$ (10)**	$ (6)	$ (23)
Actuarial (gains) losses [a]	**(22)**	(60)	20
Settlements, termination and curtailment losses (gains) [a]	**—**	1	(3)
Total pensions and other benefits items	**(32)**	(65)	(6)
Derivative reclassifications to Consolidated Statements of Operations	**12**	143	(133)
Active employee benefit investment reclassifications to Consolidated Statements of Operations	**(4)**	(1)	—
Total before tax	**(24)**	77	(139)
Tax provision (benefit)	**4**	(60)	32
Net of tax	**$ (20)**	$ 17	$ (107)

[a] These AOCI components are included in the computation of net periodic benefit cost (see Note 18 for additional details).

22. Supplemental Cash Flow Information

	Year Ended December 31,		
(In millions)	**2024**	**2023**	**2022**
Net cash used in operating activities included:			
Interest and other financial costs paid (net of amount capitalized)	**$ (35)**	$ (68)	$ (161)
Income taxes paid	**$ (53)**	$ (86)	$ (242)
Non-cash investing and financing activities:			
Change in accrued capital expenditures	**$ (109)**	$ (2)	$ 351
U. S. Steel common stock issued for employee/non-employee director stock plans	**$ 45**	$ 45	$ 46
Capital expenditures funded by finance lease borrowings	**$ 78**	$ 90	$ 52
Export Credit Agreement (ECA) financing	**$ —**	$ 5	$ —

In January 2025, the Company received a refund of approximately $44 million for the 2023 federal income tax return, which included approximately $1 million of interest.

23. Transactions with Related Parties

Related party sales and service transactions are primarily related to equity investees and were $2,505 million, $2,015 million, and $1,942 million in 2024, 2023, and 2022, respectively.

Accounts payable to related parties include balances due to PRO-TEC Coating Company (PRO-TEC) of $144 million and $137 million at December 31, 2024, and 2023, respectively for invoicing and receivables collection services provided by U. S. Steel on PRO-TEC's behalf. U. S. Steel, as PRO-TEC's exclusive sales agent, is responsible for credit risk related to those receivables. U. S. Steel also provides PRO-TEC marketing, selling and customer service functions. Payables to other related parties totaled $2 million for both the period ending December 31, 2024 and the period ending December 31, 2023.
Purchases from related parties for outside processing services provided by equity investees amounted to $19 million, $26 million, and $27 million during 2024, 2023, and 2022, respectively. Purchases of iron ore pellets from related parties amounted to $87 million, $157 million, and $131 million for the years ended December 31, 2024, 2023, and 2022, respectively.

On December 18, 2023, the Company entered into the Merger Agreement by and among the Company, Purchaser, Merger Sub, and solely as provided in Section 9.13 therein, NSC. Pursuant to the Merger Agreement, and upon the terms and subject to the conditions described therein, Merger Sub will merge with and into the Company, with the Company continuing as the surviving corporation and a wholly owned subsidiary of Purchaser.

Wheeling-Nippon Steel, Inc., ("WNS") a wholly owned subsidiary of NSC (party to the Merger Agreement described above), currently is a customer of the Company. Net sales to related parties pertaining to business with WNS amounted to $322 million for the year ended December 31, 2024. Receivables from related parties as of December 31, 2024 include $6 million due from WNS.

24. Leases

Operating lease assets consist primarily of office space, heavy mobile equipment used in our mining operations and facilities and equipment under operating service agreements for electricity generation and scrap processing. We also have operating lease assets for light mobile equipment and information technology assets. The Company also has short-term leases related to transportation services for which we apply the short-term lease exception. Significant finance leases primarily consist of heavy mobile equipment used in our mining operations. Variable lease payments are primarily related to operating service agreements where payment is solely dependent on consumption of certain services, such as raw material and by-product processing. Most long-term leases include renewal options and, in certain leases, purchase options. Generally, we are not reasonably certain that these options will be exercised. We have residual value guarantees under certain light mobile equipment leases. There is no impact to our leased assets for residual value guarantees as the potential loss is not probable (see "Other Contingencies" in Note 26 for further details). We do not have material restrictive covenants associated with our leases or material amounts of sublease income. From time to time, U. S. Steel may enter into arrangements for the construction or purchase of an asset and then enter into a financing arrangement to lease the asset. U. S. Steel recognizes leased assets and liabilities under these arrangements when it obtains control of the asset.

The following table summarizes the lease amounts included in our Consolidated Balance Sheets as of December 31, 2024 and 2023.

(In millions)	Balance Sheet Location	December 31, 2024	December 31, 2023
Assets			
Operating	Operating lease assets [a]	**$ 72**	$ 109
Finance	Property, plant and equipment [b]	**198**	176
Total Lease Assets		**$ 270**	$ 285
Liabilities			
Current			
Operating	Current operating lease liabilities	**$ 35**	$ 44
Finance	Current portion of long-term debt	**58**	43
Non-Current			
Operating	Noncurrent operating lease liabilities	**44**	73
Finance	Long-term debt less unamortized discount and issue costs	**151**	137
Total Lease Liabilities		**$ 288**	$ 297

[a] Operating lease assets are recorded net of accumulated amortization of $129 million and $138 million as of December 31, 2024, and December 31, 2023, respectively.
[b] Finance lease assets are recorded net of accumulated depreciation of $182 million and $126 million as of December 31, 2024, and December 31, 2023, respectively.

The following table summarizes lease costs included in our Consolidated Statements of Operations for the years ended December 31, 2024, December 31, 2023, and December 31, 2022.

(In millions)	Classification	Year Ended December 31, 2024	Year Ended December 31, 2023	Year Ended December 31, 2022
Operating Lease Cost [a]	Cost of sales	**$ 48**	$ 54	$ 65
Operating Lease Cost	Selling, general and administrative expenses	**14**	15	14
Finance Lease Cost				
Amortization	Depreciation, depletion and amortization	**56**	42	26
Interest	Interest expense	**14**	11	9
Total Lease Cost		**$ 132**	$ 122	$ 114

[a] Operating lease cost recorded in cost of sales includes $13 million of variable lease cost for the year ended December 31, 2024. Operating lease cost recorded in cost of sales includes $12 million of variable lease cost for both the years ended December 31, 2023, and December 31, 2022. Operating lease cost recorded in selling, general and administrative expenses includes $1 million of variable lease cost for the years ended December 31, 2024, December 31, 2023, and December 31, 2022. $1 million of short-term lease cost is included in cost of sales and selling, general and administrative expenses for the years ended December 31, 2024, December 31, 2023, and December 31, 2022.

Lease liability maturities as of December 31, 2024, are shown below.

(In millions)	Operating	Finance	Total
2025	$ 39	$ 78	$ 117
2026	24	70	94
2027	15	50	65
2028	7	29	36
2029	1	7	8
After 2029	2	—	2
Total Lease Payments	**$ 88**	**$ 234**	**$ 322**
Less: Interest	9	25	34
Present value of lease liabilities	**$ 79**	**$ 209**	**$ 288**

Lease terms and discount rates are shown below.

	December 31, 2024
Weighted average lease term	
Finance	3 years
Operating	3 years
Weighted average discount rate	
Finance	6.05 %
Operating	7.14 %

Supplemental cash flow information related to leases is as follows:

(In millions)	Year Ended December 31, 2024	Year Ended December 31, 2023	Year Ended December 31, 2022
Cash paid for amounts included in the measurement of lease liabilities:			
Operating cash flows from operating leases	**$ 47**	$ 55	$ 66
Operating cash flows from finance leases	**14**	11	9
Financing cash flows from finance leases	**49**	34	20
Right-of-use assets exchanged for lease liabilities:			
Operating leases	**4**	14	20
Finance leases	**78**	90	52

25. Restructuring and Other Charges

During 2024, the Company recorded restructuring and other charges of $8 million, which related primarily to the idling of certain coke-making facilities. Cash payments related to previously accrued restructuring programs made during the year ended December 31, 2024 were approximately $89 million.

During 2023, the Company recorded restructuring and other charges of $36 million, which relate primarily to Company-wide headcount reductions. Cash payments were made related to severance and exit costs of approximately $75 million.

During 2022, the Company recorded restructuring and other charges of $48 million, which consists of charges of $30 million related to the planned disposition of a component within the Flat-Rolled segment, $23 million related to headcount reductions under a voluntary early retirement program (VERP) offered at USSK, a $9 million favorable adjustment to the expected exit costs of indefinitely idled facilities, and $4 million of severance-related charges at other facilities. Cash payments were made related to severance and exit costs of approximately $95 million.

Charges for restructuring and ongoing cost reduction initiatives are recorded in the period U. S. Steel commits to a restructuring or cost reduction plan, or executes specific actions contemplated by the plan and all criteria for liability recognition have been met. Charges related to the restructuring and cost reductions are reported in restructuring and other charges in the Consolidated Statements of Operations.

The activity in the accrued balances incurred in relation to restructuring during the years ended December 31, 2023, and December 31, 2024, were as follows:

(in millions)	Employee Related Costs	Exit Costs	Non-cash Charges	Total
Balance at December 31, 2022	$ 132	$ 50	$ —	$ 182
Additional charges	25	11	—	$ 36
Release of prior accruals and other adjustments [a]	(2)	(1)	—	$ (3)
Cash payments/utilization [b]	(45)	(30)	—	(75)
Balance at December 31, 2023	**$ 110**	**$ 30**	**$ —**	**$ 140**
Additional charges	**(3)**	**11**	**—**	**8**
Cash payments/utilization [b]	**(62)**	**(27)**	**—**	**(89)**
Balance at December 31, 2024	**$ 45**	**$ 14**	**$ —**	**$ 59**

[a] Includes releases of accruals to reflect the current estimate of costs to complete approved restructuring programs.

(b) $4 million and $10 million of payments were made from the pension fund trust assets in the Employee Related Cost column during the years ended December 31, 2023, and 2024, respectively.

26. Contingencies and Commitments

U. S. Steel is the subject of, or party to, a number of pending or threatened legal actions, contingencies and commitments involving a variety of matters, including laws and regulations relating to the environment. Certain of these matters are discussed below. The ultimate resolution of these contingencies could, individually or in the aggregate, be material to the Consolidated Financial Statements. However, management believes that U. S. Steel will remain a viable and competitive enterprise even though it is possible that these contingencies could be resolved unfavorably.

U. S. Steel accrues for estimated costs related to existing lawsuits, claims and proceedings when it is probable that it will incur these costs in the future and the costs are reasonably estimable.

Asbestos matters – As of December 31, 2024, U. S. Steel was a defendant in approximately 990 active cases involving approximately 2,575 plaintiffs. The vast majority of these cases involve multiple defendants. About 1,600, or approximately 62 percent, of these plaintiff claims are currently pending in jurisdictions which permit filings with massive numbers of plaintiffs. At December 31, 2023, U. S. Steel was a defendant in approximately 915 cases involving approximately 2,505 plaintiffs. Based upon U. S. Steel's experience in such cases, it believes that the actual number of plaintiffs who ultimately assert claims against U. S. Steel will likely be a small fraction of the total number of plaintiffs.

The following table shows the number of asbestos claims in the current year and the prior two years:

Period ended	Opening Number of Claims	Claims Dismissed, Settled and Resolved	New Claims	Closing Number of Claims
December 31, 2022	2,505	230	235	2,510
December 31, 2023	2,510	235	230	2,505
December 31, 2024	2,505	240	310	2,575

The amount U. S. Steel accrues for pending asbestos claims is not material to U. S. Steel's financial condition. However, U. S. Steel is unable to estimate the ultimate outcome of asbestos-related claims due to a number of uncertainties, including: (1) the rates at which new claims are filed, (2) the number of and effect of bankruptcies of other companies traditionally defending asbestos claims, (3) uncertainties associated with the variations in the litigation process from jurisdiction to jurisdiction, (4) uncertainties regarding the facts, circumstances and disease process with each claim, and (5) any new legislation enacted to address asbestos-related claims.

Further, U. S. Steel does not believe that an accrual for unasserted claims is required. At any given reporting date, it is probable that there are unasserted claims that will be filed against the Company in the future. The Company engages an outside valuation consultant to assist in assessing its ability to estimate an accrual for unasserted claims. This assessment is based on the Company's settlement experience, including recent claims trends. This analysis focuses on settlements made over the last several years as these claims are likely to best represent future claim characteristics. After review by the valuation consultant and U. S. Steel management, it was determined that the Company could not estimate an accrual for unasserted claims.

Despite these uncertainties, management believes that the ultimate resolution of these matters will not have a material adverse effect on U. S. Steel's financial condition.

Environmental Matters – U. S. Steel is subject to federal, state, local and foreign laws and regulations relating to the environment. These laws generally provide for control of pollutants released into the environment and require responsible parties to undertake remediation of hazardous waste disposal sites. Penalties may be imposed for noncompliance. Changes in accrued liabilities for remediation activities where U. S. Steel is identified as a named party are summarized in the following table:

	Year Ended December 31,	
(In millions)	**2024**	**2023**
Beginning of period	**$ 107**	$ 126
Accruals for environmental remediation deemed probable and reasonably estimable	**18**	15
Adjustments for changes in estimates	**—**	(11)
Obligations settled	**(17)**	(23)
End of period	**$ 108**	$ 107

Accrued liabilities for remediation activities are included in the following Consolidated Balance Sheet lines:

(In millions)	December 31, 2024	December 31, 2023
Accounts payable	**$ 26**	$ 27
Deferred credits and other noncurrent liabilities	**82**	80
Total	**$ 108**	$ 107

Expenses related to remediation are recorded in cost of sales and were $18 million and $13 million for the years ended December 31, 2024, and December 31, 2023, respectively. It is not currently possible to estimate the ultimate amount of all remediation costs that might be incurred or the penalties that may be imposed. Due to uncertainties inherent in remediation projects and the associated liabilities, it is reasonably possible that total remediation costs for active matters may exceed the accrued liabilities by as much as 30 to 50 percent.

Remediation Projects

U. S. Steel is involved in environmental remediation projects at or adjacent to several current and former U. S. Steel facilities and other locations that are in various stages of completion ranging from initial characterization through post-closure monitoring. Based on the anticipated scope and degree of uncertainty of projects, we categorize projects as follows:

(1) Projects with Ongoing Study and Scope Development – Projects which are still in the development phase. For these projects, the extent of remediation that may be required is not yet known, the remediation methods and plans are not yet developed, and/or cost estimates cannot be determined. Therefore, significant costs, in addition to the accrued liabilities for these projects, are reasonably possible. There are three environmental remediation projects where additional costs for completion are not currently estimable, but could be material. These projects are at South Works, UPI and the former steelmaking plant at Joliet, Illinois. As of December 31, 2024, accrued liabilities for these projects totaled $7 million for the costs of studies, investigations, interim measures, design and/or remediation. It is reasonably possible that additional liabilities associated with future requirements regarding studies, investigations, design and remediation for these projects could be as much as $33 million to $46 million.

(2) Significant Projects with Defined Scope – Projects with significant accrued liabilities with a defined scope. As of December 31, 2024, there are four significant projects with defined scope greater than or equal to $5 million each, with a total accrued liability of $54 million. These projects are: Gary Resource Conservation and Recovery Act (RCRA) (accrued liability of $23 million), Duluth Works (accrued liability of $6 million), Fairfield Works (accrued liability of $8 million) and the former Geneva facility (accrued liability of $17 million).

(3) Other Projects with a Defined Scope – Projects with relatively small accrued liabilities for which we believe that, while additional costs are possible, they are not likely to be significant, and also include those projects for which we do not yet possess sufficient information to estimate potential costs to U. S. Steel. There are three other environmental remediation projects which each had an accrued liability of between $1 million and $5 million. The total accrued liability for these projects at December 31, 2024, was $5 million. These projects have progressed through a significant portion of the design phase and material additional costs are not expected.

The remaining environmental remediation projects each have an accrued liability of less than $1 million each. The total accrued liability for these projects at December 31, 2024, was approximately $4 million. The Company does not foresee material additional liabilities for any of these sites.

Post-Closure Costs – Accrued liabilities for post-closure site monitoring and other costs at various closed landfills totaled $27 million at December 31, 2024, and were based on known scopes of work.

Administrative and Legal Costs – As of December 31, 2024, U. S. Steel had an accrued liability of $11 million for administrative and legal costs related to environmental remediation projects. These accrued liabilities were based on projected administrative and legal costs for the next three years and do not change significantly from year to year.

Capital Expenditures – For a number of years, U. S. Steel has made substantial capital expenditures to comply with various regulations, laws, and other requirements relating to the environment. Such capital expenditures totaled $83 million and $70 million in 2024 and 2023, respectively. U. S. Steel anticipates making additional such expenditures in the future, which may be material; however, the exact amounts and timing of such expenditures are uncertain because of the continuing evolution of specific regulatory requirements.

European Union (the EU) Environmental Requirements - Phase IV of the EU Emissions Trading System (the EU ETS) commenced on January 1, 2021, and will finish on December 31, 2030. The European Commission issued final approval of the updated 2021-2025 Slovak National Allocation table in February 2022. The Slovak Ministry of Environment allocated 6.2 million metric tons of European Union Emission Allowances (EUA) at no charge (free allowances or free allocation) to USSE in March 2024. As of December 31, 2024, we have pre-purchased approximately 2.22 million EUA totaling €161 million (approximately $167 million) via spot purchases or settled forwards to cover the 2024 shortfall of emission allowances and expected shortfall in subsequent years.

The EU's Industrial Emissions Directive requires implementation of EU-determined best available techniques (BAT) for Iron and Steel production to reduce environmental impacts as well as compliance with BAT associated emission levels. Total capital expenditures for projects to go beyond BAT requirements were €138 million (approximately $143 million). These costs were partially offset by the EU funding received and may be mitigated over the next measurement periods if USSK complies with certain financial covenants, which are assessed annually. If we are unable to meet these covenants in the future, USSK might be required to provide additional collateral (e.g., bank guarantee) to secure 50 percent of the EU funding received. USSK complied with these covenants as of December 31, 2024, and no additional collateral will be required by the end of June 30, 2025. By this next assessment date, we expect that nine of the total fifteen projects will pass the sustainability monitoring and will be excluded from further assessment to provide additional collateral if the covenants are not met. The last assessment of financial covenants will be performed as of June 30, 2026.

Environmental indemnifications – Throughout its history, U. S. Steel has sold numerous properties and businesses and many of these sales included indemnifications and cost sharing agreements related to the assets that were divested. The amount of potential environmental liability associated with these transactions and properties is not estimable due to the nature and extent of the unknown conditions related to the properties divested and deconsolidated. Aside from the environmental liabilities already recorded as a result of these transactions due to specific environmental remediation activities and cases (included in the $108 million of accrued liabilities for remediation discussed above), there are no other known probable and estimable environmental liabilities related to these transactions.

Guarantees – The maximum guarantees of the indebtedness of unconsolidated entities of U. S. Steel totaled $7 million at December 31, 2024.

Other contingencies – Under certain finance lease agreements covering various equipment, U. S. Steel has the option to renew the lease or to purchase the equipment at the end of the lease term. If U. S. Steel does not exercise the purchase option by the end of the lease term, U. S. Steel guarantees a residual value of the equipment as determined at the lease inception date (totaling approximately $14 million at December 31, 2024). No liability has been recorded for these guarantees as the potential loss is not probable.

The Company's BR2 facility in Osceola, Arkansas qualifies for financing and related economic incentives associated with the acquisition, development, construction and operation of the facility. These incentives consist of advance lump-sum payments which are included in deferred credits and other noncurrent liabilities on the Consolidated Balance Sheets. In March 2022, the Company received a lump-sum payment of approximately $82 million as proceeds from the sale of a portion of expected future tax credits to be earned by the Company under the State of Arkansas's Recycling Tax Credit program. These funds are to be used primarily for the acquisition of project related equipment, however they may also be used for the training and development of new employees hired for the facility. The Company is contingently liable for certain repayment penalties if the Company fails to meet certain employment requirements in any given period. In April 2022, the Company received a $3 million grant from Mississippi County, Arkansas, and in May 2022, the Company received a $50 million grant from the State of Arkansas Quick Action Closing Fund. Both grants pertain to the reimbursement of qualifying project costs. For each of these incentives and grants, the balance of deferred income will be recognized into other gains, net in the accompanying Consolidated Statements of Operations on a systematic basis over the periods in which the Company earns the granted funds by complying with the investment and employment requirements of the grant programs.

In July 2024, the Company also received a lump-sum payment of approximately $75 million as proceeds from the sale of a portion of future tax credits to be earned by the Company under the State of Arkansas's Recycling Tax Credit program for the Phase II portion of the Big River Steel facilities. The Company is contingently liable for certain repayment penalties if the Company fails to meet certain employment requirements, and as such a deferred liability was recognized for this grant and will be amortized into other gains, net in the statement of operations on a systematic basis over the periods in which the Company earns the granted funds by complying with the employment requirements of the grant program.

We have incurred and expect to continue to incur significant expenses in connection with the pending Merger, including legal and investment banking fees.

Insurance – U. S. Steel maintains insurance for certain property damage, equipment, business interruption and general liability exposures; however, insurance is applicable only after certain deductibles and retainages. U. S. Steel is self-insured for certain other exposures including workers' compensation (where permitted by law) and auto liability. Liabilities are recorded for workers' compensation and personal injury obligations. Other costs resulting from losses under deductible or retainage amounts or not otherwise covered by insurance are charged against income upon occurrence.

U. S. Steel uses surety bonds, trusts and letters of credit to provide whole or partial financial assurance for certain obligations such as workers' compensation. The total amount of active surety bonds, trusts and letters of credit being used for financial assurance purposes was approximately $192 million as of December 31, 2024, which reflects U. S. Steel's maximum exposure under these financial guarantees, but not its total exposure for the underlying obligations. A significant portion of our trust arrangements and letters of credit are collateralized by the Credit Facility Agreement. The remaining trust arrangements and letters of credit are collateralized by restricted cash. Restricted cash, which is recorded in other current and noncurrent assets, totaled $46 million and $40 million at December 31, 2024, and December 31, 2023, respectively.

Capital Commitments – At December 31, 2024, U. S. Steel's contractual commitments to acquire property, plant and equipment totaled $683 million.

Contractual Purchase Commitments – U. S. Steel is obligated to make payments under contractual purchase commitments, including unconditional purchase obligations. Payments for contracts with remaining terms in excess of one year are summarized below (in millions):

2025	2026	2027	2028	2029	Later years	Total
$1,260	$1,033	$253	$218	$167	$661	$3,592

The majority of U. S. Steel's unconditional purchase obligations relate to the supply of industrial gases, and certain energy and utility services with terms ranging from 13 months to 19 years. Unconditional purchase obligations also include coke and steam purchase commitments related to a coke supply agreement with Gateway Energy & Coke Company LLC (Gateway) under which Gateway is obligated to supply a minimum volume of the expected targeted annual production of the heat recovery coke plant, and U. S. Steel is obligated to purchase the coke from Gateway at the contract price. As of December 31, 2024, if U. S. Steel were to terminate the agreement, it may be obligated to pay in excess of $26 million.

As a result of the indefinite idling of the iron and steel making processes at Granite City Works, there were $60 million and $86 million of liabilities for unconditional purchase obligations as of December 31, 2024, and December 31, 2023, respectively.

Total payments relating to unconditional purchase obligations were approximately $815 million in 2024, $787 million in 2023, and $850 million in 2022.

27. Common Stock Repurchased

On October 25, 2021, the Board of Directors authorized a share repurchase program that allowed for the repurchase of up to $300 million of its outstanding common stock from time to time in the open market or privately negotiated transactions. On January 24, 2022, the Board of Directors authorized an additional $500 million under the share repurchase program.

On July 25, 2022, following the completion of the previously authorized $800 million share repurchase programs, the Board of Directors authorized a share repurchase program that allows for the repurchase of up to $500 million of its outstanding common stock from time to time in the open market or privately negotiated transactions at the discretion of management. The Company's share repurchase program does not obligate it to acquire any specific number of shares.

U. S. Steel repurchased 7.1 million and 37.6 million shares of common stock for approximately $175 million and $849 million under these programs during 2023 and 2022, respectively. We do not expect to utilize the remainder of this authorization. No share repurchases were completed during 2024 as the Merger Agreement prohibits us from engaging in additional share repurchases without the consent of Purchaser.

FIVE-YEAR OPERATING SUMMARY (Unaudited)

(Thousands of tons, unless otherwise noted)	2024	2023	2022	2021	2020
Raw Steel Production					
Gary, IN	**5,665**	5,587	5,326	5,664	4,675
Great Lakes, MI	**—**	—	—	—	328
Mon Valley, PA	**2,724**	2,650	2,161	2,668	2,552
Granite City, IL	**—**	1,162	1,359	1,549	1,758
Total Flat-Rolled facilities	**8,389**	9,399	8,846	9,881	9,313
Mini Mill facility	**2,838**	2,953	2,650	2,688	—
U. S. Steel Košice	**3,832**	4,395	3,839	4,931	3,366
Tubular facility	**575**	568	634	464	16
Total	**15,634**	17,315	15,969	17,964	12,695
Raw Steel Capability					
Flat-Rolled	**13,200**	13,200	13,200	13,200	17,000
Mini Mill [(c)]	**6,300**	3,300	3,300	3,300	—
USSE	**5,000**	5,000	5,000	5,000	5,000
Tubular [(d)]	**900**	900	900	900	900
Total	**25,400**	22,400	22,400	22,400	22,900
Production as % of total capability:					
Flat-Rolled	**63 %**	71 %	67 %	58 %	55 %
Mini Mill [(c)]	**80 %**	89 %	80 %	81 %	— %
USSE	**77 %**	88 %	77 %	99 %	67 %
Tubular [(d)]	**64 %**	63 %	70 %	52 %	7 %
Coke Production					
Flat-Rolled	**3,164**	3,295	3,627	3,848	2,557
USSE	**1,336**	1,485	1,407	1,548	1,116
Total	**4,500**	4,780	5,034	5,396	3,673
Iron Ore Pellet Production [(a)]					
Total	**22,247**	22,134	22,059	23,369	16,981
Steel Shipments by Segment [(b)]					
Flat-Rolled	**7,845**	8,706	8,373	9,018	8,711
Mini Mill	**2,307**	2,424	2,287	2,230	—
USSE	**3,578**	3,899	3,759	4,302	3,041
Tubular	**476**	478	523	444	464
Total steel shipments	**14,206**	15,507	14,942	15,994	12,216
Average Realized Price (dollars per net ton)					
Flat-Rolled	**$ 1,013**	$ 1,030	$ 1,261	$ 1,172	$ 718
Mini Mill	**$ 857**	$ 875	$ 1,134	$ 1,314	$ —
USSE	**$ 805**	$ 873	$ 1,090	$ 966	$ 626
Tubular	**$ 1,905**	$ 3,137	$ 2,978	$ 1,696	$ 1,271

(a) Includes our share of production from Hibbing.

(b) Does not include intersegment shipments or shipments by joint ventures and other equity investees of U. S. Steel. Includes shipments from U. S. Steel to joint ventures and equity investees of substrate materials, primarily hot-rolled and cold-rolled sheets.

(c) The 2024 production as a % of total capability amount is based on Mini Mill's aggregate annual raw steel production capability of 3.3 million tons through the third quarter of 2024 and 6.3 million tons during the fourth quarter of 2024.

(d) The Fairfield Electric Arc Furnace commenced operation in October 2020. The 2020 production as a % of total capability amount is based on an October 1, 2020, start date.

FIVE-YEAR OPERATING SUMMARY (Unaudited) (Continued)

(Thousands of net tons)	2024	2023	2022	2021	2020
Steel Shipments by Market - North American Facilities [a]					
Steel service centers	**1,980**	2,622	2,208	2,660	1,450
Further conversion:					
Trade customers	**2,382**	2,669	2,935	2,385	2,063
Joint ventures [b]	**193**	211	256	490	415
Transportation and automotive [b]	**3,403**	2,893	2,631	2,372	2,012
Construction and construction products	**1,186**	1,422	1,261	1,524	1,295
Containers and packaging	**364**	571	706	959	913
Appliances and electrical equipment	**523**	507	509	679	497
Oil, gas and petrochemicals	**465**	447	494	426	430
All other	**132**	266	183	197	100
Total	**10,628**	11,608	11,183	11,692	9,175
Steel Shipments by Market - USSE					
Steel service centers	**877**	848	839	995	690
Further conversion:					
Trade customers	**245**	293	289	314	202
Transportation and automotive	**559**	636	619	590	517
Construction and construction products	**1,224**	1,319	1,052	1,346	775
Containers and packaging	**223**	312	423	449	435
Appliances and electrical equipment	**176**	172	225	266	194
Oil, gas and petrochemicals	**1**	—	3	8	5
All other	**273**	319	309	334	223
Total	**3,578**	3,899	3,759	4,302	3,041

[a] Does not include shipments by joint ventures and other equity investees of U. S. Steel, but instead reflects the shipments of substrate materials, primarily hot-rolled and cold-rolled sheets, to those entities.

[b] PRO-TEC automotive substrate shipments are included in the Transportation and Automotive category.

Item 9. CHANGES IN AND DISAGREEMENTS WITH ACCOUNTANTS ON ACCOUNTING AND FINANCIAL DISCLOSURE

None.

Item 9A. CONTROLS AND PROCEDURES

Conclusions Regarding the Effectiveness of Disclosure Controls and Procedures

Under the supervision and with the participation of U. S. Steel's management, including the chief executive officer and chief financial officer, U. S. Steel conducted an evaluation of our disclosure controls and procedures, as such term is defined under Rule 13a-15(e) promulgated under the Securities Exchange Act of 1934, as amended (the Exchange Act). Based on this evaluation, U. S. Steel's chief executive officer and chief financial officer concluded that U. S. Steel's disclosure controls and procedures were effective as of the end of the period covered by this annual report.

Management's Report on Internal Control Over Financial Reporting

See "Item 8. Financial Statements and Supplementary Data – Management's Report to Stockholders – Internal Control Over Financial Reporting."

Attestation Report of Independent Registered Public Accounting Firm

See "Item 8. Financial Statements and Supplementary Data – Report of Independent Registered Public Accounting Firm."

Changes in Internal Control Over Financial Reporting

There have not been any changes in U. S. Steel's internal control over financial reporting that occurred during the fourth quarter of 2024 which have materially affected, or are reasonably likely to materially affect, U. S. Steel's internal control over financial reporting.

Item 9B. OTHER INFORMATION

During the quarter ended December 31, 2024, none of our directors or officers adopted or terminated a "Rule 10b5-1 trading arrangement" or a "non-Rule 10b5-1 trading arrangement," as those terms are defined in Item 408 of Regulation S-K.

Item 9C. DISCLOSURE REGARDING FOREIGN JURISDICTIONS THAT PREVENT INSPECTIONS

Not Applicable.

PART III

Item 10. DIRECTORS, EXECUTIVE OFFICERS AND CORPORATE GOVERNANCE

Information concerning the directors of U. S. Steel required by this item is incorporated and made part hereof by reference to the material appearing under the heading "Election of Directors" in U. S. Steel's Proxy Statement for the 2025 Annual Meeting of Stockholders, which will be filed with the Securities and Exchange Commission, pursuant to Regulation 14A, no later than 120 days after the end of the fiscal year. Information concerning the Audit Committee, and its financial expert required by this item is incorporated and made part hereof by reference to the material appearing under the heading "Corporate Governance – Board Committees – Audit" in U. S. Steel's Proxy Statement for the 2025 Annual Meeting of Stockholders. Information regarding the Nominating Committee required by this item is incorporated and made part hereof by reference to the material appearing under the heading "Corporate Governance – Board Committees – Corporate Governance & Sustainability" in U. S. Steel's Proxy Statement for the 2025 Annual Meeting of Stockholders. Information regarding the ability of stockholders to communicate with the Board of Directors is incorporated and made part hereof by reference to the material appearing under the heading "Corporate Governance – Commitment to Stockholder Engagement – Communications from Stockholders and Interested Parties" in U. S. Steel's Proxy Statement for the 2025 Annual Meeting of Stockholders. Information regarding compliance with Section 16(a) of the Exchange Act required by this item is incorporated and made part hereof by reference to the material appearing under the heading "Delinquent Section 16(a) Reports" in U. S. Steel's Proxy Statement for the 2025 Annual Meeting of Stockholders. Information concerning the executive officers of U. S. Steel is contained in Part I of this Form 10-K under the caption "Information about our Executive Officers."

U. S. Steel has adopted a Code of Ethical Business Conduct that applies to all of our directors and officers, including our principal executive officer, principal financial officer, principal accounting officer or controller, or persons performing similar functions. U. S. Steel will provide a copy of this code free of charge upon request. To obtain a copy, contact the Office of the Corporate Secretary, United States Steel Corporation, 600 Grant Street, Pittsburgh, Pennsylvania, 15219-2800 (telephone: 412-433-1121). The Code of Ethical Business Conduct is also available through the Company's website at ***www.ussteel.com***.

We intend to post all required disclosures concerning any amendments to or waivers from, our Code of Ethical Business Conduct on our website. U. S. Steel does not intend to incorporate the contents of our website into this Annual Report on Form 10-K.

U. S. Steel has an Insider Trading Policy governing the purchase, sale and other dispositions of its securities by directors, officers and employees that is reasonably designed to promote compliance with insider trading laws, rules and regulations and NYSE listing standards. The Insider Trading Policy is filed with this Form 10-K as Exhibit 19.

Item 11. EXECUTIVE COMPENSATION

Information required by this item is incorporated and made part hereof by reference to the material appearing under the headings “Director Compensation,” “Compensation & Organization Committee Report,” “Compensation Discussion and Analysis,” “Executive Compensation Tables,” “Potential Payments Upon Termination or Change in Control” and “CEO Pay Ratio” in U. S. Steel’s Proxy Statement for the 2025 Annual Meeting of Stockholders.

Item 12. SECURITY OWNERSHIP OF CERTAIN BENEFICIAL OWNERS AND MANAGEMENT AND RELATED STOCKHOLDER MATTERS

Equity Compensation Plan Information

Plan Category	(1) Number of securities to be issued upon exercise of outstanding options, warrants and rights	(2) Weighted-average exercise price of outstanding options, warrants and rights	(3) Number of securities remaining available for future issuance under equity compensation plans excluding securities reflected in Column (1) [b]
Equity compensation plans approved by security holders [a]	7,872,563	$28.60	4,084,130
Equity compensation plans not approved by security holders[c]	—	(one for one)	—
Total	7,872,563	—	4,084,130

[a] The numbers in columns (1) and (2) of this row contemplate all shares that could potentially be issued as a result of outstanding grants under the 2005 Stock Incentive Plan and the 2016 Omnibus Incentive Compensation Plan, as amended and restated as of December 31, 2024. (For more information, see Note 15 to the Consolidated Financial Statements). Column (1) includes (i) 751,863 shares of common stock that could be issued for the Common Stock Units outstanding under the Deferred Compensation Program for Non-Employee Directors and (ii) 3,770,904 shares that could be issued for the 1,885,452 performance awards outstanding under the Long-Term Incentive Compensation Program (a program under the 2016 Omnibus Incentive Compensation Plan, as amended and restated). The calculation in column (2) does not include the Common Stock Units since the weighted average exercise price for Common Stock Units is one for one; that is, one share of common stock will be given in exchange for each unit of such phantom stock accumulated through the date of the director’s retirement. Also, the calculation in column (2) does not include the performance awards since the shares issued for performance awards can range from zero for one to two for one; that is, performance awards may result in up to 3,770,904 of common stock being issued (two for one), or some lesser number of shares (including zero shares of common stock issued), depending upon the Corporation’s common stock performance versus that of a peer group of companies or the Corporation’s return on capital employed performance over a performance period.

[b] Represents shares available under the 2016 Omnibus Incentive Compensation Plan, as amended and restated.

[c] At December 31, 2024, U. S. Steel had no securities remaining for future issuance under equity compensation plans that had not been approved by security holders. Column (1) represents Common Stock Units that were issued pursuant to the Deferred Compensation Plan for Non-Employee Directors prior to its being amended to make it a program under the 2005 Stock Incentive Plan and 2016 Omnibus Incentive Compensation Plan, as amended and restated. The weighted average exercise price for Common Stock Units in column (2) is one for one; that is, one share of common stock will be given in exchange for each unit of phantom stock upon the director’s retirement from the Board of Directors. All future grants under this amended plan/program will count as shares issued under the 2016 Omnibus Incentive Compensation Plan, as amended and restated, a stockholder approved plan.

Other information required by this item is incorporated and made part hereof by reference to the material appearing under the headings “Stock Ownership of Directors and Executive Officers” and “Stock Ownership of Certain Beneficial Owners” in U. S. Steel’s Proxy Statement for the 2025 Annual Meeting of Stockholders.

Item 13. CERTAIN RELATIONSHIPS AND RELATED TRANSACTIONS, AND DIRECTOR INDEPENDENCE

Information required by this item is incorporated and made part hereof by reference to the material appearing under the headings “Corporate Governance – Related Person Transactions Policy” and “Corporate Governance – Director Independence” in U. S. Steel’s Proxy Statement for the 2025 Annual Meeting of Stockholders.

Item 14. PRINCIPAL ACCOUNTANT FEES AND SERVICES

Information required by this item is incorporated and made part hereof by reference to the material appearing under the heading “Audit Fees” in U. S. Steel’s Proxy Statement for the 2025 Annual Meeting of Stockholders.

PART IV

Item 15. EXHIBITS AND FINANCIAL STATEMENT SCHEDULE

A. Documents Filed as Part of the Report

1. **Financial Statements and Supplementary Data**
   Financial Statements filed as part of this report are included in "Item 8 – Financial Statements and Supplementary Data".

2. **Financial Statement Schedules**
   See "Schedule II – Valuation and Qualifying Accounts and Reserves" for years ended December 31, 2024, 2023, and 2022. All other schedules are omitted because they are not applicable or the required information is contained in the applicable financial statements or notes thereto.

B. Exhibits

Exhibit No.

2. Plan of acquisition, reorganization, arrangement, liquidation or succession

(a)	Agreement and Plan of Merger, dated as of December 18, 2023, by and among the Company, Parent, Merger Sub and NSC (solely as provided in Section 9.13 therein).**	Incorporated by reference to Exhibit 2.1 to United States Steel Corporation's Form 8-K filed on December 18, 2023, Commission File Number 1-16811.

3. Articles of Incorporation and By-Laws

(a)	Amended and Restated Certificate of Incorporation of United States Steel Corporation, dated April 25, 2017	Incorporated by reference to Exhibit 3.1 to United States Steel Corporation's Form 8-K filed on April 28, 2017, Commission File Number 1-16811.
(b)	Amended and Restated By-Laws of United States Steel Corporation, dated as of January 31, 2023.	Incorporated by reference to Exhibit 3.1 to United States Steel Corporation's Form 8-K filed on February 2, 2023, Commission File Number 1-16811.

4. Instruments Defining the Rights of Security Holders, Including Indentures

(a)	Indenture between United States Steel Corporation and The Bank of New York Mellon (f/k/a The Bank of New York), dated as of May 21, 2007.	Incorporated by reference to Exhibit 4.1 to United States Steel Corporation's Form 8-K filed on May 22, 2007, Commission File Number 1-16811.
(b)	First Supplemental Indenture between United States Steel Corporation and The Bank of New York Mellon (f/k/a The Bank of New York), dated as of May 21, 2007.	Incorporated by reference to Exhibit 4.2 to United States Steel Corporation's Form 8-K filed on May 22, 2007, Commission File Number 1-16811.
(c)	Tenth Supplemental Indenture between United States Steel Corporation and The Bank of New York Mellon, dated as of February 11, 2021.	Incorporated by reference to Exhibit 4.1 to United States Steel Corporation's Form 8-K filed on February 11, 2021, Commission File Number 1-16811.
(d)	Indenture by and between United States Steel Corporation and The Bank of New York Mellon, dated as of October 21, 2019.	Incorporated by reference to Exhibit 4.1 to United States Steel Corporation's Form 8-K filed on October 21, 2019, Commission File Number 1-16811.
(e)	Indenture among Big River Steel LLC, BRS Finance Corp., BRS Intermediate Holdings LLC, each Guarantor that may become party thereto and U.S. Bank National Association, dated as of September 18, 2020.	Incorporated by reference to Exhibit 4.1 to United States Steel Corporation's Form 8-K filed on January 19, 2021, Commission File Number 1-16811.
(f)	Description of Securities.	Incorporated by reference to Exhibit 4.1 to United States Steel Corporation's Form 10-K filed on February 14, 2020, Commission File Number 1-16811.

Certain long-term debt instruments are omitted pursuant to Item 601(b)(4)(iii) of Regulation S-K. U. S. Steel agrees to furnish to the Commission on request a copy of any instrument defining the rights of holders of long-term debt of U. S. Steel and of any subsidiary for which consolidated or unconsolidated financial statements are required to be filed.

10. Material Contracts

(a)	Option Agreement by and between United States Steel Corporation and Stelco Inc., dated as of April 30, 2020.	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 8-K filed on April 30, 2020, Commission File Number 1-16811.
(b)	Commitment Agreement by and among United States Steel Corporation, Banner Life Insurance Company, William Penn Life Insurance Company of New York and State Street Global Advisors Trust Company, dated November 8, 2021.**	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-K filed on February 11, 2022, Commission File Number 1-16811.
(c)	Sixth Amended and Restated Credit Agreement, dated as of May 27, 2022, among United States Steel Corporation, the Subsidiary Guarantors from time to time party thereto, the Lenders party thereto, the LC Issuing Banks party thereto, and JPMorgan Chase Bank, N.A., as Administrative and Collateral Agent.	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 8-K filed on June 3, 2022, Commission File Number 1-16811.
(d)	Amendment No. 1 to Sixth Amended and Restated Credit Agreement, dated as of December 19, 2022, among United States Steel Corporation, the Subsidiary Guarantors from time to time party thereto, the Lenders party thereto, the LC Issuing Banks party thereto, and JPMorgan Chase Bank, N.A., as Administrative and Collateral Agent.**	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-K filed on February 3, 2023, Commission File Number 1-16811.
(e)	Third Amended and Restated Borrower Security Agreement, dated as of May 27, 2022, between United States Steel Corporation and JPMorgan Chase Bank, N.A., as Collateral Agent.	Incorporated by reference to Exhibit 10.2 to United States Steel Corporation's Form 8-K filed on June 3, 2022, Commission File Number 1-16811.
(f)	Third Amended and Restated Subsidiary Security Agreement, dated as of May 27, 2022, between the Subsidiary Guarantors and JPMorgan Chase Bank, N.A., as Collateral Agent.	Incorporated by reference to Exhibit 10.3 to United States Steel Corporation's Form 8-K filed on June 3, 2022, Commission File Number 1-16811.
(g)	Second Amended and Restated Borrower Canadian Security Agreement, dated as of May 27, 2022, between United States Steel Corporation and JPMorgan Chase Bank, N.A., as Collateral Agent.	Incorporated by reference to Exhibit 10.4 to United States Steel Corporation's Form 8-K filed on June 3, 2022, Commission File Number 1-16811.
(h)	Agreement of Sale between United States Steel Corporation and The Industrial Development Board of the City of Hoover, dated as of October 1, 2019.	Incorporated by reference to Exhibit 10.4 to United States Steel Corporation's Form 8-K filed on October 28, 2019, Commission File Number 1-16811.
(i)	Loan Agreement between United States Steel Corporation and the Allegheny County Industrial Development Authority, dated as of October 1, 2019.	Incorporated by reference to Exhibit 10.5 to United States Steel Corporation's Form 8-K filed on October 28, 2019, Commission File Number 1-16811.
(j)	Amended and Restated Credit Agreement, dated December 22, 2022, among Exploratory Ventures, LLC, as Borrower, United States Steel Corporation, as Parent Guarantor, KFW IPEX-Bank GMBH, as Mandated Lead Arranger and ECA Structuring Bank, KFW IPEX-Bank GMBH, as Facility Agent and ECA Agent, and lenders party thereto from time to time.**	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-Q filed on October 27, 2023, Commission File Number 1-16811.
(k)	Agreement of Sale between United States Steel Corporation and The Industrial Development Board of the City of Hoover regarding $63,400,000 million 6.375% Environmental Improvement Revenue Bonds, Series 2020 (United States Steel Corporation Project), dated as of November 1, 2020.	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 8-K filed on November 24, 2020, Commission File Number 1-16811.
(l)	Loan Agreement dated between United States Steel Corporation and the Indiana Finance Authority regarding $33,300,000 Indiana Finance Authority Environmental Improvement Revenue Bonds, Series 2020A (United States Steel Corporation Project) and Indiana Finance Authority Environmental Improvement Revenue Refunding Bonds, Series 2020B (United States Steel Corporation Project), dated as of November 1, 2020.	Incorporated by reference to Exhibit 10.2 to United States Steel Corporation's Form 8-K filed on November 24, 2020, Commission File Number 1-16811.
(m)	ABL Credit Agreement by and among Big River Steel LLC, BRS Intermediate Holdings LLC, Goldman Sachs Bank USA and each lender party thereto, dated as of August 23, 2017.**	Incorporated by reference to Exhibit 10.2 to United States Steel Corporation's Form 10-K filed on February 11, 2022, Commission File Number 1-16811.

(n)	First Amendment to ABL Credit Agreement by and among Big River Steel LLC, BRS Intermediate Holdings LLC, Goldman Sachs Bank USA and each lender party thereto, dated as of September 10, 2020.	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 8-K filed on January 19, 2021, Commission File Number 1-16811.
(o)	Second Amendment to ABL Credit Agreement by and among Big River Steel LLC, BRS Intermediate Holdings LLC, Goldman Sachs Bank USA and each lender party thereto, dated as of July 23, 2021.	Incorporated by reference to Exhibit 10.4 to United States Steel Corporation's Form 10-Q filed on July 30, 2021, Commission File Number 1-16811.
(p)	Third Amendment to ABL Credit Agreement by and among Big River Steel LLC, BRS Intermediate Holdings LLC, Goldman Sachs Bank USA and each lender party thereto, dated as of December 19, 2022.**	Incorporated by reference to Exhibit 10.2 to United States Steel Corporation's Form 10-K filed on February 3, 2023, Commission File Number 1-16811.
(q)	Fourth Amendment to ABL Credit Agreement by and among BRS Intermediate Holdings LLC, Big River Steel LLC, BRS Finance Corp. and Goldman Sachs Bank USA and each lender party thereto, dated as of June 16, 2023.	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-Q filed on July 28, 2023, Commission File Number 1-16811.
(r)	Bond Financing Agreement between Arkansas Development Finance Authority and each of Big River Steel LLC, BRS Finance Corp. and BRS Intermediate Holdings LLC relating to $265 million Arkansas Development Finance Authority Industrial Development Revenue Bonds (Big River Steel Project), Tax-Exempt Series 2020 (Green Bonds), dated as of September 10, 2020.	Incorporated by reference to Exhibit 10.2.1 to United States Steel Corporation's Form 8-K filed on January 19, 2021, Commission File Number 1-16811.
(s)	Definitions Annex relating to Arkansas Development Finance Authority Industrial Development Revenue Bonds (Big River Steel Project), Tax-Exempt Series 2020 (Green Bonds), dated as of September 10, 2020.	Incorporated by reference to Exhibit 10.2.2 to United States Steel Corporation's Form 8-K filed on January 19, 2021, Commission File Number 1-16811.
(t)	Bond Financing Agreement between Arkansas Development Finance Authority and each of Big River Steel LLC, BRS Finance Corp. and BRS Intermediate Holdings LLC relating to $487 million Arkansas Development Finance Authority Industrial Development Revenue Bonds (Big River Steel Project), Series 2019, dated as of May 31, 2019.	Incorporated by reference to Exhibit 10.3.1 to United States Steel Corporation's Form 8-K filed on January 19, 2021, Commission File Number 1-16811.
(u)	Definitions Annex relating to Arkansas Development Finance Authority Industrial Development Revenue Bonds (Big River Steel Project), Series 2019, dated as of May 31, 2019.	Incorporated by reference to Exhibit 10.3.2 to United States Steel Corporation's Form 8-K filed on January 19, 2021, Commission File Number 1-16811.
(v)	Loan Agreement between Arkansas Development Finance Authority and each of United States Steel Corporation and Exploratory Ventures, LLC relating to $290,000,000 Arkansas Development Finance Authority Environmental Improvement Revenue Bonds, Series 2022 (United States Steel Corporation Project) (Green Bonds), dated as of September 1, 2022.	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-Q filed on October 28, 2022, Commission File Number 1-16811.
(w)	EUR 300,000,000 Unsecured Sustainability Linked Revolving Credit Facility Agreement among U. S. Steel Košice, s.r.o., and ING Bank N.V., Komerèní banka, a.s., Slovenská sporiteľňa, a.s., UniCredit Bank Czech Republic and Slovakia , a.s., Československá Obchodná banka, a.s., and Citibank Europe plc, dated September 29, 2021.	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 8-K filed on October 1, 2021, Commission File Number 1-16811.
(x)	Supplemental Agreement No. 9 between U. S. Steel Košice, s.r.o. and ING Bank N.V., dated December 3, 2021.	Incorporated by reference to Exhibit 10.3 to United States Steel Corporation's Form 10-K filed on February 11, 2022, Commission File Number 1-16811.
(y)	First Supplemental Agreement, dated December 15, 2022, between U. S. Steel Košice, s.r.o., and ING Bank N.V., as Facility Agent, relating to an up to EUR 300,000,000 credit agreement dated September 29, 2021.**	Incorporated by reference to Exhibit 10.3 to United States Steel Corporation's Form 10-K filed on February 3, 2023, Commission File Number 1-16811.
(z)	United States Steel Corporation 2005 Stock Incentive Plan, Amended and Restated Effective April 29, 2014.*	Incorporated by reference to Appendix A to United States Steel Corporation's Definitive Proxy Statement on Schedule 14A filed on March 14, 2014, Commission File Number 1-16811.

(aa)	Form of Stock Option Grant under the Long-Term Incentive Compensation Program, a program under the United States Steel Corporation 2005 Stock Incentive Plan.*	Incorporated by reference to Exhibit 10(x) to United States Steel Corporation's Form 10-K filed on February 27, 2007, Commission File Number 1-16811.
(bb)	Form of Stock Option Grant Agreement under the Long-Term Incentive Compensation Program, a program under the United States Steel Corporation 2005 Stock Incentive Plan.*	Incorporated by reference to Exhibit 10.2 to United States Steel Corporation's Form 10-Q filed on April 26, 2011, Commission File Number 1-16811.
(cc)	Form of Non-Qualified Stock Option Grant Agreement under the Long-Term Incentive Compensation Program, a program under the United States Steel Corporation 2005 Stock Incentive Plan.*	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-Q filed on April 29, 2015, Commission File Number 1-16811.
(dd)	Administrative Procedures for the Long-Term Incentive Compensation Program under the United States Steel Corporation 2005 Stock Incentive Plan, as Amended and Restated, and under the United States Steel Corporation Annual Incentive Compensation Plan, Effective February 22, 2016.*	Incorporated by reference to Exhibit 10(kk) to United States Steel Corporation's Form 10-K filed on February 29, 2016, Commission File Number 1-16811.
(ee)	United States Steel Corporation Deferred Compensation Program for Non-Employee Directors, a program under the 2005 Stock Incentive Plan, effective as of November 29, 2005.*	Incorporated by reference to Exhibit 10(d) to United States Steel Corporation's Form 10-K filed on February 28, 2012, Commission File Number 1-16811.
(ff)	United States Steel Corporation 2010 Annual Incentive Compensation Plan, Effective April 27, 2010.*	Incorporated by reference to Appendix B to United States Steel Corporation's Definitive Proxy Statement on Schedule 14A filed on March 12, 2010, Commission File Number 1-16811.
(gg)	Administrative Procedures for the Executive Management Annual Incentive Compensation Program under the United States Steel Corporation 2010 Annual Incentive Compensation Plan, as amended November 1, 2016.*	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-Q filed on November 2, 2016, Commission File Number 1-16811.
(hh)	United States Steel Corporation Supplemental Thrift Program, Amended and Restated Effective July 31, 2013.*	Incorporated by reference to Exhibit 10.7 to United States Steel Corporation's Form 10-Q filed on October 29, 2013, Commission File Number 1-16811.
(ii)	United States Steel Corporation Supplemental Thrift Program, Amended and Restated Effective November 1, 2016.*	Incorporated by reference to Exhibit 10.3 to United States Steel Corporation's Form 10-Q filed on November 2, 2016, Commission File Number 1-16811.
(jj)	United States Steel Corporation Supplemental Thrift Program, Amended and Restated Effective January 1, 2019.*	Incorporated by reference to Exhibit 10.4 to United States Steel Corporation's Form 10-Q filed on May 3, 2019, Commission File Number 1-16811.
(kk)	United States Steel Corporation Non Tax-Qualified Retirement Account Program, Amended and Restated Effective November 13, 2013.	Incorporated by reference to Exhibit 10(dd) to United States Steel Corporation's Form 10-K filed on February 25, 2014, Commission File Number 1-16811.
(ll)	United States Steel Corporation Non Tax-Qualified Retirement Account Program, Amended and Restated Effective January 1, 2016.*	Incorporated by reference to Exhibit 10.2 to United States Steel Corporation's Form 10-Q filed on November 2, 2016, Commission File Number 1-16811.
(mm)	United States Steel Corporation Non Tax-Qualified Retirement Account Program, Amended and Restated Effective January 1, 2019.*	Incorporated by reference to Exhibit 10.3 to United States Steel Corporation's Form 10-Q filed on May 3, 2019, Commission File Number 1-16811.
(nn)	United States Steel Corporation Non Tax-Qualified Pension Plan, Amended and Restated Effective December 31, 2015.*	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 8-K filed on August 21, 2015, Commission File Number 1-16811.
(oo)	United States Steel Corporation Executive Management Supplemental Pension Program, Amended and Restated Effective December 31, 2015.*	Incorporated by reference to Exhibit 10.2 to United States Steel Corporation's Form 8-K filed on August 21, 2015, Commission File Number 1-16811.
(pp)	United States Steel Corporation Supplemental Retirement Account Program, Amended and Restated Effective January 1, 2016.*	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-Q filed on November 4, 2015, Commission File Number 1-16811.
(qq)	United States Steel Corporation Supplemental Retirement Account Program, Amended and Restated Effective January 1, 2019.*	Incorporated by reference to Exhibit 10.5 to United States Steel Corporation's Form 10-Q filed on May 3, 2019, Commission File Number 1-16811.
(rr)	United States Steel Corporation Change in Control Severance Plan, Amended and Restated Effective July 28, 2020*.	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 8-K filed on July 30, 2020, Commission File Number 1-16811.

(ss)	United States Steel Corporation Executive Severance Plan, Effective December 14, 2021.*	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 8-K filed on December 20, 2021, Commission File Number 1-16811.
(tt)	United States Steel Corporation 2016 Omnibus Incentive Compensation Plan, Effective April 26, 2016.*	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-Q filed on April 27, 2016, Commission File Number 1-16811.
(uu)	First Amendment to United States Steel Corporation 2016 Omnibus Incentive Compensation Plan, Effective February 28, 2017.*	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-Q filed on April 26, 2017, Commission File Number 1-16811.
(vv)	United States Steel Corporation 2016 Omnibus Incentive Compensation Plan, Amended and Restated Effective April 28, 2020*	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 8-K filed on May 1, 2020, Commission File Number 1-16811.
(ww)	United States Steel Corporation 2016 Omnibus Incentive Compensation Plan, Amended and Restated Effective April 27, 2021.*	Incorporated by reference to Exhibit 10.2 to United States Steel Corporation's Form 10-Q filed on April 30, 2021, Commission File Number 1-16811.
(xx)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan (Stock Option Grant).*	Incorporated by reference to Exhibit 10.3 to United States Steel Corporation's Form 10-Q filed on July 27, 2016, Commission File Number 1-16811.
(yy)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Performance Share Award Grant Agreement (2021 Grants).*	Incorporated by reference to Exhibit 10.3 to United States Steel Corporation's Form 10-Q filed on April 30, 2021, Commission File Number 1-16811.
(zz)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Performance Cash Award Grant Agreement (2021 Grants).*	Incorporated by reference to Exhibit 10.5 to United States Steel Corporation's Form 10-Q filed on April 30, 2021, Commission File Number 1-16811.
(aaa)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Restricted Stock Unit Grant Agreement (2021 Grants).*	Incorporated by reference to Exhibit 10.6 to United States Steel Corporation's Form 10-Q filed on April 30, 2021, Commission File Number 1-16811.
(bbb)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Retention Restricted Stock Unit Grant Agreement (2021 Grants).*	Incorporated by reference to Exhibit 10.7 to United States Steel Corporation's Form 10-Q filed on April 30, 2021, Commission File Number 1-16811.
(ccc)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan TSR Performance Share Award Grant Agreement (2021 Grants).*	Incorporated by reference to Exhibit 10.8 to United States Steel Corporation's Form 10-Q filed on April 30, 2021, Commission File Number 1-16811.
(ddd)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Performance Share Award Grant Agreement (2021 SVP Performance Awards)* **	Incorporated by reference to Exhibit 10.4 to United States Steel Corporation's Form 10-K filed on February 11, 2022, Commission File Number 1-16811.
(eee)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Performance Share Award Grant Agreement (2021 CEO Performance Award)* **	Incorporated by reference to Exhibit 10.5 to United States Steel Corporation's Form 10-K filed on February 11, 2022, Commission File Number 1-16811.
(fff)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Performance Non-Qualified Stock Option Grant Agreement (2021 CEO PSO)* **	Incorporated by reference to Exhibit 10.6 to United States Steel Corporation's Form 10-K filed on February 11, 2022, Commission File Number 1-16811.
(ggg)	Form of United States Steel Corporation 2016 Omnibus Incentive Plan Performance Share Award Grant Agreement (ROCE Grant)*	Incorporated by reference to Exhibit 10.2 to United States Steel Corporation's Form 10-Q filed on April 29, 2022, Commission File Number 1-16811.
(hhh)	Form of United States Steel Corporation 2016 Omnibus Incentive Plan Performance Share Award Grant Agreement (TSR Grant)*	Incorporated by reference to Exhibit 10.3 to United States Steel Corporation's Form 10-Q filed on April 29, 2022, Commission File Number 1-16811.
(iii)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Performance Share Award Grant Agreement (2023 ROCE Grants).*	Incorporated by reference to Exhibit 10.2 to United States Steel Corporation's Form 10-Q filed on April 28, 2023, Commission File Number 1-16811.
(jjj)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Performance Share Award Grant Agreement (2023 TSR Grants).*	Incorporated by reference to Exhibit 10.3 to United States Steel Corporation's Form 10-Q filed on April 28, 2023, Commission File Number 1-16811.
(kkk)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Restricted Stock Unit Grant Agreement (2023 Annual Grants).*	Incorporated by reference to Exhibit 10.4 to United States Steel Corporation's Form 10-Q filed on April 28, 2023, Commission File Number 1-16811.
(lll)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Restricted Stock Unit Grant Agreement (2023 Retention Grants).*	Incorporated by reference to Exhibit 10.5 to United States Steel Corporation's Form 10-Q filed on April 28, 2023, Commission File Number 1-16811.

(mmm)	Administrative Procedures for the Executive Management Annual Incentive Compensation Plan under the United States Steel Corporation 2016 Omnibus Incentive Compensation Plan, Effective February 28, 2023.*	Incorporated by reference to Exhibit 10.6 to United States Steel Corporation's Form 10-Q filed on April 28, 2023, Commission File Number 1-16811.
(nnn)	United States Steel Corporation Deferred Compensation Program for Non-Employee Directors, a program under the United States Steel Corporation 2016 Omnibus Incentive Plan, effective as of July 26, 2016, as amended on October 30, 2018.*	Incorporated by reference to Exhibit 10.4 to United States Steel Corporation's Form 10-K filed on February 15, 2019, Commission File Number 1-16811.
(ooo)	United States Steel Corporation Deferred Compensation Program for Non-Employee Directors, a program under the United States Steel Corporation 2016 Omnibus Incentive Plan, effective as of July 26, 2016, as amended on October 28, 2019.*	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-K filed on February 14, 2020, Commission File Number 1-16811.
(ppp)	United States Steel Corporation Deferred Compensation Program for Non-Employee Directors, a program under the United States Steel Corporation 2016 Omnibus Incentive Compensation Plan, Effective January 1, 2022.*	Incorporated by reference to Exhibit 10.7 to United States Steel Corporation's Form 10-K filed on February 11, 2022, Commission File Number 1-16811.
(qqq)	United States Steel Corporation Non-Employee Director Stock Program of the 2016 Omnibus Incentive Compensation Plan, Effective November 1, 2019.*	Incorporated by reference to Exhibit 10.2 to United States Steel Corporation's Form 10-K filed on February 14, 2020, Commission File Number 1-16811.
(rrr)	United States Steel Corporation Non-Employee Director Compensation Policy, Effective as of January 1, 2022.*	Incorporated by reference to Exhibit 10.8 to United States Steel Corporation's Form 10-K filed on February 11, 2022, Commission File Number 1-16811.
(sss)	United States Steel Corporation Non-Employee Director Compensation Policy, Adopted as of December 14, 2021, Amended as of December 15, 2022.*	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-Q filed on April 28, 2023, Commission File Number 1-16811.
(ttt)	Letter Agreement between Scott D. Buckiso and United States Steel Corporation, dated July 30, 2020.*	Incorporated by reference to Exhibit 10.4 to United States Steel Corporation's Form 10-K filed on February 12, 2021, Commission File Number 1-16811.
(uuu)	Separation Agreement and Release by and between Douglas R. Matthews and United States Steel Corporation, dated December 24, 2020.*	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-K filed on February 12, 2021, Commission File Number 1-16811.
(vvv)	Special Transition Agreement and Release by and between Christine S. Breves and United States Steel Corporation, dated February 15, 2022.	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-Q filed on April 29, 2022, Commission File Number 1-16811.
(www)	Form of Offer Letter to Jessica T. Graziano, dated June 6, 2022.**	Incorporated by reference to Exhibit 10.5 to United States Steel Corporation's Form 10-Q filed on July 29, 2022, Commission File Number 1-16811.
(xxx)	United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Restricted Stock Unit Grant Agreement (Non-Employee Directors – Base Retainer)*	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-K filed on February 2, 2024, Commission File Number 1-16811.
(yyy)	United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Restricted Stock Unit Grant Agreement (Non-Employee Directors – Chair Retainer)*	Incorporated by reference to Exhibit 10.2 to United States Steel Corporation's Form 10-K filed on February 2, 2024, Commission File Number 1-16811.
(zzz)	United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Deferred Stock Unit Grant Agreement (Non-Employee Directors – Base Retainer)*	Incorporated by reference to Exhibit 10.3 to United States Steel Corporation's Form 10-K filed on February 2, 2024, Commission File Number 1-16811.
(aaaa)	United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Deferred Stock Unit Grant Agreement (Non-Employee Directors – Chair Retainer)*	Incorporated by reference to Exhibit 10.4 to United States Steel Corporation's Form 10-K filed on February 2, 2024, Commission File Number 1-16811.
(bbbb)	Administrative Procedures for the Executive Management Annual Incentive Compensation Plan under the United States Steel Corporation 2016 Omnibus Incentive Compensation Plan, Effective February 27, 2024.*	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-Q filed on May 3, 2024, Commission File Number 1-16811.
(cccc)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Performance Share Award Grant Agreement (2024 ROCE Grants).*	Incorporated by reference to Exhibit 10.2 to United States Steel Corporation's Form 10-Q filed on May 3, 2024, Commission File Number 1-16811.

(dddd)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Restricted Stock Unit Grant Agreement (2024 Retention Grants).*	Incorporated by reference to Exhibit 10.3 to United States Steel Corporation's Form 10-Q filed on May 3, 2024, Commission File Number 1-16811.
(eeee)	Form of United States Steel Corporation 2016 Omnibus Incentive Compensation Plan Restricted Stock Unit Grant Agreement (2024 Annual Grants).*	Incorporated by reference to Exhibit 10.4 to United States Steel Corporation's Form 10-Q filed on May 3, 2024, Commission File Number 1-16811.
(ffff)	Amendment No. 2 to the Sixth Amended and Restated Credit Agreement, dated May 3, 2024, by and among United States Steel Corporation, JPMorgan Chase Bank, N.A. and the other lenders party thereto.	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-Q filed on August 2, 2024, Commission File Number 1-16811.
(gggg)	Second Supplement Agreement between U. S. Steel Kosice, S.R.O. and ING Bank N.V., dated May 3, 2024.	Incorporated by reference to Exhibit 10.2 to United States Steel Corporation's Form 10-Q filed on August 2, 2024, Commission File Number 1-16811.
(hhhh)	Supplemental Agreement No. 11 between U. S. Steel Kosice, S.R.O. and ING Bank N.V., dated May 3, 2024.	Incorporated by reference to Exhibit 10.3 to United States Steel Corporation's Form 10-Q filed on August 2, 2024, Commission File Number 1-16811.
(iiii)	First Amendment and Consent to Amended and Restated Credit Agreement, dated June 7, 2024, by and among Exploratory Ventures, LLC, United States Steel Corporation, KFW IPEX-Bank GMBH, and other lenders and parties thereto.	Incorporated by reference to Exhibit 10.4 to United States Steel Corporation's Form 10-Q filed on August 2, 2024, Commission File Number 1-16811.
(jjjj)	Supplemental Agreement No. 12 between U. S. Steel Košice, s.r.o. and ING Bank N.V., dated September 13, 2024.	Incorporated by reference to Exhibit 10.1 to United States Steel Corporation's Form 10-Q filed on November 11, 2024, Commission File Number 1-16811.

19	**United States Steel Corporation Insider Trading Policy, effective February 27, 2023.**
21	**List of Subsidiaries**
23	**Consent of PricewaterhouseCoopers LLP**
24	**Powers of Attorney**
31.1	**Certification of Chief Executive Officer required by Rules 13a-14(a) or 15d-14(a) of the Securities Exchange Act of 1934, as promulgated by the Securities and Exchange Commission pursuant to Section 302 of the Sarbanes-Oxley Act of 2002**
31.2	**Certification of Chief Financial Officer required by Rules 13a-14(a) or 15d-14(a) of the Securities Exchange Act of 1934, as promulgated by the Securities and Exchange Commission pursuant to Section 302 of the Sarbanes-Oxley Act of 2002**
32.1	**Certification of Chief Executive Officer Pursuant to 18 U.S.C. Section 1350, as Adopted Pursuant to Section 906 of the Sarbanes-Oxley Act of 2002**
32.2	**Certification of Chief Financial Officer Pursuant to 18 U.S.C. Section 1350, as Adopted Pursuant to Section 906 of the Sarbanes-Oxley Act of 2002**
95	**Mine Safety Disclosure required under Section 1503 of the Dodd-Frank Wall Street Reform and Consumer Protection Act**
97	**United States Steel Corporation Executive Officer Recoupment (Clawback) Policy, effective July 25, 2023.**
101	**The following financial information from United States Steel Corporation's Annual Report on Form 10-K for the year ended December 31, 2024, formatted in Inline XBRL (Extensible Business Reporting Language) includes: (i) the Consolidated Statements of Operations, (ii) the Consolidated Statements of Comprehensive Income (Loss), (iii) the Consolidated Balance Sheets, (iv) the Consolidated Statements of Cash Flows, and (v) Notes to the Consolidated Financial Statements.**
104	**Cover Page Interactive Data File (formatted as Inline XBRL and contained in Exhibit 101)**

* Indicates management contract or compensatory plan or arrangement.
** Schedules and exhibits have been omitted pursuant to Item 601(b)(2) of Regulation S-K. The Corporation hereby undertakes to furnish supplemental copies of the omitted schedules and exhibits upon request by the U.S. Securities and Exchange Commission; provided, however, that the parties may request confidential treatment pursuant to Rule 24b-2 of the Exchange Act for any document so furnished.

SCHEDULE II – VALUATION AND QUALIFYING ACCOUNTS AND RESERVES
YEARS ENDED DECEMBER 31, 2024, 2023, AND 2022
(millions of dollars)

Description	Balance at Beginning of Period	Additions		Deductions		Balance at End of Period
		Charged to Costs and Expenses	Charged to Other Accounts	Charged to Costs and Expenses	Charged to Other Accounts	
Year ended December 31, 2024:						
Reserves deducted in the balance sheet from the assets to which they apply:						
Allowance for doubtful accounts	**$ 38**	**$ 8**	**$ —**	**$ —**	**$ 20**	**$ 26**
Investments and long-term receivables reserve	**3**	**—**	**—**	**—**	**—**	**3**
Deferred tax valuation allowance:						
Domestic	**98**	**5**	**—**	**—**	**—**	**103**
Foreign	**3**	**43**	**—**	**—**	**—**	**46**
Year ended December 31, 2023:						
Reserves deducted in the balance sheet from the assets to which they apply:						
Allowance for doubtful accounts	$ 38	$ 14	$ —	$ —	$ 14	$ 38
Investments and long-term receivables reserve	4	—	—	—	1	3
Deferred tax valuation allowance:						
Domestic	116	—	—	18	—	98
Foreign	3	—	—	—	—	3
Year ended December 31, 2022:						
Reserves deducted in the balance sheet from the assets to which they apply:						
Allowance for doubtful accounts	$ 44	$ 17	$ —	$ —	$ 23	$ 38
Investments and long-term receivables reserve	4	—	—	—	—	4
Deferred tax valuation allowance:						
Domestic	159	18	—	61	—	116
Foreign	3	—	—	—	—	3

Item 16. FORM 10-K SUMMARY

None.

SIGNATURES

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, the Registrant has duly caused this report to be signed on its behalf by the undersigned, thereunto duly authorized.

Date: January 31, 2025

UNITED STATES STEEL CORPORATION

By: */s/ Manpreet S. Grewal*
Manpreet S. Grewal
Vice President, Controller & Chief Accounting Officer

Signature	Title
/s/ David B. Burritt **David B. Burritt**	President & Chief Executive Officer & Director (Principal Executive Officer)
/s/ Jessica T. Graziano **Jessica T. Graziano**	Senior Vice President & Chief Financial Officer (Principal Financial Officer)
/s/ Manpreet S. Grewal **Manpreet S. Grewal**	Vice President, Controller & Chief Accounting Officer (Principal Accounting Officer)
* **Tracy A. Atkinson**	Director
* **Andrea J. Ayers**	Director
* **Alicia J. Davis**	Director
* **Terry L. Dunlap**	Director
* **John J. Engel**	Director
* **John V. Faraci**	Director
* **Murry S. Gerber**	Director
* **Paul A. Mascarenas**	Director
* **Michael H. McGarry**	Director
* **David S. Sutherland**	Board Chair
* **Patricia A. Tracey**	Director

* **BY:** */s/ Manpreet S. Grewal*
Manpreet S. Grewal
Attorney-in-Fact

GLOSSARY OF CERTAIN DEFINED TERMS

The following definitions apply to terms used in this document:

2026 Senior Convertible Notes	Senior Convertible Notes due November 1, 2026
2053 ADFA Green Bonds	Arkansas Development Finance Authority Environmental Improvement Revenue Bonds due 2053
401(k) plans	defined contribution plans
ABL	Asset-Based Loan
ACCCI	American Coke and Coal Chemicals Institute
ACHD	Allegheny County Health Department
AD	antidumping
AD/CVD	antidumping and countervailing duty
ADEM	Alabama Department of Environmental Management
AHSS	advanced high-strength steel
AI	Artificial Intelligence
AISI	American Iron and Steel Institute
AOCI	Accumulated Other Comprehensive Income
AOP	Annual Operating Plan
ARO	Asset Retirement Obligation
ARPA	American Rescue Plan Act
ASC	Accounting Standards Codification
ASU	Accounting Standards Update
BART	Best Available Retrofit Technology
BAT	Best Available Technique
Big River Steel ABL Facility	Big River Steel amended senior secured asset-based revolving credit facility
BOF	Basic Oxygen Furnace Steelmaking
Big River 2 or BR2	Big River Steel 2
BRS	Big River Steel
CAA	Clean Air Act
CAFC	U.S. Court of Appeals for the Federal Circuit
CAFE	Corporate Average Fuel Economy
CAMT	corporate alternative minimum tax
CAMU	Corrective Action Management Unit
CBAM	carbon border adjustment mechanism
CDC	Chrome Deposit Corporation
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFIUS	the Committee on Foreign Investment in the United States
CIO	Chief Information Officer
CISO	the Chief Information Security Officer
CISSP	Certified Information Systems Security Professional
CIT	U.S. Court of International Trade
Cliffs	Cleveland-Cliffs Inc.
CMIP	Corrective Measure Implementation Plan
CO_2	carbon dioxide
CODM	chief operating decision maker
COETF	Coke Environmental Task Force
commodity purchase swaps	financial swaps associated with purchases of natural gas, zinc, tin and electricity
CORE	corrosion-resistant steel
COSO	Committee of Sponsoring Organizations of the Treadway Commission
cost cap	per capita dollar maximum the company is expected to pay per participant under the main U. S. Steel benefit plan
Credit Facility Agreement	Sixth Amended and Restated Credit Facility Agreement
CSIRP	Cybersecurity Incident Response Plan
CVD	countervailing duties
CWA	Clean Water Act
DAFW	OSHA Days Away From Work
D.C. Circuit	the United States Court of Appeals for the D.C. Circuit
DEI	diversity equity and inclusion
DOC	U.S. Department of Commerce

Double G	Double G Coatings Company LLC
DR	direct reduced
DRA	DRA Global and Barr Engineering Co.
EAF	Electric Arc Furnace
EBITDA	earnings before interest, taxes, depreciation and amortization
EC	European Commission
ECA	Export Credit Agreement
the “Effective Time”	effective time of the Merger
EGU	electric generating unit
EPS	earnings per share
ERGs	employee resource groups
ERISA	Employee Retirement Income Security Act of 1974
ERM	Enterprise Risk Management
ERP	enterprise resource planning
ERW	electric resistance welded
ESG	environmental, social and governance
ETS	Emissions Trading System
EU	European Union
EU ETS	EU Emissions Trading System
EUA	European Union Emission Allowances
EWPM	electric-weld pipe mill
FASB	Financial Accounting Standards Board
FIFO	first in, first out
FIP	Federal Implementation Plan
Fifth Credit Facility Agreement	Fifth Amended and Restated Credit Facility Agreement
Flat-Rolled	North American Flat-Rolled segment
foreign exchange forwards	foreign exchange forward sales contracts
FX	foreign exchange
GAAP	Generally Accepted Accounting Principles
Gateway	Gateway Energy and Coke Company LLC
GEN3	generation 3
GHG	greenhouse gas
GLNPO	Great Lakes National Program Office
Green Steels	steels made with low greenhouse gas emissions intensity
HDC	Hibbing Development Company
Hibbing	Hibbing Taconite Company
IEPA	Illinois Environmental Protection Agency
IRS	Internal Revenue Service
ISO	International Organization for Standardization
ITC	U.S. International Trade Commission
JSW	JSW Steel (USA) Inc. and JSW Steel USA Ohio, Inc.
JSW Defendants	Nucor, U. S. Steel, AK Steel Holding Group and Cleveland-Cliffs Inc.
Keetac	U. S. Steel’s iron ore operations at Keewatin, Minnesota
LIFO	last in, first out
MACT	Maximum Achievable Control Technology
Merger Sub	2023 Merger Subsidiary, Inc., a Delaware corp. and a wholly owned subsidiary of Purchaser
Midwest	Midwest Plant
Minntac	U. S. Steel’s iron ore operations at Mt. Iron, Minnesota
mmbtus	One Million British Thermal Units
mnt	thousand net tons
MPCA	Minnesota Pollution Control Agency
NAAQS	National Ambient Air Quality Standards
NAV	net asset value
NESHAP	National Emission Standards for Hazardous Air Pollutants
NGO	non-grain oriented
NIST	the National Institute of Standards and Technology
non-GAAP	Non-Generally Accepted Accounting Principles

NOV	Notice of Violation
NOx	nitrogen oxide
NPDES	National Pollutant Discharge Elimination System
NSC	Nippon Steel Corporation, a Japanese corporation
OCTG	oil country tubular goods
OECD	The Organization for Economic Co-operation and Development
OEM	original equipment manufacturer
OPEB	Other Post-Employment Benefit
Order	Administrative Order on Consent
Other Benefits	defined benefit retiree health care and life insurance plans
Patriot	Patriot Premium Threading Services, LLC
PBO	Projected Benefit Obligation
PCAOB	Public Company Accounting Oversight Board (United States)
PFAS	Per- and Polyfluoroalkyl Substances
PII	Personally Identifiable Information
PM	Particulate Matter
PPA	Pension Protection Act of 2006
ppb	parts per billion
PRO-TEC	PRO-TEC Coating Company, U. S. Steel and Kobe Steel Ltd. joint venture
PRP	potentially responsible party
PSU	Performance-based restricted Stock Unit
Purchaser	Nippon Steel North America, Inc., a New York corporation
RCRA	Resource Conservation and Recovery Act
RICO	Racketeer Influenced and Corrupt Organizations
ROCE	Return On Capital Employed
RP	Rehabilitation plan
RSU	Restricted Stock Unit
S&P	Standard & Poor’s
sales swaps	financial swaps hot-rolled coil and iron ore pellet sales
SCF	supply chain finance
SEC	Securities and Exchange Commission
SIP	State Implementation Plan
SO_2	Sulfur dioxide
SPT	Steelworkers Pension Trust
SSS	site-specific standard
Stelco	Stelco Inc., a subsidiary of Cleveland-Cliffs Inc.
sustainable steels	steels made with low greenhouse gas emissions
SWMU	Solid Waste Management Units
the 2005 Plan	2005 Stock Incentive Plan
the 2022 Labor Agreements	collective bargaining agreements with United Steelworkers effective September 1, 2022
the Committee	the Compensation & Organization Committee of the Board of Directors
the “Company”	United States Steel Corporation and its subsidiaries
the Exchange Act	the Securities Exchange Act of 1934, as amended
the “Insurers”	Banner Life Insurance Company and William Penn Life Insurance Company of New York
the insurer	Pacific Life Insurance Company
the “Merger”	pursuant to which Merger Sub will merge with and into the Company
the “Merger Agreement”	On December 18, 2023, the Company entered into an Agreement and Plan of Merger with Nippon Steel North America, Inc.
the Minntac Mine	iron ore mine located in Mt. Iron, Minnesota
the Omnibus Plan	2016 Omnibus Incentive Compensation Plan, as amended and restated
USSK Credit Agreement	USSK €150 million unsecured sustainability linked credit agreement
TRQ	tariff rate quotas
Transtar	Transtar LLC and its direct and indirect subsidiaries
TSR	Total Shareholder Return
Tubular	Tubular Products segment

U. S. Steel	United States Steel Corporation
U.S. EPA	United States Environmental Protection Agency
U.S. GAAP	accounting standards generally accepted in the United States
U.S. Supreme Court	the Supreme Court of the United States
UDEQ	Utah Department of Environmental Quality
ug/m3	micrograms per cubic meter
UK	United Kingdom
UPI	USS-POSCO Industries
USSE	U. S. Steel Europe segment
USSK	U. S. Steel Košice
USSTP	U. S. Steel Tubular Products LLC
USTR	United States Trade Representative
USW	United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union or United Steelworkers
USX	United States Steel Corporation
VEBA	trusts for retiree healthcare and life insurance
VERP	voluntary early retirement program
welded	seamless and electric resistance welded
WTO	World Trade Organization
WQS	water quality standard

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 22

U.S. Steel Corp., Current Report (Form 8-K) Pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934, June 18, 2025.

UNITED STATES
SECURITIES AND EXCHANGE COMMISSION
WASHINGTON, DC 20549

FORM 8-K

CURRENT REPORT

Pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934

Date of report (Date of earliest event reported): June 18, 2025

United States Steel Corporation
(Exact Name of Registrant as Specified in Charter)

Delaware	1-16811	25-1897152
(State or Other Jurisdiction of Incorporation)	**(Commission File Number)**	**(I.R.S. Employer Identification No.)**

600 Grant Street,
Pittsburgh, PA 15219-2800
(Address of Principal Executive Offices, and Zip Code)

(412) 433-1121
Registrant's Telephone Number, Including Area Code

(Former Name or Former Address, if Changed Since Last Report)

Check the appropriate box below if the Form 8-K filing is intended to simultaneously satisfy the filing obligation of the registrant under any of the following provisions (*see* General Instruction A.2. below):

☐ Written communication pursuant to Rule 425 under the Securities Act (17 CFR 230.425)

☐ Soliciting material pursuant to Rule 14a-12 under the Exchange Act (17 CFR 240.14a-12)

☐ Pre-commencement communication pursuant to Rule 14d-2(b) under the Exchange Act (17 CFR 240.14d-2(b))

☐ Pre-commencement communication pursuant to Rule 13e-4(c) under the Exchange Act (17 CFR 240.13e-4(c))

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	Trading Symbol(s)	Name of each exchange on which registered
Common Stock	X	New York Stock Exchange
Common Stock	X	Chicago Stock Exchange

Indicate by check mark whether the registrant is an emerging growth company as defined in Rule 405 of the Securities Act of 1933 (17 CFR §230.405) or Rule 12b-2 of the Securities Exchange Act of 1934 (17 CFR §240.12b-2).

Emerging growth company ☐

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act. ☐

Introductory Note

On June 18, 2025, United States Steel Corporation, a Delaware corporation (the "Company"), completed the transaction contemplated by the terms of the previously announced Agreement and Plan of Merger, dated December 18, 2023 (the "Agreement"), by and among the Company, Nippon Steel North America, Inc., a New York corporation ("Parent"), 2023 Merger Subsidiary, Inc., a Delaware corporation and a wholly owned subsidiary of Parent ("2023 Sub"), and, solely as provided in Section 9.13 thereof, Nippon Steel Corporation, a Japanese corporation ("Guarantor").

Pursuant to the Agreement, 2023 Sub merged with and into the Company (the "Transaction"), with the Company surviving the merger as the surviving corporation and a subsidiary of Parent. At the effective time of the Transaction (the "Effective Time"), on the terms and subject to the conditions of the Agreement, each share of common stock, par value $1.00 per share, of the Company (the "Common Stock") issued and outstanding immediately prior to the Effective Time (other than (a) shares of Common Stock owned by the Company or any wholly owned subsidiary of the Company as treasury stock or otherwise (other than shares of Common Stock reserved for issuance under any of the Company Equity Plans (as defined in the Agreement)) or held directly or indirectly by Parent, 2023 Sub or any wholly owned subsidiary of Parent immediately prior to the Effective Time and (b) shares of Common Stock that were held by holders who did not vote in favor of the adoption of the Agreement and properly demanded, exercised and perfected appraisal of such shares pursuant to Section 262 of the General Corporation Law of the State of Delaware (the "DGCL")) was automatically converted into the right to receive $55.00 in cash (the "Transaction Consideration"). Additionally, at the Effective Time, each share of common stock, par value $1.00 per share, of 2023 Sub outstanding

immediately prior to the Effective Time was converted into and became one validly issued, fully paid and nonassessable share of common stock, par value $1.00 per share, of the surviving corporation and constituted the only outstanding shares of capital stock of the surviving corporation.

Pursuant to the Agreement, each time-vested restricted stock unit award in respect of shares of Common Stock (a "Company RSU Award"), or portion thereof, that was outstanding immediately prior to the Effective Time, to the extent not vested, automatically became fully vested and was cancelled and converted into the right of the holder of the Company RSU Award (or portion thereof) to receive an amount in cash equal to (i) the Transaction Consideration *multiplied by* (ii) the number of shares underlying such Company RSU Award (or portion thereof) immediately prior to the Effective Time, together with any accrued and unpaid dividends corresponding to such vested Company RSU Award (or portion thereof).

Pursuant to the Agreement, each performance-based restricted stock unit award in respect of shares of Common Stock (a "Company PSU Award"), or portion thereof, that was outstanding immediately prior to the Effective Time, to the extent not vested, automatically became fully vested to the extent described in the following sentence and was cancelled and converted into the right of the holder of the Company PSU Award (or portion thereof) to receive an amount in cash equal to (i) the Transaction Consideration *multiplied by* (ii) the total number of shares subject to such Company PSU Award (or portion thereof) immediately prior to the Effective Time, together with any accrued and unpaid dividends corresponding to such vested Company PSU Award (or portion thereof). The total number of shares subject to a Company PSU Award were based on deemed achievement of the greater of (i) actual performance and (ii) target performance through the Effective Time. Notwithstanding the foregoing, if any portion of the Company PSU Award had been earned by its terms as of the Effective Time, but had not yet become vested, the total number of shares subject to such Company PSU Award was based on the number of shares actually earned.

Pursuant to the Agreement, each option to acquire shares of Common Stock (a "Company Option Award"), or portion thereof, that was outstanding immediately prior to the Effective Time, to the extent not vested, automatically became fully vested and was cancelled and converted into the right of the holder of each such Company Option Award to receive an amount in cash equal to (i) the excess, if any, of the Transaction Consideration over the applicable exercise price of such Company Option Award, *multiplied by* (ii) the number of shares of Common Stock subject to such Company Option Award immediately prior to the Effective Time (assuming full vesting for any Company Option Award (or portion thereof) that was subject to performance-based vesting). Any out-of-the-money Company Option Awards were cancelled without consideration therefor.

Pursuant to the Agreement, each share of Common Stock underlying a deferred restricted stock unit ("Company DSU Award") was converted into the right to receive an amount in cash equal to the Transaction Consideration or such other amount contemplated by the Company DSU Award to be settled in accordance with the terms thereof.

Item 1.01. Entry into a Material Definitive Agreement.

National Security Agreement

On June 13, 2025, the Company entered into a National Security Agreement (the "NSA"), among Guarantor, Parent, the Company and the U.S. Government, represented by the U.S. Department of the Treasury and the U.S. Department of Commerce. The NSA provides that, subject to receipt of certain regulatory approvals, the Company will issue one share of Class G Preferred Stock (the "Golden Share") to the U.S. Government. Pursuant to the NSA, and through its ownership of the Golden Share, the U.S. Government will have certain rights with respect to non-ordinary course matters with respect to U. S. Steel, including relating to governance, domestic production and trade matters.

Supplemental Indentures

Under that certain Indenture, dated as of October 21, 2019 (the "Convertible Notes Indenture"), between the Company and The Bank of New York Mellon, as trustee (the "Trustee"), relating to the Company's 5.00% Senior Convertible Notes due 2026 (the "Convertible Notes"), the consummation of the Transaction constitutes a Share Exchange Event (as defined in the Convertible Notes Indenture). In connection with the consummation of the Transaction and the occurrence of a Share Exchange Event, the Company and the Trustee entered into a First Supplemental Indenture to the Convertible Notes Indenture, dated as of June 18, 2025 (the "First Supplemental Indenture"), relating to the Convertible Notes. The First Supplemental Indenture provides that, from and after the Effective Time, each $1,000 principal amount of Convertible Notes shall be convertible solely into cash (as opposed to shares of Common Stock) in an amount equal to the product of (a) the Transaction Consideration *multiplied by* (b) the number of shares of Common Stock that a holder of Convertible Notes would have received under the conversion rate in effect immediately prior to the Transaction.

The foregoing descriptions of the Convertible Notes Indenture and the First Supplemental Indenture and the transactions contemplated thereby are subject to and qualified in their entirety by reference to (i) the full text of the Convertible Notes Indenture, which was filed as Exhibit 4.1 to the Company's Current Report on Form 8-K with the U.S. Securities and Exchange Commission (the "SEC") on October 21, 2019 and which is incorporated herein by reference, and (ii) the full text of the First Supplemental Indenture, which is filed as Exhibit 4.1 to this Current Report on Form 8-K and incorporated herein by reference.

In connection with the consummation of the Transaction, the Company and the Trustee entered into an Eleventh Supplemental Indenture, dated as of June 18, 2025 (the "Eleventh Supplemental Indenture"), to that certain Indenture, dated as of May 21, 2007 (the "Base Indenture"), as supplemented by a First Supplemental Indenture, dated as of May 21, 2007 (the "Senior Notes First Supplemental Indenture"), among the Company and the Trustee, relating to the Company's 6.65% Senior Notes due June 1, 2037 (the "2037 Notes"), and as further supplemented by a Tenth Supplemental Indenture, dated as of February 11, 2021 (the "Tenth Supplemental Indenture"), among the Company and the Trustee, relating to the Company's 6.875% Senior Notes due March 1, 2029 (the "2029 Notes" and, collectively with the 2037 Notes, the "Senior Notes"). The Eleventh Supplemental Indenture provides that, from and after the Effective Time, the definition of "Consolidated Net Tangible Assets" in Section 1.03 of the Senior Notes First Supplemental Indenture and Section 1.03 of the Tenth Supplemental Indenture is amended and restated to reference, for purpose of determining "Consolidated Net Tangible Assets", financial statements provided by the Company to holders within such time periods as would have been required by the Securities Exchange Act of 1934, as amended (the "Exchange Act"), if the Company were a "non-accelerated filer," and provide that financial statements may be deemed to be provided to holders if the Company (x) posts such financial statements on a website (which may be nonpublic and may be maintained by the Company or a third party) to which access will be given to holders that certify their status as such to the reasonable satisfaction of the Company or (y) otherwise makes the information publicly available (including by posting such information on EDGAR).

The foregoing descriptions of the Base Indenture, the Senior Notes First Supplemental Indenture, the Tenth Supplemental Indenture and the Eleventh Supplemental Indenture and the transactions contemplated thereby are subject to and qualified in their entirety by reference to (i) the full text of the Base Indenture, which was filed as Exhibit 4.1 to the Company's Current Report on Form 8-K with the SEC on May 22, 2007, and which is incorporated herein by reference, (ii) the full text of the Senior Notes First Supplemental Indenture, which was filed as Exhibit 4.2 to the Company's Current Report on Form 8-K with the SEC on May 22, 2007, and which is incorporated herein by reference, (iii) the full text of the Tenth Supplemental Indenture, which was filed as Exhibit 4.1 to the Company's Current Report on Form 8-K with the SEC on February 11, 2021, and which is incorporated herein by reference, and (iv) the full text of the Eleventh Supplemental Indenture, which is filed as Exhibit 4.2 to this Current Report on Form 8-K and incorporated herein by reference.

Item 2.01. Completion of Acquisition or Disposition of Assets.

The description contained under the Introductory Note above is hereby incorporated by reference into this Item 2.01.

The description of the effects of the Agreement and the transactions contemplated by the Agreement does not purport to be complete and is subject to, and qualified in its entirety by reference to, the full text of the Agreement, which was filed as Exhibit 2.1 to the Company's Current Report on Form 8-K filed with the SEC on December 18, 2023 and which is incorporated herein by reference.

Item 2.04. Triggering Events that Accelerate or Increase a Direct Financial Obligation or an Obligation under an Off-Balance Sheet Arrangement.

Under the Convertible Notes Indenture, the consummation of the Transaction constitutes a Fundamental Change and a Make-Whole Fundamental Change (each as defined in the Convertible Notes Indenture).

As a result of the Fundamental Change, holders of the Convertible Notes have the right (the "Fundamental Change Purchase Right") to require the Company to purchase for cash (a) all of such holder's Convertible Notes or (b) any portion of the principal amount thereof that is equal to $1,000 or an integral multiple of $1,000 in excess thereof, in each case, on July 18, 2025 (the "Fundamental Change Purchase Date"), at a purchase price equal to 100% of the principal amount of the Convertible Notes to be purchased, *plus* accrued and unpaid interest thereon, if any, to, but excluding, the Fundamental Change Purchase Date.

Notwithstanding the Fundamental Change Purchase Right, the Convertible Notes are convertible, at the option of the holder, at any time until 5:00 p.m., New York City time, on July 17, 2025. Pursuant to the terms of the Convertible Notes Indenture, as supplemented by the First Supplemental Indenture, the consideration due upon conversion of each $1,000 principal amount of Convertible Notes shall be solely an amount of cash equal to the product of (a) the Transaction Consideration *multiplied by* (b) the number of shares of Common Stock that a holder of the Convertible Notes would have received under the conversion rate in effect immediately prior to the Share Exchange Event. The conversion rate in effect immediately prior to the Share Exchange Event, taking into account all adjustments, was 74.8391 shares of Common Stock per $1,000 principal amount of Convertible Notes. As a result, holders of the Convertible Notes will be entitled to receive $4,116.15 in cash per $1,000 principal amount of Convertible Notes validly surrendered for conversion.

Item 3.01. Notice of Delisting or Failure to Satisfy a Continued Listing Rule or Standard; Transfer of Listing.

The descriptions contained under the Introductory Note, Item 2.01, and Item 5.01 of this Current Report on Form 8-K are incorporated by reference into this Item 3.01.

In connection with the consummation of the Transaction, on June 18, 2025, the Company notified the New York Stock Exchange LLC ("NYSE") and the Chicago Stock Exchange ("CSE") that the Transaction had been consummated and requested that the NYSE and the CSE (a) suspend trading of the Common Stock, (b) remove the Common Stock from listing on the NYSE and the CSE prior to the open of trading on June 18, 2025, and (c) file with the SEC a notification of delisting of Common Stock under Section 12(b) of the Exchange Act. As a result, the Common Stock will no longer be listed on the NYSE and the CSE.

Additionally, the Company intends to file with the SEC a Form 15 under the Exchange Act to terminate the registration of the Common Stock under Section 12(g) of the Exchange Act and suspend the Company's reporting obligations under Sections 13 and 15(d) of the Exchange Act.

Item 3.03. Material Modification to Rights of Security Holders.

The descriptions contained under the Introductory Note, Item 2.01, Item 3.01, Item 5.01 and Item 5.03 of this Current Report on Form 8-K are incorporated by reference into this Item 3.03.

In connection with the Transaction and at the Effective Time, holders of Common Stock immediately prior to such time ceased to have any rights as stockholders in the Company (other than their right to receive the Transaction Consideration pursuant to the Agreement).

Item 5.01. Changes in Control of Registrant.

The descriptions contained under the Introductory Note, Item 2.01 and Item 5.02 of this Current Report on Form 8-K are incorporated by reference into this Item 5.01.

As a result of the consummation of the Transaction, a change in control of the Company occurred. Pursuant to the Agreement, at the Effective Time, 2023 Sub was merged with and into the Company, with the Company continuing as the surviving corporation and becoming a subsidiary of Parent. The total equity value of the transaction was approximately $14.2 billion. The funds used by Parent to consummate the Transaction and complete the related transactions were provided by third-party debt financing.

Item 5.03. Amendments to Articles of Incorporation or Bylaws; Change in Fiscal Year.

The description contained under the Introductory Note of this Current Report on Form 8-K is incorporated by reference into this Item 5.03.

At the Effective Time, (a) the Company's certificate of incorporation was amended and restated until thereafter amended in accordance with such certificate and the DGCL and (b) the bylaws of 2023 Sub as in effect immediately prior to the Effective Time, reflecting certain amendments, became the bylaws of the surviving corporation until thereafter amended in accordance with such bylaws, the certificate of incorporation of the surviving corporation and DGCL. Following the Effective Time, the certificate of incorporation and the bylaws of the surviving corporation were further amended and restated. The Company will further amend and restate its certificate of incorporation in order to issue the Golden Share following receipt of regulatory approvals required for the issuance of the Golden Share. The Fifth Amended and Restated Certificate of Incorporation and Second Amended and Restated Bylaws of the Company are attached hereto as Exhibit 3.1 and Exhibit 3.2, respectively, and are incorporated herein by reference.

Item 9.01. Financial Statements and Exhibits.

(d) Exhibits

Exhibit No.	Exhibit

2.1*	Agreement and Plan of Merger, dated as of December 18, 2023, by and among the Company, Parent, 2023 Sub and Guarantor (solely as provided in Section 9.13 therein) (incorporated by reference to Exhibit 2.1 to the Company's Current Report on Form 8-K, filed with the U.S. Securities and Exchange Commission on December 18, 2023)
3.1	Fifth Amended and Restated Certificate of Incorporation of the Company
3.2	Second Amended and Restated Bylaws of the Company
4.1	First Supplemental Indenture, dated as of June 18, 2025, between the Company and the Bank of New York Mellon, as Trustee
4.2	Eleventh Supplemental Indenture, dated as of June 18, 2025, between the Company and The Bank of New York Mellon, as Trustee
104	Cover Page Interactive Data File (embedded within the Inline XBRL document)

* Schedules have been omitted pursuant to Item 601(b)(2) of Regulation S-K. The registrant hereby undertakes to furnish supplementally copies of any of the omitted schedules upon request by the SEC; provided, however, that the parties may request confidential treatment pursuant to Rule 24b-2 of the Exchange Act for any document so furnished.

SIGNATURES

Pursuant to the requirements of the Securities Exchange Act of 1934, as amended, the registrant has duly caused this report to be signed on its behalf by the undersigned hereunto duly authorized.

Date: June 18, 2025

UNITED STATES STEEL CORPORATION

By: /s/ Scotland M. Duncan
Name: Scotland M. Duncan
Title: Senior Vice President, General Counsel and Secretary

FIFTH AMENDED AND RESTATED
CERTIFICATE OF INCORPORATION
OF
UNITED STATES STEEL CORPORATION

United States Steel Corporation, a Delaware corporation (the "**Corporation**"), hereby certifies that this Fifth Amended and Restated Certificate of Incorporation has been duly adopted in accordance with Sections 242 and 245 of the General Corporation Law of the State of Delaware (the "**DGCL**"), and that:

A. The name of the Corporation is: United States Steel Corporation. The Corporation was originally formed as a Delaware limited liability company under the name "United States Steel LLC" on May 25, 2001 and converted to a Delaware corporation, pursuant to Section 265 of the Delaware General Corporation Law and Section 18-216 of the Delaware Limited Liability Company Act, on December 31, 2001 under the name United States Steel Corporation.

B. The original Certificate of Incorporation of the Corporation was amended and restated on September 30, 2003, further amended and restated on April 25, 2017 and further amended and restated on June 18, 2025 upon the filing of a Certificate of Merger, pursuant to which 2023 Merger Subsidiary, Inc., a Delaware corporation, merged with and into the Corporation, with the Corporation surviving the merger under the name "United States Steel Corporation".

C. This Fifth Amended and Restated Certificate of Incorporation amends and restates the Corporation's Certificate of Incorporation.

D. The Certificate of Incorporation upon the filing of this Fifth Amended and Restated Certificate of Incorporation, shall read as follows:

ARTICLE I

The name of the corporation shall be United States Steel Corporation (the "**Corporation**").

ARTICLE II

The address of its registered office in the State of Delaware is: The Corporation Trust Company, 1209 Orange Street, Corporation Trust Center, Wilmington, County of New Castle, Delaware 19801. The name of its registered agent at such address is The Corporation Trust Company.

ARTICLE III

The nature of the business or purposes to be conducted or promoted by the corporation is to engage in any lawful act or activity for which corporations may be organized under the General Corporation Law of the State of Delaware ("**DGCL"**).

ARTICLE IV

The total number of shares of all classes of stock that the Corporation has authority to issue is 1,000 consisting of 1,000 shares of Common Stock, $1.00 par value per share ("**Common Stock**")

ARTICLE V

Elections of directors need not be by written ballot unless the by-laws of the Corporation shall so provide.

Meetings of stockholders may be held within or without of the State of Delaware, as the by-laws may provide. The books of the Corporation may be kept (subject to any provision contained in the statutes) outside the State of Delaware at such place or places as may be designated from time to time by the board of directors or in the by-laws of the Corporation.

ARTICLE VI

1. The Corporation shall not, either directly or indirectly by amendment, merger, consolidation or otherwise, without (in addition to any other vote required by law or this Certificate of Incorporation) (i) at any time when Donald J. Trump is serving as President of the United States of America, the written consent of Donald J. Trump or President Trump's Designee, or (ii) at any other time, the written consent of the CMAs (as parties to the NSA) (and any such act or transaction entered into without such consent or vote shall be null and void *ab initio*, *ultra vires* and of no force or effect):

(a) alter, amend, repeal or waive any provision of this Certificate of Incorporation, except as contemplated by Article XII of the NSA;

(b) change the Corporation's name from "United States Steel Corporation", change the Corporation's headquarters from Pittsburgh, Pennsylvania, or change the Corporation's domicile to a jurisdiction other than a state, commonwealth, district or territory of the United States;

(c) reduce, waive or delay any Capital Investment (as defined in Schedule 2 to this Certificate of Incorporation), subject to receipt of necessary approvals and permits on an expedited basis;

(d) (A) prior to June 18, 2027, close, idle or sell the Corporation's Granite City Works or (B) prior to June 18, 2035, close, idle or sell any other Production Location, except, in each case of (A) and (B), any Temporary Idling or in response to, or as a result of, a Force Majeure Event;

(e) fail to follow the recommendation of the CMAs (as parties to the NSA) with respect to Trade Actions;

(f) effect any material acquisition of a business that is domiciled in the United States that competes with the Corporation or its suppliers;

(g) implement pricing of the Corporation's average spot sales price during any rolling six (6)-month period below eighty-five percent (85%) of the corresponding six (6)-month average for that applicable steel product as publicly published by the U.S. Midwest Domestic Hot-Rolled Coil Steel Index

(i.e., Hot-rolled, Cold-rolled, and Coated steel); provided, that, for the avoidance of doubt, the average spot sales price will be calculated monthly and will be based on the average spot price for the applicable steel product for each individual customer transaction in the United States;

(h) accept direct financial assistance from the Japanese government, excluding (a) financing obtained from Japan Bank for International Cooperation (JBIC), Nippon Export and Investment Insurance (NEXI) or other equivalent Japanese government related financial institutions on commercially reasonable terms and (b) financial assistance for research and development in Japan;

(i) prior to June 18, 2030, reduce the base salary of employees of the Corporation; and

(j) make material changes to the Corporation's existing raw materials and steel sourcing strategy in the United States, unless such changes are intended to benefit the Corporation, its operations or customers, which changes, among others, include: to the extent steel making raw materials or inputs are or become inadequate in quantity or quality; and initial imports to the Corporation to accelerate the transfer of technology or commissioning or qualification of facilities committed to being built in the United States (e.g., grain oriented electrical steel).

2. For purposes of this Article VI:

(a) "**Disqualified Individual**" is defined on Schedule 1 to this Certificate of Incorporation.

(b) "**Force Majeure Event**" means acts of God, natural disaster or the elements, explosion, insurrection, riot, strikes, lockouts, boycotts, picketing, labor disturbances, acts of public enemy, war (declared or undeclared), acts of terrorism, epidemics or pandemics, but in each case only to the extent that such act or event prevents, impedes, or reduces Production Capacity.

(c) "**NSA**" means the National Security Agreement, effective as of June 13, 2025, by and among Nippon Steel Corporation, a publicly traded company incorporated in Japan ("**NSC**"), Nippon Steel North America, Inc., a New York corporation, the Corporation, and the U.S. Government, represented by the U.S. Department of the Treasury and the U.S. Department of Commerce as the CFIUS Monitoring Agencies (the "**CMAs**").

(d) "**Production Capacity**" means the name plate capacity to produce and supply steel and steel-related products from the following facilities of the Corporation in the United States involved in the production, including support for production, of steel products as of the effective date of this Certificate of Incorporation: Automotive Center (Troy, Michigan); Big River Steel; Big River 2; Fairfield Tubular Operations; Fairfield Works; Gary Works; Granite City Works; Great Lakes Works; Midwest Plant; Minnesota Ore Operations (including Keetac and Minntac); Mon Valley Works (including Clairton Plant, Edgar Thomson Plant, Fairless Plant, and Irvin Plant); Research and Technology Center (Munhall, Pennsylvania); U. S. Steel Tubular Products Innovation and Offshore Operations (Houston, Texas); and Wheeling Machine Products (Pine Bluff, Arkansas) (each such facility, a "**Production Location**".

(e) "**Temporary Idling**" means the idling of a Production Location in connection with, or to address, issues related to safety and environmental issues, maintenance and repairs, upgrades made to the equipment, or related assets, labor and logistical disruptions, weather events, or natural disasters.

(f) "**President Trump's Designee**" means such individual who Donald J. Trump, in his capacity as President of the United States of America, designates to provide the consent required pursuant to this Article VI, and upon such designation, such individual will serve as President Trump's Designee until (i) he or she is removed as President Trump's Designee or (ii) such time as Donald J. Trump is no longer serving as President of the United States of America; provided that in no event shall a Disqualified Individual be President Trump's Designee.

(g) "**Trade Actions**" means trade measures under U.S. law such as antidumping/countervailing duty orders, safeguard measures, Section 232 national security actions, or any other legal action, including filing a petition or otherwise initiating a case, or policy advocacy related to U.S. trade or imports.

ARTICLE VII

Subject to Article VI of this Certification of Incorporation, the Corporation reserves the right to amend, alter, change or repeal any provision contained in this Certificate of Incorporation, in the manner now or hereafter prescribed by statute, and all rights conferred upon stockholders herein are granted subject to this reservation.

ARTICLE VIII

The Corporation is to have perpetual existence.

ARTICLE VIX

Section 203 of the DGCL shall not apply to the Corporation.

ARTICLE X

No director or officer shall be personally liable to the Corporation or its stockholders for monetary damages for any breach of fiduciary duty by such director or officer as a director or officer, except (i) in the case of directors or officers, for breach of the director's or officer's duty of loyalty to the Corporation or its stockholders, (ii) in the case of directors or officers, for acts or omissions not in good faith or which involve intentional misconduct or a knowing violation of law, (iii) in the case of directors, liability pursuant to Section 174 of the DGCL, (iv) in the case of directors or officers, for any transaction from which the director or officer derived an improper personal benefit and (v) in the case of officers, any action by or in the right of the Corporation. No amendment to or repeal of this Article X shall apply to or have any effect on the liability or alleged liability of any director or officer of the Corporation for or with respect to any acts or omissions of such director or officer occurring prior to such amendment or repeal.

* * *

IN WITNESS WHEREOF, this Fifth Amended and Restated Certificate of Incorporation has been executed by the Corporation's duly authorized officer this 18th day of June, 2025.

UNITED STATES STEEL CORPORATION

By: /s/ Scotland M. Duncan
Name: Scotland M. Duncan
Title: Senior Vice President, General Counsel and Secretary

Schedule 1

Disqualified Individuals

"**Disqualified Individual**" means an individual who is, or was within the five (5) years prior to election as a Class G Director, (i) a director, manager, officer, partner, owner, investor, agent or consultant of, or otherwise affiliated with or acting in concert or on behalf of, a Competitor of the Corporation, Nippon Steel North America, Inc. or their affiliates, (ii) a member of the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union (the " **USW**"), (iii) listed below in this Schedule 1, or (iv) an immediate family member of any individual described in clause (i), (ii) or (iii).

"**Competitor**" means any person engaged in the same or similar line of business as the Corporation.

Disqualified Individuals

- James Chadwick
- Fred DiSanto
- Alan Kestenbaum
- Any other individual affiliated with, or acting in concert or on behalf of, Ancora Holdings Group, LLC

Schedule 2

Capital Investments

"**Capital Investments**" means, collectively, the investments by Nippon Steel Corporation ("**NSC**") or its affiliates set forth below in this Schedule 2. Thespecific investment amounts in each year and each facility may change, while the total investment amounts from 2025 through 2028 will not change:

State	Facility	2025[1]	2026	2027	2028	Total 2025-2028
Arkansas	Big River Steel	$0.1	$0.9	$0.9	$1.3	$3.0
Indiana	Gary Works	$0.4	$0.9	$0.8	$1.1	$3.1
Pennsylvania	Mon Valley	$0.1	$0.7	$0.7	$0.9	$2.4
Minnesota	Keetac/Minntac	$0.2	$0.2	$0.3	$0.3	$0.8
Alabama	Fairfield Works	$0.2	$0.2	$0.1	$0.1	$0.5
TBD	New Mini Mill	-	-	-	$1.0	$1.0
Total	--	$0.9	$2.7	$2.6	$4.6	$10.8

($ in Billions)

"**Incurred**" means, with respect to a Capital Investment, that the amount has been paid or, in respect of a capital project relating to a facility listed in this Schedule 2, become committed to be paid. In the event that an investment cannot be made for a key project listed in this Schedule 2 as a result of the delay or rejection of the necessary approvals and permits on an expedited basis, the amount of such investment will be deemed "incurred".

[1] Inclusive of all amounts incurred at any time in 2025.

Exhibit 3.2

SECOND AMENDED & RESTATED

BYLAWS OF

UNITED STATES STEEL CORPORATION

ARTICLE I OFFICES

SECTION 1.1. REGISTERED OFFICE. The registered office of the corporation shall be established and maintained at the office of The Corporation Trust Company, 1209 Orange Street, Corporation Trust Center, Wilmington, Delaware 19801, and said corporation shall be the registered agent of this corporation in charge thereof.

SECTION 1.2. OTHER OFFICES. The corporation shall have its principal office in Pittsburgh, Pennsylvania and may have other offices, either within or without the State of Delaware, at such place or places as the Board of Directors may from time to time appoint or the business of the corporation may require.

ARTICLE II MEETING OF STOCKHOLDERS

SECTION 2.1. ANNUAL MEETINGS. Annual meetings of stockholders for the election of directors and for such other business as may be stated in the notice of the meeting, shall be held in person or by remote communication at such place, either within or without the State of Delaware, and at such time and date as the Board of Directors, by resolution, shall determine and as set forth in the notice of the meeting.

If the date of the annual meeting shall fall upon a legal holiday, the meeting shall be held on the next business day. At each annual meeting, the stockholders entitled to vote shall elect a Board of Directors and they may transact such other corporate business as shall be stated in the notice of the meeting.

SECTION 2.2. OTHER MEETINGS. Meetings of stockholders for any purpose other than the election of directors may be held in person or by remote communication at such time and place, within or without the State of Delaware, as shall be stated in the notice of meeting.

SECTION 2.3. VOTING. Each stockholder entitled to vote in accordance with the terms of the Certificate of Incorporation and in accordance with the provisions of these Bylaws shall be entitled to one vote, in person or by proxy, for each share of stock entitled to vote held by such stockholder, but no proxy shall be voted after three years from its date unless such proxy provides for a longer period. Upon the demand of any stockholder, the vote for directors and the vote upon any question before the meeting, shall be by ballot. All elections for directors shall be decided by plurality vote; all questions shall be decided by majority vote except as otherwise provided by the Certificate of Incorporation or the laws of the State of Delaware.

A complete list of the stockholders entitled to vote at the ensuing election, arranged in alphabetical order, with the address of each, and the number of shares held by each, shall be open to the examination of any stockholder, for any purpose germane to the meeting, during ordinary business hours, for a period of at least ten days prior to the meeting, either at a place within the city where the meeting is to be held, which place shall be specified in the notice of the meeting, or, if not so specified, at the place where the meeting is to be held. The list shall also be produced and kept at the meeting and place of the meeting during the whole time thereof, and may be inspected by any stockholder who is entitled to be present.

SECTION 2.4. QUORUM. Except as otherwise required by law, by the Certificate of Incorporation or by these Bylaws, the presence, in person or by proxy, of stockholders holding shares constituting a majority of the voting power entitled to vote shall constitute a quorum at all meetings of the stockholders. In case a quorum shall not be present at any meeting, a majority in interest of the stockholders entitled to vote thereat, present in person or by proxy, shall have the power to adjourn the meeting from time to time, without notice other than announcement at the meeting, until the requisite amount of stock entitled to vote shall be present. At any such adjourned meeting at which the requisite amount of stock entitled to vote shall be represented, any business may be transacted which might have been transacted at the meeting as originally noticed; but only those stockholders entitled to vote at the meeting as originally noticed shall be entitled to vote at any adjournment or adjournments thereof.

SECTION 2.5. SPECIAL MEETINGS. Special meetings of the stockholders for any purpose or purposes may be called by the Board of Directors, President or Secretary, or upon the written request of the stockholders holding shares constituting a majority of the voting power entitled to vote at the meeting requested to be called.

SECTION 2.6. NOTICE OF MEETINGS. Written notice stating the place, date and time of the meeting, and the general nature of the business to be considered, shall be given to each stockholder entitled to vote thereat at his address as it appears on the records of the corporation, not less than ten nor more than sixty days before the date of the meeting. No business other than that stated in the notice shall be transacted at any meeting without the unanimous consent of all the stockholders entitled to vote thereat. The attendance of any stockholder at a meeting, in person or by proxy, without protesting the lack of notice of such meeting prior to the conclusion of the meeting, shall constitute a waiver of notice by such stockholder.

SECTION 2.7. ACTION WITHOUT MEETING. Unless otherwise provided by the Certificate of Incorporation, any action required or permitted to be taken at any annual or special meeting of stockholders, or any action which may be taken at any annual or special meeting, may be taken without a meeting, without prior notice and without a vote, if a consent in writing, setting forth the action so taken, shall be signed by the holders of outstanding stock having not less than the minimum number of votes that would be necessary to authorize or take such action at a meeting at which all shares entitled to vote thereon were present and voted. Prompt notice of the taking of the corporate action without a meeting by less than unanimous written consent shall be given to those stockholders who have not consented in writing.

ARTICLE III DIRECTORS

SECTION 3.1. NUMBER AND TERM. The Board of Directors shall consist of one or more members and shall not exceed nine members. At each annual meeting, the stockholders shall determine the number of directors; provided, that between annual meetings the authorized number of directors may be increased or decreased by the stockholders or pursuant to Section 3.6 of these Bylaws. From and after the election of the Independent U.S. Directors, a majority of the Board of Directors shall be comprised of members who are U.S. citizens. A director shall hold office until a successor is elected and qualified, or until the earlier death, resignation, disqualification, or removal of the director.

SECTION 3.2. INDEPENDENT U.S. DIRECTORS. As soon as practicable after the adoption of these Bylaws, three members of the Board of Directors shall be elected and shall be “Independent U.S. Directors,” each of whom shall: (i) be a U.S. citizen and (ii) have a background in the steel industry, U.S. national security, trade matters, manufacturing and/or labor.

SECTION 3.3. RESIGNATIONS. Any director, member of a committee or other officer may resign at any time. Such resignation shall be made in writing, and shall take effect at the time specified therein, and if no time be specified, at the time of its receipt by the President or Secretary. The acceptance of a resignation shall not be necessary to make it effective.

SECTION 3.4. VACANCIES. If the office of any director, member of a committee or other officer becomes vacant, the remaining directors in office, though less than a quorum, by a majority vote, may appoint any qualified person to fill such vacancy, who shall hold office for the unexpired term and until his or her successor shall be duly chosen. If the office of any director becomes vacant and there are no remaining directors, the stockholders, by the affirmative vote of the holders of shares constituting a majority of the voting power of the corporation, at a special meeting called for such purpose, may appoint any qualified person to fill such vacancy.

SECTION 3.5. REMOVAL. Any director or directors may be removed either for or without cause at any time by the affirmative vote of the holders of a majority of all the shares of stock outstanding and entitled to vote, at a special meeting of the stockholders called for the purpose and the vacancies thus created may be filled, at the meeting held for the purpose of removal, by the affirmative vote of a majority in interest of the stockholders entitled to vote.

SECTION 3.6. INCREASE OF NUMBER. Subject to Section 3.1 of these Bylaws, the number of directors may be increased by the affirmative vote of a majority interest of the stockholders, at the annual meeting or at a special meeting called for that purpose, and by like vote the additional directors may be chosen at such meeting to hold office until the next annual election and until their successors are elected and qualify.

SECTION 3.7. POWERS. The Board of Directors shall exercise all of the powers of the corporation except such as are by (a)(i) law, (ii) the Certificate of Incorporation of the corporation or (iii) these Bylaws or (b) resolution of the stockholders conferred upon or reserved to the stockholders.

SECTION 3.8. COMMITTEES. The Board of Directors may, by resolution or resolutions passed by a majority of the whole Board of Directors, designate one or more committees, each committee to consist of two or more directors of the corporation or dissolve any such committee. The Board of Directors may designate one or more directors as alternate members of any committee, who may replace any absent or disqualified member at any meeting of the committee. In the absence or disqualification of any member of such committee or committees, the member or members thereof present at any meeting and not disqualified from voting, whether or not he/she or they constitute a quorum, may unanimously appoint another member of the Board of Directors to act at the meeting in the place of any such absent or disqualified member. Any such committee, to the extent provided in the resolution of the Board of Directors, or in these Bylaws, shall have and may exercise all the powers and authority of the Board of Directors in the management of the business and affairs of the corporation, and the Board of Directors may, by resolution or resolutions passed by a majority of the whole Board of Directors, revoke or amend any such powers and authority; but no such committee shall have the power or authority in reference to amending the Certificate of Incorporation, adopting an agreement of merger or consolidation, recommending to the stockholders the sale, lease or exchange of all or substantially all of the corporation's property and assets, recommending to the stockholders a dissolution of the corporation or a revocation of a dissolution, or amending the Bylaws of the corporation; and, unless the resolution, these Bylaws, or the Certificate of Incorporation expressly so provide, no such committee shall have the power or authority to declare a dividend or to authorize the issuance of stock.

SECTION 3.9. MEETINGS. Regular meetings of the directors may be held without notice at such places and times as shall be determined from time to time by resolution of the directors.

Special meetings of the Board of Directors may be called by the President or by the Secretary on the written request of any director, on at least one day notice to each director and shall be held at such place or places as may be determined by the directors, or shall be stated in the call of the meeting.

Unless otherwise restricted by the Certificate of Incorporation or by these Bylaws, members of the Board of Directors, or any committee designated by the Board of Directors, may participate in a meeting of the Board of Directors, or any committee, by means of conference telephone or similar communications equipment by means of which all persons participating in the meeting can hear each other, and such participation in a meeting shall constitute presence in person at the meeting.

SECTION 3.10. QUORUM. A majority of the directors shall constitute a quorum for the transaction of business. If at any meeting of the Board of Directors there shall be less than a quorum present, a majority of those present may adjourn the meeting from time to time until a quorum is obtained, and no further notice thereof need be given other than by announcement at the meeting which shall be so adjourned. The vote of the majority of all the directors then in office shall be the act of the Board of Directors unless otherwise permitted under the Certificate of Incorporation of the corporation or these Bylaws.

SECTION 3.11. COMPENSATION. Each director of the corporation who is not a salaried officer or employee of the corporation, or of a parent or affiliate of the corporation, shall receive such compensation for serving as a director and such fees for attendance at meetings of the Board of Directors or any committee of the Board of Directors as the Board of Directors may from time to time determine. By resolution of the Board of Directors a fixed fee and reimbursement of expenses related to attendance may be allowed for attendance by directors at each meeting. Nothing herein contained shall be construed to preclude any director from serving the corporation in any other capacity as an officer, agent or otherwise, and receiving compensation therefor.

SECTION 3.12. CHAIRMAN OF THE BOARD. At the first regular meeting of the Board of Directors in each year (at which a quorum shall be present) held next after the annual meeting, the Board of Directors shall proceed to the election of the Chairman of the Board of Directors from among its members.

SECTION 3.13. ACTION WITHOUT MEETING. Any action required or permitted to be taken at any meeting of the Board of Directors, or of any committee thereof, may be taken without a meeting, if prior to such action a written consent thereto is signed by all members of the Board of Directors, or of such committee as the case may be, and such written consent is filed with the minutes of proceedings of the Board of Directors or committee.

ARTICLE IV OFFICERS

SECTION 4.1. GENERALLY. The Board of Directors, at its first meeting after each annual meeting of stockholders, shall elect at least the following officers: a Chief Executive Officer, a President, a Chief Financial Officer, one or more Vice Presidents and a Secretary. The Board of Directors may also elect, appoint, or provide for the appointment of such other officers and agents as may from time to time appear necessary or advisable in the conduct of the affairs of the corporation. The Chief Executive Officer is empowered to appoint officers from time to time, other than a President, Chief Financial Officer, Executive Vice President and Secretary. The Corporate Secretary or any officer elected by the Board of Directors acting in conjunction with the Corporate Secretary may appoint such assistant officers (including one or more Assistant Secretaries) as may be necessary or desirable for the conduct of the business of the corporation. Officers of the corporation shall hold office until their successors are chosen and qualified or until their earlier death, resignation or removal, and shall perform such duties as from time to time shall be prescribed by these Bylaws and by the Board of Directors and, to the extent not so provided, as generally pertain to their respective offices. The Board of Directors may fill any vacancy occurring in any office of the corporation. Two or more offices may be held by the same person.

SECTION 4.2. CHIEF EXECUTIVE OFFICER. The Chief Executive Officer, subject to the overall direction and supervision of the Board of Directors and

committees thereof, shall be in general charge of the affairs of the corporation and its officers, and shall consult and advise with the Board of Directors and committees thereof on the business and the affairs of the corporation. The Chief Executive Officer shall have the power to make and execute contracts and other instruments, including powers of attorney, on behalf of the corporation and to delegate such power to others. The Chief Executive Officer shall perform all duties incident to the office of the Chief Executive Officer, and any other duties as may be from time to time assigned to the Chief Executive Officer by the Board of Directors, in each case subject to the control of the Board of Directors.

SECTION 4.3. PRESIDENT. The President shall report and be responsible to the Chief Executive Officer. The President shall have such powers and perform such duties as from time to time may be assigned or delegated to the President by the Board of Directors or the Chief Executive Officer or that are incident to the office of President. The President shall also have the power to make and execute contracts on the corporation's behalf and to delegate such power to others.

SECTION 4.4. CHIEF FINANCIAL OFFICER. The Chief Financial Officer shall be the principal financial officer of the corporation and shall have such powers and perform such duties as may be assigned by the Board of Directors or the Chief Executive Officer. The Chief Financial Officer shall also have the power to make and execute contracts on the corporation's behalf and to delegate such power to others.

SECTION 4.5. VICE PRESIDENTS. Each Executive Vice President, Senior Vice President and Vice President shall have such powers and perform such duties as may be assigned to the officer by the Board of Directors or by the Chief Executive Officer. Each Executive Vice President, Senior Vice President and Vice President shall have all the powers and duties as are commonly incident to the office of Vice President, or that are delegated to him or her by the Board of Directors, the Chief Executive Officer or his or her superior officer. A Vice President may be designated by the Board of Directors to perform the duties and exercise the powers of the President in the event of the President's absence or disability. Each Executive Vice President, Senior Vice President and Vice President shall also have the power to make and execute contracts on the corporation's behalf and to delegate such power to others.

SECTION 4.6. SECRETARY. The powers and duties of the Secretary are: (i) to act as Secretary at all meetings of the Board of Directors, of the committees of the Board of Directors and of the stockholders, and to record the proceedings of those meetings in a book or books to be kept for that purpose; (ii) to see that all notices required to be given by the corporation are duly given and served; (iii) to have charge of the books, records and papers of the corporation and see that the reports, statements and other documents required by law to be kept and filed are properly kept and filed; and (iv) to have any other powers and perform all of the duties as are commonly incident to the office of Secretary, or as the Board of Directors or the Chief Executive Officer may from time to time prescribe. The Secretary shall have the responsibility for authenticating records of the corporation, and shall also have the power to make and execute contracts on the corporation's behalf and to delegate such power to others.

SECTION 4.7. ASSISTANT SECRETARIES. The Assistant Secretary, if there is one, or if there shall be more than one, the Assistant Secretaries in the order determined by the Board of Directors (or if there shall have been no determination, then in the order of their election) shall, in the absence of the Secretary or in the event of the Secretary's inability or refusal to act, perform the duties and exercise the powers of the Secretary.

SECTION 4.8. DELEGATION OF AUTHORITY. Such other officers as the Board of Directors may choose shall perform such duties and have such powers as from time to time may be assigned to them by the Board of Directors. The Board of Directors may delegate to any other officer of the corporation the power to choose such other officers and to prescribe their respective duties and powers. All powers and authority conferred to officers of the corporation in these bylaws shall be subject to (a) any limitations on authority as the Board of Directors may adopt, amend or repeal and (b) any requirement that stockholders approve an action or matter.

SECTION 4.9. REMOVAL. Any officer of the corporation shall serve at the pleasure of the Board of Directors (or, in the case of an officer appointed by the Chief Executive Officer, at the pleasure of the Chief Executive Officer) and shall hold office until the officer's successor is chosen and qualified or until the officer's earlier death, resignation or removal. Any officer may be removed at any time, with or without cause, by the Board of Directors (and, in the case of an officer appointed by the Chief Executive Officer, by the Chief Executive Officer). The removal shall be without prejudice to the contractual rights of the officer, if any, with the corporation.

SECTION 4.10. COMPENSATION. The compensation of officers of the corporation shall be fixed by the Board of Directors or by any officer(s) authorized by the Board of Directors to prescribe compensation for other officers.

SECTION 4.11. VOTING UPON INTERESTS IN OTHER BUSINESS ENTITIES. Unless otherwise ordered by the Board of Directors, any Officer or any person or persons appointed in writing by any of them, shall have full power and authority on behalf of the corporation to attend and to act and to vote at any meetings of stockholders of any corporation in which the corporation may hold stock, or at meetings of partnerships in which the corporation may hold partnership interests, or at any other meetings of holders of interests in business entities in which the corporation may hold interests, including limited liability companies, and at any such meeting shall possess and may exercise any and all rights and powers incident to the ownership of such stock, partnership interest or other interest, and which, as the owner thereof, the corporation might have possessed and exercised if present. The Board of Directors, by resolution, from time to time, may confer like powers upon any other person or persons.

ARTICLE V MISCELLANEOUS

SECTION 5.1. CERTIFICATES OF STOCK. Certificates of stock, signed by the President, Vice-President, Secretary or Assistant Secretary, may be issued or shares of stock may remain uncertificated. Any of or all the signatures may be facsimiles.

SECTION 5.2. LOST CERTIFICATES. A new certificate of stock may be issued in the place of any certificate theretofore issued by the corporation, alleged to have been lost or destroyed, and the directors may, in their discretion, require the owner of the lost or destroyed certificate, or such owner's legal representatives, to give the corporation a bond, in such sum as they may direct, not exceeding double the value of the stock, to indemnify the corporation against any claim that may be made against it on account of the alleged loss of any such certificate, or the issuance of any such new certificate.

SECTION 5.3. TRANSFER OF SHARES. The shares of stock of the corporation shall be transferable only upon its books by the holders thereof in person or by their duly authorized attorneys or legal representatives, and upon such transfer the old certificates shall be surrendered to the corporation by the delivery thereof to the person in charge of the stock and transfer books and ledgers, or to such other person as the directors may designate, by whom they shall be cancelled, and new certificates shall thereupon be issued. A record shall be made of each transfer and whenever a transfer shall be made for collateral security, and not absolutely, it shall be so expressed in the entry of the transfer.

SECTION 5.4. STOCKHOLDERS RECORD DATE. In order that the corporation may determine the stockholders entitled to notice of or to vote at any meeting of stockholders or any adjournment thereof, or to express consent to corporate action in writing without a meeting, or entitled to receive payment of any dividend or other distribution or allotment of any rights, or entitled to exercise any rights in respect of any change, conversion or exchange of stock or for the purpose of any other lawful action, the Board of Directors may fix, in advance, a record date, which shall not be more than sixty nor less than ten days before the date of such meeting, nor more than sixty days prior to any other action. A determination of stockholders of record entitled to notice of or to vote at a meeting of stockholders shall apply to any adjournment of the meeting;

provided, however, that the Board of Directors may fix a new record date for the adjourned meeting.

SECTION 5.5. DIVIDENDS. The Board of Directors may from time to time declare such dividends as they shall deem advisable and proper, subject to such restrictions as may be imposed by law and the Certificate of Incorporation.

SECTION 5.6. NO CORPORATE SEAL. There shall be no corporate seal.

SECTION 5.7. FISCAL YEAR. The fiscal year of the corporation shall be determined by resolution of the Board of Directors.

SECTION 5.8. CHECKS. All checks, drafts or other orders for the payment of money, notes or other evidences of indebtedness issued in the name of the corporation shall be signed by such officer or officers, agent or agents of the corporation, and in such manner as shall be determined from time to time by resolutions of the Board of Directors.

SECTION 5.9. NOTICE AND WAIVER OF NOTICE. Whenever any notice is required by these Bylaws to be given, personal notice is not meant unless expressly so stated, and any notice so required shall be deemed to be sufficient if given by depositing the same in the United States mail, postage prepaid, addressed to the person entitled thereto at his address as it appears on the records of the corporation, and such notice shall be deemed to have been given on the day of such mailing. Stockholders not entitled to vote shall not be entitled to receive notice of any meetings except as otherwise provided by law.

Whenever any notice whatever is required to be given under the provisions of any law, or under the provisions of the Certificate of Incorporation of the corporation or these Bylaws, a waiver thereof in writing, signed by the person or persons entitled to said notice, whether before or after the time stated therein, shall be deemed equivalent thereto.

ARTICLE VI INDEMNIFICATION

SECTION 6.1. RIGHT TO INDEMNIFICATION. The corporation shall indemnify and hold harmless to the fullest extent permitted by law any person who was or is made or is threatened to be made a party or is involved in any action, suit, or proceeding whether civil, criminal, administrative or investigative ("proceeding") by reason of the fact that he or she, or a person for whom he or she is the legal representative, is or was a director, officer or employee of the corporation or is or was serving at the request of the corporation as a director, officer or employee of another corporation or of a partnership, joint venture, trust, enterprise or non-profit entity, including service with respect to employee benefit plans, against all expenses, liability, and loss reasonably incurred or suffered by such person. The corporation shall indemnify any person seeking indemnity in connection with a proceeding initiated by such person only if the proceeding was authorized by the Board of Directors.

SECTION 6.2. PREPAYMENT OF EXPENSES. The corporation shall pay the expenses reasonably incurred in defending any such proceeding in advance of its final disposition; provided, however, the payment of expenses incurred by a director, officer or employee in his or her capacity as a director, officer or employee (except with regard to service to an employee benefit plan or nonprofit entity) in advance of the final disposition of the proceeding shall be made only upon the agreement by the director, officer or employee to repay all amounts advanced if it should be determined that the director, officer or employee is not entitled to be indemnified under this Article VI or otherwise, and provided, further, that the corporation shall have no obligation to pay any expenses in advance pursuant to this Section 6.2 to any person who is or was an employee of the corporation (other than a director or an officer) or is or was serving at the request of the corporation as an employee of another corporation or of a partnership, joint venture, trust, enterprise or non-profit entity, with respect to any proceeding by or in the right of the corporation to procure a judgment in its favor.

SECTION 6.3. CLAIMS. If a claim under this Article VI is not paid in full within ninety days after a written claim has been received by the corporation, the claimant may file suit to recover the unpaid amount of such claim and, if successful in whole or in part, shall be entitled to be paid in addition the expense of prosecuting such claim. In any such action the corporation shall have the burden of proving that the claimant was not eligible for indemnification under applicable law.

SECTION 6.4. NON-EXCLUSIVITY OF RIGHTS. The rights conferred on any person by this Article VI shall not be exclusive of any other right which such person may have or hereafter acquire under any statute, provision of the Certificate of Incorporation, these Bylaws, agreement, vote of stockholders or disinterested directors or otherwise.

SECTION 6.5. EFFECT OF AMENDMENT OR REPEAL. The foregoing provisions of this Article VI shall be deemed to be a contract between the corporation and any person described in Section 6.1 above. Any repeal or modification of this Article VI shall not affect any rights or obligations then existing with respect to any acts or omissions occurring prior to such amendment or repeal, regardless of whether any action, suit or proceeding based in whole or in part on any such acts or omissions is commenced before or after any such repeal or modification.

ARTICLE VII AMENDMENTS

These Bylaws may be altered or repealed and Bylaws may be made at any annual meeting of the stockholders or at any special meeting thereof if notice of the proposed alteration or repeal or Bylaw or Bylaws to be made be contained in the notice of such special meeting, by the affirmative vote of a majority of the stock issued and outstanding and entitled to vote thereat.

Effective: June 18, 2025

FIRST SUPPLEMENTAL INDENTURE

FIRST SUPPLEMENTAL INDENTURE, dated as of June 18, 2025 (this "Supplemental Indenture"), between United States Steel Corporation, a Delaware corporation (the "Company") and The Bank of New York Mellon, as trustee (the "Trustee"), to the Indenture, dated as of October 21, 2019 (the "Base Indenture", as supplemented by this Supplemental Indenture and as further amended and supplemented from time to time, the "Indenture"), between the Company and the Trustee.

W I T N E S S E T H

WHEREAS, the Company previously issued its 5.00% Senior Convertible Notes due 2026 (the 'Notes") under the Base Indenture;

WHEREAS, in connection with that certain Agreement and Plan of Merger, dated as of December 18, 2023 (as amended, restated, amended and restated, supplemented or otherwise modified from time to time, the "Agreement"), among, *inter alios*, the Company, Nippon Steel North America, Inc., a New York corporation ("Parent"), and 2023 Merger Subsidiary, Inc., a Delaware corporation and a wholly owned subsidiary of Parent ('Purchaser"), pursuant to which, effective as of June 18, 2025 (the "Effective Date"), (A) Purchaser merged with and into the Company (the 'Merger"), with the Company surviving the Merger as a wholly owned subsidiary of Parent and (B) at the Effective Date, each outstanding share of common stock of the Company, par value $1.00 per share (the "Shares") (excluding (x) Shares owned by the Company or any wholly owned subsidiary of the Company as treasury stock or otherwise, but including, for the avoidance of doubt, any Shares held by any Company Employee Plan (as defined in the Agreement) or trust related thereto (other than, for the avoidance of doubt, Shares reserved for issuance under any of the Company Equity Plans (as defined in the Agreement)) or held, directly or indirectly, by Parent, Purchaser or any wholly owned subsidiary of Parent immediately prior to the Effective Date and (y) Shares that are issued and outstanding immediately prior to the Effective Date (other than the shares described in the foregoing clause (x)) and that are held by holders that did not vote in favor of the adoption of the Agreement or consented thereto in writing and are entitled to demand and properly demand, exercise and perfect appraisal of such shares pursuant to Section 262 of the General Corporation Law of the State of Delaware) were automatically converted into the right to receive $55.00 per share (the "Merger Consideration") in cash, without interest, subject to any required tax withholding;

WHEREAS, in connection with the foregoing, Section 14.07(a) of the Base Indenture provides that, at the Effective Date, the right to convert each $1,000 principal amount of Notes into a number of shares of the Common Stock equal to the Conversion Rate in effect immediately prior to the Merger will, without the consent of the Holders, be changed into a right to convert each $1,000 principal amount of Notes into or based on a number of Units of Reference Property equal to the Conversion Rate in effect immediately prior to the Merger, and provides that the Company shall execute a supplemental indenture with the Trustee to provide for such change in the right to convert each $1,000 principal amount of Notes;

WHEREAS, pursuant to Section 10.01 of the Base Indenture, the Trustee is authorized to sign any amendment, supplement or waiver to the Base Indenture without the consent of any Holder if such amendment, supplement or waiver does not adversely affect the rights, duties or immunities of the Trustee under the Indenture.

NOW, THEREFORE, in consideration of the foregoing and for other good and valuable consideration, the receipt of which is hereby acknowledged, the Company and the Trustee mutually covenant and agree for the equal and ratable benefit of the Holders as follows:

(1) Definition of Terms.

(a) Capitalized terms used herein without definition shall have the meanings assigned to them in the Indenture.

(b) All references herein to Articles and Sections, unless otherwise specified, refer to the corresponding Articles and Sections of the Indenture.

(c) The terms "herein", "hereof", "hereunder" and other words of similar import refer to this Supplemental Indenture.

(d) In the event of a conflict between any definition set forth in the Indenture and any definition set forth in this Supplemental Indenture, the definitions set forth in this Supplemental Indenture shall control.

(2) Settlement upon Conversion. In accordance with Section 14.07(a) of the Indenture, in connection with the consummation of the Merger and the occurrence of a Share Exchange Event, from and after the Effective Date, each $1,000 principal amount of Notes shall be convertible solely into an amount of cash equal to (i) the Merger Consideration *multiplied* by (ii) the number of shares of Common Stock that a Holder would have received under the Conversion Rate in effect immediately prior to the Merger, which is the amount of cash that Holders of the Notes would have been entitled to receive upon the consummation of the Merger had each $1,000 principal amount of the Notes been converted into a number of shares of Common Stock equal to the Conversion Rate immediately prior to the Merger. The procedures for settlement upon conversion set forth in the Indenture shall continue to apply *mutatis mutandis* to the Holders' right to convert the Notes into the cash amount described in this Supplemental Indenture, and any reference in the Indenture to Holders' right to convert the Notes into any Settlement Amount shall be deemed to be a reference to Holders' right to convert the Notes into the cash amount described in this Supplemental Indenture.

(3) Ratification of Indenture; Supplemental Indenture Part of Indenture. Except as expressly provided for herein, the Indenture is in all respects ratified and confirmed and all the terms, conditions and provisions thereof shall remain in full force and effect. This Supplemental Indenture shall form a part of the Indenture for all purposes, and every Holder of Notes heretofore or hereafter authenticated and delivered shall be bound hereby.

(4) No Recourse Against Others. No director, officer, employee, incorporator or stockholder of the Company shall have any liability for any obligations of the Company under the Notes, the Indenture, the Supplemental Indenture or any claim based on, in respect of, or by reason of, such obligations or their creation. Each Holder, by accepting a Note, waives and releases all such liability. The waiver and release are part of the consideration for issuance of the Notes.

(5) Governing Law. This Supplemental Indenture, and any claim, controversy or dispute arising under or related to this Supplemental Indenture shall be governed by, and construed in accordance with, the laws of the State of New York.

---

(6) Execution in Counterparts. The parties may sign any number of copies of this Supplemental Indenture. Each signed copy shall be an original, but all of them together shall represent the same agreement. Delivery of an executed counterpart of a signature page to this Supplemental Indenture by telecopier, facsimile or other electronic transmission (e.g. a "pdf" or "tif") (including any electronic signature complying with the New York Electronic Signatures and Records Act (N.Y. State Tech. §§ 301-309), as amended from time to time, or other applicable law) shall be effective as delivery of a manually executed counterpart thereof.

(7) Effect of Headings. The section headings herein are for convenience only and shall not affect the construction hereof.

(8) Effect on Successors and Assigns. All covenants and agreements in this Supplemental Indenture given by the parties hereto shall bind their successors and assigns, whether so expressed or not.

[*Remainder of Page Intentionally Left Blank; Signature Pages Follow*]

IN WITNESS WHEREOF, the parties hereto have caused this Supplemental Indenture to be duly executed, all as of the date first above written.

UNITED STATES STEEL CORPORATION

By: /s/ Arne Jahn
Name: Arne Jahn
Title: Vice President – Treasurer & Chief Risk Officer

[Signature Page to First Supplemental Indenture]

THE BANK OF NEW YORK MELLON,
as Trustee

By: /s/ Glenn McKeever
Name: Glenn McKeever
Title: Vice President

[Signature Page to First Supplemental Indenture]

Exhibit 4.2

ELEVENTH SUPPLEMENTAL INDENTURE

ELEVENTH SUPPLEMENTAL INDENTURE, dated as of June18, 2025 (this " Supplemental Indenture"), between United States Steel Corporation, a Delaware corporation (the "Company") and The Bank of New York Mellon (formerly known as The Bank of New York), as trustee (the "Trustee").

W I T N E S S E T H

WHEREAS, the Company and the Trustee executed and delivered an Indenture, dated as of May21, 2007 (the "Base Indenture"), as supplemented by the First Supplemental Indenture, dated as of May21, 2007 (the " First Supplemental Indenture"), among the Company and the Trustee, relating to the Company's 6.65% Senior Notes due June1, 2037 (the " 2037 Notes"), and as further supplemented by the Tenth Supplemental Indenture, dated as of February11, 2021 (the "Tenth Supplemental Indenture" and, collectively with the Base Indenture and the First Supplemental Indenture, the "Indenture"), among the Company and the Trustee, relating to the Company's 6.875% Senior Notes due March 1, 2029 (the "2029 Notes" and, collectively with the 2037 Notes, the "Notes");

WHEREAS, in connection with that certain Agreement and Plan of Merger, dated as of December18, 2023 (as amended, restated, amended and restated, supplemented or otherwise modified from time to time), among the Company, Nippon Steel North America,Inc., a New York corporation (" Parent"), and 2023 Merger Subsidiary,Inc., a Delaware corporation and a wholly owned subsidiary of Parent (" Purchaser"), pursuant to which Purchaser will merge with and into the Company (the "Merger"), with the Company surviving the Merger as a wholly owned subsidiary of Parent;

WHEREAS, in connection with the Merger, the Company shall cease to prepare annual and quarterly reports on Form 10-K and Form 10-Q;

WHEREAS, pursuant to Section 9.01(9) of the Base Indenture, the Company, when authorized by an Establishment Action, and the Trustee, may from time to time enter into a supplemental indenture without the consent of the Holders for the purpose of curing any ambiguity or correcting or supplementing any provision of the Indenture which may be defective or inconsistent with any other provision of the Indenture;

WHEREAS, all things necessary to make this Supplemental Indenture a legal and binding supplement to the Indenture in accordance with its terms and the terms of the Indenture have been done; and

WHEREAS, the Company (i)has complied with all conditions precedent provided for in the Indenture relating to this Supplemental Indenture and (ii)desires and has requested the Trustee to join with it in entering into this Supplemental Indenture for the purpose of amending the Indenture in certain respects as permitted by Section 9.01(9) of the Base Indenture.

NOW, THEREFORE, in consideration of the foregoing and for other good and valuable consideration, the receipt of which is hereby acknowledged, the Company and the Trustee mutually covenant and agree for the equal and ratable benefit of the Holders as follows:

(1) Scope of Supplemental Indenture. This Supplemental Indenture constitutes a supplement to the Indenture and an integral part of the Indenture and shall be read together with the Base Indenture and each of the First Supplemental Indenture and Tenth Supplemental Indenture, as applicable, as though all the provisions thereof are contained in one instrument. Except as expressly amended by this Supplemental Indenture, the terms and provisions of the Indenture shall remain in full force and effect. Notwithstanding the foregoing, this Supplemental Indenture shall only apply to the Notes.

(2) Definition of Terms.

(a) Capitalized terms used herein without definition shall have the meanings assigned to them in the Indenture.

(b) All references herein to Articles and Sections, unless otherwise specified, refer to the corresponding Articles and Sections of the Indenture.

(c) The terms "herein", "hereof", "hereunder" and other words of similar import refer to this Supplemental Indenture.

(d)In the event of a conflict between any definition set forth in the Indenture and any definition set forth in this Supplemental Indenture, the definitions set forth in this Supplemental Indenture shall control.

(3) Amendments to Indenture. With respect to the Notes, each of the First Supplemental Indenture and the Tenth Supplemental Indenture is hereby corrected and supplemented pursuant to Section9.01(9)of the Base Indenture to amend and restate, in its entirety, the definition of "Consolidated Net Tangible Assets" in Section 1.03 of the First Supplemental Indenture and Section 1.03 of the Tenth Supplemental Indenture as follows:

"Consolidated Net Tangible Assets" means, as of the time of determination, the aggregate amount of the assets of the Company and the assets of its consolidated Subsidiaries after deducting (1)all goodwill, trade names, trademarks, service marks, patents, unamortized debt discount and expense and other intangible assets and (2)all current liabilities, as reflected on the consolidated balance sheet contained in financial statements for the most recently completed fiscal quarter and prepared by the Company in accordance with GAAP and provided to the Holders within such time periods as would have been required by the Exchange Act if the Company were a "non-accelerated filer" (and which financial statements have not been subsequently disclaimed as being not reliable by the Company) prior to the time as of which "Consolidated Net Tangible Assets" is being determined. Financial statements may be deemed to be provided to holders if the Company (x)posts such financial statements on a website (which may be nonpublic and may be maintained by the Company or a third party) to which access will be given to Holders that certify their status as such to the reasonable satisfaction of the Company or (y) otherwise makes the information publicly available (including by posting such information on EDGAR).

(4) No Recourse Against Others. No director, officer, employee, incorporator or stockholder of the Company shall have any liability for any obligations of the Company under the Notes, the Indenture, the Supplemental Indenture or any claim based on, in respect of, or by reason of, such obligations or their creation. Each Holder, by accepting a Note, waives and releases all such liability. The waiver and release are part of the consideration for issuance of the Notes.

(5) Trust Indenture Act Controls. If any provision hereof limits, qualifies or conflicts with the duties imposed by Section310 through 317 of the Trust Indenture Act, the imposed duties shall control.

(6) Governing Law. This Supplemental Indenture shall be governed by, and construed in accordance with, the laws of the State of New York.

(7) Execution in Counterparts. The parties may sign any number of copies of this Supplemental Indenture. Each signed copy shall be an original, but all of them together shall represent the same agreement. Delivery of an executed counterpart of a signature pageto this Supplemental Indenture by telecopier, facsimile or other electronic transmission (e.g. a "pdf" or "tif") (including any electronic signature complying with the New York Electronic Signatures and Records Act (N.Y. State Tech. §§ 301-309), as amended from time to time, or other applicable law) shall be effective as delivery of a manually executed counterpart thereof.

(8) Effect of Headings. The section headings herein are for convenience only and shall not affect the construction hereof.

(9) Effect on Successors and Assigns. All covenants and agreements in this Supplemental Indenture given by the parties hereto shall bind their successors and assigns, whether so expressed or not.

(10) Trustee Disclaimer. The Trustee makes no representation as to the validity or sufficiency of this Supplemental Indenture other than as to the validity of its execution and delivery by the Trustee. The recitals and statements herein are deemed to be those of the Company and not the Trustee.

[*Remainder of Page Intentionally Left Blank; Signature Pages Follow*]

IN WITNESS WHEREOF, the parties hereto have caused this Supplemental Indenture to be duly executed, all as of the date first above written.

UNITED STATES STEEL CORPORATION

By:/s/ Arne Jahn
Name: Arne Jahn
Title: Vice President – Treasurer & Chief Risk Officer

[Signature Page to Eleventh Supplemental Indenture]

THE BANK OF NEW YORK MELLON,
as Trustee

By:/s/ Glenn McKeever
Name: Glenn McKeever
Title: Vice President

[Signature Page to Eleventh Supplemental Indenture]

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 23

Obayashi, Y. (2025, August 28) Nippon Steel bets on $11 billion investment, tech transfer to lift U.S. Steel profit, *Reuters*.

Learn more about LSEG

https://www.reuters.com/business/nippon-steel-bets-11-billion-investment-tech-transfer-lift-us-steel-profit-2025-08-28/

Nippon Steel bets on $11 billion investment, tech transfer to lift U.S. Steel profit

By **Yuka Obayashi**, **Katya Golubkova** and **Ritsuko Shimizu**

August 28, 2025 12:03 PM CDT · Updated August 28, 2025



The Nippon Steel logo is displayed at the company's East Nippon Works Kimitsu Area plant in Kimitsu, east of Tokyo, Japan May 26, 2025. REUTERS/Issei Kato/File Photo Purchase Licensing Rights

Summary Companies

Nippon steel bets on $11 bln U.S. Steel investment

Sees profit contribution of 250 billion yen by fiscal 2028

Detailed investment plan to follow later this year

TOKYO, Aug 29 (Reuters) - Japan's Nippon Steel (5401.T) plans to increase profit at U.S. Steel through an $11 billion investment and the transfer of its operational techniques and advanced technologies to expand capacity and add more high-grade products, a senior executive said.

Nippon Steel's $14.9-billion acquisition of U.S. Steel closed in June, ending an 18-month process that had been caught up in the shifting political landscape during the transition between the Biden and Trump administrations.

The investment, running through 2028, and transfer of expertise aim to lift U.S. Steel's annual profit contribution to 250 billion yen ($1.70 billion) as early as fiscal 2028, up from an expected 150 billion yen in 2026 and 80 billion this year.

"Real effects from the investment will appear after 2028," Nippon Steel Vice Chairman Takahiro Mori told Reuters on Thursday, adding that profitability could even grow beyond 250 billion yen.

Mori, the lead negotiator on the deal and now Chairman of U.S. Steel, said the investment would raise U.S. Steel's domestic crude steel capacity to around 20 million tons from 17 million.

The acquisition also lifts Nippon Steel's global annual crude steel capacity to 86 million tons, edging closer to its longer-term 100 million-ton target.

A detailed investment plan will be announced later this year as part of Nippon Steel's new medium-term business strategy.

Nippon Steel said in July it would raise 500 billion yen through a subordinated loan to partially repay a 2 trillion yen bridging loan that funded the deal.

Mori said the steelmaker also has flexibility with hybrid financing and may consider convertible and corporate bonds.

"We'll assess the optimal timing, interest rates, and whether yen or dollar denominations are preferable to pursue the best financing strategy," he said, adding that equity financing was possible, but only within limits to avoid shareholder dilution.

U.S. Steel would fund the $11 billion investment initially, with Nippon Steel stepping in if resources prove insufficient, Mori said.

He said that U.S. Steel is assessing the impact of an August explosion at its Clairton plant in Pennsylvania, which could lower, although not significantly, the expected 80 billion yen profit contribution to Nippon Steel for the current year.

($1 = 147.3300 yen)

Reporting by Yuka Obayashi, Katya Golubkova and Ritsuko Shimizu; Editing by Kirsten Donovan

Our Standards: **The Thomson Reuters Trust Principles.**

Suggested Topics:

Yuka Obayashi
Thomson Reuters

Yuka Obayashi reports on Japan's energy, metals and other commodities.

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 24

Lovrien, J. (2024, May 23) Keetac's new DR-grade plant up and running, *Duluth News Tribune*.

Duluth News Tribune
CONNECTED • ENGAGED • ENTRUSTED

https://www.duluthnewstribune.com/news/local/keetacs-new-dr-grade-pellet-plant-up-and-running

NEWS LOCAL

Keetac's new DR-grade pellet plant up and running

Employees, surrounding community are hopeful it will ensure a more stable future at Keewatin's iron ore mine and pellet plant.



A Keetac employee works in U.S. Steel's new DR-grade pellet plant Thursday. Wyatt Buckner / Duluth Media Group



By Jimmy Lovrien
May 23, 2024 at 6:42 PM

Comments Share News Reporting

KEEWATIN — Of the six operating taconite mines and pellet plants on the Iron Range, U.S. Steel's Keetac facility is often the first to idle and the last to reopen when the economy slumps or steel prices fall.

U.S. Steel Celebrates New Keetac DR-Grad…

Produced by Wyatt Buckner

But workers and community leaders hope Keetac's recently completed $150 million direct reduced-grade pellet plant could change that.

"It should give us extra options when markets kind of dip … I think it will be good," said Jake Friend, a Keetac electrician and president of United Steelworker Local 2660.



Flotation tanks remove silica from iron concentrate in the Keetac DR-grade pellet plant. Wyatt Buckner / Duluth Media Group

DR-grade pellets serve as feedstock when making direct-reduced iron or hot-briquetted iron, which in turn supply electric arc

furnaces making steel.

Electric arc furnaces now make more than 70% of steel in the U.S.

Until the first shipment of DR-grade pellets left Keetac on May 7, U.S. Steel's two Minnesota ore operations, Keetac and Minntac in Mountain Iron, only provided pellets to traditional blast furnaces.

More markets could help boost demand for Keetac pellets and keep the facility's approximately 500 employees working consistently and further into the future. According to the company, the DR-grade pellet plant created 33 new jobs.



Steam rises from the new Keetac DR-grade pellet plant. Wyatt Buckner / Duluth Media Group

"It gives our little Keewatin a future to look forward to," Keewatin Mayor Michael LaBine told the crowd gathered in a tent at Keetac on Thursday to celebrate the plant's opening.

The DR-grade pellet plant was built to the side of the existing pellet plant, allowing it to intercept iron particles that have already been crushed and concentrated with existing equipment. The new facility then crushes the particles into an even finer powder and removes more waste material with magnets and chemical flotation separation. That leads to an iron concentrate with more iron and less silica.

The iron concentrate then returns to the existing facility, where it is dried, shaped and baked into marble-sized pellets, taken by rail to the Allouez Ore Dock in Superior and shipped to third-party steel producers.

Minnesota Gov. Tim Walz told the crowd it's "the golden age of infrastructure investment." He noted that the raw material needed for steel to build a replacement for the Blatnik Bridge linking Duluth and Superior and other projects will come from the Iron Range.

He said having the vision to see future needs means investments and expansions today and that the new DR-grade plant helps secure Iron Range jobs.



Minnesota Gov. Tim Walz speaks at the ribbon-cutting event for U.S. Steel's new Keetac DR-grade pellet plant. Wyatt Buckner / Duluth Media Group

“These are good-paying union jobs. These are jobs that built the middle class. These are the jobs that allow people in this room to live in communities they choose to live in,” Walz said.

Thursday’s celebration comes as Japan’s Nippon Steel tries to buy U.S. Steel for $14.9 billion. (https://www.duluthnewstribune.com/news/national/japans-nippon-steel-to-buy-us-steel-in-14-9-billion-deal) But the deal faces opposition from the United Steelworkers, President Joe Biden and former President Donald Trump. The U.S. Department of Justice launched an anti-trust investigation into the deal last month.

Representatives from Nippon Steel were at Thursday’s event.

U.S. Steel President and CEO Dave Burritt speaks to the media Thursday. Wyatt Buckner / Duluth Media Group

U.S. Steel President and CEO Dave Burritt said Nippon had "deeper pockets" and could provide "security that would be better than before" for the company.

And Keetac and Minntac would be part of the company's future.

"This facility is critical to the success of not just U.S. Steel, but also Nippon … This is clearly a competitive advantage," Burritt told reporters. "This is the best mine site — Minntac and Keetac — in all of Minnesota. Nobody's close to us here and that's good news, and they (Nippon) know that."

Earlier this week, U.S. Steel sparred with rival iron ore miner and steelmaker Cleveland-Cliffs through news releases.

U.S. Steel began looking for potential buyers last August after what Burritt called a “hostile takeover” attempt by Cliffs. U.S. Steel rejected Cliffs’ $7.3 billion, or $35 per share, offer that month.

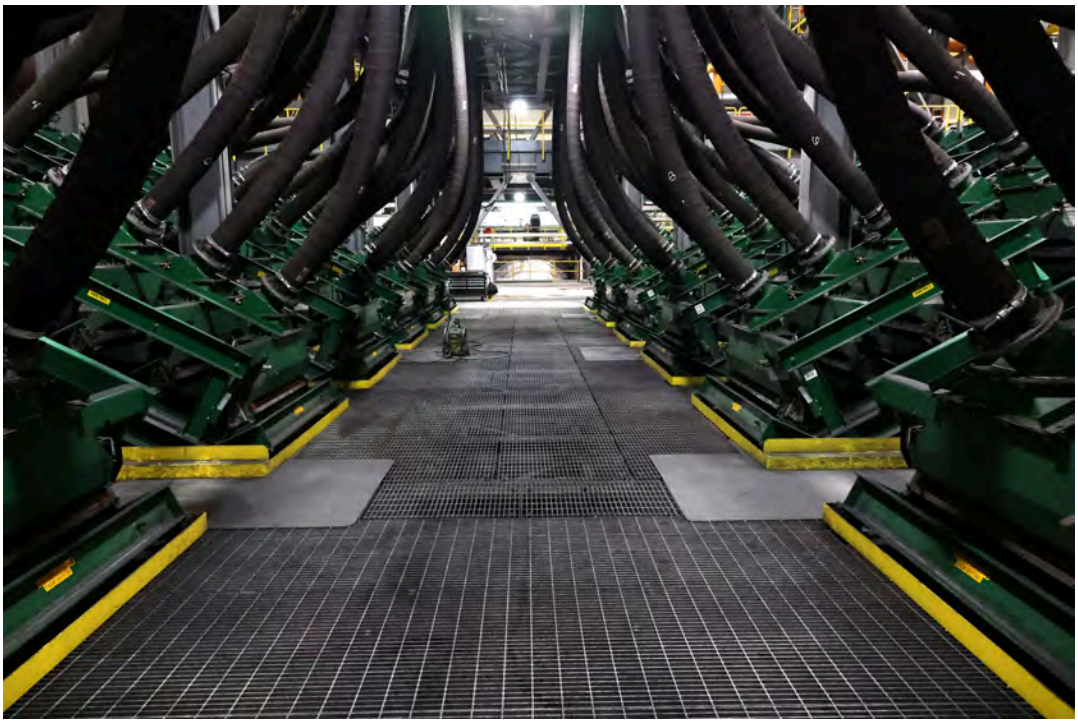
It then rejected Cliffs’ sweetened offer of $54 per share in December over antitrust concerns, picking Nippon’s $55-per-share offer instead.



A high-intensity grinding mill at Keetac DR-grade pellet plant. Wyatt Buckner / Duluth Media Group

Cliffs has criticized the U.S. Steel-Nippon deal ever since. (https://www.duluthnewstribune.com/news/local/cleveland-cliffs-slams-us-steel-nippon-deal) That prompted the U.S. Steel board of directors to issue a statement Monday.

“The investment by (Nippon) has been under attack since day one by one of our competitors and unsuccessful bidder — Cleveland-Cliffs — who have been sowing misinformation to our stakeholders in a relentless and unbridled effort to derail the transaction,” the board wrote.



A screen filters iron concentrate so large iron particles can undergo additional grinding. Wyatt Buckner / Duluth Media Group

Cliffs shot back in a statement a few hours later, noting the United Steelworkers are staunchly opposed to the U.S. Steel-Nippon deal and have said it has a contractual provision allowing it to veto the deal.

“With a USW-represented facility, you are not entitled to sell to whomever you please,” said Lourenco Goncalves, president and CEO of Cliffs. “We knew this, and you apparently did not. We tried to explain to you, but you did not listen to us. The board of directors of U.S. Steel failed its stockholders in this ‘strategic review process,’ and is attempting to blame Cliffs for its own self-inflicted disaster.

"My opinion remains the same: You cannot and will not close your announced deal with Nippon Steel.”

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 25

EPA, Comments on Review of Two Draft NPDES Permits,
U.S. Steel Keetac Mining Area (MN0031879) and U.S. Steel Keetac Tailings Basin (MN0055948), Keewatin, Minnesota, Sept. 6, 2024.

REGION 5
CHICAGO, IL 60604

September 6, 2024

Theresa Haugen, Manager
Water and Mining Section
Industrial Division
Minnesota Pollution Control Agency
520 Lafayette Road North
Saint Paul, Minnesota 55155-4194
Theresa.haugen@state.mn.us

Re: Review of Two Draft NPDES Permits, U.S. Steel Keetac Mining Area (MN0031879) and U.S. Steel Keetac Tailings Basin (MN0055948), Keewatin, Minnesota

Dear Ms. Haugen:

The U.S. Environmental Protection Agency has reviewed the two pre-public notice draft National Pollutant Discharge Elimination System (NPDES) permits, fact sheets, and supporting documents for the U.S. Steel Keetac mining operation located in Keewatin, Minnesota. The Keetac Tailings Basin (MN0055948) documents were submitted to EPA on July 30, 2024, and the Keetac Mining Area (MN0031879) documents were submitted to EPA on August 1, 2024. Based on our review to date, EPA has the following comments.

1. ***Anti-Backsliding with the Inclusion of New Compliance Schedules for Sulfate*** – The previously-issued and currently-effective permits contain compliance schedules for the facilities to meet water quality-based effluent limitations (WQBELs) for sulfate of 14 milligrams per liter (mg/L) as an average monthly limit and 24 mg/L as a maximum daily limit by August 17, 2018, at the mine site and August 17, 2019, at the tailings basin site. The draft permits include new compliance schedules for the same parameter, with interim monthly maximum limits set to 167 mg/L, and no fixed date for the facility to come into compliance with final WQBELs. By extending the date for compliance with the WQBELs beyond the dates specified in the current permits, the draft permits include less stringent effluent limitations and conditions than the prior permits. This approach is in conflict with the backsliding prohibition in 33 U.S.C. § 1342(o) and 40 C.F.R. § 122.44(l)(1) [1] unless one of the exceptions in those statutory and regulatory provisions applies, which does not appear to be the case.

2. ***Compliance Schedules are not Appropriate*** **-** Even if one of the anti-backsliding exceptions applied**,** inclusion of compliance schedules in the permits is not appropriate because the

[1] All cited federal regulations are made applicable to states by 33 U.S.C. §§ 1314(i), 1342(c)(2) and 40 C.F.R. § 123.25.

Minnesota Pollution Control Agency (MPCA) has not made a finding supported by the record that compliance schedules are appropriate (*see* 40 C.F.R. § 122.47). As explained in an EPA memorandum[2]:

> In order to grant a compliance schedule in an NPDES permit, the permitting authority has to make a reasonable finding, adequately supported by the administrative record and described in the fact sheet (40 C.F.R. § 124.8), that a compliance schedule is "appropriate" and that compliance with the final WQBEL is required "as soon as possible." *See* 40 C.F.R. §§ 122.47(a), 122.47(a)(1).
>
> And
>
> Factors relevant to whether a compliance schedule in a specific permit is "appropriate" under 40 C.F.R. § 122.47(a) include: how much time the discharger has already had to meet the WQBEL(s) under prior permits; [and] the extent to which the discharger has made good faith efforts to comply with the WQBELs and other requirements in its prior permit(s); …

We are not able to locate an MPCA finding that compliance schedules are appropriate for these permits.

3. ***Compliance Schedules do not Comport with NPDES Permitting Requirements*** - Finally, even if one of the anti-backsliding exceptions applied and MPCA demonstrated that compliance schedules are appropriate, the compliance schedules are not consistent with other aspects of 40 C.F.R. § 122.47. Specifically:

    a. The draft schedules do not include an "enforceable sequence of actions or operations leading to compliance with a [water quality-based] effluent limitation ["WQBEL"]" as required by the definition of "schedule of compliance" in 40 C.F.R. § 122.2 and 33 U.S.C. § 1362(17). *See* also the Hanlon Memo in footnote 2. Specifically, the draft permits describe the deadline for achieving compliance with the final sulfate effluent limitations as "within 12 months of completing construction," but this milestone and others are triggered from milestones that hinge on MPCA's approval of various submissions, actions that may never occur and are not connected to specific dates. Therefore, there is no final date for compliance in either of the permits.

        There is no demonstration that the draft schedules of compliance require compliance with the final effluent limitations "as soon as possible" in accordance with 40 C.F.R. § 122.47(a)(1).

    b. The draft schedules of compliance do not identify specific dates for the completion of interim requirements ("interim dates") as required by 40 C.F.R. § 122.47(a)(3). All

[2] *See* Hanlon Memo (https://www3.epa.gov/npdes/pubs/memo_complianceschedules_may07.pdf).

interim dates must be established in accordance with 40 C.F.R. § 122.47(a)(3)(i) and 40 C.F.R. § 122.47(a)(3)(ii).

c. The draft schedules of compliance do not comply with the 14-day reporting requirements for each interim date and the final date of compliance as specified in 40 C.F.R. § 122.41(l)(5).

4. ***Evaluation of the need for WQBELs for specific conductance to protect aquatic life*** **-** The fact sheets indicate that the discharges have elevated specific conductance but do not show that MPCA determined whether the discharge of specific conductance or constituent ions from any outfalls will cause, have the reasonable potential to cause, or contribute to an excursion above any state water quality standard, including narrative water quality standards. *See* 40 C.F.R. § 122.44(d)(1)(i). During the course of MPCA's Class 3 and 4 standards revision rulemaking, MPCA determined that ionic pollutants, as measured by specific conductance, may adversely affect aquatic life and cause violations of Minnesota's Class 2 narrative criteria at Minn. R. 7050.0150, Subp. 3 and Minn. R. 7050.0222. This is consistent with analyses that EPA has conducted (*see e.g.*, EPA's *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams*, EPA/600/R-10/023F, March 2011). MPCA provided assurance[3] as well as a white paper that summarized how it would evaluate the need for specific conductivity conditions in implementation of its standards.[4] That white paper identified ionic pollutants as being of possible concern for waters downstream of the facility.

   We understand from the fact sheets that MPCA believes that any water quality issues related to specific conductivity or constituent ions will be resolved when sulfate in the discharge is reduced sufficiently to meet the wild rice criteria. However, the compliance schedule for sulfate does not require the facility to consider and report treatability information for other ions when developing its sulfate treatment/mitigation alternatives plans. Because it is unclear that the plans the facility develops to address sulfate will also reduce ionic pollutants to meet narrative water quality criteria, EPA does not agree that a plan to address sulfate should be a substitute for an analysis that directly addresses specific conductivity or its non-sulfate constituent ions. Please add to the record an analysis of the discharge of specific conductance or constituent ions to determine whether pollutants will cause, have the reasonable potential to cause, or contribute to an excursion above any state water quality standard, including narrative water quality standards. *See* 40 C.F.R. § 122.44(d)(1)(i). To the extent such "reasonable potential"

[3] E.g., See p. 15 of MPCA's Implementing the Aquatic Life Narrative Standard document ("In cases where the evaluation clearly shows that the facility is causing or contributing to a biological impairment, the permit conditions would include specific effluent limits, likely to be based on meeting a specific water quality value for a given pollutant, which may be based on existing benchmark or criteria values or established as a site-specific standard") and p. 185 of MPCA's Statement of Need and Reasonableness in the Matter of Proposed Revisions of Minnesota Rule Chapters 7050 and 7053, Relating to Water Quality Standards – Use Classifications 3 and 4; Revisor ID No. 04335, available at https://www.pca.state.mn.us/sites/default/files/wq-rule4-17k.pdf ("Moving forward, when permits for the identified dischargers are reissued or revised, or when new permits are issued for discharges into those waters, the permitting process will specifically consider what permit conditions are needed to ensure the protection of the biological community. Some potential permit actions and conditions are described in the Appendix").

[4] S-5 Implementing the Aquatic Life Narrative Standard (https://www.pca.state.mn.us/sites/default/files/wq-wwprm1-36.pdf)

exists and MPCA stands by the belief captured above, the fact sheet and permit will need to meet 40 C.F.R. § 122.44(d)(1)(vi)(C)(*1*)-(*4*).

5. ***Functional Equivalent Direct Discharge (FEDD) -*** Page 1 of both permits provide broad authorization to discharge from the "facility." The Keetac Mining Area permit (MN0031879) needs to include language similar to that in the Tailings Basin permit (MN0055948). Specifically, the discharge authorization statement in the Mining Area permit needs to be revised to exclude any point source discharges to waters of the United States through ground water that are the functional equivalent of direct discharges under the Supreme Court decision in County of Maui v. Hawaii Wildlife Fund, 140 S. Ct. 1462 (2020). If the alternative is intended (i.e., the discharges are to be authorized), the permit needs appropriate technology- and water quality-based effluent limitations and other conditions for any authorized "functional equivalent" discharges.

In addition to the comments above, EPA recommends you consider and address the comments identified in Enclosure A to improve each permit and fact sheet.

When the proposed permits are prepared, please forward one copy each and any significant comments received during the public notice period to this office at r5NPDES@epa.gov. Please include the permittee name and permit numbers in the subject line and cc batka.allan@epa.gov. If you have any technical questions related to EPA's review, please contact Allan Batka of my staff. He can be reached by telephone at (312) 353-7316 or batka.allan@epa.gov.

Thank you for your cooperation during the review process and your thoughtful consideration of our comments.

Sincerely,

STEPHEN JANN Digitally signed by STEPHEN JANN
Date: 2024.09.06 16:24:15 -05'00'

Stephen M. Jann
Manager, Permits Branch
Water Division

Enclosure

cc: Stephanie Handeland, MPCA, stephanie.handeland@state.mn.us

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 26

Johnson BL, Johnson MK, An Evaluation of a Field-Based Aquatic Life Benchmark for Specific Conductance in Northeastern Minnesota, November 2015.

AN EVALUATION OF A FIELD-BASED AQUATIC LIFE BENCHMARK FOR SPECIFIC CONDUCTANCE IN NORTHEAST MINNESOTA

(November 2015)

Prepared by Bruce L. Johnson and Maureen K. Johnson for Water Legacy[1]

I. Introduction

A. Specific Conductance

Specific conductance is an accurate, low cost, easily completed measurement directly related to salinity, a difficult-to-measure combined effect of all ions in the water. Under most conditions, specific conductance is applicable to identify ionic changes in surface water that have been shown to affect aquatic life. Native ion concentration levels are necessary to aquatic life, but negative effects on aquatic life from anthropogenic cumulative ionic toxicity are related to higher specific conductance levels.

This evaluation answers two questions:

1. Are the methods used by U.S. Environmental Protection Agency (EPA) to develop a specific conductance aquatic life benchmark for Appalachian ecoregions applicable in developing specific conductance aquatic life protections for ecoregions in Minnesota? For purpose of this evaluation the primary reference is EPA's *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams* (EPA Conductivity Benchmark Study, 2011)[2].

2. Is the 300 micro Siemens per centimeter (µS/cm) guidance developed by EPA for the Appalachian ecoregions directly applicable as a maximum aquatic life benchmark for northeast Minnesota ecoregions 50n, the northern portion of 50p, and 50t (EPA, 2007)[3] or as a Minnesota NPDES permit condition when sufficient background data is available?

This evaluation for northeast Minnesota is not a comprehensive review of all data sources relating to chemistry and benthic invertebrates in the specified area. Its intent is to demonstrate that significant data exists, and that if other existing historical and current data is added, little new data would be needed to support Minnesota's adoption of a

[1] Bruce L. Johnson is a biologist/chemist with 30 years of experience including water quality research with the U.S. Environmental Protection Agency, mining research with Minnesota Department of Natural Resources, mining permit enforcement with Minnesota Pollution Control Agency, and supervisory NPDES and hazardous waste permits compliance and research with Minnesota Department of Transportation. Among other responsibilities, Johnson served as the field chemist in charge of the metal pathways portion of the Minnesota Regional Copper-Nickel Study. Maureen K. Johnson is a biologist with 26 years of scientific experience, including water quality sampling and analysis for both U.S. Environmental Protection Agency and U.S. Forest Service, and managing cleanups of hazardous waste sites for the Minnesota Pollution Control Agency.

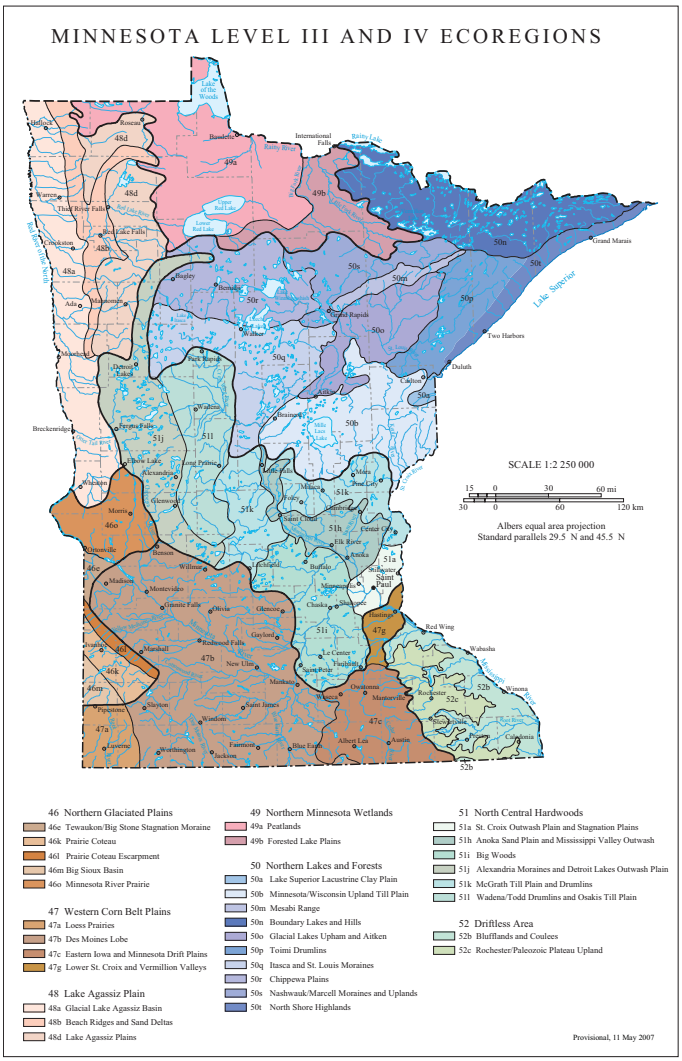
[2] U.S. Environmental Protection Agency, *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams,* Office of Research and Development, National Center for Environmental Assessment, Washington, DC., 2011 EPA/600/R-10/023F. (hereinafter "EPA Conductivity Benchmark Study")

[3] U.S. Environmental Protection Agency, *Minnesota Level III and IV Ecoregions*, 2007, www.epa.gov/wed/pages/ecoregions/mn_eco.htm.

numeric specific conductance benchmark or standard, at least as stringent as the Appalachian 300 µS/cm specific conductance benchmark, based on protection of aquatic life in Minnesota ecoregions 50n, the northern portion of 50p, and 50t.

Figure 1, Map of Minnesota Level III and IV Ecoregions, illustrates these northeast Minnesota ecoregions. Pending such adoption of a data-driven specific conductance rule, the data is sufficient to support permit conditions implementing this 300 µS/cm specific conductance benchmark in order to begin meeting Minnesota's existing narrative standards for aquatic life.

Figure 1. Map of Minnesota Level III and IV Ecoregions.



EPA defines "ecoregion" as an ecological region "identified through the analysis of the patterns and the composition of biotic and abiotic phenomena that affect or reflect differences in ecosystem quality and integrity. These phenomena include geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. The relative importance of each characteristic varies from one ecological region to another regardless of

the hierarchical level." [4] (EPA, 2015). In general the Laurentian Divide delineates the southern boundary of the Ecoregion 50n and the coinciding northern boundary of 50p. At this interface, the area along the northern boundary of 50p is similar to 50n in climate, geology, topography, soils, hydrology, and vegetation. This inclusion is supported by the Minnesota Department of Natural Resources (MDNR) and U.S. Department of Agriculture Forest Service (USFS) Ecological Classification System, which differentiates between this 50p inclusion and the 50p region south of it (MDNR, USFS, et al. 1999).[5] Thus the review includes this area in evaluating a Specific Conductance benchmark for permit limits or standard development for the 50n, northern part of 50p, and 50t ecoregions in Minnesota.

This review evaluates some of the available data for establishment of a numeric benchmark or standard on which to base permit effluent limits to comply with existing narrative standards for aquatic life in Minnesota. It compares aquatic life genera (a biological classification of a group of species) and specific conductance levels of unimpacted and mining-impacted headwater streams in Minnesota as well as comparing water chemistry and biological data in unimpacted and impacted streams in the coal mining area in two Appalachian headwater ecoregions. These ecoregions were studied in the EPA Conductivity Benchmark Study. After internal, external and public review of the EPA Study, EPA's Science Advisory Board concluded, "the benchmark is applicable to the regions in which it was derived and the benchmark and the methodology may be applicable to other states and regions with appropriate validation." (EPA Conductivity Benchmark Study, 2011).[6]

In this evaluation of data, for each genus which both Minnesota and Appalachian ecoregions have in common, the EPA's specific conductance level at which 5 percent of the taxa have been lost as determined at the genus level (the XC95%) was recorded in column K of Table 1, Detailed Invertebrate Background, which is attached as Appendix A. As explained in the EPA Conductivity Benchmark Study, this evaluation criterion uses field data instead of lab data and is based on the EPA's "standard methodology for deriving water-quality criteria, in that it uses the 5th centile of a species sensitivity distribution (SSD) as the benchmark value. SSDs represent the response of aquatic life as a distribution with respect to exposure."[7] (EPA Conductivity Benchmark Study, 2011).

EPA's Conductivity Benchmark Study explains,

> The method used in this report is based on the standard methodology for deriving water-quality criteria, as explained in Stephan *et al*. (1985), in that it used the 5th centile of a species sensitivity distribution (SSD) as the benchmark value. SSDs represent the response of aquatic life as a distribution with respect to exposure.

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[4] U.S. Environmental Protection Agency, *Ecoregion Maps and GIS Resources*, updated March 30, 2015 and citations therein, including Wiken 1986; Omernik 1987; Omernik 1995. See http://archive.epa.gov/wed/ecoregions/web/html/ecoregions-2.html.
[5] Minnesota Department of Natural Resources, U.S. Department of Agriculture Forest Service, *et al*., *Ecological Classification System, and Subsections Map,* 1999. http://www.dnr.state.mn.us/ecs/index.html and http://files.dnr.state.mn.us/natural_resources/ecs/subsection.pdf
[6] *Ibid.,* 2, EPA Conductivity Benchmark Study, p. viii.
[7] *Id.,* 2, EPA Conductivity Benchmark Study, p. xiv.

> Data analysis followed the standard methodology in aggregating species to genera and using interpolation to estimate the centile. It differs primarily in that the points in the SSDs are extirpation concentrations (XCs) rather than median lethal concentrations (LC50s) or chronic values. The XC is the level of exposure above which a genus is effectively absent from water bodies in a region. For this benchmark value, the 95th centile of the distribution of the probability of occurrence of a genus with respect to conductivity was used as a 95th centile extirpation concentration. Hence, this aquatic life benchmark for conductivity is expected to avoid the local extirpation of 95% of native species (based on the 5thcentile of the SSD) due to neutral to alkaline effluents containing a mixture of dissolved ions dominated by salts of SO_4^{-2} and HCO_3^{-1}. Because it is not protective of all genera and protects against extirpation rather than reduction in abundance, this level is not fully protective of sensitive species or higher quality, exceptional waters designated by state and federal agencies.[8] (EPA Conductivity Benchmark Study, 2011).

EPA further notes, "an invertebrate genus may represent several species, and this approach identifies the pollutant level that extirpates all sampled species within that genus, that is, the level at which the least sensitive among them is rarely observed."[9] (EPA Conductivity Benchmark Study, 2011).

EPA provided Final Guidance in a memorandum to EPA Regional Administrators (EPA Final Guidance, 2011) on reviewing surface coal mining and applying the Conductivity Benchmark Study: "This final peer-reviewed study concludes that 5% of native macroinvertebrate genera are extirpated where the conductivity level reaches 300 µS/cm." EPA Final Guidance also stated that when 5% of the native macroinvertebrate genera are extirpated, that conductivity level is "associated with significant biological degradation from loss of stream life," and may prevent compliance with regulations for Clean Water Act Section 404 permits.[10] (EPA Final Guidance, 2011). In other words, "significant biological degradation" indicates unacceptable pollution.

Minnesota rules reflect a similar definition of toxicity for aquatic life, establishing that the absence of toxic effects means "the protection of no less than 95% of all the species in any aquatic community." (Minn. Rule 7050.0217, Subp. 2A).

It should be noted that this index of unacceptable pollution is not comparable to a watershed stressor evaluation using the Index of Biological Integrity (IBI)[11] (EPA, Index of Biological Integrity, 1998). IBI studies identify differences between unimpacted and impacted areas to determine the biological integrity (general health) of a component of a

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[8] *Id.*. 2, EPA Conductivity Benchmark Study, p. xiv. It should be noted that XC95% is equivalent to an EC5% standard.
[9] *Id., 2*, EPA Conductivity Benchmark Study, p. 26.
[10] U.S. EPA, *Improving EPA Review of Appalachian Surface Coal Mining Operations Under the Clean Water Act, National Environmental Policy Act, and the Environmental Justice Executive Order*, July 21, 2011, pp. 32-33. [Hereinafter "EPA Final Guidance"]. Guidance approved in *National Mining Association v. McCarthy*, 758 F.3d 243 (D.C. Cir. 2014). EPA reference to regulations at 40 C.F.R. 230.10 and to Clean Water Act Section 404(b).
[11] EPA Office of Water, Office of Wetlands and Watersheds, *Developing an Index of Biologic Integrity,* EPA843-F-98e, July 1998, http://water.epa.gov/type/wetlands/assessment/fact5.cfm

biological system such as taxa richness. But an IBI does not relate taxa to water chemistry parameters like specific conductance or numeric standards. The IBI score may ignore outliers caused by a stressor that could be damaging numerous genera but is not captured by the "general health."

B. Approach: Current Scientific Methods in Water Quality Protection

Due to the complexity and diversity of aquatic ecosystems, in practice no single or series of numeric standards or bioassays can be 100% protective of surface waters. There can be unidentified confounding factors such as unacceptable synergistic chemical (elemental and compound) impacts. Because of this, numerous methods have been developed to address impacts. The following is a brief discussion of some of the well-used methods:

Single chemical bioassays use extensively studied aquatic organisms under laboratory conditions. From these tests, acute and chronic toxicity values are determined by using a single toxicant. The resultant standard is then developed for the most sensitive of the laboratory test species for the specific chemical tested. Bioassays are also used to determine the impacts from wastewater by testing known organisms with suspect wastewater over an arbitrary time limit.

Synergistic impacts (multiple chemical toxicity) often can be addressed by using whole effluent toxicity testing (WET) procedures (EPA-821-R-02-013) [12]. This method applies a series of standard bioassay organisms likely to be sensitive to the suspected contaminants. But, instead of single toxicant additions, it uses the field water in question to evaluate impact. The standard organisms may not be native to the field water.

Narrative standards may be used to address synergistic effects as well as the effects of single parameters. Examples of these standards in Minnesota are found in Minn. Rules 7050.0150, 7050.0170, 7050.0180, 7050.0185, 7050.0186, and 7052.0230.

Numeric standards can be based on uses such as irrigation of crops, as in Minn. Rule 7050.0224, Subp. 2. Numeric standards can also protect aquatic life and recreation, as in Minn. Rule 7050.0222, where Class 2 waters are protected for fishable and swimmable uses.

Field based benchmark methods are used to develop numeric standards. The field-based method has advantages over laboratory bioassays as follows:

1. The species involved are indigenous to the water tested;

2. The exposure time to the chemical is not arbitrarily limited;

[12] EPA, *Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms.* October 2002. Available at http://water.epa.gov/scitech/methods/cwa/wet/disk3_index.cfm

3. The method assesses all life stages of the population and ecological interactions;

4. The method represents all exposure conditions for the parameter.

As stated previously, due to the complexity of aquatic life, all methods, among them water chemistry, bioassays, and species sensitivity distributions, must be used as applicable and appropriate to evaluate impacts. This field-based benchmark for specific conductance is the approach on which this paper is focused. Specific conductance is chosen because it is a synergistic measure of the effects of ionized substances in the water on aquatic life.[13]

C. Regulatory Provisions

Exceedances of individual numeric standards are accepted as indicative of polluted conditions (Minn. Rule 7050.0220, Subp. 1). Currently, Minnesota does not have a numeric specific conductance standard based on aquatic life criteria.

The existing Minnesota specific conductance standard of 1000 µS/cm is a numeric limit applied to class 4A waters used for irrigation statewide (Minn. Rule 7050.0224, Subp. 2). The standard has been in place since 1966 with no change, based on protection of waters for irrigation of crops or vegetation.

Since then, specific conductance has commonly been used to observe daily, seasonal, and significant changes in water quality. However, beyond application to irrigation, Minnesota's standard is antiquated and fails to adequately protect aquatic life. As in Appalachian regions of Kentucky and West Virginia, under Minnesota rules narrative standards also apply. If both numeric and narrative standards are in place, the more stringent standard applies (Minn. Rule 7050.0150, Subp. 2).

The narrative standard in Minn. Rule 7050.0150, Subp. 3 further requires that "lower aquatic biota" not be seriously impaired or altered materially. Minnesota toxic pollutant regulations are applicable to protect the aquatic community from toxic effects, defined to mean "the protection of no less than 95% of all the species in any aquatic community. Greater protection may be applied to a community if economically, recreationally, or ecologically important species are very sensitive." (Minn. Rule 7050.0217 Subp. 1, 2).

Minn. Rule 7050.0180 designates waters of the Boundary Waters Canoe Area Wilderness, Department of Natural Resources designated scientific and natural areas, Lake Superior, and other waters of the state that warrant stringent protection from pollution, as *Outstanding resource value waters*. Those listed waters, unlisted waters, and unlisted wetlands in the Lake Superior Basin that are not designated Outstanding resource value waters or Class 7 waters are designated as *Outstanding international resource waters* under Minn. Rule 7052.0300, Subp. 3. These designations provide specific protections.

[13]American Public Health Association, *et al*., *Standard Methods for the Examination of Water and Wastewater*, 12th Ed., 1965. p. 280.

Although specific conductance is not a listed toxic pollutant in Minnesota rules, "toxic pollutants" means pollutants, or combinations of pollutants, that will directly or indirectly cause "death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, including malfunctions in reproduction, or physical deformation." (Minn. Stat. §115.01, Subd. 20).

In summary, under Minnesota Rules, loss of 5% of the species in a community is considered polluted. The protection of 95% of all genera is the criterion EPA has determined to be protective for specific conductance in the Appalachians. EPA has also determined a loss of 5% of the genera within a community represents a significant degradation[14] (EPA Conductivity Benchmark Study, 2011) and unacceptable. Minnesota's rules are consistent with the EPA Appalachian specific conductance benchmark determination method, and an aquatic life benchmark for specific conductance could be implemented in Minnesota from a regulatory standpoint.

II. Methods

A. Applicability of Existing Specific Conductance Data

1. Existing Minnesota Data Sets

To obtain a relevant numeric specific conductance standard for Minnesota, existing water chemistry and biological data must be compared. As in the Appalachians, Minnesota has historical background data for the aforementioned Minnesota ecoregions. One source of such data is from the late 1970's, the State of Minnesota's Regional Copper-Nickel Study[15] (Copper-Nickel Study, 1980), a comprehensive examination of the potential cumulative impacts, including environmental impacts, of copper-nickel mineral development in northeast Minnesota. The Copper-Nickel Study includes an assemblage of numerous research reports authored by staff from Minnesota Environmental Quality Board, MDNR, Minnesota Pollution Control Agency (MPCA), and the former State Planning Agency, as well as University of Minnesota faculty and students, and consultants.

Objectives of the Copper-Nickel Study included:

> 1) to characterize the region in its pre-copper-nickel development state, and
>
> 2) to identify and assess the impacts of primary copper-nickel development and secondary regional growth.

The Copper-Nickel Study scientists collected sets of ecological data to assess the background of a 500-square mile area, mainly in ecoregion 50n, preparatory to potential mining. These included lake and stream surface water chemistry and invertebrate identifications. This Regional Study is a relevant background for evaluating current unimpacted and impacted chemistry and invertebrate populations. The Copper-Nickel

[14] *Ibid.,* 2, EPA Conductivity Benchmark Study, p. 32.
[15] State of Minnesota, *Regional Copper-Nickel Study*, 1976-1980, a collection of research papers located at the Minnesota Legislative Reference Library, www.leg.state.mn.us/lrl/lrl.asp. Several specific research papers are referenced in this review. (hereinafter "Copper-Nickel Study").

Study data significantly reduces the need for additional data collection to apply the EPA protocol to these regions of Minnesota.

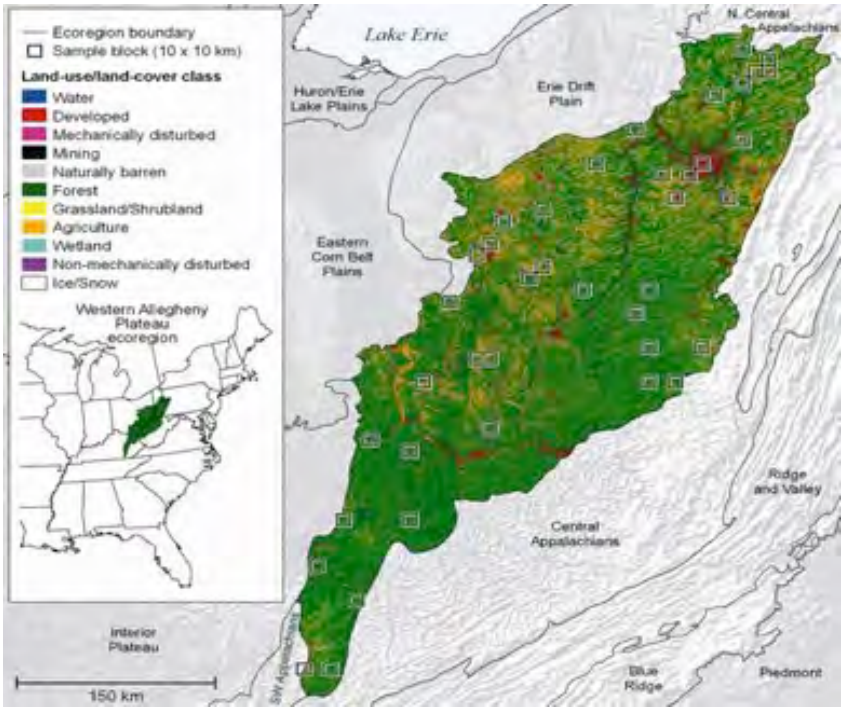
Additional more recent data was obtained by the authors from USFS Superior National Forest (SNF) and MPCA reports and National Permit Discharge Elimination System (NPDES) permit discharge monitoring reports (DMRs).

2 . Regional Similarities

Obviously climate differences exist between northeastern Minnesota and the West Virginia/Kentucky Appalachians. However the Appalachian Western Allegheny Plateau ecoregion can be compared to the northeast Minnesota ecoregions in terms of aquatic life. The Appalachian Ecoregions 68, 69, 70 and northeastern Minnesota Ecoregions 50n, the northern portion of 50p, 50t have the following similarities:

1. Both are defined by headwater streams (order 1 through 5);
2. Unimpacted streams all share low specific conductance, although Minnesota backgrounds are even lower;
3. Unimpacted ionic mixtures have similar important chemical constituents - low calcium (Ca), magnesium (Mg), sulfate ($S0_4$), and bicarbonate (HCO_3) at circumneutral to alkaline pH 6.0 to 10;
4. Unimpacted sites contain only trace amounts of heavy metals;
5. Both share benthic invertebrates with similar genera, however Minnesota has more genera than those in common.

Figure 2. Map of Appalachian Western Allegheny Plateau Ecoregion



3. Chemistry of Specific Conductance

Specific conductance is a measurement of the ability of water to conduct an electrical current. Salinity is the total concentration of all dissolved salts in water. Salinity can be calculated from specific conductance where complicating factors do not exist.

Specific conductance is a simple, fast, inexpensive test that can be performed in the field by persons with minimal training. The more cations and anions contained in water, the more electrical current it will conduct. Conductivity represents the sum of all cations and anions in water at 25 degrees Celsius (°C). The most common of these ions are calcium (Ca), magnesium (Mg), sodium (Na), bicarbonate (HCO_3), and sulfate (SO_4), but ions can also include one or more heavy metals including, but not limited to selenium (Se), copper (Cu), nickel (Ni), cobalt (Co), zinc (Zn), and cadmium (Cd).

Crushed and fractured rock from any mining increases the unweathered rock surface exposed to water dissolution and can drastically affect common cation and anion balances, with increases in both common and rare ions that are from within the rock structure. Minnesota has considerable specific conductance data from both unimpacted and impacted waters.

4. EPA Method for Specific Conductance Benchmark

The method EPA used to develop a specific conductance benchmark for West Virginia and Kentucky was based on a standard methodology[16] (EPA Conductivity Benchmark Study, 2011). The EPA method correlated water chemistries with observed changes in a community of benthic invertebrates to determine where there was impact or no impact. As stated previously, EPA applied the criterion that elimination of more than 5% of genera from a community caused by an increased specific conductance indicated an unacceptable level of impact or a polluted condition. This impact/no-impact determination is the same one that EPA uses to set other numeric standards using laboratory bioassays, for chemicals such as copper, nickel, selenium, etc.

In West Virginia and Kentucky ecoregions 69, 70, the threshold for unimpacted or low-impacted waters -- where 5% of the genera were eliminated, resulting in an unacceptable impact -- was determined to be a specific conductance level of 300 µS/cm or greater.[17] (EPA Conductivity Benchmark Study, 2011).

Many aquatic organisms are sensitive to imbalances in the ambient ion concentrations. The EPA has explained: "Exposure of aquatic organisms to salinity is direct. Fish, amphibians, mussels, and aquatic macroinvertebrates are especially exposed on their gills or other respiratory surfaces that are in direct contact with dissolved ions in water. All animals have specific structures to transport nutrient ions and control their ionic and osmotic balance (Bradley, 2009; Evans, 2008a, b, 2009; Wood and Shuttleworth, 2008;

[16] *Ibid.,* 2, EPA Conductivity Benchmark Study, p. 1.
[17] *Id.*, EPA Conductivity Benchmark Study, pp. xiv- xv.

Thorp and Covich, 2001; Komnick, 1977; Smith, 2001; Sutcliff, 1962; Hille, 2001). However, these cell membrane and tissue structures function only within a range of salinities. For example, some aquatic insects such as most Ephemeroptera [mayflies] have evolved in a low-salt environment."[18] (EPA Conductivity Benchmark Study, 2011, p. 2).

Aquatic life is not dead during the winter. Although adaptations to lower temperatures occur, ion imbalances during the cold period can still cause stress or impact.

B. Application of the EPA Appalachian Method to Minnesota

All waters do not contain a similar diversity of organisms or similar concentrations of ions. In Minnesota, for example, conductivities (and compositional concentrations) in the Minneapolis/St. Paul area are naturally higher than in the northeastern part of the state. Thus, data on Minnesota's aquatic life and background ion levels in the specific region being evaluated are required to determine applicability of the benchmark found for the Appalachian ecoregions[19] (Thingvold, 1979).

Although EPA cautions that the numeric benchmarks themselves may not be directly applicable nationwide, EPA recommends the methods used for their determination. Generally, to duplicate the EPA's specific conductance evaluation for other ecoregions, the following basic methods and conditions would be required[20] (EPA Conductivity Benchmark Study, 2011):

1. Sampling of rivers with watershed areas under 155 km^2 (order 5 streams and lower) using sampling methods similar to EPA's Appalachian study, or other appropriate method; if streams are Order 5 or over, different sampling methods are required.
2. Sampling of surface waters with a natural background - unimpacted or near-unimpacted surface waters as well as impacted waters.
3. Presence of waters dominated by calcium, magnesium, sulfate, and bicarbonate at a circumneutral to alkaline, pH 6.0 to 10.
4. Invertebrate surveys, identified to at least genus level (species level when possible), once per year, in spring or summer, focusing on genera that are mostly sensitive to specific conductance, e.g. Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies).
5. Water chemistry analysis that includes analysis for confounding ions beyond the common ions as discussed in item 3 above.
6. Results are evaluated using a species sensitivity distribution with 95% confidence bounds.

[18] *Id.,* EPA Conductivity Benchmark Study, p. 2.
[19] Thingvold, Daryl, Nancy Sather, Peter Ashbrook, *Water Quality Characterization of the Copper-Nickel Research Area,* December, 1979, pp. 7-19. Available at http://archive.leg.state.mn.us/docs/pre2003/other/CN153.pdf
[20] *Ibid.,* 2, EPA Conductivity Benchmark Study, pp. 4-22.

III. Results of Data Comparisons and Analysis

A. Minnesota Data to Support a Specific Conductance Benchmark

Minnesota's ecoregion 50n already has significant data that would support a specific conductance standard at least as stringent as the EPA's 300 µS/cm guideline for Appalachia. In this ecoregion of Minnesota, due to the naturally lower values of major cations and anions, coupled with the lack of confounding factors, the specific conductance standard that would protect 95% of lower aquatic biota may be even lower than 300 µS/cm. Other Minnesota ecoregions with geology and water chemistry similar to ecoregion 50n could be protected with the same specific conductance standard.

The above conclusion is based primarily on data produced in the late 1970's by the Copper-Nickel Study, a $4 million compilation of many research papers about potential environmental impact of copper-nickel mining on Minnesota's 500 square miles that could be affected. Water quality work was conducted to establish baseline conditions, mostly in ecoregion 50n. This water chemistry and biological data demonstrates significant similarities to the Appalachian study chemistry and biology.

Beyond the Copper-Nickel Study, important data sources demonstrating availability and quality to support Minnesota-specific benchmarks for conductivity include but are not limited to:

1. The United States Forest Service (USFS) has input additional stream water chemistry data to the EPA national water quality data base (STORET) from the lakes and streams in the Superior National Forest;

2. NPDES water chemistry data is available from the Minnesota Pollution Control Agency (MPCA) permit DMRs and in studies related to mine permitting;

3. MPCA also has an EQUIS database that contains water chemistry analyses of numerous streams in the area from their statewide water quality monitoring program.

4. MDNR Fisheries Division, Fond du Lac Resource Management, and 1854 Treaty Authority have compiled specific conductance data along with fish and macroinvertebrate surveys in the ecoregion.[21] (Lindgren *et al*., 2006).

5. U.S. Geological Survey (USGS) has been measuring flows and water parameters and conducting research accessible on its website.[22] (USGS, 2015)

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[21] Lindgren, John (Minnesota Department of Natural Resources), Nancy Schuldt (Fond du Lac Resource Management), Brian Borkholder (Fond du Lac Resource Management), Andrew Levar (DNR Grand Rapids), Caryle Olson (1854 Treaty Authority), Jeff Tillma (DNR Grand Rapids Area Fisheries), Darren Vogt (1854 Treaty Authority) *A Study of the St. Louis River*, 2006. [Hereinafter "MDNR/Tribal Agencies SLR Study"]. Available at http://files.dnr.state.mn.us/areas/fisheries/duluth/st_louis_river_study.pdf

[22] U. S. Geological Survey, www.USGS.gov/water, select surface water, water quality data.

The evaluation in this report includes some of the available water quality data, selected based on ease of access as well as professional judgment.

The unimpacted water chemistry concentrations in both the Appalachian study and the Minnesota ecoregions are similar in that they both have:

1. Similar headwater stream orders (1-5);

2. Low anion and cation concentrations and circumneutral pH;

3. Significant invertebrate data;

4. Impacts from mining waste rock drainage containing similar major ions and impacts to invertebrates;

5. Some of the same genera demonstrated to be sensitive to specific conductance.

Where Minnesota genera differed from those in EPA's Conductivity Benchmark Study, efforts have been made to match water chemistry data with genera data in this evaluation.

B. Chemical Data Comparisons

1. Minnesota Baseline Water Quality and Mining Impacts

Over 37 years of water chemistry data exists in the Minnesota ecoregions for both basic chemistry and other parameters, in reports or on the EPA national water quality database. Before entry into the EPA database, quality control/quality assurance has been checked for appropriate methods, precision and accuracy.

This evaluation uses multiple sources of water quality data, including the Copper-Nickel Study. This Copper-Nickel Study data was a major undertaking in the state of Minnesota designed to characterize the study area's baseline water quality with hundreds of sampling results over three years. It represents a solid baseline. The key parameters in the water chemistry in the Minnesota ecoregions and the Appalachian ecoregions are similar.

Table 2 below compares the Minnesota Copper-Nickel Study water chemistry data [23] (Thingvold, 1979) with the EPA Conductivity Benchmark Study water chemistry data for Appalachian streams. [24] (EPA Conductivity Benchmark Study, 2011).

Table 2- Water Chemistry Comparison - EPA Appalachia and Minnesota Copper Nickel Study										
		EPA Appalachian streams					Minnesota Cu-Ni Study streams			
Parameter	**Units**	**Median**	**Min.**	**Max.**	**Number Samples**		**Median**	**Min.**	**Max.**	**Number Samples**
Conductivity	µS/cm	261	15.4	11,646	2,210		65	12	1198	463

[23] *Ibid.,* 19, Thingvold, Copper-Nickel Study Water Quality Characterization.
[24] *Ibid.,* 2, EPA Conductivity Benchmark Study, Table 2, p. 10.

Hardness	mg/l	91.1	0.5	1,492	1,148		31	5.3	310	206
Alkalinity	mg/l	66.7	0.2	560	1425		23	1	190	457
Sulfate	mg/l	37	1	6000	1428		7.4	1	630	434
Chloride	mg/l	5.2	1	1153	1118		2	0.1	88	462
T. Calcium	mg/l	25.1	0.002	430	1154		7.4	1.8	80	333
T. Magnesium	mg/l	6.3	0.05	204	1150		3.8	1	40	333
TSS	mg/l	4	1	190	1442		nd	nd	nd	nd
T. Iron	mg/l	0.26	0.005	110	1433		0.61	0.099	5.5	457
NO_2-NO_3	mg/l	0.2	0.01	30	1178		0.1	0.01	13	260
T. Al	mg/l	0.11	0.01	12	1436		.090	0.0016	.760	270
Diss. Al	mg/l	0.05	0.01	0.93	1287		nd	nd	nd	0
Diss. Fe	mg/l	0.042	0.001	11.8	1259		nd	nd	nd	0
T. Mn	mg/l	0.004	0.003	7.25	1430		0.05	0.005	1.2	309
Diss. Mn	mg/l	0.07	0.01	1.06	20		nd	nd	nd	0
T. Phosphate	mg/l	0.02	0.01	2.36	1181		nd	nd	nd	260
Diss. Se	mg/l	0.001	0.001	1.26	313		nd	nd	nd	0
T. Se	mg/l	0.001	0.001	1.26	496		nd	nd	nd	0
Fecal Coliform	Counts/110ml	170	0	250,000	2035		nd	nd	nd	0
DO	mg/l	9.2	1.02	18.35	2182		nd	nd	nd	0
pH	std	7.62	6.02	10.48	2210		6.9	4.7	8.4	458
catchment area	km2	6.965	1.73	153.014	717		nd	nd	nd	0
temperature	C	18.4	-0.28	31.9	2210		nd	nd	nd	0
Potassium	mg/l	nd*	nd*	nd*	nd*		0.6	0.2	8.4	310
Sodium	mg/l	nd*	nd*	nd*	nd*		1.8	0.2	45	304
Bicarbonate	mg/l	nd*	nd*	nd*	nd*		25	6	151	257
T. Cu	mg/l	nd*	nd*	nd*	nd*		0.0015	0.0002	0.012	447
T. Ni	mg/l	nd*	nd*	nd*	nd*		0.0012	0.0002	0.21	447
T. Co	mg/l	nd*	nd*	nd*	nd*		0.0004	0.0001	0.011	410
T. Zn	mg/l	nd*	nd*	nd*	nd*		0.0022	0.0001	0.03	446

*nd= no data available

Median concentrations in Minnesota unimpacted waters for specific conductance , Ca (calcium), Mg (magnesium), SO_4 (sulfate), HCO_3 (bicarbonate), pH, and trace metals are comparable and, in some respects, are lower in Minnesota than in the unimpacted Appalachian streams. The one exception may be the Minnesota minimum pH of 4.7, the source of which was identified in the Copper-Nickel Study Water Quality Characterization report as a result of acid bog drainage in some headwater streams. This exception does not affect the median pH of 6.9 representing 459 samplings over three years. Background specific conductance and ionic levels compare favorably with the Appalachian data on unimpacted streams.

The Appalachian ecoregions studied are roughly four times larger in area than the northeastern Minnesota ecoregions. Although the number of samples of the Copper-Nickel Study is less than half of EPA Appalachian report, there is more concentrated data per unit area. Additionally, as stated previously, significant additional and confirmatory data exists from the USFS, MPCA and MDNR since the Copper-Nickel Study. The Copper-Nickel Study water quality reports also contain extensive data regarding heavy metals. This data demonstrates unimpacted waters in Minnesota have trace levels of heavy metals. Heavy

metal protocols today use same analytical methods, with the exception of mercury. Thus the 1976 data are directly comparable from a methods standpoint.

Heavy metals values in unimpacted northeast Minnesota streams are near detection limits. Heavy metals would not add to benthic invertebrate toxicity in background streams. This is similar to the data EPA determined for background Appalachian streams.

In both locations, mining activities have increased the same major ions in the water and have increased specific conductivity. As in the Appalachians, the studied Minnesota ecoregions' major impacts are from mining. The difference is the type of ore mined: coal wastes (leachate from mountaintop removal and waste in valley fill) in Appalachia, and iron ore and taconite mining, some of which excavated sulfur-bearing rock (leachate from pits, waste rock, and tailings) in Minnesota. In both cases the major chemicals involved in mining that drive elevated specific conductance are Ca, Mg, SO_4, HCO_3 and pH. In Minnesota mining, sulfide minerals will increase heavy metals, as well as $S0_4$.[25] (MDNR, 2004). Further comparisons and impacts from these minerals will be discussed in the biology section.

Table 1, which is attached in Appendix A to this evaluation, identifies and provides detailed information on macroinvertebrate species. For genera common to Appalachia and the targeted Minnesota ecoregions, Table 1 provides specific conductance levels at which 95% of genera would survive, according to the EPA Conductivity Benchmark Study data. Table 1 also includes water chemistry information from the Minnesota Copper-Nickel Study on tolerances of various Minnesota genera to hardness, sulfate and pH. This table will be discussed in more detail later in terms of biological impacts of parameters on benthic invertebrates.

Dunka Mine.

Minnesota already has an example of consequences of sulfide mining waste rock, based on history with some of the waste rock at Dunka Mine, now owned and managed by Cliffs Erie corporate entities (Hereinafter "Cliffs"). At the Dunka Mine, Duluth Complex copper-nickel bearing waste rock was removed to mine the underlying taconite deposit. The Dunka site has over 37 years of data on waste rock seepages.

The chemistry and biology of the seepage is documented in the Copper-Nickel Study, in DMRs for NPDES permits, and in MDNR reports. When sampled, past and current Dunka Mine seepages routinely have specific conductance similar to 2011 data, which ranged from 350 to 2,761 µS/cm[26] (Cliffs, NPDES DMRs).

The seepages from the low sulfur Duluth Complex waste rock flow into recently reconstructed man-made wetland designed to treat some heavy metals. The wetland systems discharge into Unnamed Creek, a Class 2B water, which flows into Bob Bay of Birch

[25] MDNR, *Drainage from Copper-Nickel Tailings: Summary of a Three Year Study*, Division of Lands and Minerals, July 2004, Table 3.
[26] Cliffs, NPDES Permit MN0042579, DMRs, 2011 -2014.

Lake. Birch Lake is a dammed portion of the Kawishiwi River, a Class 2Bd water which "shall be such as to permit the propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life and their habitats," and aquatic recreation of all kinds. (Minn. Rule 7050.0222, Subp. 3).

Since a 2010 Consent Decree as a result of Clean Water Act litigation, Cliffs modified its experimental passive wetland mitigation system with limestone to attempt to resolve the metals toxicity from Dunka Mine discharge. In 2011 the calculated acute toxicity and the chronic whole effluent toxicity bioassays on treated discharges did not violate chronic and acute toxicity limits, although SD009 approached the acute toxicity limit in January and February. However, several inconsistencies with Minnesota Rules contribute to the apparent compliance of the results:

1. Applying a variance to calculate toxicity differently from procedures in Minnesota Rules;

2. Using maximum hardness values of 400 mg/l in toxicity calculations rather than background hardness of unimpacted streams, consistent with Copper-Nickel Study data (see Table 2).

3. Allowing a mixing zone of almost a mile rather than sampling at the discharge. Since Unnamed Creek has a 7Q10 of zero, there is not enough water to dilute the seepages with a mixing zone conditionally allowed at Minn. Rule 7050.0210 Subp. 5.

The passive system at Dunka does not reduce specific conductance in the discharges even approaching background unimpacted levels. Even after dilution of Dunka discharge with clean water from approximately one mile of the unimpacted portions of the watershed, DMRs document that the specific conductance in Unnamed Creek, before it enters Bob Bay of Birch Lake, reaches between 800-900 µS/cm. In the winter, when wetland discharge flows are diminished, concentrations are substantially higher. Recently, from January through May 2014, Unnamed Creek data showed that even Minnesota's irrigation standard of 1,000 µS/cm is often exceeded downstream of Dunka, with sampling data respectively for each month of 1,225 µS/cm, 1,255 µS/cm, 1,111 µS/cm, 936 µS/cm, and 417 µS/cm. (Cliffs NPDES DMRs) The more concentrated creek water forms a measurable density current of higher specific conductance along the bottom of Bob Bay.[27]

Figure 3 shows the locations of Dunka Mine surface discharge sites (SD005 and SD007) and the downstream surface water sampling location (SW-001). Then, Table 3 compares the water chemistry of the Dunka waste rock-impacted Unnamed Creek with background levels from the Copper-Nickel Study Water Quality Characterization. The Copper-Nickel Study background represents the median average of three years of sampling of nine watersheds north of the Laurentian Divide and five watersheds south of the Divide in the 500 square mile Copper-Nickel Study region.

[27] Johnson, Bruce, personal knowledge.

Figure 3. Map of Dunka Mine LTV Discharge Locations (Cliffs NPDES/SDS Permit)

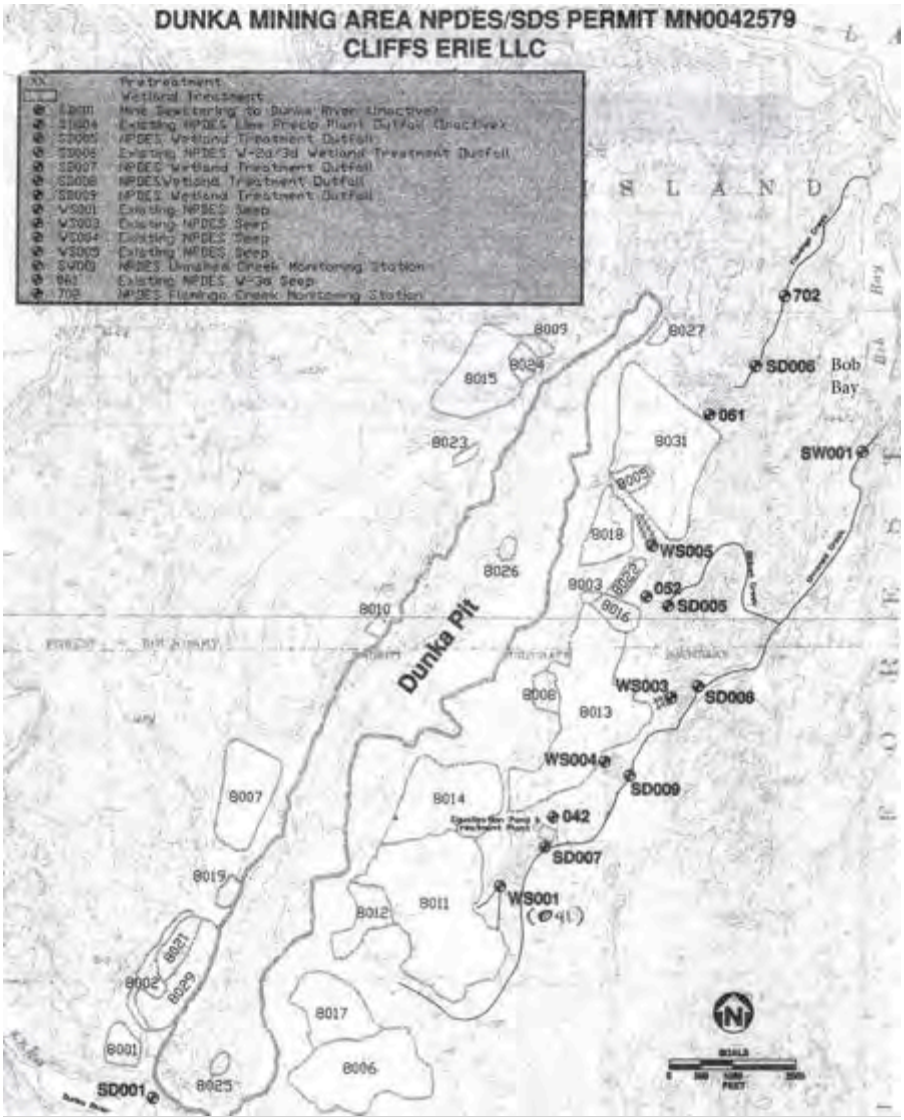


Table 3 shows specific conductance, calcium, magnesium, and sulfate from SD005 and SD007 discharges from Cliffs' wetland treatment outfalls into Unnamed Creek. Site SW001 on Unnamed Creek is downstream of the discharge sites near the Unnamed Creek confluence into Bob Bay of Birch Lake.

Table 3 – Water Chemistry Comparison of Copper-Nickel Study Background with Two Dunka Mine Discharges & Unnamed Creek

	Cu-Ni Study Median	Cliffs Impact 2011 Mean		
	Stream Background	SD005	SD007	SW001
Specific Conductance (µS/cm)	65	1,469	2,000	960
Calcium (mg/L)	7.4	131	269	84
Magnesium (mg/L)	3.8	133	153	70
Sulfate (mg/L)	7.4	1,181	1,166	445

Table 3 demonstrates that at the time of the NPDES permit study, all of the specific conductance-related parameters of concern (specific conductance, calcium, magnesium and sulfate) were highly elevated from the ecoregional background concentration. For example, the Dunka Mine NPDES discharge reports document specific conductance discharges between 1,469 and 2,000 µS/cm from the wetland treatment outfalls SD005 and SD007 into Unnamed Creek. These specific conductance values are between 22 times and 38 times the ecoregional background.

Site SW001, also a sampling location used by Cliffs and the Copper-Nickel Study for benthic invertebrates, is near where Unnamed Creek discharges into Bob Bay of Birch Lake. The specific conductance at this point remains at a mean of 960 µS/cm; this is 15 times the ecoregional background in Table 3. The slightly lower specific conductance values at SW001 are due to freshwater runoff dilution from unimpacted portions of the watershed. Dunka Mine discharges provide a perspective on specific conductance of leachate from sulfide-bearing rock. During 2011 wetland treatment at each of the seepages failed to reduce the source specific conductance below Minnesota's agricultural irrigation standard of 1,000 µS/cm.

Northshore Peter Mitchell Mine Pit

The Northshore Mining Company (Northshore) Peter Mitchell mine pit is one of the largest taconite mining discharge sources in the region. Mineralized rock from the mine is shipped by rail to the Northshore plant on the Lake Superior shore. Approximately eight miles in length, the pit straddles the Laurentian Divide and releases dewatering discharges to both the Dunka River in the Kawishiwi watershed of the Rainy River basin and to the Partridge River in the St. Louis River watershed of the Lake Superior basin. Specific conductance from Peter Mitchell pit dewatering discharged to the Dunka River ranges from 300 µS/cm to 900 µS/cm. This specific conductance is composed mainly of Ca, Mg, SO_4, and HC03 at elevated levels over background. [28] (Benzie, 1977)
Mesabi Nugget.

The Mesabi Nugget smelting facility (MN0067687) has a special process to remove slag from the taconite concentrate, leaving pig iron. It discharges into the former LTV Pit 1, an abandoned, inundated taconite mine pit, about 1.5 miles long and containing an estimated 13.7 billion gallons of water. During 2001, for example, specific conductance averaged 1,291 µS/cm at the surface. Although no point source discharges out of Pit 1 were reported at the time, Pit 1 demonstrates overflow of the hardrock rim to a shallow ground water flow in surficial soils to Second Creek[29] (Northeast Technical Services, 2002). In 2012, 2013 and 2014 DMRs, Second Creek stream sample site SW002 downstream of Pit 1 was reported to have specific conductance averaging 1076 µS/cm, 902 µS/cm, and 791 µS/cm

[28] Benzie, Dan, *Water Quality of the Dunka River "the Characterization of a Watershed Affected by Mining"*, Plan B Thesis for Master of Science University of Minnesota, June 1977, p. 4. Minnesota Legislative Reference Library http://archive.leg.state.mn.us/docs/pre2003/other/CN023.pdf
[29] Northeast Technical Services, *Phase I – Environmental Assessment, Cliffs Erie Properties including: the Hoyt Lakes Facility, Dunka Property, Taconite Harbor, and Railroad Corridors*, September 2002, pp. 10, 13.

respectively. In addition, the DMRs reported elevated hardness (~500 to 750 mg/l) and bicarbonates (~300 mg/l, 4.91 meq/l) in both Pit 1 and Second Creek[30] (Mesabi Nugget , 2012-2014).

In October 2012, Mesabi Nugget obtained a variance to discharge hardness, bicarbonates, total dissolved salts (solids) and specific conductance pollutants above Minnesota effluent limits, exceeding even Minnesota's irrigation standard for specific conductance of 1,000 µS/cm. The effluent limits applied in this permit were 1,889 µS/cm monthly average and 1,965 µS/cm daily average[31] (Mesabi Nugget, 2012). Although the EPA overturned the variance that allowed this excursion from specific conductance standards in July 2014[32] (EPA, letter to MPCA, 2014), MPCA has to date taken no action to reopen or revise the Mesabi Nugget NPDES permit.

Abandoned mining pits.

Mined out iron ore and taconite mine pits are scattered over the eastern Mesabi (including the Embarrass Mountains) and Vermillion Iron Ranges. On maps they appear as lakes of various sizes and shapes, and some have lake names.

In addition to the chemistry of the economic minerals of interest, pit water chemistry is directly related to the chemical constituents of the host rock (the non-economic part of the rock, which is also known as waste rock and tailing). In taconite mining this can amount to approximately 60% of the total rock removed. The specific conductance in pit water will depend on the chemistry of the host rock. In an open pit mine, excess inflow into a pit discharges through or to one or all of the following: surface water, granular material on the edge of the pit to surface water and ground water [33] (Jones, 2002).

The MDNR has sampled water quality in 13 abandoned, inundated iron ore (not taconite) mine-pits in the Biwabik Iron Formation. These mines were small compared to today's taconite mines, ranging from 11 acres to 165 acres; in contrast, the Peter Mitchell pit is approximately 8 miles long.

Three of these abandoned iron mines are in the ecoregions covered by this report: St. James, closed in 1963; Embarrass, closed in 1977; and Miners Lake, an underground glory hole, closed in 1967.[34] (Pierce *et al.*, 1989). This MDNR study found there were differences in water quality and chemistry from pit to pit for these 13 mines, due to the host rock, including variability in NO_3 (nitrate), SO_4 (sulfate), dissolved solids, hardness, and phosphate.

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[30]Mesabi Nugget, *Permit MN0067687, DMRs*, 2012-2014.
[31] Mesabi Nugget, *NPDES/SDS Permit MN0067687*, approved October 23, 2012.
[32] U.S. EPA, letter, Dr. Susan Hedman, to MPCA Commissioner John Linc Stine, July 2, 2014.
[33] Jones, Perry M., *Characterization of Ground-Water Flow Between the Canisteo Mine Pit and Surrounding Aquifers, Mesabi Iron Range, Minnesota,* U.S. Geological Survey, Water-Resources Investigations Report 02-4198, 2002, available at http://pubs.usgs.gov/wri/wri024198/pdf/wri024198.pdf
[34] Pierce, Rodney B., Cynthia M. Tomcko, *Limnological Characterization of Mine Pit Lakes in Northeast Minnesota,* Minnesota Department of Natural Resources, Section of Fisheries, November 1989, #399, available at http://files.dnr.state.mn.us/publications/fisheries/investigational_reports/399.pdf

Miners Lake has a permanent chemocline at the 35 m (114 ft) depth, which has rotten egg odor, an indication of hydrogen sulfide (H_2S). Hydrogen sulfide is a toxic gas released during decomposition or degradation of sulfur compounds[35] (ATSDR, 2014). The three pits in this evaluation's ecoregions had specific conductance ranging from 289 to 1,380 µS/cm, SO_4 ranging from 13 to 300 mg/l, and hardness ranging from 194 to 353 mg/l. MDNR reported elevated specific conductance in all 13 pits tested [36] (Pierce *et al.*, 1989).

C. Biological Studies and Comparisons

1. Studies Reviewed

Substantial benthic invertebrate sampling data are reported for the Minnesota ecoregions evaluated in this paper. Studies used in this paper are as follows:

1. Minnesota's Regional Copper-Nickel Study surveyed benthic invertebrates on 55,516 km of streams in a 500-square mile study area using drift net and kick samplers[37] (Lager *et al*., 1979). These are all headwater streams. The work surveyed populations to the lowest taxon possible, all to genus, many to species level. The streams were all Order 1 through 5 headwater streams, similar to the Appalachian Study.

2. A Copper-Nickel Study Tolerance Report assessed the environmental requirements and pollution tolerance of the area's Aquatic Insects[38] (Bartoo, 1978).

3. MDNR has performed a one-year study on the Pigeon River in far northeast Minnesota using drift nets, hand picking and kick net sampling; the study identified invertebrates to the genus level[39] (Montz, 1993);

4. MDNR, Fond du Lac Resource Management, and 1854 Treaty Authority sampled the lower, middle, and upper reaches of the St. Louis River for basic chemistry and invertebrates using kick nets, and identified taxa to the genus level[40] (Lindgren *et al*., 2006);

5. As part of the Agency's statewide watershed base monitoring and assessment program, MPCA has identified a number of the St. Louis River headwater streams as impaired for benthic invertebrates in its draft St. Louis River Watershed Stressor Identification

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[35] Agency for Toxic Substances and Disease Registry, *DRAFT TOXICOLOGICAL PROFILE FOR HYDROGEN SULFIDE AND CARBONYL SULFIDE*, October 2014.
[36] *Ibid.,* 34, Pierce *et al*., Tables 4, 5, 6, and 9.
[37] Lager, Thomas, Steven Johnson, Jeffery McCulloch, Steven Williams, Mark Johnson, *Regional Copper-Nickel Study Stream Benthic Invertebrates*, Minnesota Environmental Quality Board, February, 1979, available at http://archive.leg.state.mn.us/docs/pre2003/other/CN088.pdf
[38] Bartoo, Paul, *The Environmental Requirements and Pollution Tolerance of Aquatic Insects of the Regional Copper-Nickel Study Area*, Minnesota Environmental Quality Board, Author: September 1978, available at http://archive.leg.state.mn.us/docs/pre2003/other/CN018.pdf
[39] Montz, Gary R., *Aquatic Macroinvertebrates of the Pigeon River, Minnesota*, Minnesota Department of Natural Resources, Ecological Services Section, November 1993, Conservation Biology Research Grants Program, Nongame Wildlife Program, Division of Ecological Services, Minnesota Department of Natural Resources
[40] *Ibid.,* 21, MDNR/Tribal Agencies SLR Study.

Report (MPCA, Draft SLR Stressor Report, 2013).[41]

6. The Regional Copper-Nickel Study performed a 3-year survey on invertebrates impacts at the Dunka Mine from low-level copper-nickel sulfide waste rock that was removed to mine the underlying taconite.[42] (Johnson *et al*., 1978). These leachates discharged into Unnamed Creek. Sampling methods used both Hester-Dendy artificial substrates and drift nets.

7. Unnamed Creek has received Dunka Mine sulfate waste rock leachate for over 37 years. Cliffs has sampled Unnamed Creek for the past ten years (after mine closure). They used Hester-Dendy artificial substrates.[43] (Hartman, 2011). These surveys identified Ephemeroptera, Plecoptera, and Trichoptera to the genus level. Other invertebrates were not all identified to the genus level, and are not cited in this report.

8. The USFS has sampled 16 streams in the Superior National Forest (SNF) - most of them for three years. This survey, summarized in Table 1, included all benthic invertebrates to the genus level and many to a species level. These samplings used kick nets and the MPCA benthic invertebrate protocols and QAQC.[44] (USFS SNF data, 2015). The USFS has also compiled significant water chemistry data on the SNF watersheds.

9. MDNR sampled iron ore mine pit lakes for chemistry, other parameters, and for benthic invertebrates.[45] (Pierce, *et al*., 1989).

Additional data may be available but are beyond the scope of this report.

2. Considerations for Evaluation of Biological Impacts

Any evaluation of water chemistry and biological impacts in aquatic ecosystems must be examined holistically. Such analysis must consider all life stages of each biological system (plant and/or animal). Both maximum and mean water chemistry concentrations must be used for data for all 12 months of the year.

In this case benthic invertebrates overwinter underwater and are alive, but undergo substantial changes in their metabolic activities. The winter is marginal for survival for most taxa; high single concentrations in water chemistry during this period can result in significant population impacts or mortality. Thus, environmental chemistry data cannot be limited solely to means during open water months.

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[41] MPCA, *St Louis River Watershed Identification Report,* Draft October 2013, electronic copy labeled as "12-31-13 (142 pages)," provided in Attachment B. (hereinafter "Draft SLR Stressor Report").
[42] Johnson, Mark, Steve Williams, *Regional Copper-Nickel Study Erie Mining Project Biological Sampling*, Minnesota Environmental Quality Board, October 1978, available at http://archive.leg.state.mn.us/docs/pre2003/other/CN083.pdf
[43] Hartman, Craig, *Memo from Cliffs Natural Resources to Richard Clark*, Minnesota Pollution Control Agency, December 9, 2011.
[44] Butcher, Jason, USDA Forest Service Superior National Forest, unpublished data, provided as a result of correspondence with Bruce Johnson. April, 2015. (hereinafter "USFS SNF data"). This data was used in the attached Table 1 to provide detailed invertebrate background in columns F through J.
[45] *Ibid.,* 33, Pierce *et al*., Limnological Characterization of Mine Pit Lakes.

In addition, over-emphasis on average water chemistry concentrations ignores impacts from periods of elevated chemical concentrations. For example, a single relatively short occurrence of a high concentration can heavily impact benthic invertebrates and other populations in any season.

Averaging of concentrations must also be scrutinized since it can demonstrate a continuous low-level stressor impact to populations. These stressors can reduce a population's ability to survive or reproduce, leaving the remaining individuals of a populations open to predation and subsequent extirpation.

In determining impacts of specific conductance on aquatic organisms, stream assemblages are far more reliable indicators than are conventional whole effluent toxicity (WET) tests.

> "Generally WET limits alone have not been shown to protect water quality from the effects of conductivity. Available scientific information, including the SAB [Scientific Advisory Board] review of EPA's conductivity benchmark report, has highlighted that the current WET testing organisms are not good surrogates for the native aquatic organisms with respect to the effects of conductivity. EPA believes this evidence makes clear that the macroinvertebrate assemblage in central Appalachian streams is more sensitive to the effects of elevated TDS [Total Dissolved Solids] or conductivity than the standard WET testing organisms."[46] (EPA Final Guidance, 2011)

For example, some commonly tested invertebrates are quite insensitive to specific conductance. Cliffs' Request for Variance for the Dunka Mining Area stated that Kennedy *et al.* (2005) produced data to show "significant adverse responses from Ceriodaphnia specifically due to specific conductance are not likely until specific conductance reaches approximately 4,000 to 8,000 µmhos/cm" (equal to 4,000 to 8,000 µS/cm)[47] (Cliffs, 2011, p. 24).

3. Pollution Tolerance of Minnesota Benthic Invertebrates

The Copper-Nickel Study Tolerance Report surveyed the pollution tolerance of benthic invertebrates in the Minnesota study area.[48] (Bartoo, 1979) for the orders Plecoptera (stoneflies), Ephemeroptera (mayflies), Trichoptera (caddisflies), Diptera (true flies), Coleoptera (beetles), and Odonata (dragonflies). This Tolerance Report identified the sensitivity of genera to pH, alkalinity, hardness, sulfate, temperature, and dissolved oxygen (Table 3). In general, the Copper-Nickel study data suggested Plecoptera were sensitive to most parameters other than high pH. Many Ephemeroptera taxa are known to be very sensitive to pollution. With few exceptions, Trichoptera can tolerate high pH and hardness. Diptera demonstrated tolerance to extremes in pH and other chemical stresses. In general, Coleoptera also had tolerance to extremes of pH and hardness, alkalinity and other water

[46] *Ibid*., 10, EPA Final Guidance, p. 19-20.
[47] Cliffs, *Request for Variance from Hardness and Specific Conductance Water Quality Standards at the Dunka Mining Area*, June 7, 2011, p. 24.
[48] *Ibid.,* 38, Bartoo, Copper-Nickel Study Tolerance Report, 1979.

chemistry parameters.

Overall, the Copper-Nickel Study Tolerance Report concluded that polluted conditions impacted resulted in fewer overall genera. Trichoptera numbers of genera remained the same; Ephemeroptera and Plecoptera numbers of genera decreased; and Odonata and Diptera increased.

4. Minnesota Benthic Invertebrate Data

Two other Copper-Nickel Study reports surveyed stream benthic invertebrates in both unimpacted waters and waters impacted by mining[49] (Thingvold, 1979; Lager *et al*., 1979) . The main objective of these reports was to identify general population dynamics. Although the reports were not designed to look at genera sensitivity to specific conductance, the data on genera identified is applicable here, since specific conductance is strongly related to hardness in Minnesota ecoregion waters and other confounding chemistry is documented to be minimal (see Table 2).

In the Appalachian ecoregions, the EPA identified genera and developed an extirpation concentration for each genus.[50] (EPA Conductivity Benchmark Study, 2011). EPA cited 40 C.F.R. § 230.10(c)(2) and (3) for the requirement to prevent "significantly adverse effects of the discharge of pollutants on life stages of aquatic life and other wildlife dependent on aquatic ecosystems" and "on aquatic ecosystem diversity, productivity, and stability." The EPA Benchmark Study, as well as other EPA bioassay studies, concluded that extirpation of 5% of sensitive native benthic invertebrate genera would demonstrate significant surface water degradation. In the Appalachians this value was determined to be a specific conductance greater than 300 µS/cm[51] (EPA Conductivity Benchmark Study, 2011). This benchmark is generally protective of significant impacts from pollutants to life stages of benthic invertebrates at the genera level, dependent on the aquatic ecosystems or ecosystem diversity.[52] (EPA Conductivity Benchmark Study, 2011).

Table 1 in Appendix A of this report demonstrates that, in unimpacted waters within the study ecoregion, Minnesota invertebrates are exposed to low ionic strength, low heavy metal water, with specific conductance at a median of 65 µS/cm. The median specific conductance in unimpacted Minnesota waters is below the Appalachian median of 261 µS/cm. This would suggest that sensitive genera in Minnesota may be unable to tolerate high levels of specific conductance from mining activities, particularly at the levels reflected by Minnesota's irrigation-based standard of 1,000 µS/cm. The invertebrate orders of Ephemeroptera, Trichoptera and Plecoptera are numerous in unimpacted Minnesota ecoregion study streams.[53] (Lager *et al*., 1979). Many of these genera are known to be sensitive to elevated specific conductance ion concentrations.

Table 1 in Appendix A compares some Minnesota streams, which have substantial benthic

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[49] *Ibid.,* 19, Thingvold *et al*., *Copper-Nickel Study Water Quality Characterization*, 1979; *Ibid.,* 37, Lager *et al*., *Copper-Nickel Study Invertebrates*, 1979.
[50] *Ibid.,* 2, EPA Conductivity Benchmark Study,, p. 13.
[51] *Ibid.,* 2, EPA Conductivity Benchmark Study,. p. 23.
[52] *Ibid.,* 2, EPA Conductivity Benchmark Study, p. xiv.
[53] *Ibid.,* 37, Lager *et al*., *Copper-Nickel Study Invertebrates*. 1979.

invertebrate data, with the Appalachian streams data. Table 1 Column D summarizes all the genera/species that were identified in the specific northeast Minnesota ecoregions by the Copper-Nickel Study. Column C identifies the Appalachian genera common to both areas. Columns D through J identify genera/species in Minnesota unimpacted headwater sites and the study/year(s) where and when each genus was found. Column K identifies the EPA XC95% specific conductance for each genus in common.[54] Columns L, M and N identify the Hardness (Ca and Mg), Sulfate and pH tolerances for benthic invertebrates derived from the Minnesota Copper-Nickel Study Tolerance Report. (Bartoo, 1978).

The complete Table 1 data demonstrate that Minnesota shares 92 genera or 28% of the total genera identified in Appalachian ecoregional streams. Among the common genera, Minnesota has 31 of the common genera demonstrated to be sensitive below 1,000 µS/cm, 21 sensitive below 600 µS/cm, and 12 that are sensitive below 350 µS/cm. For the remainder of the Minnesota invertebrate genera, there are no comparable EPA calculations of XC95% for specific conductance in the Appalachian Study.

Table 4 below summarizes data on identified benthic invertebrate genera from unimpacted waters of Minnesota and the Appalachians:

Table 4 – Common Benthic Invertebrates in Unimpacted Appalachian and Minnesota Streams

Order	**MN Genera**	**Genera in Common**
Ephemeroptera	45	18
Plecoptera	29	13
Trichoptera	56	14
Odonata	25	3
Coleoptera	12	4
Megaloptera	4	3
Hemiptera	16	1
Diptera	136	36
TOTAL:	***323***	***92***

For a point of reference to evaluate low and high specific conductance, Pond, *et al.,* divided coal mined waters with elevated specific conductance into "low" conductivity at < 500 µS/cm [n = 7], "medium" at 500-1,000 µS/cm [n = 8], and "high" at >1,000 µS/cm [n = 12]." (Pond *et al*., 2008).[55] These categories were used primarily for graphical interpretations and to interpret taxonomic composition along a categorical gradient.

[54] The same genus in Minnesota is assumed to be sensitive to the specific conductance identified in the Appalachian study, above which 5% of the individual genus population was extirpated.
[55] Pond, Gregory J., Margaret E. Passmore, Frank A. Borsuk, Lou Reynolds, and Carole J. Rose, *Downstream effects of mountaintop coal mining: comparing biological conditions using family- and genus-level macroinvertebrate bioassessment tools,* Region 3, US Environmental Protection Agency; J. N. Am. Benthol. Soc., 27(3):717–737 (8 July 2008).

In addition to the data on sensitivity for genera in common with the EPA, Column L in Table 1 of Appendix A identifies Minnesota genera/species that the Copper-Nickel Tolerance Report identified as sensitive to hardness, sulfate, and pH. In many cases, these values identify genera/species that are sensitive to mining pollutants in addition to those found in the EPA's Appalachian XC95% Column K values.

IV. Discussion: Mining Impacts to Northeast Minnesota Waters

This Section of the evaluation will review impacted mining areas in Ecoregion 54n (see Figure 1 Minnesota Ecoregion Map) using some of the existing benthic invertebrate and water chemistry data. Open-pit taconite and copper-nickel mining and production facilities produce waste rock and tailing. As in mountain-top mining for coal, Minnesota's mining leachates contain elevated specific conductance, composed mainly of Ca, Mg, SO_4 and HCO_3, which are released into waters with natural low concentrations of these ions in circumneutral pH. Taconite mine dewatering has not been documented to release levels of heavy metals beyond chronic numeric stream water standards, with some exceptions for iron and mercury where the Duluth Complex or the Virginia Formation have been disrupted.

A. Kawishiwi River Subwatershed, Rainy River Basin

In addition to elevated specific conductance, Duluth Complex and Virginia Formation waste leachates have been demonstrated to contain levels of heavy metals above chronic surface water standards and to be acutely and chronically toxic. Heavy metal ions have been documented in the following Minnesota sites: Cliffs' Dunka taconite mine Duluth Complex waste rock, Minnamax Copper-Nickel test shaft (closed), and INCO's Copper-Nickel bulk sample site (closed) near Filson Creek, all north of the Laurentian Divide. The proposed NorthMet PolyMet would also produce heavy metals, but its primary drainage effects would occur in the St. Louis River subwatershed of the Lake Superior Basin.

1. Dunka Taconite Mine with Sulfide-Bearing Waste Rock

At the Dunka taconite mine (currently owned by Cliffs), the prior owner, LTV, encountered low-level sulfide-bearing waste rock, including both Duluth Complex and Virginia Hornfels overlying the Biwabik Iron Formation (taconite). Leachate seepages from 1970's stockpiles of Duluth Complex waste rock discharge to Unnamed Creek, classified as a water of the United States and of the State in the Rainy River watershed. MDNR reports and NPDES permit DMRs for over 37 years have documented significantly elevated specific conductance at this site.

For example, as illustrated in Table 5, derived from Cliffs NPDES permit MN00042579 DMRs, despite wetland treatment, Dunka discharge into Unnamed Creek and to Birch Lake

from January through May 2014, contain elevated levels of specific conductance.[56] (Cliffs, Permit DMRs, 2014) as follows:

Table 5 - Dunka Discharge to Unnamed Creek (2014)
Specific Conductance Levels

Site	Mean (µS/cm)	High (µS/cm)	Low (µS/cm)	Number
SD007	2,133	2,512	2,133	9
SD009*	2,765	3,284	2,001	9
SW001 (Unnamed Creek)	579	1,225	203	10

* Cycled back to SD007 due to elevated levels.

The Copper-Nickel Study classified Unnamed Creek as an order 1-2 stream. Since mining has ceased, this Creek is likely an order 1 stream due to the cessation of pit dewatering. The Copper-Nickel Study biologically evaluated the Creek and compared it with six other streams in the study region. The Study's Biological Sampling established that benthic invertebrates in Unnamed Creek "should be similar in streams of nearly equal stream order although the species in each stream may be different." It concluded:

> "[A] number of major biological differences between Unnamed Creek and other streams in the region are evident. Most of these differences indicate that Unnamed Creek is stressed. Low invertebrate population size, diversity of drifting invertebrate population, and the number of invertebrate taxa all indicate stress conditions."[57] (Johnson *et al.,* 1978)

This Biological Sampling report noted that highly fluctuating mine dewatering and heavy metals might have adversely affected the benthic invertebrates in the Creek.[58] (Johnson *et al.*, 1978). Cliffs has contracted for benthic invertebrate studies starting in 2000.[59] (Doran, 2012). The sampling is not robust in that it is limited to results from Hester-Dendy multiple plate artificial substrate samplers. Cliffs' contracted research also has not performed detailed genus level identification of all taxa beyond Ephemeroptera, Plecoptera, and Trichoptera (hereinafter referred to as "EPT"). However, Hester-Dendy multiple plate samplers are documented to be more selective for EPT than other invertebrates, and studies have shown that average total abundance and species richness for EPT did not differ between Hester-Dendy and kick samples.[60] (Letovsky *et al*., 2012). Thus, for EPT abundance and richness evaluations, the Hester-Dendy samplers should be adequate for EPT comparisons.

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[56] *Ibid.,* 26.
[57] *Ibid.,* 42, Johnson *et al*., Copper-Nickel Study Erie Biological Sampling, p. 31.
[58] *Id*., p. 31.
[59] Doran, Peter, Letter to Bruce Trebnick Northeast Technical Services copied to MPCA, September 17, 2012.
[60] Letovsky, Erin, Ian E. Myers, Alexandra Canepa, Declan McCabe, *Differences between kick sampling techniques and short-term Hester-Dendy sampling for Stream Macroinvertebrates*, 2012, Department of Biology, Saint Michael's College, Colchester Vermont 05439, p. 53, available at http://wolfweb.unr.edu/~cmmoore/Christopher_Moore/BIOL322_files/CritiquePaper_SamplingTechniques.pdf

The Cliffs analysis did not compare Unnamed Creek with other unimpacted similar streams in the area. On December 9, 2011 Cliffs reported the benthic invertebrate sampling results for 2011 to the MPCA with the following summary statements: "This total [invertebrates] compares favorably with the previous 12 years of sampling, and suggests no significant decline in overall insect diversity over the 12 year period of sampling."[61] (Hartman, 2011). Cliffs further stated: "this riffle is characterized by more of the fist-sized, cobble type rocks typically considered optimum habitat for benthic invertebrates in a stream system." The riffle habitat described by Cliffs is near MPCA NPDES site SW001 in Unnamed Creek, before the Creek discharges into Bob Bay of Birch Lake, shown on the Figure 3 Dunka Mine Map.

Almost 40 years ago, Copper-Nickel Study biological sampling suggested that mine dewatering causing varying flows and substrate disruption might have contributed to the negatively impacted Unnamed Creek invertebrate populations.[62] (Johnson, 1978). Since the LTV Dunka Mine closure, no pit dewatering discharges have entered the Creek. Cliffs has concluded that the substrate at the sampling location is suitable and the recent 12 years of invertebrate data has had no significant change.[63] (Cliffs, Request for Variance, 2011). With neither flow issues nor poor substrates as potential contributors to observed invertebrate impacts, *contaminant chemicals in the water are the most likely cause of continuing negative invertebrate impacts*. Recent invertebrate data underscore that passive wetland treatment and management changes since 2010 have not re-established the invertebrate populations.

Comparison of Cliffs' report of Unnamed Creek family and genera richness for Ephemeroptera, Plecoptera, Trichoptera with Table 1 Appendix A data from four unimpacted similar streams in the same ecosystem indicates there are far fewer families, fewer genera, and less total richness of EPT than background streams. This data is reflected in the following Table 6.[64] (Cliffs, 2011; Doran, 2014).

Table 6 - Benthic Invertebrate Richness Comparison
Dunka (Impacted) Unnamed Creek & Background Creeks (Cu-Ni Study)

	Unnamed	Background	Unimpacted Streams (3 yrs)			
	(6 yrs)	Creek Mean	Keeley	Filson	August	Nira
Ephemeroptera families	3	6.25	7	7	6	5
Plecoptera families	1	3.75	3	3	5	4
Trichoptera families	10	9	7	9	10	10
Ephemeroptera genera	4	11	12	12	9	11
Plecoptera genera	2	5	4	3	8	5
Trichoptera genera	13	15.8	17	17	18	21
Total EPT Genera Richness	19	33.3	29	32	35	37
Total EPT Family Richness	14	19.5	17	19	21	19

[61] *Ibid.,* 43, Hartman, Cliffs Memo to MPCA.
[62] *Ibid.,* 42, Johnson *et al., Copper-Nickel Study Erie Biological Sampling*, p. 37.
[63] *Ibid.,* 47, Cliffs Variance Request, Part 1, p. 31.
[64] *Id.,* Appendix 2, Table 1; Doran, Peter D., 2014 *Summary Report of Aquatic Macroinvertebrate Sampling for Unnamed Creek, Dunka Mine Area*, Northeast Technical Services Inc., December 5, 2014.
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In Table 6, a summary of six years of family and genera EPT for Unnamed Creek is compared with a summary of three years of data from four unimpacted background streams in the same area. Background streams are close to Unnamed Creek and of similar stream order. This table suggests Unnamed Creek is substantially less rich in both Ephemeroptera and Plecoptera families and genera. In the underlying data, the unimpacted Keeley Creek has 29 EPT genera; Filson Creek has 32 EPT genera; August Creek has 35 EPT genera; and Nira Creek has 37 EPT genera. Unnamed Creek has only 19 EPT genera. The composition measure of EPT also decreases when compared with background streams.

In general as discussed previously, Trichoptera tend to be insensitive to pollutants, so the differences in Trichoptera are minor. Far more significant disparities in Ephemeroptera and Plecoptera families and genera are evident: there are more than twice as many Ephemeroptera families and more than three times as many Plecoptera families in unimpacted waters. There are also 275 percent more Ephemeroptera genera and 250 percent more Plecoptera genera in unimpacted waters than in the Unnamed Creek waters impacted by Dunka Mine discharge. These values are consistent with EPT richness losses reported by Pond[65] (Pond, 2008) in the mined areas of the Appalachians.

This disparity in taxa richness cannot be attributed to non-anthropogenic geology. Filson Creek is located on an exposed Duluth Complex rock similar to the location of Dunka Mine. Yet, as shown in Table 6, Filson Creek has demonstrated no invertebrate impairment. With Filson as a paired background creek, the exposed Duluth Complex at Dunka is unlikely to be a significant contributor to the invertebrate impairment.

Cliffs' report on Unnamed Creek used the Hilsenhoff Biotic Index (HBI) to estimate the overall health of the invertebrate population in Unnamed Creek. The HBI estimates the *general* overall tolerance of the community according to relative abundance of the family taxonomic groups in the Creek community that were given a numeric sensitivity value. In using the HBI, the Cliffs report missed some important aspects of data interpretation.

The HBI protocol counts all Ephemeroptera families as highly sensitive. In fact, for specific conductance, this is not the case. The EPA has determined that many Ephemeroptera genera common to Minnesota (Table 1, Column K, in Attachment A) are tolerant to high specific conductance. For example, Ephemeroptera Caenis sp. has a XC95% tolerance that exceeds >3,923 µS/cm, compared to Ephemeroptera Leptophlebia sp. with a tolerance of 251 µS/cm. Compared to the methods of the EPA Conductivity Benchmark Study, the HBI as used by Cliffs is a gross method of evaluation and lacks necessary sensitivity for this report, as follows:

1. The HBI was developed using invertebrate sensitivity to organic pollutants that deplete oxygen, such as nutrients.[66]

[65] *Ibid.,* 55, Pond *et al., Downstream effects of mountaintop coal mining*, 2008.
[66] *See e.g.,* University of Vermont, Manual for Calculation of Metrics, http://www.uvm.edu/~streams/PDFFiles/Manual_Calc_Of_Metrics.pdf

2. Cliffs used a family tolerance value to calculate the HBI, but often genera within a family are not uniformly tolerant.

3. Although Cliffs described the population in each genus within the Unnamed Creek community, its report failed to compare similar unimpacted communities.

To further establish the relationship between elevated specific conductivity in Unnamed Creek and the loss of EPT richness, Unnamed Creek EPT genera can be compared with the EPA XC95% specific conductivity values and the Copper-Nickel Study Tolerance Study values[67] (EPA Conductivity Benchmark Study, 2011; Bartoo, 1978). The mean specific conductance for Unnamed Creek at SW001 in 2014 was 579 µS/cm. However, as shown in Table 5 above, Unnamed Creek experienced specific conductance as high as 1,225 µS/cm.

As shown in Table 7 below, each genus identified by Cliffs in Unnamed Creek can be compared to data on sensitivity to contaminants. Two of the genera in Ephemeroptera - Baetis sp. and Caenis sp. - are very tolerant of elevated specific conductance, hardness, sulfate and pH. Two other genera - Leptophlebia and Paraleptophlebia - are more sensitive. Plecoptera has one genus that is very tolerant of specific conductance as high as >3,314 µS/cm, and the other genus is sensitive at 463 µS/cm. Among the 13 Trichoptera genera, two of the seven for which data is identified are sensitive to high specific conductance - Pycnopsyche sp. and Lepidostoma sp. The remaining six genera have no sensitivity levels documented or have inconclusive taxonomies.

Table 7 - EPT Taxa Identified by Cliffs in Unnamed Creek Analysis for Sensitivity to Specific Conductance, other Pollutants

Cliffs (2005-2010) Unnamed Creek Genera	EPA Benchmark Study XC95% for SC	Copper-Nickel Study Tolerance Report Hardness	Sulfate	pH
Ephemeroptera				
Baetis sp.	>1,395	16-1,000	<10-5,700	5.6-8.5
Caenis sp.	>3,923	6-705	<1-450	5.4-8.5
Leptophlebia sp.	251	nd*	nd*	nd*
Paraleptophlebia sp.	463	nd*	nd*	nd*
Plecoptera		nd*	nd*	nd*
Isoperla sp.	460	nd*	nd*	nd*
Perlesta sp.	3,314	nd*	nd*	nd*
Trichoptera		nd*	nd*	nd*
Hydropsyche sp.	>7,010	nd*	nd*	nd*
Cheumatopsyche sp.	>9,180	nd*	nd*	nd*
Chimarra sp.	>3,792	4-800	7.3-510	6.8-8.7
Pycnopsyche sp.	295	4-705	2.4-750	6-8.8

[67] *Ibid.,* 2, EPA Conductivity Benchmark Study, 2011; *Ibid* 38, Bartoo, Copper-Nickel Study Tolerance Report, 1979. This data is reflected in Table 1, Appendix A.

Lepidostoma	~121	6-66	2.5-25	6.4-7.3
Polycentropus sp.	>4,713	nd*	nd*	nd*
Ptilostomis sp.	nd*	nd*	nd*	nd*
Anabolia sp.	nd*	nd*	nd*	nd*
Limnephilis sp.	nd*	nd*	nd*	nd*
Phryganea sp.	nd*	nd*	nd*	nd*
Ochrotrichia sp.	>2,971	nd*	nd*	nd*
Neureclipsis sp.	nd*	nd*	nd*	nd*
Ceraclea sp.	nd*	nd*	nd*	nd*
nd* = no data available				

At least five of the 13 genera for which specific conductance XC95% levels are known, or 38% of the identified EPT genera, are sensitive to specific conductance. Additional genera, such as Trichoptera Lepidostoma sp. and Chimarra sp. might also be sensitive to increased hardness or sulfate.

The Copper-Nickel Study Biological Sampling report from 1978 stated that the sampling areas immediately downstream of the Dunka Mine waste rock seepages had two to ten times fewer organisms than further downstream near Birch Lake.[68] (Johnson *et al.,* 1978). The Sampling report further stated the "Recolonization of impacted stream areas by aquatic insects is generally rapid after a stress is discontinued."[69] The Cliffs data near the SW001 Unnamed Creek site is similar to the Copper-Nickel Study data near the same location despite the passage of 37 years. Unnamed Creek continues to demonstrate significant EPT stress when compared with similar unimpacted streams in the area.

2. Northshore Peter Mitchell Pit

The Northshore Peter Mitchell taconite mine pit, as previously discussed, discharges its eastern dewatering to the Dunka River in the Rainy River watershed. Specific conductivity concentrations in this discharge range from 300 µS/cm to 900 µS/cm, and are high enough to have potential impacts on sensitive genera.

Research in Minnesota has concluded that Peter Mitchell Mine discharge is toxic to aquatic life: "Using toxicity data compiled by Clark (12), parameters in Reserve's [now Northshore] discharge with a mean concentration above the minimum known toxicity to fish or aquatic invertebrates include Na [sodium], Ca [calcium], NH_3 [ammonia], Mn [magnesium], and Fe [iron]."[70] (Benzie, 1977).

Peter Mitchell NPDES discharges SD001, SD002, SD003, SD004, and SD005 enter the Dunka River watershed and flow into Birch Lake, a reservoir in the Kawishiwi River.

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[68] *Ibid.,* 42, Johnson *et al*., Copper-Nickel Study Biological Sampling, 1978, p. 22.
[69] *Id.*, p . 9.
[70] *Ibid*., 28, Benzie, *Water Quality of the Dunka River*, p. 38.

Figure 4. Map of Northshore Peter Mitchell Mine Pit Discharge Sites



The NPDES DMRs document discharges at different times during the years from 2002 to 2015, including specific conductance mean and maximum levels at these discharge points that are high enough to have potential impacts on sensitive genera of invertebrates. These data are summarized in Table 8 below[71] (Northshore DMRs)

Table 8 - Northshore Peter Mitchell Specific Conductance Discharge to Dunka River (NPDES 0046981 DMRs 2002-2015)		
Location	Mean Conductivity (µS/cm)	Maximum Conductivity (µS/cm)
SD001	374	667
SD002	494	711
SD003	305	527
SD004	667	833
SD005	605	918

[71] Northshore Mining Company, NPDES Permit MN0046981 and DMRs, 2002-2015.

Considering EPA's benchmark and the data on invertebrates in Unnamed Creek, most if not all of these levels are high enough to have potential impacts on sensitive genera.

B. St. Louis River Watershed, Lake Superior Basin

1. Minnesota Pollution Control Agency Draft SLR Stressor Report

In a report prepared in 2013 but not released to the public, the MPCA determined that 32% of the St. Louis River tributary assessment units tested were impaired for fish and/or invertebrates. In the segment of the St. Louis River from mile 72 to mile 193.3 the following major tributaries were determined by the MPCA to be impaired: Embarrass River - fish; Spring Mine Creek - invertebrates, fish; Wyman Creek – fish[72] (MPCA, Draft SLR Stressor Report, 2013). The MPCA Draft St. Louis River Stressor Identification Report explicitly attributed impairments to discharge from mining facilities:

> "Fish results from the upper Embarrass River (the portion upstream of the town of Embarrass) show extremely low fish counts and limited taxa richness. . . Two of the impaired streams in this watershed zone, Spring Mine Creek and the Embarrass River, receive water originating from mine pits. Sampling results from these streams show elevated specific conductance and sulfate concentrations."[73] (MPCA, Draft SLR Stressor Report, 2013)

In explaining the impairment of Spring Mine Creek, MPCA's Draft SLR Stressor report acknowledged the difference in sensitivity of invertebrates and the potential for taxa imbalance as a result of mine discharge:

> "Spring Mine Creek is the only stream in this watershed zone that is listed as impaired for macroinvertebrate bioassessments. . . [A]ncillary information considered in the assessment process (elevated specific conductivity readings; invertebrate samples dominated by Gammarus and Corixidae) resulted in an impairment listing. Symptoms of impairment observed in Spring Mine Creek include a very low relative percentage of non-hydropsychid caddisfly taxa (1.6%) and imbalance in the distribution of taxa present. Over 76% of the individuals counted were from the five most abundant taxa in the sample. Bear Creek, the potential reference stream for this watershed zone, shows more balance among taxa present, supports more intolerant taxa, and better representation from the order trichoptera."[74] (MPCA, Draft SLR Stressor Report, 2013)

MPCA methods were different from and less sensitive than the methods in the EPA Conductivity Benchmark Study. MPCA used a single background reference stream, and MPCA's statements regarding the relationship between fish or aquatic invertebrate impairments and specific conductance were not definitive. Even with these limitations,

[72] *Ibid.,* 41, MPCA, Draft SLR Stressor Report, 2013, pdf auto pp. 16, 25, 26, 97 Attachment B.
[73] *Id.*, pdf auto p. 16,
[74] *Id.*, pdf auto p. 109..

MPCA's analysis suggests that there are adverse impacts on fish and invertebrates in the St. Louis River watershed resulting from sulfate and conductivity originating from mine facilities.

In general, the MPCA Draft SLR Stressor Report noted, "With increases in ionic strength, macroinvertebrate taxa richness (particularly Ephemeroptera sp.) have been found to decrease (Piscart *et al*., 2005). Echols et. al (2009) observed a reduction in EPT abundance as conductivity values increased." MPCA found that sites with conductivities "higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams."[75] (MPCA, Draft SLR Stressor Report, 2013)

2. Northshore, LTV & Mesabi Nugget Discharges to Yelp Creek and Partridge River

As shown in Figure 4, Map of Northshore Peter Mitchell Mine Pit Discharge Sites, several St. Louis River watershed tributaries receive direct mine drainage and/or flow through heavily mined areas, including Yelp Creek and the Partridge River.

Under Permit MN0046981 the Peter Mitchell Pit has eight permitted discharges south of the Laurentian Divide, all of which eventually reach the Partridge River: two discharge to Yelp Creek, then into the Partridge River and another six discharge to unnamed creeks or to wetlands of the Partridge River.

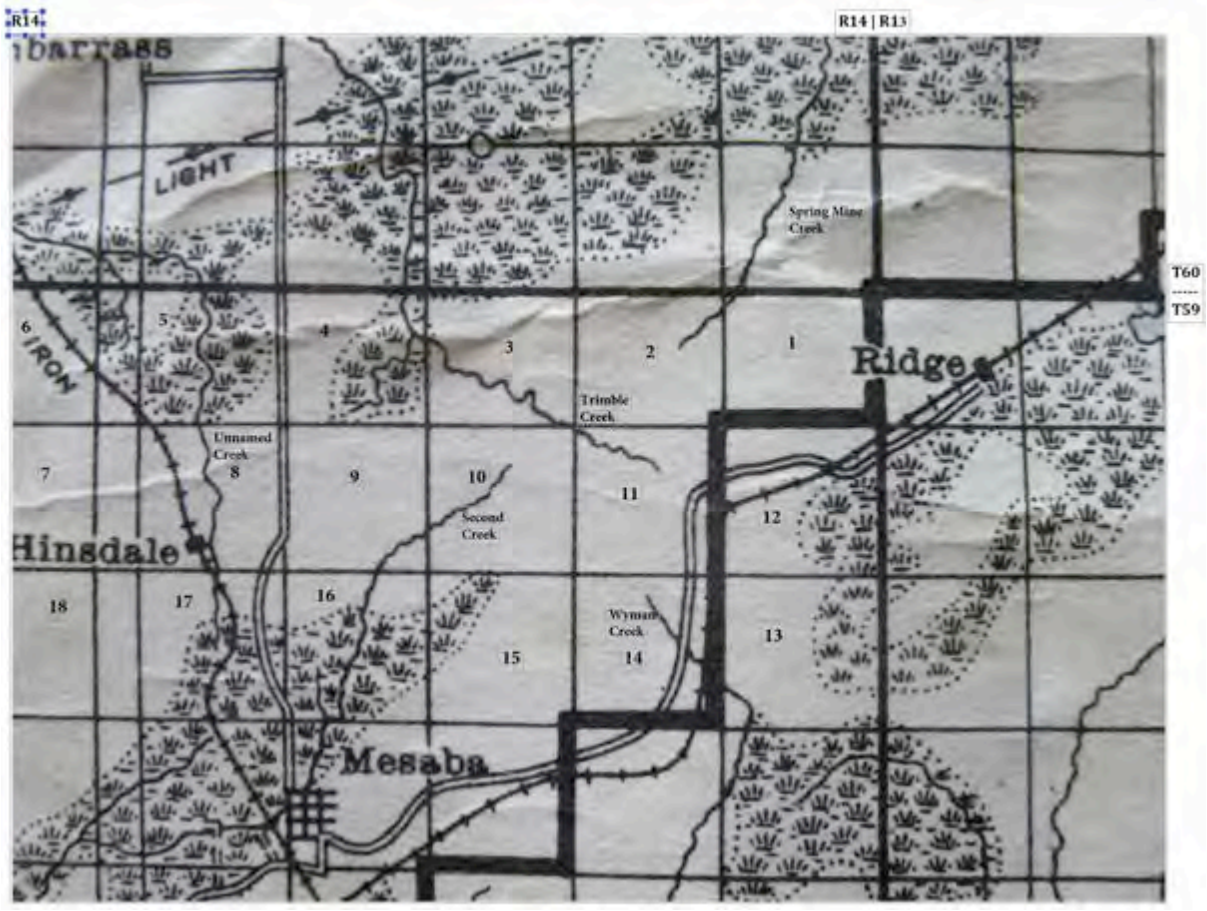
A winter survey of the Partridge River by the MDNR[76] (Kruse, 2011) documented that Partridge River flows from November 2008, December 2010, January 2011, February 2011, and March 2011 showed large volumes of discharge. The flows reported ranged from 0 to 41.9 cubic feet per second or cfs (219,912 gallons per minute or gpm). From November 24-26, 2008, the Partridge River had flows between .040 cfs and .063 cfs. Again on Jan. 25, 2011 flows ranged from .030 cfs to 0.41 cfs. This data demonstrates that the main Partridge River flows upstream of Colby Lake are significantly affected by Peter Mitchell discharges. NPDES DMR data reported discharges for the month of January 2010 from SD009 (Yelp Creek) of 5.5 cfs. During certain portions of the year, Partridge River discharge fluctuations mimic the reported fluctuations from the Peter Mitchell Pit to the Dunka River watershed as reported in the Copper-Nickel Study.[77] (Benzie, 1977). Northshore's NPDES permit requires water chemistry monitoring of the Partridge River at SW004 at the Highway 666 bridge east of Hoyt Lakes, just before Wyman Creek enters the Partridge River. The DMR reports from 2010 to 2014 demonstrate specific conductance in the range of 250 to 350 µS/cm level.[78] (Northshore DMRs).

The closed LTV taconite plant and tailing basin were constructed over the headwaters of

[75] I*d*. pdf auto p. 38.
[76] Kruse, G., Minnesota Department of Natural Resources, *Partridge and Embarrass River Winter Base Flow Study*, 2011, 2008-2011 data.
[77] *Ibid*., 28, Benzie, *Water Quality of the Dunka River*, 1977, pp. 3-41.
[78] *Ibid.,* 71, Northshore NPDES permit DMRs.

three streams. (U.S.F.S., Superior National Forest maps 1938,[79] and 1977, revised 2011[80]). Figures 5a, 5b, and 5c below illustrate the progression of LTV tailings facility construction.

Figure 5a. Area of LTV facility portions of map, Superior National Forest, Minnesota, 1938.[81]



The above map from 1938 shows township, range and section notations along with creek names for Second Creek, Trimble Creek, Wyman Creek, Spring Mine Creek and Unnamed Creek. The LTV tailings basin will be located in the sections of Figure 5a identified as 3, 4, 5, 8, 9, and 10.

The origin of Second Creek lies under the LTV southern tailing basin, facility in the area identified as section 10 on Figure 5a and under mine waste rock piles in and near section 16 on Figure 5a. Second Creek flows south and southwest to the Partridge River. Trimble Creek runs beneath the tailings basin in section 3 of Figure 5a in the northeast quarter of the tailing basin and flows northwest toward the Embarrass River. An unnamed creek

[79] U.S. Department of Agriculture Forest Service, *Superior National Forest, Minnesota*, 1938, map area of R14 T59N, T60N.
[80] U.S. Department of Agriculture Forest Service, *Superior National Forest, Minnesota*, map constructed in 1997, revised in 2011, map area of R14 T59N, T60N.
[81] *Ibid*., 78, U.S.F.S. Superior National Forest, map, 1938.

emerges from under the northwest corner of the tailing basin in approximately section 5 of Figure 5a and flows generally west to Embarrass River.

Over time, in addition to headwaters for Second Creek the LTV tailings basin will inundate Trimble Creek and Unnamed Creek. Figure 5b below features portions of the Superior National Forest reflecting 1997 conditions.[82] Figure 5b also shows the relationship of Second Creek to wetlands. As of 1997, the northeast quadrant of the LTV tailing basin, north of the Taconite Processing Plant still shows Trimble Creek headwaters that will later be inundated with tailings, as shown in Figure 5c.

Figure 5b, LTV facility and Second Creek features as of 1997.



Since the 1997 conditions shown in Figure 5b, Second Creek has received cumulative mining discharges impacting its water quality. Its headwaters are impacted by the plant site and seepage from the LTV tailings basin, monitored at SD026, shown in Figure 5c. This surface discharge location reported bicarbonates averaging 454 mg/l, hardness of 610 mg/l, and specific conductance of 1,115 µS/cm.[83] (Cliffs, 2012). Under a 2010 Consent Decree, surface water contaminated with seepage is collected and pumped back to the tailing basin. The pump-back does not capture all seepage and SD026 specific conductance remains high, likely due to continued seepage with underground flow through subsurface tills.

[82] *Ibid*., 77, USFS, Superior National Forest, map, constructed 1997, updated 2011.
[83] Cliffs, NPDES/SDS Permit MN0042536, Variance Addendum Renewal Cliffs Erie Hoyt Lakes Mining Area Surface Discharge Stations SD026 and SD033, December 10, 2012. p. 2, Table 1,

Monitoring at SD026 in 2013, more than a decade after processing of tailings ceased and despite the implemented pump-back, indicates specific conductance ranging from 666.2 µS/cm to 980.9 µS/cm, with a mean of 842.5 µS/cm.[84] (Barr, 2014). These levels are high enough to have potential impacts on sensitive genera.

Figure 5c, Map of PolyMet Proposed Tailings & Mine Locations, with Sampling Sites

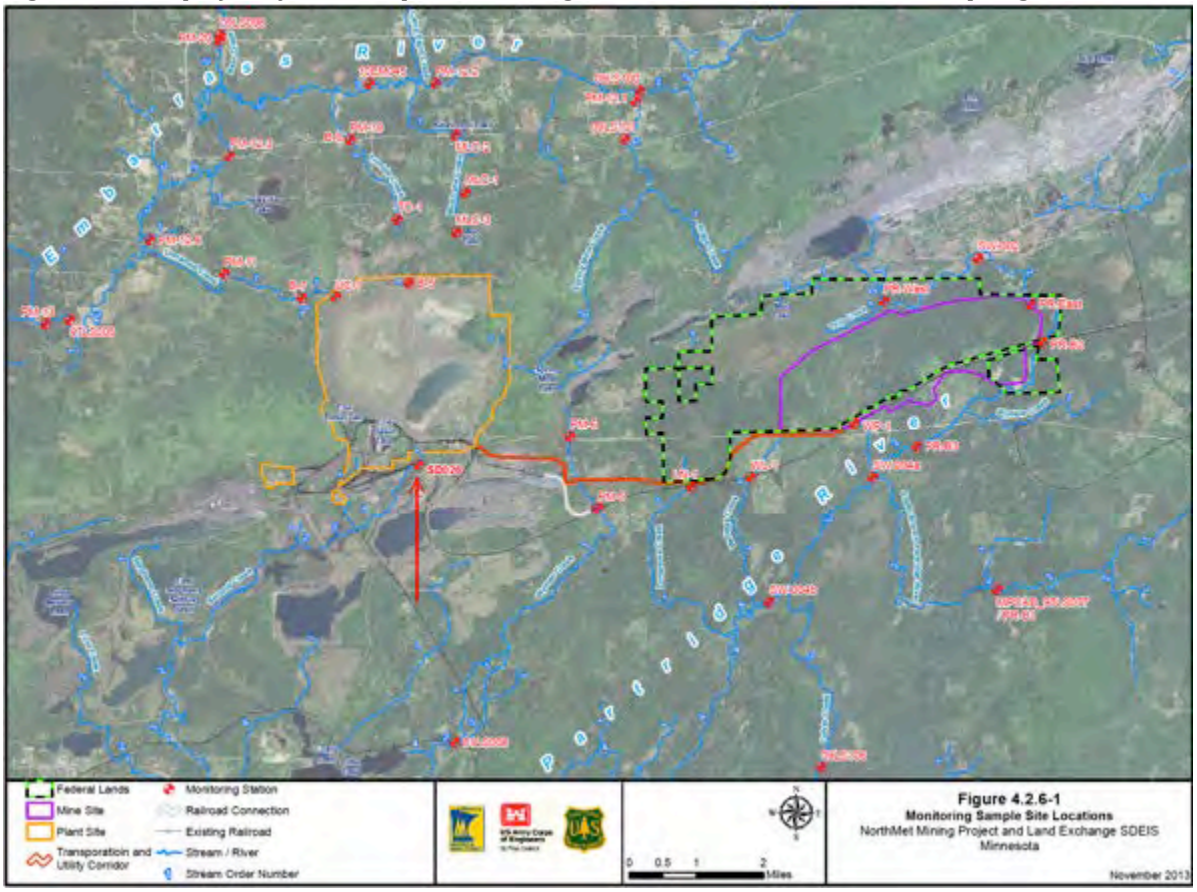


Figure 5c shows the former LTV tailing basin and facility in orange and the SD026 monitoring location on Second Creek with a red arrow. LTV Pit 1 extends to the west from the small orange portion of the facility.[85] (MDNR *et al.,* 2013).

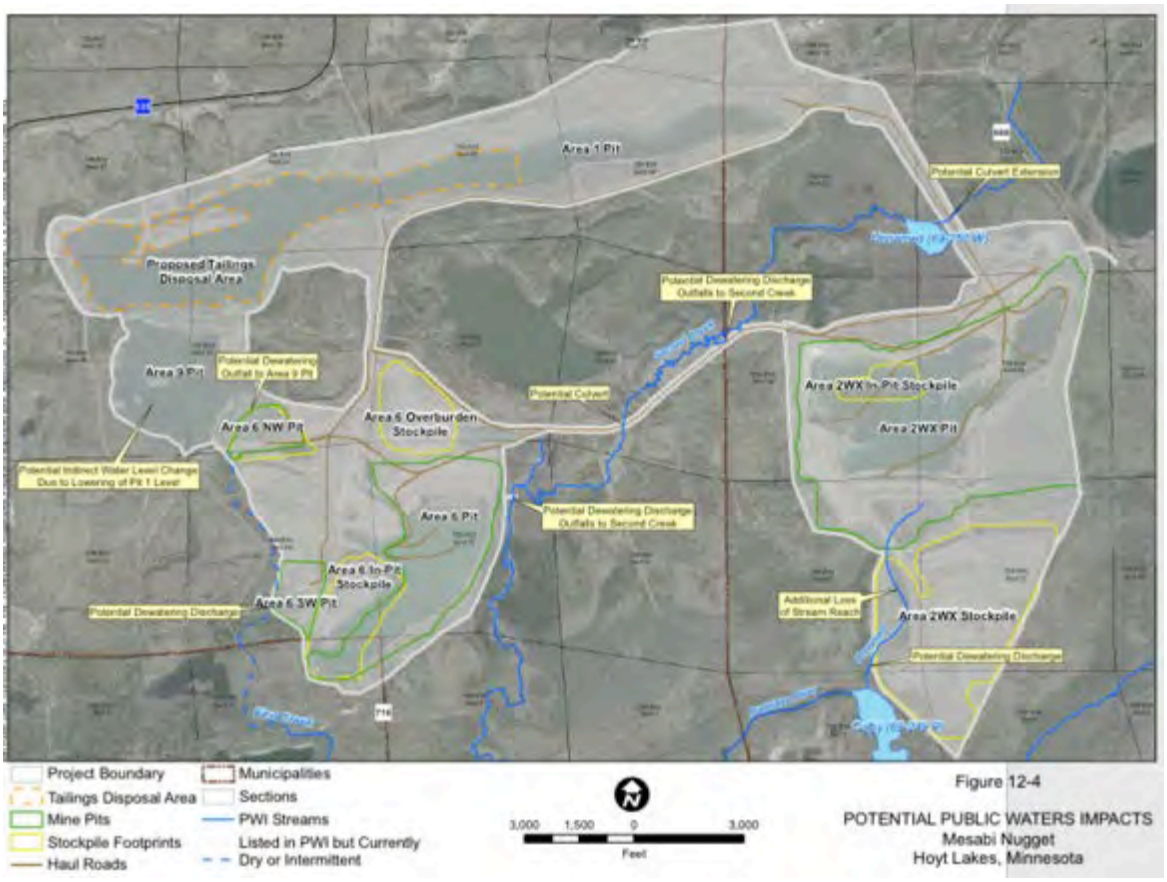
Downstream from SD026, Second Creek may receive pit water from additional mine sources: from LTV Pit 2/2E water moving through groundwater to Pit 2W, which then flows to Second Creek.[86] (MDNR *et al.*, 2015); from flow from the Knox and Stephens mines through surface water or shallow groundwater (Figure 5b); and from Pit 9 ground water

[84] Barr Engineering, Summary of 2013 NorthMet Groundwater and Surface Water Monitoring Data, , *Summary of 2013 NorthMet Groundwater and Surface Water Monitoring Data,* Technical Memorandum to MPCA, March 28, 2014, Table 1.
[85] MDNR, U.S. Army Corps of Engineers, and U.S. Department of Agriculture Forest Service, *PolyMet Supplemental Draft Environmental Impact Statement NorthMet Mining Project and Land Exchange*, November 2013 Figure 4.2.6-1.
[86] MDNR, U.S. Army Corps of Engineers, and U.S. Department of Agriculture Forest Service*, PolyMet NorthMet Preliminary Final Environmental Impact Statement*, June 2015, p. 6-13. (hereinafter "PolyMet PFEIS")

inflows to Pit 1. According to an EPA site visit report,[87] LTV mine pits also contain waste rock, increasing the potential release of contaminants from pit water.

Second Creek may also receive Pit 1 discharge from Mesabi Nugget in permit-approved months. Figure 6 illustrates potential locations where Mesabi Nugget could impact public waters during smelting operations.[88] (Barr, 2008).

Figure 6, Map of Mesabi Nugget Potential Public Waters Impacts



As a result of upstream discharges, specific conductance at Mesabi Nugget NPDES SW001, Second Creek just upstream of Pit 1 discharge location, in 2014 averaged 699 µS/cm. Bicarbonates were also elevated at 266 mg/L and hardness averaged 343 mg/L, with a sulfate mean concentration of 80.9 mg/L. When operating, Mesabi Nugget's smelter discharges into Pit 1, with discharge to WS003 of 75.9 mg/l bicarbonates; 1,224 mg/l hardness (Ca and Mg); 2,031 mg/l sulfate; and specific conductance of 3,873 µS/cm. (Mesabi Nugget DMRs, 2014). Pit 1 is estimated to contain 13.7 billion gallons of water.

[87] U.S. EPA, Technical Resource Document Extraction and Beneficiation of Ores and Minerals, Volume 3, *Iron*, August 1994, EPA 530-R94-030, NITS PB94-195203, Mine Site Visit: LTV Steel Mining Company
[88] Barr Engineering, Mesabi Nugget EAW Report, July 28, 2008, Figure 12-4. The proposal for mining has recently been withdrawn.

Average specific conductance of Pit 1 water discharged at SD001 in 2013 (January –March, October -December) was 1,290 µS/cm. Discharge from Pit 1 at SD001 into Second Creek, for 2014 January through March, averaged 334 mg/l bicarbonates; 752 mg/l hardness (Ca and Mg); 480 mg/l sulfate; and 1,389 µS/cm in specific conductance. From 2013-2014, specific conductance in this discharge ranged from 974 µS/cm to 1434 µS/cm. [89] (Mesabi Nugget DMRs, 2013-2014).

PolyMet's environmental review documents provide little characterization of benthic invertebrate populations. The PolyMet PFEIS applies the Hilsenhoff Biotic Index (HBI) to two sampling sites downstream of Northshore Peter Mitchell Mine discharge (PR-West and PR-East), and characterizes these sites as having an HBI ranking of "fair." No other Partridge River sites are assessed for HBI ranking. No invertebrate data is provided downstream of the LTV discharge site SD026.[90] (MDNR *et al.*, 2015). Single sampling dates at the few locations sampled in either the Partridge River or Embarrass River watershed, and failure to identify specific invertebrate genera and species,[91] and the paucity of data does not permit an assessment of the relative richness of taxa related to various discharge sites. With so little and such poor quality data available regarding benthic invertebrates under current conditions, effective monitoring of potential impacts of the proposed PolyMet copper-nickel mine project on sensitive macroinvertebrate genera is unlikely.

In summary, specific conductance, hardness, sulfate, and bicarbonates concentrations are elevated in Second Creek as a result of mine and smelting drainage. These values are higher than levels in Unnamed Creek impacted by Dunka mine discharge that seem to demonstrate significant invertebrate impact. The scarce data available suggests that benthic invertebrates at the genera and species levels in Second Creek are likely to be significantly impacted by elevated specific conductance and other mining discharge. Background invertebrate data provided for PolyMet environmental review are inadequate either to characterize current conditions or evaluate potential future impacts.

It should be noted that, like other unlisted waters in the northeast Minnesota ecoregions in the Lake Superior basin, Second Creek is considered to be an Outstanding International Resource Value Water. Minn. Rule 7052.0010 Subp. 34.

3. LTV and Impaired Waters - Wyman Creek and Spring Mine Creek

Wyman Creek is a headwaters stream that flows southeast of the LTV tailing basin and then south to the Partridge River just above Colby Lake (See Figures 5a- 5c). Cliffs' abandoned

[89] Mesabi Nugget NPDES Permit MN0067687, DMRs, 2013-2014.
[90] *Ibid. 85*, see PolyMet PFEIS, Table 4.2.6-6, p. 4-259 and sites in Figure 4.2.6-1. See also p, 4-252, "No aquatic biota studies have been conducted in Longnose Creek, Wetlegs Creek, or Second Creek, and no fish or macroinvertebrate community or habitat characteristics could be documented, although, like Yelp Creek, all are first-order streams within the vicinity of the NorthMet Project area."
[91] *Id*., see Table 4.2.6-14, p. 4-276 regarding macroinvertebrates in the Embarrass River watershed and sites in Figure 4.2.6-1.

Pit 3 discharges to Wyman Creek at 350 gpm (0.8 cfs). [92] (MDNR *et al*., 2015).

The LTV tailing basin has contaminated groundwater that emerges as seeps including one measured at SD012, the closest to Wyman Creek. In 2010, average specific conductance in SD012 tailings seepage was 1,097 µS/cm, and specific conductance at PM5 in Wyman Creek was 431 µS/cm.[93] (Barr, 2010). Other Cliffs mining facilities - Pit 5S and Pit 3 discharge to Wyman Creek and may also indirectly discharge to Wyman Creek via groundwater.[94] (MPCA, Cliffs Permit Approach, 2013).

The MPCA Draft St. Louis River Stressor Report noted that the headwaters of Wyman Creek are impacted by a series of mine pits and that historically Wyman Creek supported small populations of brook trout. In 2012, MPCA determined that Wyman Creek is impaired for fish communities. MPCA automatic sampling "SONDI" recorders reported a mean specific conductance of 360 µS/cm (range 350 to 364 µS/cm) in 196 samples taken in August 2012 and a mean specific conductance level of 366 µS/cm (range 350 to 374 µS/cm) in 583 samples taken in August and September of 2013. The MPCA's Draft SLR report did not complete the analysis of the potential anthropogenic stressors for Wyman Creek or other impaired waters.[95] (MPCA, Draft SLR Stressor Report, 2013).

Spring Mine Creek originates from a mine pit high on Giants Ridge. Spring Mine Creek headwaters in Section 2 (Figures 5a and 5b) are affected by mine pits and, possibly, by the LTV tailing basin. Buried stream beds continue to conduct water and act as underground conduits after burial. Some drainage from the tailing basin appears to follow a "former channel" into a pit named Spring Mine Lake.[96] (Barr, 2014). The pit/lake then discharges into Spring Mine Creek to the Embarrass River. Area mine pits and LTV tailing seepages contain elevated specific conductance, bicarbonates, hardness, and sulfates.

Table 9 below summarizes data on Spring Mine Creek specific conductance and sulfate from MPCA site S006-548, just upstream from the Creek's confluence with Embarrass River approximately 4.5 miles from the tailing basin. [97] (MPCA, 2015). During this period of sampling in 2011 and 2012, mean specific conductance was 819 µS/cm.

Although detailed benthic invertebrate sampling was provided in this report, MPCA has listed Spring Mine Creek as impaired for both fish and macroinvertebrates.[98] (MPCA, Draft SLR Stressor Report, 2013).

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[92] *Id*., PolyMet PFEIS, p. 6-13.
[93] Barr Engineering, *Short Term Mitigation Evaluation and Implementation Plan for the Tailing Basin NPDES/SDS Permit No. MN0054089*, June 2010, Table 2 Water Quality Summary SD002,
[94] MPCA, *Cliffs Erie Permitting Approach* Preliminary Draft, February 27, 2013.
[95] *Ibid.,* 41, MPCA, Draft SLR Stressor Report, 2013, pdf auto pp. 98, 109,
[96] *Ibid.*, 84, Barr, *Summary of 2013 NorthMet Groundwater and Surface Water Monitoring Data*, 2014, Figure 1
[97] MPCA, EQUIS database, on line, 2015.
[98] *Ibid.,* 41, MPCA, Draft SLR Stressor Report, pdf auto p. 109..

Table 9 - Spring Mine Creek Water Chemistry Specific Conductance and Sulfate		
Date	Specific Conductance (µS/cm)	Sulfate (mg/l)
4/13/11	372	115
6/23/11	788	246
11/30/11	1,406	585
4/17/12	936	378
5/30/12	555	192
7/10/12	858	nd*
nd*= no data available	Mean 819	

6. Mining Impacts and St. Louis River

The MDNR, Fond du Lac Resource Management, and 1854 Treaty Authority produced a detailed St. Louis River Study in 2006.[99] (Lindgren, *et al.,*, 2006). This Study identified conditions such as flow and stream bed conditions, basic water chemistry, habitat, fisheries and benthic invertebrate populations at numerous sites along the St. Louis River. Although the Study was only one year in duration, it confirmed biosurveys conducted in prior decades and provided basic data suggesting that impacts related to elevated specific conductance are occurring in what the Study calls the upper and middle St Louis.

In the 2006 St. Louis River Study, benthic invertebrates are identified to the genus level at 22 sites along the St. Louis River and specific conductance and other chemicals are provided in 23 sites.[100] (Lindgren, *et al.,* 2006). From mile 139. 6 to the headwaters at 193.3, in the "upper" St. Louis, specific conductance has a mean of 59 µS/cm. At mile 129, the Report documents significant mining activity and the specific conductance increases to 258 µS/cm.[101] (Lindgren, *et al.*, 2006). From mile 129 to what was selected as the end of the "middle" St. Louis at Mile 72, specific conductance had a mean of 260 µS/cm.

This "middle" segment of the St. Louis River receives significant mining facility discharges, some of which have been described previously. Identified NPDES permitted discharge sources include Northshore's active Peter Mitchell Pit, the LTV inundated mine pits, the four-and-a-half square mile tailings facility left when LTV went bankrupt and transferred permits to Cliffs, and the Mesabi Nugget facility.

Table 10 summarizes specific conductance in the upper reaches and the mining-impacted middle segment of the St. Louis River.

[99] *Ibid.,* 21, MDNR/Tribal Agencies SLR Study, 2006.
[100] *Id.*, Appendices 11 to 17.
[101] *Id.*, Appendix 6.

Table 10 - St. Louis River Specific Conductivity Upper Reaches and Mining-Impacted Middle Segment			
	Specific Conductance (µS/cm)		
	Mean	Minimum	Maximum
Upper Reaches Mile 139.6 to 193.3	59	41.4	101
Mining-Impacted Segment Mile 72 to 129	260	160	386

Benthic richness in the two reaches of the St. Louis River studied by the MDNR and Tribal Agencies is summarized in Table 11 below. (Lindgren, *et al.,* 2006).[102]

Table 11- St. Louis River Benthic Invertebrates Richness in Upper Reaches and Mining-Impacted Middle Segment		
	Mile 193.3 to 139.6	**Mile 129 to 72**
Total Richness	(59 µS /cm Mean Conductivity)	(260 µS Mean Conductivity)
Family	45	44
Genera	88	72
EPT Richness		
Family	19	17
Genera	35	27

Although this is just one year of sampling, the St. Louis Report data shows a difference in the total richness and richness of Ephemeroptera, Plecoptera, and Trichoptera (EPT) at a genus level. In the mining impacted middle segment of the St. Louis River, from Mile 129 to Mile 72, specific conductance was elevated to 260 µS/cm - more than 400 percent of background levels in the upper St. Louis. The number of genera observed in this impacted segment was reduced by about 18% and the number of EPT genera observed was reduced by about 23% as compared to the unimpacted reaches further upstream in the St. Louis River.

EPA recommends three years of sampling to provide a more robust data set, but there appear to be some interesting and significant genera losses in the existing data. Comparing genera in the upper segment unimpacted by mining with data in the downstream middle segment impacted by mining activity, some invertebrate genera with populations of over 10 individuals identified in the upstream sampling have only 0 or 1 individuals present in the middle segment of the St. Louis River. Table 12 provides a more detailed analysis of

[102] *Id*., Appendices 11 to 17.

these deficits. (Lindgren *et al*., 2006)[103]

Table 12 - St. Louis River Presence of Specific Benthic Invertebrates in Upper Segment and Mining-Impacted Middle Segment*

Genus and Species	**Upper Segment Mile 193.3 TO 139.6** (**59 µS/cm** Mean Conductivity) Population Present	**Middle Segment Mile 129 to 72** **(260 µS/cm** Mean Conductivity) Population Present
Ephemeroptera		
Baetiscicae		
Baetisca sp.	129	0
Heptageniidae		
Stenacron		
Vicarium sp.	86	1
Leptophlebiidae		
Leptophlebia sp.	114	0
Hemiptera		
Corixidae		
Hesoerocorixa sp.	62	0
Plecoptera		
Perlidae		
Paragnetina sp.	10	0

There are other genera present in the unimpacted upper reaches of the St. Louis River that do not exist in the middle reaches impacted by mining. But, since this is only one year of data, genera with fewer than 10 individuals in the upper reaches were not included in this table.

Currently available data demonstrates that headwater streams in the mining impacted area of the St. Louis River watershed have specific conductance levels far above background levels and diminished invertebrate richness. Mine facility discharges, waste rock, seepages, a tailing basin, and inundated pits containing waste rock are sources of minerals and salts resulting in high levels of specific conductance. These high levels of specific conductance may persist many miles downstream in the St. Louis River.[104]

[103] *Id*., Appendices 11, 12, 16

[104] *Tribal Cooperating Agencies Cumulative Effects Assess*ment, NorthMet Mining Project and Land Exchange, September 2013, contained in Appendix C of the PolyMet NorthMet Supplemental Draft Environmental Impact Statement, November 2013, at pp. 16-18 suggests that specific conductivity persisted above 150 µS/cm as much as 200 kilometers downstream of elevated discharge from mining.

V. Conclusions: Recommendation for Development of Aquatic Life Benchmark for Specific Conductance in Northeast Minnesota

A. Findings

Based on the EPA Conductivity Benchmark Study research and the references discussed in this evaluation, this report makes the following findings:

1. The EPA protocols described are applicable to northeast Minnesota surface waters.

2. The median of all 463 Copper-Nickel Study samples (including impacted streams) is 68 µS/cm, so the background conductivity for unimpacted streams alone based on the Copper-Nickel Study would be less than 68 µS/cm.

3. Existing data from Minnesota ecoregions 50n, northern 50p, and 50t demonstrate impacts on invertebrate genera from elevated specific conductance in mining impacted waters.

4. In the Minnesota ecoregions discussed in this report, discharge of specific conductance above the level of 300 µS/cm, established as guidance for Appalachian streams is highly likely to result in extirpation of 5% or more of invertebrate genera. Such discharge should be prohibited under Minnesota narrative standards preventing degradation and toxic pollution.

B. Recommendations

The following recommendations would protect aquatic life and ensure the development of a protective Field-Based Benchmark for specific conductance in Northeast Minnesota:

1. Apply the aquatic life benchmark of 300 µS/cm as a chronic value for year-round application for organisms exposed throughout their life cycle in ecoregions 50n, the northern part of 50p, and 50t, pending further analysis to determine if a more stringent limit on specific conductance is needed to protect aquatic life in northeast Minnesota ecoregions, according to the XC 95% criterion.

2. Complete existing data gathering for ecoregion 50n and 50t, focusing on invertebrate genera and water chemistry parameters in mining impacted and unimpacted waters and complete the development of a specific conductance benchmark for the specified Minnesota ecoregions.

3. Facilitate and encourage sources with single year benthic invertebrate sampling to add two more years of data and focus on impacts to headwaters streams from mine dewatering, seepage and discharge.

4. Require a reasonable potential analysis for any NPDES-permitted mining facility and make determinations whether the facility discharge would have the potential to

result in degradation and/or toxic pollution under Minnesota narrative standards in addition to potential violation of numeric standards for irrigation.

5. Gather data for other nearby ecoregions in the Lake Superior and Rainy River Basins to determine whether a wider applicability of the 300 µS/cm specific conductance guideline should be generally applicable or whether a more stringent limit on specific conductance must be developed.

In mining impacted areas, large discharges into headwaters streams from pit dewatering, surface runoff and tailing basin seepages are likely to require regulatory controls without consideration of possible dilution. See Minn. Rules 7050.0210, Subp. 7; 7050.0222, Subp. 7(C). Minnesota's narrative standards that prevent toxic pollution (Minn. Rules 7050.0150 and 7050.0217, Subp. 1, 2) would seem to require that levels of specific conductance that would be chronically toxic to 5% or more of benthic invertebrates in low-volume headwaters streams should be prohibited for NPDES-permitted discharge.

EPA has suggested that "the salt mixture dominated by salts of SO_4^{2-} and HCO_3^{-1} is believed to be an insurmountable physiological challenge for some species."[105] (EPA Conductivity Benchmark Study, 2011). In Minnesota ecoregions discussed in this evaluation, special attention will need to be given to discharges with high sulfate and bicarbonates.

C. Qualifiers

To understand the limits of this review, note that EPA Conductivity Benchmark Study specifically states, "Because it is not protective of all genera and protects against extirpation rather than reduction in abundance, this level is not fully protective of sensitive species or higher quality, exceptional waters designated by state and federal agencies."[106] (EPA Conductivity Benchmark Study, 2011). Additional work will be needed to ensure adequate protection of Minnesota waters affected by mining and governed by NPDES permits, particularly given the lower background level of specific conductance in Minnesota waters and the potential prevalence of more intolerant genera as compared with Appalachia.

This qualification is important, since in Minnesota ecoregions 50n, 50p, and 50t BWCAW waters, scientific and natural areas, unlisted high value waters, and other listed waters are Outstanding Resource Value Waters (ORVW) with special protections for higher quality or exceptional waters. (Minn. Rule 7050.0180, Subp. 2). Subp. 3 of this Rule states, "No person may cause or allow a new or expanded discharge of any sewage, industrial waste, or other waste to waters within the Waters in the Boundary Waters Canoe Area Wilderness; portions of Lake Superior . . . or Department of Natural Resources designated scientific and natural areas." Subp. 9 of this Rule precludes deterioration in the quality of any downstream ORVW.

[105] *Ibid*., 2, EPA Conductivity Benchmark Study, 2011, p. xv.
[106] *Id*., 2, p. xiv

Surface waters and wetlands of Minnesota in the Lake Superior Basin not specifically listed as Outstanding Resource Value Waters (ORVW) are "Outstanding International Resource Waters" or "OIRWs" subject to non-degradation standards. (Minn. Rule 7052.0300, Subp. 1(C)(2), Subp. 3). For OIRWs, "Existing water uses under part 7050.0185 and the level of water quality necessary to protect existing uses must be maintained and protected. Where designated uses of the waterbody are impaired, there must be no lowering of the water quality with respect to the GLI pollutants causing the impairment." (Minn. Rule 7052.0300, Subp. 2).

D. Permit Requirements

A lack of attention in northeast Minnesota to designing and enforcing mining permits has resulted in elevated specific conductance in headwaters and further downstream, including waters of the middle segment of the St. Louis River. Minnesota's narrative standards apply to mining discharges and should be enforced to prevent impairment or alteration of lower aquatic life. Under the Clean Water Act, EPA requires that a state permitting authority must examine whether elevated conductivity levels could create a reasonable potential for violation of the narrative standard.[107] (EPA Final Guidance, 2011).

Permit requirements concerning specific conductance should include but are not limited to:

1. Prior to approving new or expanding discharge of specific conductance, multi-year baseline sampling of benthic invertebrates to the genus level both upstream and downstream of the proposed discharge using MPCA methodology.

2. Pertinent sampling and water chemistry including specific conductance and major cations and anions related to specific conductance for the benthic invertebrate community in the area;

3. Sampling and flow measurements of the company discharge, receiving water and similar order streams;

4. Limits based on ORVW/OIRW status and cumulative effects on the receiving water;

5. Bioassays using at least three organisms (one of which should be an aquatic plant) known to be sensitive to low levels of chemicals and possible synergies contained in the tailing process such as flotation reagents and flocculants; and

6. Invertebrate sampling to the species level downstream close to the discharge, and in at least one background site, with permits to reopen if impacts are detected.

E. Requirements for new/expanded facilities

Technical and environmental review for any new or expanded facility must include these

[107] *Ibid.,* 10, EPA Final Guidance, 2011, Appendix 6, p. xviii.

items that concern specific conductance:

1. Establishment of site specific background water chemistry and invertebrate community data to genus and species, using all available data with quality assurance, not only the monitoring of the proposing company, and requiring additional background data where quality and duration is insufficient.

2. Monitoring plans, sampling and analysis immediately upstream of a discharge, of the discharge, at a distance downstream of the discharge, and just after any permit-allowed mixing zone; detection monitoring; and monitoring of both public waters and waters used as treatment systems in time to prevent meromixis, or a lack of mixing between surface and deep water lake strata.

3. Estimates of contaminants, concentrations, and mass loadings of waste rock, tailing, waste and pit inflow and outflow water must be derived from data obtained that is representative of all possible chemicals in the host rock and of all chemicals used in beneficiation and processing.

4. Detailed modeling based on sufficient and quality assured data, rather than assumptions, of specific conductance and contaminants for any proposed new or expanded mining facility to predict whether facility discharges result in degradation or toxic pollution under both numeric and narrative Minnesota rules, including direct, indirect and cumulative impacts. Where facts are insufficient, additional data must be gathered prior to modeling and decision-making.

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TABLE 1 DETAILED INVERTEBRATE BACKGROUND																							
A	B	C	F	D	E	F			G			H			I	J			K	L		
	Genus/Species in NE MN in Ecoregions 50n,50p(northern),50t	Appalachian Unmined *	Cu-Ni Study (CN088) ****	Pigeon River **	DNR Upper St Louis 2005 ***	USFS Keeley Creek ******			USFS Filson Creek ******			USFS August Creek ******			Little Isabella ******	Nira Creek ******			USEPA (KY) SC 5% loss common to Mn	Pollution Tolerance Hardness (mg/l)/Sulfate (mg/l)/pH Cu-Nickel Study (CN018)*****		
					mile 139.6-19	2011	2012	2013	2011	2012	2013	2011	2012	2013	2008	2011	2012	2013	(uS/cm) *	hardness	sulfate	pH
EPHEMEROPTERA (Mayflies)	GENUS																						
Leptophlebiidae					2	26	28	14	38	29	1	8	14	4	3		21	2				
	Leptophlebia	x	x	x	114														251			
	Tricorythodes sp.																					
	Choroterpes sp.		x																	114-117	24.6-25.1	8.8
	Paraleptophlebia sp.	x	x	x												1			463			
	P.debilis		x																			
	P.guttata	x	x																	705	450	7.9
	P.mollis		x																			
	P.praepedita	x	x																	87	26.5	7.2
	P.volitans	x	x																	21	3.6	6.6
Baetiscidae																						
	Baetisica sp.				129																	
	B.carolina		x																			
	B.lacustris		x																			
Baetidae																						
	Acerpenna sp.	x					1		2	4									~649			
	Baetis sp.	x	x	x	66						1								>1,395	16-1000	<10-5700	5.6-8.5
	B.brunneicolor		x			1			1													
	B.flavistriga		x																			
	B. hageni		x																			
	B.intercalaris		x																			
	B.levitans		x																			
	B.phyllis		x																			
	B.pygmaeus		x																			
	B.vagans		x																			
	Iswaeon sp.														1							
	Labiobaetis propinquus								1													
	Paracloedes sp.	x		x	60																	
	Pseudocloeon sp.		x	x																20-260	3.-235	6.6-8.4
	P.anoka		x																			
	P. carolina		x																			
	P.cingulataum		x																			
	P.dubium		x																			
	P.parvulum		x																			
	Cloeon sp.		x	x																		
	Centroptilum sp.		x	x		2	3			1												
	Callibaetis sp.		x	x																		
	Callibaetis ferrugineus			x																		
	Baetisca sp.				129																	
	Heterocloen curiosis		x																			
Ephemeridae							1															
	Ephemera sp.	x	x	x	21										2				696			
	E. simulans		x	x																		
	Hexagenia sp.		x	x	16															70-233	34.9-45.2	6.2-7.9
	H. limbata																					
	H.bilineata		x																			
	Litobrancha recurvata		x																			
Ephemerellidae					8		1							1								
	Seratella deficiens	x		x			9												535 (genera)			
	Eurylophella sp.	x				8	9	14	1	38					6	8		12	490			
	E. funeralis												1									
	Attenella sp.	x		x	1														~698			
	Ephemerella sp.	x																5	299			
	E. attenuata		x																			
	E. aestiva			x																		
	E.bicolor		x								9									322	313	7.2

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					mile 139.6-19	2011	2012	2013	2011	2012	2013	2011	2012	2013	2008	2011	2012	2013	(uS/cm) *	hardness	sulfate	pH
	E.deficiens		x																		13- 124	7.2
	E.invaria		x										49	25	7		6					
	E.minimella		x																			
	E.needhami		x																			
	E.rotunda		x																			
	E.serrata		x																			
	E.simplex		x																	15	2.7	6.9
	E.sordida		x																			
	E.subvaria		x																			
	E.temporalis		x														24			6-216	2-135	6.8-8.4
	Teloganopsis deficiens														4							
Isonychiidae																						
	Isonychia sp.	x		x						1					3				1,180			
Caenidae																						
	Brachyercus sp.		x																			
	Caenis sp.	x	x	x	4		2										2		>3,923	6-705	<1-450	5.4-8.5
	C.Diminuta gr.					7	36	1		3		23	1	1	52	77	74	8				
Siphloneuridae																						
	Siphlonurus sp.		x	x	7																	
	S. alternans		x alternatus	x																		
	S.isonychia sp.		x																			
	Hydropsyche sp.		x				8				13	4	5							13	43	6.9
	H.betteni										20	2	5			1	5	2				
Tricorythidae																						
	Tricorxthodes sp.		x	x																6-705	1.3-450	5.4-8.5
Heptageniidae					4				10			1			1							
	Leucrocuta sp.	x											3						424			
	L. hebe			x																		
	Rhithrogena sp.		x	x																		
	Eneorus vitrea			x																		
	Heptagenia sp.	x	x flavescens	x															326			
	H. pulla			x																		
	H. hebe		x																			
	Maccaffertium sp.	x				2	3	11	7	7	6	3	2	2	5	1	10	1	~1,035			
	M. vicarium						1		7					1			1					
	Stenonema sp.				3														>745(genera)			
	S.candidum.	x	x	x																		
	S. exiguum		x	x	1																	
	S.modestum			x																		
	S.vicarium			x	86												1					
	S.exiquum			x	1																	
	S. terminatum		x		26																	
	S.rubrum		x																			
	S.quinquespinum		x																			
	S.smithae		x																			
	S.tripunctatum		x																	60-800	418-370	7.2-8.4
	Epeorus sp.	x	x																307			
	Stenacron sp.	x			16		2		1	3									~782			
	S. interpuctatum		x																	13-705	<1-450	5.6-8.4
	S. minnetonka		x																			
	S.femoratum		x																			
	S. fuscum		x																			
	S. fuscum rivulicolum		x																			
	S. candidum		x																			
	S.annexum		x																			
	S.integrum		x																			
	S.pulchellum		x																	7-233	<1-72.8	5.8-8.4
	Nixe sp.	x										2							319			

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					mile 139.6-19	2011	2012	2013	2011	2012	2013	2011	2012	2013	2008	2011	2012	2013	(uS/cm) *	hardness	sulfate	pH
	Arthroplea bipunctata		x																				
	Stenacron candidum		x																				
Metretopodidae	Siphloplecton interlineatum		x																				
Polymitacyidae																							
	Ephoron sp.																						
	E. leukon		x																				
PLECOPTERA (stoneflies)																							
Nemouridae																							
	Amphinemura delosa	x	x																>812 (genera)				
	A. linda		x																				
	Prostoia completa		x																				
	Shipsa rotunda		x																				
	Podmosta macdunnoughi		x																				
Lectridae																							
	Leuctra sp.	x											1						>2,087 (genera)				
	L. ferruginea		x																				
Capniidae										1			3		5		1						
	Allocapina minima	x	x																542 (genera)				
	A. pygmaea		x																				
	Capnia manitoba		x																				
	Paracapinia sp.	x												3					334 (genera)				
	P. angulata		x																				
	P. opis		x																				
Perlidae												4	1			5	1						
	Isogenoides sp.		x																				
	Isoperia bilineata	x	x																460 (genera)				
	I. frisoni?			x																			
	I. dicala		x																				
	I.lata		x																				
	I. Illies		x																				
	I. orata		x																				
	I.signata		x																				
	I. slossonae		x																				
	I. transmarina		x																				
	Acroneuria sp.	x	x abnormis	x									2		2				>2,630				
	A. lycorias		x	x				2		1 rare		1	2	1		1	1						
	A. abnormis			x																			
	A.carolinensis												1										
	A. internata?		x	x																			
	Agetinia.sp.																						
	Paragnetina sp.	x		x															2,087				
	Paragnetina media							1				1	p	2									
	Perlesta sp.	x		x															3,314				
	Isoperia sp.																						
Pteronarcyidae																							
	Pteronarcys sp.	x	x				2												~634				
	P. dorsata?			x																			
Taeniopterygidae							4																
	Strophopterx fasciata		x																				
	Taeniopteryx sp.	x					2	9	11	4	12		1		12		9	15	260				
	T.burski		x																				
	T. rivlis sp.		x																	70-82	45.1-45.2	6.0-6.8	
Chloroperlidae																							
	Alloperla? sp.	x		x															246				
	Hastaperla sp.			x																			
Perlodidae													1					1					

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					mile 139.6-19	2011	2012	2013	2011	2012	2013	2011	2012	2013	2008	2011	2012	2013	(uS/cm) *	hardness	sulfate	pH
	Acroneuria abnormis		x	x sp.																		
	A.internata		x	x																		
	A.lycorias		x	x																		
	Neoperla clymene		x																			
	Paragenetina media		x																			
	Perlesta placida	x	x																3,314(genera)			
	Perlinella drymo		x																			
	Phasganophora capitata		x																			
	Isoperia sp.	x	x bilineata	x															460			
	Isogenoides sp.		x																			
	I.dicala		x																			
	I.frisoni		x																			
	I.lata		x																			
	I. signata		x																			
	I. slossonae		x																			
	I. transmarina		x																			
	I. Illies		x																			
	I. orata		x																			
	Agetinia.sp.																					
TRICHOPTERA (caddisflies)																						
Glossosomatidae																						
	Glossosma sp.	x	x	x											2				>1,652			
	Agapetus sp.		x																365	66	25	7.3
Philopotamidae																						
	Chimarra sp.					36	1	1	36	2	8	13	35	22	9	4	2	9	>3,972			
	C. socia	x		x																		
	C. atterima			x	1															15-19	7.6-7.7	6.8
	C. obscura		x	x																124-600	14.2-510	7.6-8.3
	C. socia		x		31															4-800	7.3-25	6.3-8.7
	C. feria		x																	23	3.2	7.1
	Dolophilodes distinctus	x	x																863 (genera)			
Psychomyiidae																						
	Psychomyia flavida	x	x	x	1			1				1			11		3	3	>1,131 (genera)			
	Lype diversa		x								6									87	26.5	7.2
Lepidostomatidae																						
	Lepidostoma sp.	x	x	x								3	5	10	8	1			~121	6-66	2.5-25	6.4-7.3
Leptoceridae										4							1					
	Ceraclea sp.			x		1	2		1								1					
	C.ancylus		x																			
	C.annulicornis	column H	x																			
	C. diluta		x																			
	C.maculata		x																			
	C.misca		x																			
	C.neffi		x																			
	C.resurgens		x																			
	Triaenodes sp.									5										66-287	25-251	6.7-7.3
	T.injusta		x																	21-800	3.5-46	6.6-8.8
	T.marginta		x																			
	T. tarda		x																			
	Setodes sp.																					
	Mystacides sp.				1	14	1	2				7				2						
	M.sepulchralis		x																			
	Nectopsyche sp				1																	
	N.candida		x																			
	Oecetis sp.				1		1															
	O.avara		x				1															
	O. Furva Gr.					2						1				10						
	O.cinerascens		x																			

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					mile 139.6-19	2011	2012	2013	2011	2012	2013	2011	2012	2013	2008	2011	2012	2013	(uS/cm) *	hardness	sulfate	pH
	O.testacea										4	1	2					1				
Rhyacophilidae																						
	Rhyacophila fuscula	x		x															>1,890 (genera)			
	R.vibox		x													1						
Limnephilidae					2	1	1	15	1	18	12		1	1			1	5				
	Pycnonsyche sp.	x		x	3														295	4-705	2.4-750	6-8.8
	P.suttifer		x																			
	P.scabripennis		x																			
	Glyphopsyche sp.			x																		
	G.goera sp.		x																			
	Hydatophylax argus		x					3		1	1											
	Limnephilus sp.		x								3	1	2	1				1		6-164	2.4-24	6.4-8.5
	Nemotaulius hostilis		x						1													
	Neophylx nacatus		x																	66-87	25-26	7.2-7.5
	Anabolia bimaculata		x																			
	G.irrorata		x																			
	Platycentropus sp.		x																	66	25	7.3
	P. seudostenophylax sp.		x																			
	Anabolia sp.			x																		
Polycentropodidae									2					1	3							
	Neureclipsis sp.		x	x	67								2							8-800	<1-72.8	5.5-8.5
	Paranyctionphylax sp.				8																	
	Polycentropus sp.	x		x	44	1			1	2									>4,713			
	P. flavus			x																		
	Phylocentropus sp.			x																		
	P.placidus		x																			
	P.centralis		x																			
	P.cinereus		x																			
	P.interruptus		x																			
	P.remotus		x																			
	Nyctiophylax sp.								1													
	N. moestus		x																			
	N.vestitus		x																			
Odontoceridae																						
	Psilotreta indecisa			x																		
Hydropsychidae					6	3		20	3		4	1		14			11					
	Cheumatopsyche sp.	x	x	x		3	14	13	3	2	2	2	3	4	32		1	2	>9,180			
	Ceratopsyche sp.	x			6	3							11						>6,468			
	C.bronta														28							
	C. slossonae				2		1						2		3							
	C.sparma																16	1				
	Pycnopsyche sp.																			4-705	2.4-450	6.0-8.8
	Hydropsyche sp.	x		x	27			20	7	6			5					10	>7,010			
	H. morosa			x																		
	H. slossone		x	x ?											3							
	H. bronta			x											28							
	H. sparna			x										10								
	H. alhedra			x																		
	H. betteni		x	x				10	7	1		2	5	2						154-2100	56.2-313	5.9-8.5
	H. walkeri??			x																		
	H.cuanis		x																	114-117	2.2-44	6.8-8.8
	H.orris		x																	12-233	2.2-44	6.8-7.9
	H.simulans		x																	9-117	0.6-25.1	6.2-8.8
	Macronema zebratum		x																			
	Stactobiella sp.		x																			
	Potamyia flava															1						
Hydroptilidae																						
	Agraylea sp.		x																			

TABLE 1 DETAILED INVERTEBRATE BACKGROUND																							
A	B	C	F	D	E	F			G			H			I	J			K	L		
	Genus/Species in NE MN in Ecoregions 50n,50p(northern),50t	Appalachian Unmined *	Cu-Ni Study (CN088) ****	Pigeon River **	DNR Upper St Louis 2005 ***	USFS Keeley Creek ******			USFS Filson Creek ******			USFS August Creek ******			Little Isabella ******	Nira Creek ******			USEPA (KY) SC 5% loss common to Mn	Pollution Tolerance Hardness (mg/l)/Sulfate (mg/l)/pH Cu-Nickel Study (CN018)*****		
					mile 139.6-19	2011	2012	2013	2011	2012	2013	2011	2012	2013	2008	2011	2012	2013	(uS/cm) *	hardness	sulfate	pH
	Hydroptila sp.	x	x	x		5						3			4	2	1	1	>11,227			
	0xyethira sp.		x	x			6			10	4				8	2	3					
	Ochrotrichia sp.	x	x																>2,791			
	Ithytrichia sp.		x																			
	I.clavat			x																		
	Mayatrichia ayama		x																			
	Neotrichia sp.		x																			
Brachycentridae																						
	Brachycentrus numerosus		x	x	24																	
	B.americanus		x																			
	Micrasema sp.		x												12	1		1				
	M. rickeri												3				1					
	M.Rusticum Gr.													1								
Phryganeidae								1														
	Agrypina improba		x																			
	Banksiola crotchi		x																			
	Phryganea cinerea		x																			
	Ptilostomis sp.		x		1			2												70-287	26.5-251	3.3-7.4
Pteronarcyidae																						
	Pteronarcys (sp. Dorsata?)			x																		
Chloroperlidae																						
	Alloperla? sp.			x																		
	Hastaperla sp.			x																		
Brachycentridae																						
	Numerosus sp.																					
Sericostomatidae																						
	Agarodes sp.				2																	
	A.distinctum		x													2						
	A.distinctus																2	2				
Molannidae	Molanna sp.									1	4											
	M. blenda		x																			
	M.tryphenna		x																			
	M.uniophila		x																			
Helicopsyche																						
	Helicopsyche borealis		x							2	1				3							
Uenoidae																						
	Neophylax sp.	x												2					316			
ODONATA (Dragonflies)																						
Aeshnidae																						
	Aeshna			x	2					1	1			1				1				
	A. umbrosa		x			1			1													
	Boyeria sp.	x			25						2								>7,340			
	B. grafiana			x																		
	B. vinosa		x	x		2	1		1	3	2			1	2		1	1				
	Basiaeschna sp.			x																		
	B. janata		x		9																	
Macromiidae															1	1						
	Macromia sp.				26																	
	M. illinoiensis		x	x																		
	Didmops transversa		x																			
Corduliidae							3															
	Neurocordulia sp				1					1												
	N.yamaskanensis		x																			
	Somatochlora sp.			x																		
	S.linearis		x																			
	S.minor		x																			
	S.Williamsoni		x																			
	Epitheca princeps		x																			

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					mile 139.6-19	2011	2012	2013	2011	2012	2013	2011	2012	2013	2008	2011	2012	2013	(uS/cm) *	hardness	sulfate	pH
Coenagrionidae					15					3													
	Argia sp.				1																		
	A. apicalis		x																				
	Enallagma sp.		x																				
	Ischnura/Anomalagrion sp.		x																				
Cordulegastridae																							
	Cordulegaster maculatus	x	x										1						>1,436 (genera)				
	C. maculata																						
Gomphidae			x		12	5	1				1	2			2	3	3	2					
	Dromogomphus spinosus		x																				
	Hagenius sp.																						
	H.brevistylus		x	x	12	3																	
	Hylogomphus bervis		x																				
	Gomphus sp.				7						1												
	G. spicatus			x																			
	Ophiogomphus sp.				16																		
	O.aspersus		x																				
	O.colubrinus													1rare									
	Phanogomphus sp.				14																		
	Styogomphus sp.	x			6														>6,468				
	S. albistylus		x																				
	Optioservus sp.			x			10	26	73	36	28	31	18	1	13	8	3			87-800	13-46	7.2-8.2	
	0. anomalus			x																			
Calopterygidae											1				1	9	1	2					
	Calopteryx sp.		x	x	26						1	1	3										
	C. aequabilis						1			4			2	1			3						
Lestidae																							
	Lestes sp.			x																			
Libellulidae					2																		
	Perithemis sp.				1																		
	Enallagma sp.			x																			
Zygoptera																							
	Calopterygidae sp.										3				1								
COLEOPTERA (beetles)																							
Elmidae												8	1										
	Stenelmis sp.	x	2	x	5	2	3	30	22	5	3	88	10	2	2	10	3	1	>9,790				
	S. crenata			x																11-705	<1-450	5.5-8.8	
	0ptioservus sp.	x		x	4		10												>9,790				
	O. fastiditus			x																114-800	14.2-46.1	8-8.8	
	Dubiraphia sp.	x		x	2	2	21	11							23	3			>7,370				
	Macronychus sp.	x		x	7							3							>1,890				
	M. glabtrtus											1	2			1	10	5					
Dryopidae																							
	Holichus sp.			x																			
Gyrinidae										1													
	Gyrinus sp.				11					4	3												
	Dineutus sp.				4																		
Dytiscidae					2												1						
	Coptotomus sp.			x																			
	Laccophilus sp.									1													
	Liodessus sp.									8	2												
Hydrophilidae																							
	Sperchopsis tesselatus			x																			
Chrysomelidae																							
	Donacia sp.			x																			
MEGALOPTERA																							
Corydalidae														4		5		3					
	Nigronia	x										1	3		1	2			>9,790				

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					mile 139.6-19	2011	2012	2013	2011	2012	2013	2011	2012	2013	2008	2011	2012	2013	(uS/cm) *	hardness	sulfate	pH	
	N. serricornis		x																				
	Chauliodes rastricornis		x																				
Sialidae																							
	Sialis sp.	x	x	x				1		1	2						1		>11,227				
Corydalidae																							
	Nigronia serricornis	x		x															>9,790				
NEUROPTERA (net winged)																							
Sisyridae	Climacia sp.		x																				
	Sisyra sp.		x			2																	
HEMIPTERA (true bugs)																							
Veliidae																							
	Rhagovelia obesa	x	x																>2,030 (genera)				
Corixidae					32			3						1									
	Sigara sp.				13																		
	Palmacorixa sp.			x																			
	Hesperocorixa sp.				62		1								2								
Hydrometridae																							
	Hydrometra sp.		x																				
Notonectidae																							
	Buenoa sp.		x	x																			
	Notonecta sp.				4																		
	N. lunata		x																				
Naucoridae																							
	Pelocoris sp.		x																				
Nepidae																							
	Rantra sp.		x		7		1 rare																
Mesoveliidae																							
	Mesovelia sp.		x																				
Gerridae					1																		
	Gerris sp.			x																			
	G. remigis		x																				
	Metrobates sp.				2																		
	M hesperius		x																				
	Reumatobates rileyi		x																				
Belostomatidae																							
	Belostoma sp.		x	x	14																		
	B. flumineum (rare)									1				1	1	1		1					
	Lethocerus sp.		x																				
Pleidae																							
	Plea striola		x																				
DIPTERA (True flies)																							
Athericidae																							
	Atherix sp.																		>11,646				
	A.variegata	x	x		18																		
Tabainidae																							
	Chrysops sp.	x	x																>11,646				
Prodiamesinae																							
	Monodiamesa sp.			x																			
Empididae																							
	Phoridae sp.		x																				
	Roederiodes sp.							1						4									
	Neoplasta sp.							1						2									
	Hemerodromia sp.	x					4	34	6		14	21	5				7	68	>9,790				
Syrphidae																							
	Helophilus		x																				
Tanypodinae																							
	Ablabesmvia sp.			x	7																		

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					mile 139.6-19	2011	2012	2013	2011	2012	2013	2011	2012	2013	2008	2011	2012	2013	(uS/cm) *	hardness	sulfate	pH
	A. mallochi			x																		
	Ablabesmyia sp					5		1								9	2					
	Clinotanypus sp.			x	4																	
	Coelottanypus sp.																					
	Larsia sp.						1							3								
	Nilotanypus sp.																					
	Natarsia sp.																1					
	Pentaneura sp.																					
	Psectrotanypus sp.																					
	Conchapeliopia sp.				24																	
	Labrundinia sp.			x		1																
	Procladius sp.			x	18	3	10	1	2	1		2						1				
	Tanypus sp.																					
	Thienemannimyia complex				26		10		5		39			32	9		10					
	Zavrelimyia sp.			x																		
Culicidae	Ades commuis		x																			
	Anopheles punctipennis	x	x																>2,768 (genera)			
Orthocladiinae							3		1			1					1					
	Brillia sp.		x	x		1			1				1	3				4				
	Cardiocladius sp.		x																			
	coryneura sp.		x		1																	
	Cricotopus sp.		x	x	10	1	1						2	2		5		3		82-5000	25-135	6.3-8.8
	C. bicinctus group			x									4									
	C. tremulus group			x																		
	Diplocladius sp.		x																			
	D. cultriger											1										
	Eukiefferiella sp.		x	x														2		82-110	25-45	6-8.7
	E. gracei group			x																		
	E. devonica group			x																		
	Epicocladius sp.		x		1																	
	Lopescladius sp.			x																		
	Heterotrissocladius sp.		x										1									
	Nanocladius sp.			x	11		2															
	N. narvulus group			x																		
	Parametreocnemus sp.		x	x					2		15											
	Psectrocladius sp.		x	x			1															
	Synorthocladius sp.			x																		
	Tvetenia sp.				3																	
	T. discoloripes group			x										1								
	Thienemanniella sp.		x		3																	
	Trissocladius sp.		x																			
	Parakiefferiella sp.						3		5	1	11	1		2				5				
	Orthocladius sp.		x		1			3					1	19	4							
	Psectrocladius sp.				4																	
	Rheocricotopus sp.		x		6									2				2				
	Smittia sp.		x																			
	Xylotopus sp.				1						5			1								
Chironomidae					54																	
	Chironomini sp.		x			3			1													
	Chironomus sp.	x			1											1	1		>11,646	18-1600	0.7-370	3-8.4
	Cladotanytarsus sp.	x				20	4			3		1							>11,646			
	Cryptochironomus sp.	x	x	x		10	2	9	1			7				2	1		>3,489			
	Cryptotendipes sp.					1																
	Demicryptochironomus sp.	x		x							1								322			
	Dicrotendipes sp.	x	x		2	1	1					2							>11,646	15-2100	0.6120-0.4	6.3-8.4
	Endochironomus sp.		x	x	1															7.0-9000	2.4-480	6.4-8
	Micropsectra sp.	x		x		17	18		6	4	5				1			1	>6,468			
	Microtendipes sp.	x			8	88	5	2	2	21	9	4	4		3	7	18		>3,489			

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A	B	C	F	D	E	F			G			H			I	J			K	L		
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					mile 139.6-19	2011	2012	2013	2011	2012	2013	2011	2012	2013	2008	2011	2012	2013	(uS/cm) *	hardness	sulfate	pH
	M.pedallus group																					
	Paratendipes sp.		x	x		26										1						
	Paralauterborniella? sp.			x																		
	P.nigrohalterale												2	1								
	Phaenospectra sp.	x	x		17	8	4		3		1	1				9			~2,332			
	Polypedilum sp.	x	x	x		17	14	3	5		1	2	38	9					>4,884	Jun-00	<1-315	3.8-8.8
	P. fallax group			x																		
	P. convictum group			x																		
	Stenochironomus sp.		x	x		1		5	1		6					2	2	4				
	Stictochironomus sp.		x	x				2														
	Stempellinella sp.	x				3			3								2		>927			
	Stempellina sp.	x					1					1							644			
	Tribelos sp		x	x		1	4	1		6	1					25	3	7				
	Einfeldia sp.																					
	Glyptotendipes sp.		x																	21-900	3.2-480	6.6-8.5
	Micropsectra sp.	x	x			17			6										>6,468			
	Parachironomus sp.		x																			
	Rheotanytarsus sp.	x	x	x	1		9	12		1	4	1	3	45	7		3		>3,489			
	Ablabesmyia	x				x													>11,646			
	Xenochironomus sp.		x																			
	Xylotopus par								1		5											
	X.xenolabis								1								1					
	Nilothauma sp.		x			5				3	2					3		1				
	Nanocladius sp.								1													
	Pseudochiromus sp.	x	x			3	2												>11,646			
	Paracladopelma sp.		x																			
	Lauterborniella sp.		x																			
	L.agrayloides						1								2	4	2	1				
	Zavrelia sp.	x	x																413	6	2.5	6.4
	Stegopterna?? sp.		x																			
	Thienemannimyia Gr.					14	10	16	5	14		37	29			10		20	>6,468			
	Parametriocnemus sp.	x					13		2				8	14		13	4	11				
	Trissopelopia ogemawi												9		1							
	Pagastiella sp.							1		3												
	Paramerina sp.									3												
	Parametriocnemus sp.	x								2									>4,713			
	Paratanytarsus sp.	x					2			4	3								>3,489			
	Limnophyes sp.	x						1											>5,120			
	Lauterborniella agrayloides														2		2					
	Psectrocladius sp.						1															
	Tanytarsus sp.	x	x	x		8	7	1	7	5	2		1			1	3		>9,180			
Tanytarsini								2														
	Cladotanytarsus sp.			x																		
Tabanidae																						
	Chrysops sp.	x			12														>11,646			
Empididae																						
	Hemerodromia sp.	x		x			4	34	6		14	21	5	19		3	7		>9,790			
Ceratopogonidae											1				1							
	Bezzia / Palpomyia	x								2	1								380			
	Probezzia sp.		x	x								3										
	Palpomyia sp.		x																			
	Ceratopogoninae sp.					1		1	3	2	1		1	10	1	1	1	4				
	Serromyia sp.											1										
	Mallochohelea sp.											3										
	Neoplasta sp.							1														
Tipulidae													1									
	Antocha sp.	x	x											1	5				>6,468			
	Dicranota sp.	x	x																>7,010			

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					mile 139.6-19	2011	2012	2013	2011	2012	2013	2011	2012	2013	2008	2011	2012	2013	(uS/cm) *	hardness	sulfate	pH
	Helius sp.		x					1														
	Hexatoma sp.	x	x																>9,790			
	Limonia sp.	x	x																>5,057			
	Peicia sp.		x																			
	Pedicia sp.		x																			
	Hemerodromyia sp.		x																			
	Limnophila? sp.	x																	~1,503			
	Pseudolimnophila sp.	x	x											1					>1,357			
	Tipula sp.	x	x		7														>1,979			
Simuliidae (Black Flies)																						
	Stegopterna?? sp.			x																		
	Hexatoma sp.		x																			
	Prosimulium sp.	x	x																~531			
	Limnophila? sp.		x																			
	Cnephia sp.		x																			
	Simulium sp.	x	x		30		1	10	1		15			21				4	>6,468			
	S. pictipes		x	x																		
	S. jenningsi??			x																		
	Eusimulium eurmandiculum		x																			
	Byssodon ruggelsi		x																			
Streatiomyiidae																						
	Odontomyia sp.																					
Athericidae																						
	Atherix varieqata		x																			
Blephariceridae																						
	Blepharicera.tenuipes		x																			
	S. jenningsi??		x																			
Diamesinae																						
	Atherix varieqata		x																			
	Blepharicera sp.		x																			
	Potthastia? sp.		x															2				
	Diamesa sp.		x											2								
Podonominae																						
	Lasiodiamesa sp.		x																			
Ptychopteridae	Bittacomorpha sp.															1						
Limoniidae	Pilaria sp.											1										

Coding: x in Columns C - D means the species or genus is present; a number in Columns E - J is the count of individuals.

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WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 27

Susan Cormier, EPA ORD, Review of "An Evaluation of a Field-Based Aquatic Benchmark for Specific Conductance in Northeast Minnesota," Prepared by B. L. Johnson and M. K. Johnson, February 4, 2016.

REVIEW: "An Evaluation of a Field-Based Aquatic Benchmark for Specific Conductance in Northeast Minnesota" (November 2015). Prepared by B. L. Johnson and M. K. Johnson for WaterLegacy.

PREPARER: Susan M. Cormier, Ph.D.
National Center for Environmental Assessment—Cincinnati,
Office of Research and Development, U.S. EPA

DATE: February 4, 2016

Introduction

The evaluation by Johnson and Johnson (2015) examined the ionic mixtures of mining effluents and their impact on northeast Minnesota waters. The authors made the following inference: Because organisms (benthic macroinvertebrates) are extirpated in Appalachian streams by mineral additions that increase specific conductivity (SC)[1] to 300 microsiemens per centimeter (µS/cm) where natural background is 146 µS/cm (U.S. EPA, 2011), then organisms in waters of northeast Minnesota waters are likely to be affected by the same levels given a similar mineral composition.

"Northeast Minnesota waters" defined by Johnson and Johnson (2015) refers to a portion of the Northern Lakes and Forests Level III Ecoregion 50 (Omernik, 1987), which includes parts of the Boundary Lakes and Hills (50n), the northern portion of Toimi Drumlins (50p), and North Shore Highlands (50t). The Minnesota Pollution Control Agency (MPCA, 2016) describes the Northern Lakes and Forests on their website:

> "This heavily forested ecoregion is made up of steep, rolling hills interspersed with pockets of wetlands, bogs, lakes and ponds. Lakes are typically deep and clear, with good gamefish populations. These lakes are very sensitive to damage from atmospheric deposition of pollutants, storm water runoff from logging operations, urban and shoreland development, mining, inadequate wastewater treatment, and failing septic systems" (MPCA accessed 1/5/2016).

[1] This review uses conductivity as a measure of ionic concentration rather than as description of an electrical property of water. As ionic concentration increases, conductivity increases. Both specific conductivity and specific conductance are often used synonymously in the open literature indicating normalization or measurement at 25°C. Conductivity is a property of water expressed in units of micro-Siemens per centimeter (µS/cm). Conductance of a sample or electrical component is measured as Siemens (S). All measurements in this review refer to specific conductivity, µS/cm at 25°C and background is estimated as the 25th centile of SC measurements.

The Johnson and Johnson (2015) evaluation describes the ionic mixture of effluents in northeast Minnesota. In Appalachia (U. S. EPA, 2011) and northeast Minnesota, the ionic mixture is dominated by bicarbonate and sulfate anions and calcium and magnesium cations (Thingvold et al., 1979). This finding is consistent with dominant ions for Ecoregion 50 (including Minnesota, Wisconsin, and Michigan) reported by Griffith (2014), whose study Johnson and Johnson (2015) did not cite. The data set used in the Johnson and Johnson study had a reported mean (note: not the 25th centile) background SC of 68 µS/cm in the defined regions of Ecoregion 50 (parts of 50n, 50p, and 50t). This is less than the 25th centile SC of the data set used in the development of the central Appalachian benchmark (146 µS/cm). The Johnson and Johnson (2015) report provides evidence that where the SC is high, there are disturbed environments. In particular, the mean and maximum SC in their study area increase below mineral effluent discharges associated with mines in the northeast region of Minnesota.

The study also provides evidence that benthic invertebrates are adversely affected where SC is greater than background. Where SC is greater than background, benthic invertebrate diversity and abundance decreases and the proportion of dominant genera increases. Attachment A, Table 1 of Johnson and Johnson (2015) identified the genera occurring in both central Appalachia and northeast Minnesota.

Overall, the weight of evidence supports the inference that effluents that increase waterbody SC to more than 300 µS/cm have adverse effects in northeast Minnesota waters. Using effect levels developed in central Appalachia, more than 5% of these shared genera are likely to be extirpated in waters with SC >300 µS/cm.

Confirmation using independent data sets

Benthic invertebrate and water quality data sets collected by the MPCA had been made available to the U.S. Environment Protection Agency (EPA) for research on stressor-response relationships. These data are used here to assess the validity of the Johnson and Johnson's findings. In Ecoregion 50, the MPCA data set consists of 40,585 water chemistry samples collected from less than 2000 sites between 1996−2013, with most of the water chemistry samples collected from repeated sampling in the same location in the same year between June and September. Annual site averages (geometric means) for SC and several other measured water quality parameters were calculated. The mean, median, minimum, maximum, and several quantiles for the population of sites in the data set are shown in Table 1.

Table 1. Summary statistics of annual geometric mean water chemistry parameters for Ecoregion 50 (MPCA, 1996−2013) prepared for this review. Mean, minimum, 5th–95th quantiles, and maximum are shown.

Parameter	*N*	Mean	Min	5th	10th	25th	50th	75th	90th	95th	Max
SC (µS/cm)	1,409	210	23	64	83	135	222	338	461	567	1,458
Alk (mg/L, unfiltered)	293	78.4	7.9	17.1	24.8	47.0	90.8	142	220	249	363
Chl a (µg/L)	200	2.3	0.5	0.8	1.0	1.5	2.3	3.7	5.2	6.6	14.6
DO (mg/L)	1,362	8.8	0.1	4.7	5.8	7.5	9.0	10.2	11.3	11.9	17.2
NH_3 (mg/L)	616	0.06	0.00	0.02	0.03	0.04	0.05	0.07	0.14	0.22	1.24
NO_x (mg/L)	850	0.09	0.00	0.02	0.03	0.05	0.07	0.15	0.34	0.63	20.8
OP (filtered, mg/L)	149	0.015	0.004	0.005	0.006	0.010	0.012	0.025	0.045	0.078	0.32
OP (unfiltered, mg/L)	339	0.013	0.001	0.005	0.005	0.007	0.011	0.020	0.037	0.058	0.61
TDS (mg/L)	165	170	49	62	70	117	200	250	307	372	780
TKN (mg/L)	632	0.77	0.20	0.43	0.50	0.59	0.74	0.96	1.29	1.54	3.91
TN (mg/L)	799	0.84	0.12	0.44	0.50	0.62	0.79	1.05	1.49	1.95	21.5
TP (mg/L)	1,151	0.043	0.003	0.015	0.019	0.026	0.042	0.066	0.102	0.154	0.91
Transp (cm)	1,768	71.5	4.9	33.6	45	60	79	99	100	100	122
TSS (mg/L)	1,217	6.4	1.0	1.7	2.0	3.0	5.1	10.4	28.3	50.9	1,076
Turbidity (NTU)	223	8.1	0.6	1.7	1.9	2.9	5.9	17.1	52.2	117.0	453

Alk = alkalinity; Chl a = chlorophyll a; DO = dissolved oxygen; NH_3 = ammonia; NO_X = oxides of nitrogen; OP = orthophosphate; TDS = total dissolved solids; TKN = total Kjeldahl nitrogen; TN = total nitrogen; TP = total phosphorous; Transp = transparency; TSS = total suspended solids; NTU = nephelometric turbidity units.

Background conductivity

The 25th centile of all samples from the MPCA data set (years: 1996−2013) was used to estimate the background SC for seven Level III ecoregions in Minnesota (see Figure 1). The estimated background SC for the entire Level III Ecoregion 50 in northeastern Minnesota is 135 µS/cm (90% confidence interval [CI] 130−140 µS/cm, N = 1,409). A number of the MPCA sampling sites had paired biological and chemical measurements. The 25th centile estimated background SC for sites with paired MPCA biological and chemical measurements was 108 µS/cm (90% CI 97−116 µS/cm, N = 735). Estimates were not made for the Level IV Ecoregions. Using either data set, Ecoregion 50 has the lowest background SC among the ecoregions in Minnesota (see Figure 1).

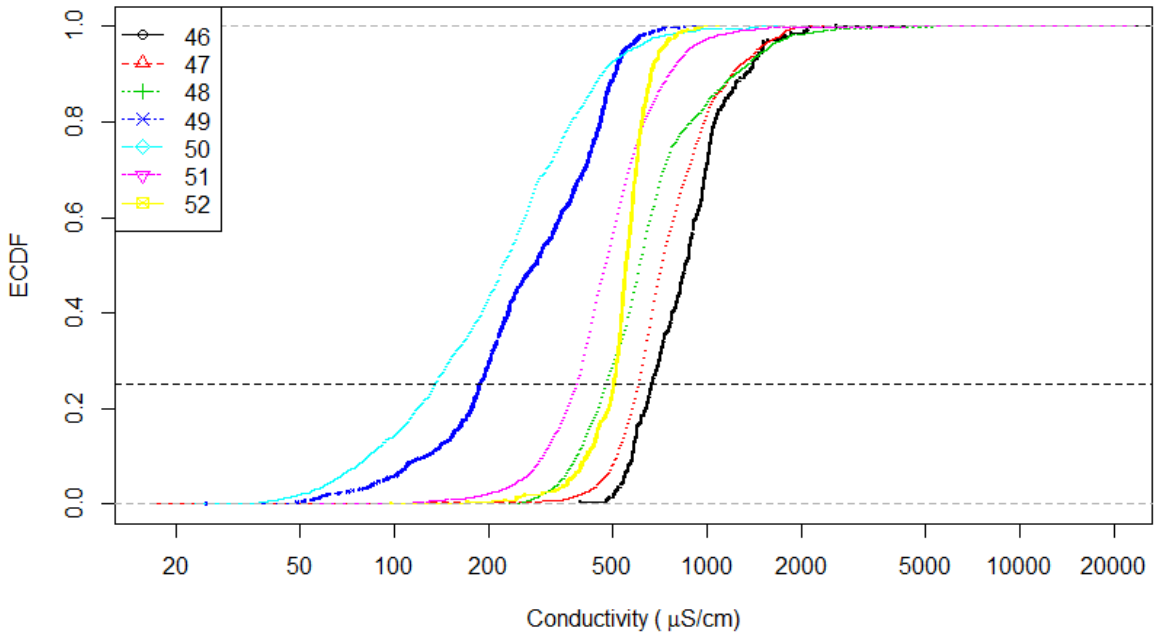


Figure 1. **Empirical cumulative distribution function (ECDF) of annual geometric mean conductivity values in ecoregions of Minnesota.** The dark horizontal dashed line is the 25th centile of ECDF. Ecoregion 50 is the Minnesota ecoregion with the lowest background SC and is plotted at the far left in turquoise (data: MPCA, 1996−2013).

Another water chemistry analysis was published in 2014 by Griffith for the entire Ecoregion 50 extending from northeastern Minnesota through Wisconsin and into northern Michigan. These published results were generated from data sets compiled from several EPA surveys that used probability-based sampling designs (Griffith, 2014). The 25th centile SC for that data set at the Level III Ecoregion 50 was 111 µS/cm (N = 151), which is less than in the Appalachian study data set.

In comparison, Table 2 contains values from the Minnesota Environmental Quality Board MEQB (1979), which were collected between 1975 and 1977. This earlier sampling effort is confined to an area of interest consisting of 14 watersheds that are included in the Johnson and Johnson evaluation (2015). The median stream SC is reported as 55 µS/cm. Johnson and Johnson (2015) report a mean of 68 µS/cm using data from a comparable time period. Both values are less than the 25th centile background in Appalachia streams (U.S. EPA, 2011).

Based on these independent data sets, it appears that, currently and 40 years ago, the background SC in the study area has been less than the background estimated from the data set used to derive the conductivity benchmark for the combined Appalachian Ecoregions 69 and 70 (U. S. EPA, 2011). This confirms the Johnson and Johnson claim.

Table 2. Data from Minnesota Environmental Quality Board collected between 1975 and 1977 from streams in "Group C stations" and reproduced here for the reader's convenience

Parameters	Median stream value
Specific conductivity (µS/cm) (25°C)	55
Al (µg/L)	90
As (µg/L)	0.8
Ca (mg/L)	6.0
Cd (µg/L)	0.03
Cl (mg/L)	1.6
Co (µg/L)	0.4
Cu (µg/L)	1.3
Fe (µg/L)	560
F (mg/L)	310
Hg (µg/L)	0.08
K (mg/L)	0.6
Mg (mg/L)	3
Mn (µg/L)	35
Na (mg/L)	1.6
Ni (µg/L)	1.0
Pb (µg/L)	0.5
Zn (µg/L)	2.0
Alkalinity (mg/L))($CaCO_3$)	19
TOC (mg/L)	15
P-total (µg/L)	20
Total Nitrogen (mg/L)	0.79
SO_4 (mg/L)	6.6
pH	6.9
Color (Pt-Co scale)	90.2
Silica (mg/L)	6.3

TOC = total organic carbon; P-total = total phosphorous; Pt-Co = platinum-cobalt.

Biological effect

Extirpation is the loss of a taxon from its normal habitat, such as a portion of a stream or geographic area. For this review, the concentration resulting in extirpation is defined as the SC level above which less than 5% of observations of a genus were made in an ecoregion, an extirpation concentrations (XC_{95}) (U. S. EPA, 2011).

Johnson and Johnson (2015, Attachment A, Table 1 of their report) identified the benthic macroinvertebrate genera occurring in both Appalachia and northeast Minnesota streams. They used XC_{95} values for Appalachian genera to evaluate extirpation of the same genera in northeast Minnesota streams. Using effect levels developed in central Appalachia, more than 5% of these shared genera are likely to be extirpated in waters with SC >300 µS/cm. Because Johnson and Johnson did not use Minnesota data to calculate effect levels for individual genera in northeastern Minnesota streams, there is uncertainty whether the species comprising a genus in Minnesota is similar enough to those in West Virginia for comparison. This point is important because the extirpation concentration (XC_{95}) values represent the effect level for the most tolerant species in that genus.

We were able to overcome this limitation for this review because we had a paired biological and SC data from Ecoregion 50 in Minnesota. Using the MPCA data set, we directly calculated XC_{95} levels for benthic invertebrates in northeastern Minnesota streams. Then, we used these Ecoregion 50-Minnesota XC_{95} values to predict the SC at which 5% of benthic invertebrate genera are likely to be extirpated.

Estimation of specific conductivity (SC) likely to cause extirpation

Paired biological and chemical data were analyzed using the MPCA data set from 1996−2013 (see Figure 2) and using the methods described in EPA (2011). XC_{95} values were calculated for 164 genera (see Table 3) that occurred at $\geq$25 sites in the MPCA paired data set (see Figure 2) using the methods in EPA (2011). Although the number of sites was modest (number of samples was 734, number of sites was 596) and the range of SC values is limited, the tolerance range was defined for more than 12% of genera that were analyzed, which allowed confident estimation of the SC that would result in the loss of 5% of genera.

Estimation of the specific conductivity (SC) likely to extirpate 5% of genera

In this review, extirpation of 5% of genera was used as the effect threshold. The SC level predicted to cause 5% extirpation is referred to as the hazardous concentration (HC_{05}) (U.S. EPA, 2011). Using the available data set, the interpolated 5th centile of the ranked XC_{95} values (HC_{05}) for Ecoregion 50 in Minnesota is 320 µS/cm. Note that even if a genus is not extirpated at the HC_{05}, the abundance or ecoregion occurrences may still be reduced. The

Minnesota HC_{05} for Ecoregion 50 (320 µS/cm) is similar to the HC_{05} of the Appalachian study (295 µS/cm).

Most samples in the MPCA data set were collected during August and September, and many salt-intolerant genera may not have been collected because they are more likely to be collected earlier in the year. Therefore, this HC_{05} may be higher than would be obtained with a data set that included more mayfly genera which are collected in the spring and tend to be among the more intolerant genera. Also, the estimated HC_{05} is for this review only and it does not represent a benchmark for Ecoregion 50. Additional analyses are recommended to evaluate the seasonal effects in the data set that was used for the estimate.

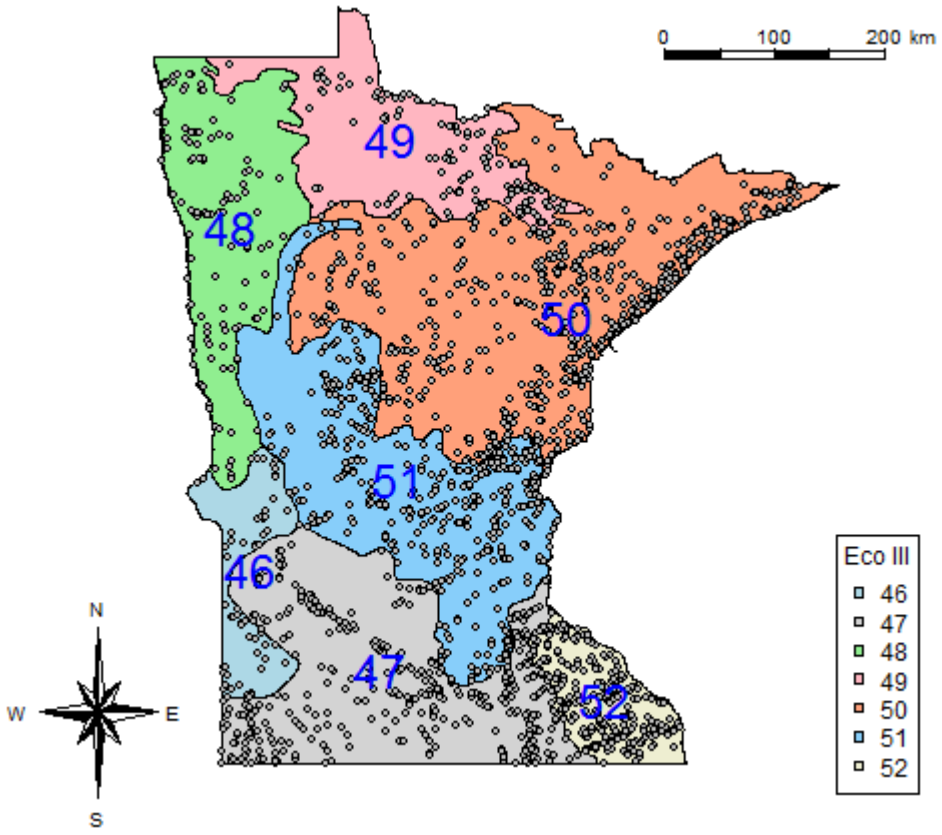


Figure 2. **Ecoregion 50 is contained in the orange area in the northeast portion of Minnesota.** Circles represent paired biological and water quality sampling sites. There are fewer samples in the area bordering Canada, often referred to as the boundary waters, which are less accessible for sampling.

Table 3. XC_{95} values for 164 genera with ≥25 occurrences in Ecoregion 50 of Minnesota prepared for this review

Genus	XC_{95} µS/cm	Samples	Genus	XC_{95} µS/cm	Samples	Genus	XC_{95} µS/cm	Samples
Dolophilodes	191	82	*Protoptila*	717	106	*Rheotanytarsus*	912	477
Epeorus	201	94	*Psychomyia*	717	71	*Tvetenia*	912	347
Rhyacophila	254	35	*Pycnopsyche*	717	51	*Nilothauma*	1,008	71
Ophiogomphus	272	73	*Chimarra*	719	277	*Dicranota*	1,029	70
Serratella	283	40	*Ephemera*	719	44	*Chrysops*	1,110	38
Boyeria	298	117	*Ephemerella*	719	144	*Clinotanypus*	1,110	31
Agnetina	302	25	*Nyctiophylax*	719	30	*Gammarus*	1,110	40
Trissopelopia	327	25	*Paratendipes*	719	67	*Sigara*	1,110	52
Xenochironomus	335	36	*Pteronarcys*	719	82	*Ceraclea*	1,134	140
Larsia	338	25	*Stenonema*	719	184	*Neophylax*	1,134	26
Paraponyx	338	33	*Dixa*	736	28	*Nigronia*	1,134	101
Eurylophella	357	151	*Neoplea*	736	71	*Potthastia*	1,134	30
Stictochironomus	361	46	*Stenochironomus*	736	205	*Stempellina*	1,134	112
Helisoma	374	95	*Xylotopus*	736	64	*Chironomus*	1,138	86
Lopescladius	390	60	*Hexagenia*	829	32	*Zavrelimyia*	1,138	34
Leptophlebia	416	43	*Stenacron*	859	125	*Micrasema*	1,182	162
Leucrocuta	435	124	*Acroneuria*	867	225	*Antocha*	1,185	123
Labiobaetis	456	55	*Atherix*	867	211	*Cryptochironomus*	1,185	83
Plauditus	464	38	*Endochironomus*	867	53	*Dicrotendipes*	1,185	197
Triaenodes	502	58	*Isonychia*	867	98	*Glyptotendipes*	1,185	47
Nilotanypus	510	50	*Neureclipsis*	867	127	*Taeniopteryx*	1,185	33
Nectopsyche	529	56	*Labrundinia*	872	198	*Conchapelopia*	1,353	51
Liodessus	559	73	*Oecetis*	872	329	*Gyraulus*	1,353	107
Procloeon	568	131	*Paragnetina*	872	161	*Hydropsyche*	1,353	294
Callibaetis	620	26	*Sublettea*	872	28	*Limnephilus*	1,353	25
Cryptotendipes	620	35	*Tricorythodes*	872	141	*Nanocladius*	1,353	140
Valvata	620	26	*Enallagma*	879	53	*Tanytarsus*	1,353	511
Ancyronyx	626	45	*Parakiefferiella*	879	134	*Thienemannimyia*	1,353	524
Hexatoma	626	37	*Brachycentrus*	882	113	*Hydraena*	1,370	86
Atrichopogon	630	29	*Macronychus*	882	159	*Ablabesmyia*	1,412	297
Acentrella	650	164	*Rheocricotopus*	882	163	*Helicopsyche*	1,412	213
Cardiocladius	650	30	*Probezzia*	912	40	*Maccaffertium*	1,412	244
Glossosoma	650	191	*Psectrocladius*	912	105	*Microtendipes*	1,412	412

Table 3. XC_{95} values for 164 genera with ≥25 occurrences in Ecoregion 50 of Minnesota prepared for this review (continued)

Genus	XC_{95} µS/cm	Samples	Genus	XC_{95} µS/cm	Samples	Genus	XC_{95} µS/cm	Samples
Pseudochironomus	1,412	27	*Anacaena*	1,594	39	*Dixella*	1,998	102
Stenelmis	1,412	302	*Anopheles*	1,594	79	*Eukiefferiella*	1,998	198
Tribelos	1,412	66	*Baetis*	1,594	402	*Ferrissia*	1,998	348
Thienemanniella	1,417	259	*Ceratopsyche*	1,594	436	*Haliplus*	1,998	109
Micropsectra	1,426	275	*Cladotanytarsus*	1,594	97	*Hydatophylax*	1,998	88
Polypedilum	1,442	628	*Dubiraphia*	1,594	371	*Iswaeon*	1,998	87
Cricotopus	1,447	508	*Gyrinus*	1,594	60	*Limnophyes*	1,998	69
Hemerodromia	1,447	308	*Hyalella*	1,594	436	*Mystacides*	1,998	95
Parachironomus	1,447	34	*Lype*	1,594	62	*Orconectes*	1,998	54
Pentaneura	1,447	56	*Simulium*	1,594	463	*Orthocladius*	1,998	219
Corynoneura	1,451	274	*Somatochlora*	1,594	35	*Paraleptophlebia*	1,998	217
Cheumatopsyche	1,458	422	*Tipula*	1,594	120	*Paramerina*	1,998	120
Hydroptila	1,458	223	*Physa*	1,818	387	*Parametriocnemus*	1,998	286
Isoperla	1,458	42	*Caenis*	1,825	369	*Phaenopsectra*	1,998	187
Optioservus	1,458	401	*Acerpenna*	1,998	251	*Polycentropus*	1,998	138
Oxyethira	1,458	233	*Aeshna*	1,998	79	*Procladius*	1,998	205
Paratanytarsus	1,458	238	*Baetisca*	1,998	41	*Pseudocloeon*	1,998	82
Amnicola	1,527	80	*Belostoma*	1,998	75	*Ptilostomis*	1,998	97
Bezzia	1,527	94	*Brillia*	1,998	118	*Sialis*	1,998	88
Cordulegaster	1,527	29	*Caecidotea*	1,998	39	*Stempellinella*	1,998	330
Fossaria	1,527	49	*Calopteryx*	1,998	259	*Synorthocladius*	1,998	47
Lepidostoma	1,527	267	*Centroptilum*	1,998	67			

Conclusion

The results of the analyses performed for this review support the conclusions of Johnson and Johnson (2015) concerning the effects of SC on benthic invertebrates.

1. Independent data sets from different decades confirm Johnson and Johnson's conclusion that the background SC in Ecoregion 50 in Minnesota is less than the background of the data set used to develop the SC benchmark for Ecoregions 69 and 70 in Central Appalachia. Hence, a benchmark value for SC in Ecoregion 50 is not expected to be greater than the benchmark for central Appalachia, i.e. 300 µS/cm.

2. Likewise, the inference that 5% extirpation of benthic invertebrates would occur at similar conductivity levels in central Appalachia and Ecoregion 50 in Minnesota was supported by analysis of an independent data set of paired benthic invertebrate and SC data from Ecoregion 50 in Minnesota. We estimated that more than 5% of genera would be extirpated in streams greater than 320 µS/cm. However, additional analyses are needed to evaluate the effect of seasonal collection.

3. Johnson and Johnson evaluated biological effects where SC was greater than background at several mine sites and streams draining in or near the mines. SC associated with discharges and mine pits exceeded 300 µS/cm. For some sites, dilution may reduce the SC below 300 µS/cm in the waterbody, but the data are not shown and may not be available for all sites. In other cases, SC is very high (>1,000 µS/cm) and biological effects have been reported by MPCA. The severity of the effects are consistent with effects expected for increased level of SC.

4. Metal contamination, habitat alteration, temperature, and nutrient enrichment may contribute to biological effects at some of the mine sites. These stressors may exacerbate the effect, but the extirpation due to SC would still occur if these stressors were removed based on removal of other stressors and persistent effects observed in Appalachia when only conductivity was high and other stressors were low or absent (U.S. EPA, 2011; Timpano et al., 2015; Cook et al., 2015).

Johnson and Johnson (2015) make several recommendations based on their findings. These are policy decisions and are not part of this scientific review.

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WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 28

EPA, Review of Revisions to the Fond du Lac Band of Lake Superior Chippewa's Water Quality Standards Under Section 303(c) of the Clean Water Act, October 5, 2020.

EPA's Review of Revisions to the
Fond du Lac Band of Lake Superior Chippewa's Water Quality Standards
Under Section 303(c) of the Clean Water Act
WQSTS # TR2018-1280

Date: October 5, 2020

I. Executive Summary

Section 303(c)(1) of the Clean Water Act (CWA) requires that, every three years, states and authorized tribes[1] hold public hearings for reviewing and, as appropriate, updating water quality standards (WQS) (i.e., the "triennial review"). The objective of this requirement is to ensure that state and tribal WQS reflect current science and public policy. On August 6, 2020, the U.S. Environmental Protection Agency received a triennial review submission from the Fond du Lac Band of Lake Superior Chippewa (hereafter referred to as "Fond du Lac" or "the Band") containing revisions to the Band's WQS rules found in the Band's Ordinance # 12/98[2]. Fond du Lac's rule revisions include changes to the Band's antidegradation implementation procedures, adoption of numeric nutrient criteria, adoption of EPA's recommended criteria for ammonia to protect aquatic life, adoption of a specific conductance criterion to protect aquatic life, and adoption of WQS applicable to wetlands.

As discussed in Section II of this document, EPA has determined that these rule revisions are consistent with the relevant requirements of the CWA and federal regulations at 40 CFR parts 131 and 132 and therefore approves the WQS revisions. Consistent with the requirements of the Endangered Species Act (ESA), EPA evaluated the potential impacts of its approval of the WQS revisions on federally-protected species and designated critical habitat and determined that consultation with the U.S. Fish and Wildlife Service (FWS) is necessary. As discussed in Section III of this document, EPA developed a biological evaluation (BE) that evaluates potential effects of its approval and sent it to FWS on September 18, 2020, seeking concurrence with EPA's conclusion that approval of the Band's WQS revisions may affect, but is not likely to adversely affect, federally-listed species. Lastly, as discussed in Section IV of this document, EPA provided substantive opportunity for all tribes with treaty rights near the Fond du Lac Reservation to provide input on EPA's decision-making process and has therefore fulfilled its duty to consult on a government-to-government basis with federally-recognized tribes on actions that may affect tribal interests, consistent with the "*EPA Policy on Consultation and Coordination with Indian Tribes*."

[1] "Authorized tribes" in this document refers to those federally recognized Indian tribes with authority to administer a CWA Section 303(c) WQS program. Under EPA's regulations at 40 CFR § 131.4(c), a tribe that is eligible to administer WQS is likewise eligible to administer CWA Section 401 water quality certifications.

[2] Fond du Lac Band of Lake Superior Chippewa Water Quality Standards of the Fond du Lac Reservation Ordinance #12/98, as amended by Resolution #1321/20 of the Fond du Lac Reservation Business Committee on July 8, 2020 [hereafter, "Ordinance #12/98, Amended, [Section]"]. Fond du Lac Band's previously federally approved Water Quality Standards are hereafter referenced as "Ordinance #12/98, [Section]."

II. EPA Review of Fond du Lac's Submittal

WQS requirements of CWA sections 101(a)(2) and 303(c)(2) are implemented through federal regulations contained in 40 CFR Part 131. WQS requirements of CWA Section 118, specific to waters of the Great Lakes System, are implemented through federal regulations contained in 40 CFR Part 132. Consistent with federal regulations at 40 CFR § 131.21, new or revised WQS do not become applicable WQS for CWA purposes until they are approved by EPA. The criteria by which EPA evaluates a state or authorized tribe's adopted WQS are identified in 40 CFR §§ 131.5(a)(1) through (a)(8). Because the revisions included in this rule package do not grant any WQS variances, affect any tribal adopted provisions authorizing the use of schedules of compliance or affect any tribal standards that do not include the uses specified in Section 101(a)(2) of the CWA, the WQS requirements in 40 CFR §§ 131.5(a)(4), (5) and (7) are not relevant in considering whether to approve Fond du Lac's new or revised WQS. EPA's review of each of the applicable criteria of Part 131 can be found in sections II.A - D. EPA's review for consistency with the WQS requirements specific to waters of the Great Lakes System in 40 CFR Part 132 can be found in Section II.E.2.

A. Whether the State or Authorized Tribe has adopted designated water uses that are consistent with the requirements of the CWA. (40 CFR § 131.5(a)(1))

Section 101(a)(2) of the CWA states:

> it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983.

Section 303(c)(2)(A) of the CWA requires states and authorized tribes to establish WQS for their waters, taking into consideration the use of waters for "propagation of fish and wildlife" among other uses. 40 CFR § 131.10 governs designation of uses for surface waters. With respect to the uses specified in Section 101(a)(2) of the CWA (hereafter collectively referred to as "101(a)(2) uses"), states and authorized tribes must adopt uses consistent with those specified in Section 101(a)(2) of the CWA or demonstrate why attaining these uses is not feasible through a use attainability analysis (UAA). With respect to uses not specified in Section 101(a)(2) of the CWA (hereafter collectively referred to as "non-101(a)(2) uses"), states and authorized tribes are not required to designate waters with those uses but must submit documentation justifying how their consideration of the use and value of the water for those uses appropriately supports such a designation. As specified at 40 CFR §§ 131.10(g) and (h)(1), states and authorized tribes may not remove a designated use if it is an existing use.

1. Definition of the Band's cultural use designation

The Band's existing WQS include a cultural use designation at Ordinance #12/98, Section 302(e) that applies to wild rice waters and aesthetic waters. The Band's revisions clarify the cultural use by adding the following general definition:

> Water-based activities essential to maintaining the Band's cultural heritage, including but not limited to ceremony, subsistence fishing, hunting and harvesting. This use includes primary and secondary contact. Ordinance #12/98, Amended, Section 302(E).[3]

Fond du Lac's cultural use designation is not intended to protect aquatic life or recreation in and on the water[4] and, thus, is a non-101(a)(2) use. As discussed in Section II.A above, states and authorized tribes are not required to establish non-101(a)(2) uses but where they choose to do so, Section 303(c)(2)(A) of the CWA provides that such standards shall be established "taking into consideration their use and value for public water supplies, propagation of fish and wildlife, recreational purposes, and agricultural, industrial, and other purposes."

The Band's revisions do not alter the use designations for any individual waterbodies but only clarify the definition of the existing cultural use by providing examples of the types of water-based activities intended to be protected by the cultural use. Additionally, the revision does not limit protection under the cultural use to only those activities listed in the definition and, thus, would not prevent the Band from applying the cultural use to any water-based activities previously considered to be "essential to maintaining the Band's cultural heritage." Because the adopted revisions do not change the level of protection provided by the Band's cultural use designation, EPA concludes that Fond du Lac's revisions to its cultural use designation at Section 302(e) (now denoted as 302(E)) are consistent with the CWA and 40 CFR § 131.10.

2. Wetland designated use

Fond du Lac's adopted revisions establish a new wetland designated use defined in Chapter 7 of the Band's WQS Ordinance as follows:

> For all wetlands, as defined by the Cowardin classification scheme, the uses to be protected include, but are not limited to: baseflow discharge, cultural opportunities, flood flow attenuation, groundwater recharge, indigenous floral and faunal diversity and abundance, nutrient cycling, organic carbon export/cycling, protection of downstream water quality, recreation, resilience against climatic effects, sediment/shoreline stabilization, surface water storage, wild rice, and water-dependent wildlife to the extent that such uses, functions, and values occur as represented by reference wetlands. Ordinance #12/98, Amended, Section 701.

The Band's additional revisions at Ordinance #12/98, Amended, Section 302(I) apply the newly adopted wetland designated use to all wetlands in the Fond du Lac Reservation.

To develop the wetland designated use, the Band used EPA's *Templates for Developing Wetland Water Quality Standards* (hereafter referenced as "Wetland WQS Templates" and accessible at https://www.epa.gov/wqs-tech/templates-developing-wetland-water-quality-standards). As

[3] EPA notes that the Band's previously approved WQS used lower case letters to denote subsections within Section 302 and that the Band's current submittal includes relabeling these subsections with capital letters.
[4] While the Band's revised definition states that the use includes "primary and secondary contact," the rest of the definition indicates that the contact with the water would occur as part of water-based activities related to the Band's cultural heritage and, thus, is not intended to protect water-based recreation activities.

discussed in EPA guidance *Narrative Templates for Wetland Water Quality Standards Frequently Asked Questions* (May 2016) (hereafter referenced as "Narrative Templates FAQs"), the templates are intended for states and authorized tribes "to use to simplify and streamline the development of protective standards that will guide maintenance of the spatial and functional components of wetlands."

The Band's definition of the wetland designated use includes protection for both aquatic life ("indigenous floral and faunal diversity and abundance" and "water-dependent wildlife") and recreation and, thus, includes the uses specified in Section 101(a)(2) of the CWA. As discussed above, Section 302(I) of the Band's revised WQS ensures that the wetland designated use, which includes the 101(a)(2) uses, applies to all wetlands in the Fond du Lac Reservation.

Because the Band's wetland designated use includes the uses specified in Section 101(a)(2) of the CWA and the Band's revised WQS apply those uses to all wetlands in the Fond du Lac Reservation, EPA concludes Fond du Lac's wetland designated use and the application of that use to all wetlands are consistent with the CWA and 40 CFR § 131.10.

3. Downstream protection provision

Fond du Lac's WQS revisions establish a new provision at Section 301(q) requiring that:

> All waters of the Reservation shall maintain a level of water quality that provides for the attainment and maintenance of the water quality standards of downstream waters, including the downstream waters of a state or another federally-recognized tribe. Ordinance #12/98, Amended, Section 301(q).

Federal WQS regulations at 40 CFR § 131.10(b) require that:

> In designating uses of a water body and the appropriate criteria for those uses, the State[5] shall take into consideration the water quality standards of downstream waters and shall ensure that its water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters.

The Band's revision at Section 301(q) requires the attainment and maintenance of WQS in downstream waters, consistent with 40 CFR § 131.10(b), and, thus, EPA concludes that Ordinance #12/98, Amended, Section 301(q) is consistent with the CWA and 40 CFR § 131.10.

4. Natural background provision

Fond du Lac inserted a new provision into the introductory language of Section 302 of its WQS that provides:

> Some waters of the Reservation may have natural ambient water quality containing concentrations of parameters that exceed water quality criteria necessary for the

[5] As defined at 40 CFR § 131.3(j), the term "state" as it is used in 40 CFR Part 131 includes "Indian Tribes that EPA determines to be eligible for purposes of the water quality standards program."

> protection of a designated use. Natural ambient water quality is defined as the quality in absence of human caused additions of a substance, and shall be determined by water quality monitoring. Designated uses will not be used to control, and are not invalidated by, natural ambient water quality. Ordinance #12/98, Amended, Section 302.

Fond du Lac's revision does not modify the designated use or criteria for any specific waterbody but only establishes the Band's general intention that designated uses reflect natural ambient water quality.

Federal rules regarding designated uses at 40 CFR § 131.10(g)(1) allow states and authorized tribes to modify designated uses based on a use attainability analysis demonstrating, among other factors, that "[n]aturally occurring pollutant concentrations prevent the attainment of the use" and, thus, EPA concludes that Fond du Lac's revision to the introductory language of Section 302 is consistent with the CWA and 40 CFR § 131.10.

As discussed above, Fond du Lac's adopted revision does not modify the designated use or criterion for any specific waterbody but only provides a factor that Fond du Lac will consider in the future. Any individual designated use change or site-specific criterion that Fond du Lac may adopt using these rules will be case-specific and must be submitted to EPA for approval under Section 303(c) of the CWA, taking into consideration the documentation supporting Fond du Lac's decision to adopt any given designated use or criterion change. For such future submittals, EPA will approve those designated use changes that are consistent with the federal regulations at 40 CFR § 131.10 and those criteria that are consistent with 40 CFR § 131.11.

B. Whether the State or Authorized Tribe has adopted criteria that protect the designated water uses based on sound scientific rationale consistent with §131.11. (40 CFR § 131.5(a)(2))

40 CFR § 131.11(a) provides that

> States must adopt those water quality criteria that protect the designated use. Such criteria must be based on sound scientific rationale and must contain sufficient parameters or constituents to protect the designated use.

40 CFR § 131.11(b) provides that states and authorized tribes should

(1) Establish numerical values based on:
  (i) 304(a) Guidance; or
  (ii) 304(a) Guidance modified to reflect site-specific conditions; or
  (iii) Other scientifically defensible methods;
(2) Establish narrative criteria or criteria based upon biomonitoring methods where numerical criteria cannot be established or to supplement numerical criteria.

1. Numeric nutrient criteria

Fond du Lac's existing narrative criterion for nutrients at Ordinance #12/98, Section 301(d) requires that, "[r]eservation waters shall be free from nutrients (nitrogen and phosphorus) entering the waters as a result of human activity in concentrations that create nuisance growths of aquatic weeds and algae." The adopted revisions modify this criterion by establishing numeric nitrogen, phosphorus and chlorophyll *a* criteria for nine primary fisheries lakes identified in Appendix 5 of Fond du Lac's WQS. As required by Ordinance #12/98, Amended, Section 301(d), the numeric nutrient thresholds for each lake will be applied as follows:

> The lakes listed in Appendix 5 will be considered in attainment with their nitrogen thresholds if the summer mean concentration for nitrogen is not exceeded. Exceedance of the summer mean total phosphorus threshold and either the summer mean chlorophyll-a threshold or the Fond du Lac Secchi disk transparency index, developed as a component of the Fond du Lac Assessment Methodology, is required to indicate a polluted condition.

The basis for the numeric nutrient criteria is described in a report prepared for the Tribe and included in the Tribe's Triennial Review Submittal. *See* Patricia Soranno, *Development of Lake-specific Numerical Nutrient Criteria for Water Quality Standards in Reservation Lakes* (May 20, 2011) (hereafter referenced as "the Soranno Report"). The Soranno Report discusses that the basis for the numeric nutrient criteria for these nine primary fisheries lakes is that each lake is currently in a minimally impacted condition, nutrients are not currently impacting designated uses, and therefore, maintenance of current ambient conditions will protect designated uses.

To reach the conclusion that the nine lakes are currently in a minimally impacted condition, the Band considered evidence detailed in the Soranno Report as well as a 2015 report: PhycoTech, Inc., *Development of Lake-specific Numerical Nutrient Criteria for Water Quality Standards in Fond du Lac Reservation Lakes: Analysis of the Phytoplankton Rapid Assay Results 1998-2012 Compared to Southern MN Lakes* (August 20, 2015) (hereafter referenced as "the PhycoTech Report"). As discussed in the Soranno Report, human land use makes up a small percentage of the watersheds of the nine lakes, which suggests that anthropogenic nutrient loading to the lakes is low. In most cases, the proportion of the watershed subject to human use was less than 5%, with 12% (in the Big Lake watershed) being the highest proportion. Additionally, the Soranno Report compared ambient phosphorus, nitrogen and chlorophyll *a* concentrations in the nine lakes with reference (non-impacted) lakes in the same ecoregion (Northern Lakes and Forests) and concluded that phosphorus and chlorophyll *a* concentrations in the nine lakes were similar to concentrations in the reference lakes. While nitrogen concentrations in the nine lakes were greater than nitrogen concentrations in the reference lakes, the Soranno Report concluded that the nine lakes were more limited by phosphorus than nitrogen and, thus, that the higher nitrogen concentrations in the nine lakes would not be expected to cause excessive algal growth. The fact that the Fond du Lac lakes did not have greater chlorophyll *a* concentrations than the reference lakes supported this conclusion.

To further support the assertion that the nine lakes are currently in a minimally impacted condition, Fond du Lac's Triennial Review Submittal also included information from the

PhycoTech Report, which evaluated data on phytoplankton communities in the nine lakes. The PhycoTech Report analyzed the results of sampling data collected by the Band between 1998 and 2012 using the phytoplankton rapid assay method. As discussed in the PhycoTech Report, because different algal taxa have different pigment composition, chlorophyll *a* measurements may not be able to detect relative changes among the different algal taxa due to nutrient inputs. Therefore, algal community composition is considered to be a more sensitive indicator of system change due to nutrient inputs than chlorophyll *a* measurements.

The PhycoTech Report determined that the composition of algal communities in the nine lakes was relatively stable over the study period, with cryptophytes, dinoflagellates, chrysophytes and diatoms dominating the algal communities in the lakes. Non-toxin-producing bluegreen algae (cyanobacteria) were consistent contributors but rarely dominated phytoplankton communities in the nine lakes. Additionally, the lakes had a low percentage of taxa that produce harmful algal blooms. The PhycoTech Report also compared phytoplankton communities in the nine Fond du Lac lakes with phytoplankton communities in Central Minnesota lakes[6] with varying levels of productivity. Using multidimensional scaling and cluster analysis, the PhycoTech Report analyzed the phytoplankton community composition in all lakes (both Fond du Lac and Central Minnesota lakes) and identified five groups of lakes. The five groups were characterized by distinct phytoplankton community characteristics. Conversely, lakes classified within the same group displayed similar phytoplankton community characteristics. The nine Fond du Lac lakes all clustered within the highest water quality group (Group 1), which was characterized by "a high proportion of [cryptophyte/dinoflagellate] and [chrysophyte/diatom] taxa, moderately low [chlorophyte], [non-toxin producing cyanobacteria] and [toxin-producing heterocystic cyanobacteria] taxa, and low [euglenophyte/other] taxa." PhycoTech Report at 14.

To evaluate the effect of using other numeric response variables and to address potential quality assurance/quality control issues, the PhycoTech Report also described a 2014 PhycoTech calibration study using phytoplankton samples collected at each lake (both Fond du Lac and the Central Minnesota lakes). The calibration study compared results based on different quantitative measures of the algal community (i.e., percent biovolume, percent cell concentration, and phytoplankton rapid assay) and phytoplankton results based on different independent algal identification analysts. The PhycoTech Report determined that "[n]one of the response variables produced significantly different clusters, consistent with the analysis of the larger database." PhycoTech Report at 16.

Since the analyses provided in the Soranno and PhycoTech reports indicated that the current condition of each lake is not affecting algal communities and that nuisance growths of aquatic weeds and algae do not currently occur on the lakes, the Band concluded that the current ambient concentrations of nitrogen, phosphorus and chlorophyll *a* in each lake would be protective of the designated use. The Soranno Report evaluated total nitrogen, total phosphorus and chlorophyll *a* data collected on each lake between 1999 and 2009 (all available data at the time the Soranno Report was written) and identified the threshold protective of current conditions as the upper 90th

[6] The Central Minnesota lakes considered in the PhycoTech Report include 38 lakes near Minneapolis, sampled by Minneapolis Parks and Recreation and Minnehaha Creek Water District. A full list of the Central Minnesota lakes can be found in Table 1 of the PhycoTech Report and maps of the Central Minnesota lakes can be found in figures 1, 3 and 4 of the PhycoTech Report.

percentile of all samples for each parameter within the summer season (July, August and September) for each lake. Accordingly, the Band set the criteria for total nitrogen, total phosphorus and chlorophyll *a* for each lake at the thresholds identified in the Soranno Report.

As discussed above, the Soranno and PhycoTech reports demonstrated that the nine lakes are currently supporting their designated uses and, thus, that maintenance of the current condition of each lake will ensure continued protection of the designated use in each lake. Additionally, as discussed in the Soranno Report, the numeric nutrient criteria are set to maintain or improve the current condition of each lake, which will ensure protection of the designated use in each lake. Therefore, EPA concludes, in accordance with 40 CFR §§ 131.5(a)(2) and 131.11(a), that Fond du Lac's numeric nutrient criteria at Ordinance #12/98, Amended, Section 301(d) and Appendix 5 are based on sound scientific rationale and are protective of Fond du Lac's aquatic life uses.

2. Ammonia

To protect the Band's aquatic life use designations, Fond du Lac adopted acute and chronic criteria for ammonia at Ordinance #12/98, Amended, Section 301(f) and Appendix 4 that are consistent with EPA's current CWA Section 304(a) criteria recommendations (EPA, "Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater," 78 *Fed. Reg.* 52191-52194 (2013)).

Consistent with Section 304(a) of the CWA, EPA publishes national recommended water quality criteria that accurately reflect the latest scientific knowledge regarding criteria necessary to protect the aquatic life uses specified in Section 101(a)(2) of the CWA. As discussed in Chapter 3 of EPA's *Water Quality Standards Handbook*[7], EPA's CWA 304(a) criteria recommendations, if not exceeded, generally ensure adequate water quality for protection of a 101(a)(2) aquatic life designated use and "[i]f a state or authorized tribe relies on 304(a) criteria recommendations (or other up-to-date EPA guidance documents), they may reference and rely on the data in those documents and may not need to create duplicative or new material for inclusion in their records." WQS Handbook, Chapter 3 at 2-3.

EPA's 2013 CWA 304(a) ammonia criteria include separate criteria recommendations for waters where salmonids in the genus *Oncorhynchus* are present and for waters where salmonids in the genus *Oncorhynchus* are absent. The Band's adopted ammonia criteria are consistent with the recommended criteria for waters where *Oncorhynchus* are present, which are the more stringent set of criteria and, thus, would also be protective of waters where *Oncorhynchus* are absent.

As discussed above, EPA's CWA 304(a) criteria recommendations are developed to ensure protection of the aquatic life uses specified in CWA Section 101(a)(2) and incorporate the latest scientific knowledge. Therefore, EPA concludes in accordance with 40 CFR §§ 131.5(a)(2) and 131.11(a) that Fond du Lac's ammonia criteria at Ordinance #12/98, Amended, Section 301(f)

[7] U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, *Water Quality Standards Handbook,* (2017) at https://www.epa.gov/wqs-tech/water-quality-standards-handbook, last accessed September 2020 (hereafter referenced as "the WQS Handbook").

and Appendix 4 are based on sound scientific rationale and protective of Fond du Lac's aquatic life uses.

3. Specific conductance

Fond du Lac's existing narrative criterion at Ordinance #12/98, Section 301(j) requires that, "[e]xisting mineral quality shall not be altered by municipal, industrial and instream activities or other waste discharges so as to interfere with the designated uses for a water body." The adopted revisions modify the Band's narrative criterion by establishing a numeric criterion for specific conductance of 300 µS/cm, not to be exceeded as an annual average. Ordinance #12/98, Amended, Section 301(k)[8].

Fond du Lac submitted the following documents to support its adoption of the 300 µS/cm numeric criterion:

- Johnson and Johnson, *An Evaluation of a Field-Based Aquatic Life Benchmark for Specific Conductance in Northeast Minnesota* (November 2015) (hereafter referenced as "the Johnson and Johnson Report") and
- Susan Cormier, EPA Office of Research and Development, *Review: An Evaluation of a Field-Based Aquatic Benchmark for Specific Conductance in Northeast Minnesota* (February 2016) (hereafter referenced as "Cormier Review").

In addition, both documents relied on and evaluated the appropriateness of applying the results of an earlier EPA study (EPA, *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams* (March 2011) (hereafter referenced as "the EPA Benchmark Report")) within the Fond du Lac Reservation.

a. EPA's 2011 Benchmark

The EPA Benchmark Report established a 300 µS/cm benchmark that is consistent with CWA Section 101(a)(2) and protective of aquatic life in parts of West Virginia and Kentucky (in ecoregions 68, 69 and 70). As discussed in the EPA Benchmark Report, conductivity levels at or below 300 µS/cm would be expected to prevent the extirpation of 95% of invertebrate genera in ecoregions 68, 69 and 70, which corresponds with the level of protection provided under EPA's 1985 Guidelines for Protection of Aquatic Organisms[9] (protection of 95% of aquatic species).

As discussed in the EPA Benchmark Report, the 300 µS/cm benchmark was derived using a field-based method modeled on EPA's 1985 methodology for deriving ambient water quality

[8] EPA notes that the Band's narrative mineral quality criterion was previously found at Section 302(j) but the Band reordered the subsections in Section 302 due to the insertion of a new subsection for the ammonia criteria to protect aquatic life at Section 302(f), as described in Section II.B.2. Therefore, the narrative mineral quality criterion is now found at Section 302(k) in the Band's amended WQS.

[9] Stephan, C., D. Mount, D. Hansen, J. Gentile, G. Chapman, and W. Brungs, *Guidelines for Deriving Numerical Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* (1985) (hereafter "Guidelines for Protection of Aquatic Organisms").

criteria for the protection of aquatic life. EPA Benchmark Report at 3. Specifically, Chapter 3 of the EPA Benchmark Report describes the field-based method, which involved three steps:

> [F]irst, the extirpation values (XCs) for each invertebrate genus was derived. Second, the XC_{95} values for all genera were used to generate [a species sensitivity distribution] and the 5th centile of the distribution, the 5th centile hazardous concentration (HC_{05}). (The HC_X terminology for concentrations derived from [species sensitivity distributions] is not in the EPA method [Stephan et al., 1985[10]], but its usage has become common more recently [Posthuma et al., 2002[11]]). Finally, background values were estimated for the regions to ensure that the benchmark is not in the background range. EPA Benchmark Report at 13.

Additionally, the EPA Benchmark Report noted that relationships between conductivity and biological responses appear to vary among different mixtures of ions and, thus, that the benchmark would not be applicable in areas with different ionic compositions. Specifically, the EPA Benchmark Report stated that the benchmark is intended to address "loss of aquatic life in the Appalachian Region associated with a mixture of salts dominated by [calcium], [magnesium], [sulfate], and [bicarbonate] at circum-neutral pH" and "might not apply when the relative concentrations of dissolved ions are not dominated by salts of [calcium], [magnesium], [sulfate] and [bicarbonate] or the natural background exceeds the benchmark." EPA Benchmark Report at 41. On the other hand, in areas where the ionic composition is analogous to that found in ecoregions 68, 69, and 70, the relationship between conductivity and biological responses should be the same.

In summary, the EPA Benchmark Report identified three factors that affect ion toxicity and, thus, the protective level of conductivity in an area:

1) The sensitivity of aquatic organisms found in the area,
2) The ionic composition of waters in the area, and
3) The natural background conductivity levels in the area.

This field-based methodology and the resulting 300 µS/cm benchmark underwent an extensive peer review process from both reviewers within EPA and external reviewers, including a review by EPA's Science Advisory Board. EPA's Science Advisory Board's Mountaintop Mining Panel concluded that "the general approach, including the use of field data and the resulting benchmark, is sound and provides a degree of protection comparable to or greater than a conventional ambient water quality criterion derived from traditional chronic toxicity testing…." U.S. Environmental Protection Agency Science Advisory Board Panel on Ecological Impacts of Mountaintop Mining and Valley Fills, *Review of Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams* (March 25, 2011) at 3.

[10] Guidelines for Protection of Aquatic Organisms (as cited in the EPA Benchmark Report).
[11] Posthuma, L., G.W. Suter II, and T.P. Traas (eds.), *Species Sensitivity Distributions in Ecotoxicology* (2002) (as cited in the EPA Benchmark Report).

b. Information provided by Fond du Lac and reviewed by EPA in applying the EPA 2011 Benchmark method to Reservation waters

To develop the conductivity criterion, the Band started by requesting that the authors of the Johnson and Johnson Report evaluate whether EPA's 2011 Benchmark would be appropriate for waters within the Fond du Lac Reservation. The Johnson and Johnson Report concluded that the 2011 300 µS/cm benchmark would be protective of aquatic life in the Fond du Lac Reservation because ion concentrations in northeast Minnesota streams are similar to the Central Appalachian streams considered in the EPA Benchmark Report, and northeast Minnesota streams contain many of the same genera as Central Appalachia that are demonstrated to be sensitive to conductivity. Johnson and Johnson Report at 12.

To evaluate Johnson and Johnson's conclusions and the scientific validity and protectiveness of the 300 µS/cm benchmark for Reservation waters, the Band subsequently requested that Susan Cormier of EPA's Office of Research and Development review the Johnson and Johnson Report. As discussed in the Cormier Review, Cormier considered the information in the Johnson and Johnson Report, as well as data from other sources, to evaluate whether the assumptions underlying the 2011 Benchmark are met in Reservation waters and to calculate the protective level of conductivity for waters in the Fond du Lac Reservation using the methods described in the Benchmark Report.

As discussed in Section II.B.3.a above, EPA's 2011 Benchmark (i.e., the scientific method used to derive the benchmark) is a scientifically sound approach for deriving criteria sufficient to protect aquatic life from adverse effects associated with a mixture of salts dominated by calcium, magnesium, sulfate and bicarbonate at circum-neutral pH. While the EPA Benchmark Report applied that method specifically to data from Central Appalachian streams, it is reasonable to assume that the same method could also be used to calculate conductivity levels protective of aquatic life outside the region covered in the Report where the assumptions underlying the approach are true. As discussed in Section II.B.3.a above, the methodology in the EPA Benchmark Report is based on the following assumptions:

1) Ionic composition in the area waters is dominated by calcium, magnesium, sulfate, and bicarbonate at circum-neutral pH, and
2) Natural background conductivity levels do not exceed the benchmark.

As discussed below, the Band's Triennial Review Submittal included documentation analyzing each of the above factors in the context of the Fond du Lac Reservation.

i. Ionic composition in the area waters is dominated by calcium, magnesium, sulfate, and bicarbonate at circum-neutral pH.

As discussed in the EPA Benchmark Report, the 300 µS/cm benchmark was derived based on biological and water chemistry data from streams where loss of aquatic life is associated with a mixture of salts dominated by calcium, magnesium, sulfate and bicarbonate at circum-neutral pH. As discussed in the EPA Benchmark Report, at the Central Appalachian sites used to derive the 300 µS/cm benchmark, pH ranged between 6 and 10, with a median pH of 7.62. A pH range

of less than 6 was found at some sites in the ecoregions, but EPA excluded those sites from the analysis to prevent potential confounding effects. EPA Benchmark Report at 10-11. Consequently, pH between 6 and 10 would be considered circum-neutral for the purposes of the benchmark method.

In seeking to translate the EPA Benchmark Report to Reservation waters, the Johnson and Johnson Report considered water chemistry data from the Minnesota Copper-Nickel Study[12]. The Minnesota Copper-Nickel Study included hundreds of water quality samples collected from 32 stream sites and 35 lake sites between March 1976 and September 1977. Based on the relative concentrations of the ions measured, Johnson and Johnson concluded that the most prevalent ions were sulfate, calcium, magnesium and bicarbonate. Additionally, pH ranged between 4.7 and 8.4, with a median of 6.9. Consequently, the Johnson and Johnson Report concluded that "[t]he key parameters in the water chemistry in the Minnesota ecoregions and the Appalachian ecoregions are similar." Johnson and Johnson Report at 12-13.

Subsequently, the Cormier Review evaluated Johnson and Johnson's results and also considered additional data from stream surveys conducted by EPA and cooperating agencies since 1985[13]. Based on the available data, The Cormier Review concluded that:

> In Appalachia (U. S. EPA, 2011)[14] and northeast Minnesota, the ionic mixture is dominated by bicarbonate and sulfate anions and calcium and magnesium cations (Thingvold et al., 1979)[15]. This finding is consistent with dominant ions for Ecoregion 50 (including Minnesota, Wisconsin, and Michigan) reported by Griffith (2014)[16], whose study Johnson and Johnson (2015) did not cite. Cormier Review at 2.

Consequently, there is a sound scientific rationale for the Band's conclusion that ionic composition in Reservation waters is dominated by calcium, magnesium, sulfate and bicarbonate at circum-neutral pH.

ii. Natural background conductivity levels do not exceed the benchmark.

As discussed in the EPA Benchmark Report, background conductivities (estimated to be equal to the 25th percentile of probability based samples) in the ecoregions for which the 300 µS/cm benchmark was derived were 72 µS/cm for Ecoregion 69, 153 µS/cm for Ecoregion 70 and 116 µS/cm when samples from both ecoregions were combined. EPA Benchmark Report at 22. When considering only reference sites in the ecoregions, background conductivities (estimated to be the 75th percentile of conductivity samples at reference sites) were 66 µS/cm for

[12] D. Thingvold, N. Sather, P. Ashbrook, *Water Quality Characterization of the Copper-Nickel Research Area* (December 1979), https://www.leg.state.mn.us/docs/pre2003/other/CN153.pdf (hereafter referenced as the Minnesota Copper-Nickel Study).
[13] M.B. Griffith, "Natural Variation and Current Reference for Specific Conductivity and Major Ions in Wadeable Streams of the Conterminous U.S.," *Freshwater Science* 33(1): 1-17 (as cited in the Cormier Review).
[14] EPA Benchmark Report (as cited in the Cormier Review).
[15] Minnesota Copper-Nickel Study (as cited in the Cormier Review).
[16] Griffith at 1-17 (as cited in the Cormier Review).

Ecoregion 69, 214 µS/cm for Ecoregion 70 and 150 µS/cm when samples from both ecoregions were combined. EPA Benchmark Report at 22.

The data from the Minnesota Copper-Nickel Study considered in the Johnson and Johnson Report indicated that median conductivity in the study area was 65 µS/cm, which is lower than both the 300 µS/cm Appalachian benchmark and the 261 µS/cm median conductivity in Central Appalachian streams used to derive the Appalachian benchmark. Johnson and Johnson Report at 12-13.

According to information submitted by the Band in its Triennial Review Submittal, the Cormier Review considered the data presented in the Johnson and Johnson Report, along with additional water chemistry data from MPCA collected between 1996 and 2013, EPA surveys in Ecoregion 50 (including Griffith 2014), and Minnesota Environmental Quality Board (MN EQB) data from 1975-1977. Cormier Review at 2-4. Table 1 summarizes these data as compared with the corresponding data from the Central Appalachian streams used to derive the Appalachian benchmark.

Based on the available data, the Cormier Review concluded that:

> Independent data sets from different decades confirm Johnson and Johnson's conclusion that the background [specific conductance] in Ecoregion 50 in Minnesota is less than the background of the data set used to develop the [specific conductance] benchmark for Ecoregions 69 and 70 in Central Appalachia. Hence, a benchmark value for [specific conductance] in Ecoregion 50 is not expected to be greater than the benchmark for central Appalachia, i.e., 300 µS/cm. Cormier Review at 9.

Consequently, there is a sound scientific rationale supporting the Band's conclusion that background conductivity levels in Reservation waters do not exceed the Central Appalachian benchmark and are similar to, or less than, conductivity levels in the waters used to derive the Central Appalachian benchmark.

Table 1. Comparison of estimates of natural background conductivity levels (µS/cm) in northeast Minnesota reported in the documents submitted by the Band with natural background conductivity levels in Central Appalachian streams reported in the EPA Benchmark Report.

Region	Ecoregion	Data Source	25th Percentile	Mean	75th Percentile (reference sites only)
Central Appalachian streams	Ecoregion 69	EPA Benchmark Report	72		66
	Ecoregion 70	EPA Benchmark Report	153		214
	Combined	EPA Benchmark Report	116		150
Northeast Minnesota	Ecoregion 50	Cormier Review (MPCA)	135	210	
	Ecoregion 50 (paired sites only)	Cormier Review (MPCA)	108		
	Ecoregion 50	Cormier Review (Griffith, 2014)	111		
	Ecoregion 50	Cormier Review (MN EQB)		55	

c. Application of 2011 Benchmark method to Reservation waters.

Because the Band concluded that the assumptions underlying the method used to calculate the 2011 EPA Benchmark are valid for Reservation waters, the Band determined that the method could be applied to Reservation waters.

As discussed in Section II.B.3.a above, the EPA Benchmark Report's 300 µS/cm threshold was calculated by first determining for each invertebrate genus the specific conductance level that is expected to extirpate the genus (XC_{95}) and then calculating the 5th percentile of the distribution of XC_{95} values, which corresponds to the specific conductance level that is expected to extirpate 5% of the genera in the ecoregion (HC_{05}). For Central Appalachian streams, EPA calculated XC_{95} values for 163 genera, which ranged between 121 and >11,646 µS/cm. The calculated HC_{05} was 295 µS/cm. EPA Benchmark Report at 18 and Appendix D.

The Cormier Review used the methods described in the EPA Benchmark Report to evaluate biological and water chemistry data collected by MPCA in Ecoregion 50 between 1996 and 2013. Cormier Review at 6. Cormier calculated XC_{95} values for each of the benthic

macroinvertebrate genera that occurred at 25 sites or more in Ecoregion 50. Data were sufficient to calculate XC_{95} values for 164 benthic macroinvertebrate genera and Cormier concluded that the data allowed for a "confident estimation of the [specific conductance] that would result in the loss of 5% of genera." Cormier Review at 6. Using the 164 XC_{95} values, Cormier calculated the specific conductance level estimated to extirpate 5% of genera (HC_{05}) to be 320 µS/cm, which is similar to the corresponding level calculated in the Appalachian study (295 µS/cm). Cormier Review at 67. Consequently, Cormier concluded that "the inference that 5% extirpation of benthic invertebrates would occur at similar conductivity levels in central Appalachia and Ecoregion 50 in Minnesota was supported by analysis of an independent data set of paired benthic invertebrate and [specific conductance] data from Ecoregion 50 in Minnesota." Cormier Review at 10.

As discussed in the EPA Benchmark Report, the benchmark method is based on exposures to aquatic organisms "throughout their life cycle" and, thus, the resulting benchmark is a chronic value. EPA Benchmark Report at 41. Research by Cormier and others in 2018, further clarified that benchmarks produced using this method are intended to be applied based on an annual average duration.[17] Accordingly, the Band set the duration of specific conductance criterion as an annual average that is not to be exceeded.

As discussed in Section II.B.3.a above, EPA's 2011 Benchmark (i.e., the scientific method used to derive the benchmark) is a scientifically sound approach for deriving a conductivity benchmark sufficient to protect aquatic life. Because application of that method to Fond du Lac waters resulted in a protective specific conductance level protective of aquatic life that is similar to, if not greater than, the 2011 EPA Benchmark (300 µS/cm), EPA finds that there is a sound scientific rationale to conclude that the 300 µS/cm specific conductance criterion would be protective of aquatic life in Reservation waters. Ordinance #12/98, Amended, Section 301(k).

d. Conclusion

In summary, the 300 µS/cm benchmark was developed using a valid scientific method to calculate the conductivity level protective of aquatic life in Central Appalachian streams. EPA Benchmark Report at 1. As discussed above, the Band's Triennial Review Submittal included information demonstrating that (1) ionic composition of Reservation waters is similar to the waters in which extirpation values were derived, and (2) natural background conductivity in Reservation waters does not exceed the benchmark and, thus, that the assumptions underlying the method used to calculate the 2011 Benchmark are valid for Fond du Lac Reservation waters. Application of the method used to calculate the 2011 Benchmark to Fond du Lac waters indicated that conductivity levels at or below 300 µS/cm on an annual average basis would protect aquatic life in Reservation waters. Therefore, the Band's submittal provided a sound scientific rationale to conclude that the 300 µS/cm benchmark is also protective of aquatic life uses in Fond du Lac's Reservation waters and is consistent with Section 101(a)(2) of the CWA. Accordingly, EPA concludes, in accordance with 40 CFR §§ 131.5(a)(2) and 131.11(a), that

[17] Cormier, et al. "Field-based method for evaluating the annual maximum specific conductivity tolerated by freshwater invertebrates," *Science of the Total Environment* 633: 1637-1646 (2018).

Fond du Lac's conductivity criterion at Ordinance #12/98, Amended, Section 301(k) is based on sound scientific rationale and protective of Fond du Lac's aquatic life uses.

4. Narrative wild rice criterion

To protect wild rice, the Band adopted a narrative criterion at Ordinance #12/98, Amended, Section 301(n) requiring that:

> Water quantity and quality and habitat alterations that may limit the growth and propagation of, or otherwise cause or contribute to an adverse effect to wild rice and other flora and fauna of cultural importance to the Band shall be prohibited.

Federal rules at 40 CFR § 131.11(a)(1)[18] require that "[s]tates must adopt those water quality criteria that protect the designated use. Such criteria must be based on sound scientific rationale and must contain sufficient parameters or constituents to protect the designated use." 40 CFR § 131.11(b)(2) provides that states and authorized tribes may "establish narrative criteria or criteria based upon biomonitoring methods where numerical criteria cannot be established or to supplement numerical criteria."

As described in Ordinance #12/98, Amended, Section 301(n), the narrative criterion is intended to protect aquatic flora and fauna of cultural importance to the Band. The Band specifically identified wild rice as an aquatic plant species of cultural importance to the Band. As part of its Triennial Review Submittal and specifically to support this adopted narrative criterion, the Band provided a report: Fond du Lac Band of Lake Superior Chippewa, *Expanding the Narrative of Tribal Health: The Effects of Wild Rice Water Quality Rule Changes on Tribal Health* (undated) (hereafter referenced as the Wild Rice Report). According to the Wild Rice Report, wild rice may be affected by multiple stressors:

> The decline in stands of natural wild rice has been linked to modified hydrology, such as extensive ditching or channelization that drains a rice bed, or inundation from dams or industrial discharges that overwhelm the shallow-rooted plants. … Shoreline development can increase runoff, sedimentation and nonpoint source pollutants. Wild Rice Report at 50.

In its review of a similar narrative criterion adopted by the Lac du Flambeau Band (*see EPA's Review of Lac du Flambeau Band of Lake Superior Chippewa Indians' Water Quality Standards Under Section 303(c) of the Clean Water Act* (September 17, 2010) (hereafter "EPA LDF Review")), EPA reviewed the scientific literature on wild rice ecology and the importance of hydrologic cycles, water quality, and habitat (e.g., sediment quality) to support the growth and development of wild rice. EPA LDF Review at 13-16. As part of its review of Fond du Lac's narrative criterion, EPA reviewed additional studies on wild rice ecology published since 2010. This research largely has focused on the effects of surface water sulfate and sediment porewater

[18] Because the narrative criterion at Ordinance #12/98, Section 301(n) does not relate to toxic pollutants, the federal rules regarding narrative criteria for toxic pollutants at 40 CFR § 131.11(a)(2) are not applicable to this provision.

sulfide on wild rice (*e.g., see* Myrbo et al. (2017)[19]), and confirms the role of water quality in supporting the growth and development of wild rice. EPA also reviewed scholarship[20] that investigated the role of water quantity and/or habitat on wild rice growth, all of which confirmed the role of water depth as a factor of wild rice growth.

The information submitted in the Band's Triennial Review Submittal is consistent with EPA's 2010 literature review and research conducted since 2010 that indicates the potential for adverse effects to wild rice through effects on water quality and hydrologic and physical modifications of waterways. Therefore, EPA finds that the Fond du Lac Band has demonstrated that its narrative criterion is consistent with the available data on wild rice ecology and ensures protection of the Band's cultural use of waters for wild rice harvesting by maintaining the conditions necessary to support wild rice growth. Consequently, EPA concludes in accordance with 40 CFR § 131.5(a)(2) and § 131.11(a) that Fond du Lac's narrative criterion at Ordinance #12/98, Amended, Section 301(n) is based on sound scientific rationale and protective of Fond du Lac's cultural use designation.

5. Narrative hydrologic conditions criterion

To protect aquatic life, Fond du Lac adopted a narrative criterion at Ordinance #12/98, Amended, Section 301(o) providing that:

> Natural hydrologic conditions supportive of the natural biological community, including all flora and fauna, and physical characteristics naturally present in the waterbody shall be protected to prevent any adverse effects. The migration of fish and other aquatic biota normally present shall not be hindered.

As provided by Ordinance #12/98, Section 301 of Fond du Lac's WQS, the narrative criterion applies to all waters of the Fond du Lac Reservation.

EPA guidance has recognized that narrative criteria may be appropriate for the protection of aquatic life from hydrologic alterations. For example, as discussed in Chapter 3 of EPA's WQS Handbook:

> The natural flow regime, defined as the characteristic pattern of flow magnitude, timing, duration, frequency, and rate of change, plays a central role in supporting the chemical, physical, and biological integrity of streams and rivers and the services they provide. Hydrologic alteration is a change to a natural flow regime and can include an increase or

[19] A. Myrbo, et al, "Sulfide Generated by Sulfate Reduction is a Primary Controller of the Occurrence of Wild Rice (*Zizania palustris*) in Shallow Aquatic Ecosystems," *Journal of Geophysical Research: Biogeosciences* 122: 2736-2753 (2017).

[20] K. Aagard, et al., "Modeling the Relationship between Water Level, Wild Rice Abundance, and Waterfowl Abundance at a Central North American Wetland," *Wetlands* 39:149-160 (2019); Z. Li, et al, "Effects of Water Depth and Substrate Type on Rhizome Bud Sprouting and Growth in *Zizania latifolia*," *Wetlands Ecology and Management* 26:277-284 (2018); R.C. Tucker, et al., "Effects of Water Depth and Seed Provenance on the Growth of Wild Rice (*Zizania aquatica* L.)," *Aquatic Botany*: 113-118 (2011); and Z. Yang, et al, "Responses of an Emergent Macrophyte, *Zizania latifolia*, to Water-level changes in Lakes with Contrasting Hydrological Management," *Ecological Engineering* 151:105814 (2020).

> decrease in water volume, seasonal pulse flow disruption, dramatic variation in water temperature, and other factors. CWA programs can incorporate strategies to protect aquatic ecosystems from the harmful effects of hydrologic alteration, and WQS programs in particular can include water quality criteria for flow to protect designated uses such as aquatic life, recreation, fishing, or shellfish harvesting. Several states and authorized tribes have adopted a narrative form of flow criteria in their WQS. EPA, WQS Handbook at 21.

Because the Band's narrative criterion applies to all surface waters and provide protection consistent with the aquatic life designated use, EPA concludes in accordance with 40 CFR §§ 131.5(a)(2) and 131.11(a) that Fond du Lac's narrative criterion at Ordinance #12/98, Amended, Section 301(n) is based on sound scientific rationale and protective of Fond du Lac's aquatic life uses.

6. Criteria to protect the wetland designated use

As discussed in Section II.A.2 above, Fond du Lac adopted a new wetland designated use that applies to all wetlands in the Fond du Lac Reservation. To protect the wetland designated use, the Band adopted narrative wetland criteria in Ordinance #12/98, Amended, Chapter 7:

> All wetlands, as defined by the Cowardin classification scheme, shall maintain biological, physical, chemical, and hydrological conditions - as determined by reference wetlands - including, but not limited to: base flow, flow regime, wetland hydroperiod; chemical, nutrient, dissolved oxygen regime of the wetland; conditions favorable to protect propagation of threatened, endangered, and at-risk species; conductivity; floristic quality; integrity of species diversity, abundance, and zonation; normal movement of fauna; pH of wetland waters; salinity; size and shape; soil type horizon structure; water currents, erosion, or sedimentation patterns; water levels or elevations; and water temperature variations. Ordinance #12/98, Amended, Section 702.

To develop the wetland narrative criterion, the Band used EPA's Wetland WQS Templates. As discussed in EPA's Narrative Templates FAQs, the templates are intended for states and authorized tribes "to use to simplify and streamline the development of protective standards that will guide maintenance of the spatial and functional components of wetlands."

EPA guidance has recognized that narrative criteria may be appropriate for the protection of attributes and functions unique to wetlands:

> [W]etlands are different from other surface water systems in that they provide different functions and have different vulnerabilities. Without specific recognition of these attributes and functions – along with statements to protect and maintain those attributes and functions – it is possible to lose or impair these features. … Given the complex spatial and temporal heterogeneities of these unique ecosystems, narrative (rather than numeric) statements may be the best approach for states when first developing water quality standards for wetlands. Narrative Templates FAQs at 3.

The Fond du Lac narrative criterion requires the maintenance of all biological, physical, chemical and hydrological conditions in wetlands and, thus, would prevent adverse impacts to wetland functions and attributes. Consequently, EPA concludes in accordance with 40 CFR §§ 131.5(a)(2) and 131.11(a) that Fond du Lac's narrative criterion at Ordinance #12/98, Amended, Section 702 is based on sound scientific rationale and protective of Fond du Lac's wetland use.

In addition to the narrative criterion at Ordinance #12/98, Amended, Section 702, the Band also revised appendices 1 and 2 of its WQS to apply the Band's existing criteria for aquatic life, human health and wildlife to the wetland designated use. Ordinance #12/98, Amended, Appendices 1 and 2. As discussed in EPA's Narrative Templates FAQs:

> Water quality criteria for the protection of human health are based on the toxicity of a contaminant and the amount of the contaminant consumed through ingestion of water and fish regardless of the type of water body. Narrative Templates FAQs at 4.

The Band's numeric criteria, although not designed specifically for wetlands, were designed to be protective of aquatic life, wildlife and human health regardless of waterbody type. Ordinance #12/98, Amended, Section 601. EPA previously reviewed those criteria and determined that there was a sound scientific rationale to conclude that those criteria are protective of aquatic life, wildlife and human health in surface waters. EPA, *U.S. EPA Record of Decision for Approval of Fond du Lac Band's Water Quality Standards Under § 303 of the Clean Water Act* (2001). EPA's review of the Band's criteria at that time was not based on the type of water body that the criteria applied to but was only based on the available data on potential effects to aquatic life, wildlife and human health.

Because those criteria are protective of the aquatic life, wildlife and human health use designations irrespective of water body type, there is a sound scientific rationale to conclude that those criteria are also protective of the aquatic life, wildlife and human health components of the wetland use adopted by the Band.

C. Whether the State or Authorized Tribe has adopted an antidegradation policy that is consistent with §131.12, and whether the State or Authorized Tribe's adopted antidegradation implementation methods are consistent with §131.12.
(40 CFR § 131.5(a)(3))

Federal regulations regarding antidegradation implementation methods at 40 CFR § 131.12(b) require that:

> The State shall develop methods for implementing the antidegradation policy that are, at a minimum, consistent with the State's policy and with paragraph (a) of this section. The State shall provide an opportunity for public involvement during the development and any subsequent revisions of the implementation methods, and shall make the methods available to the public.

The adopted revisions do not modify the Band's existing EPA-approved antidegradation policy at Ordinance #12/98, Section 105(a), but the Band made several revisions to its antidegradation implementation methods in Ordinance #12/98, Amended, Section 105(b). These revisions are discussed below.

1. Whether Fond du Lac's methods for implementing the antidegradation policy are consistent with the State or Authorized Tribe's policy and 131.12(a).

a. Identification of waters for Tier 2 protection

Fond du Lac's previously approved antidegradation implementation procedures define "High Quality Waters" as:

> Surface waters of the Reservation in which, on a parameter by parameter basis, the quality of the waters exceeds levels necessary to support propagation of fish, shellfish and wildlife and recreation in and on the water. Ordinance #12/98, Section 201(z)[21].

In Fond du Lac's Triennial Review Submittal, these "High Quality Waters" have been renamed as "Exceptional Resource Waters," and

> . . . shall mean high quality waters not specifically classified as Outstanding Reservation Resource Waters. Exceptional Resource Waters are subject to the provisions of 105(a)(2) and (4) of the Fond du Lac antidegradation policy. Ordinance #12/98, Amended, Section 201(t).

The Band's "Outstanding Reservation Resource Waters (ORRW) continue to be defined as:

> . . . those waters of the highest quality that are designated by the Reservation Business Committee for their uniqueness or ecological sensitivity. Waters may be designated as ORRW because of their exceptional cultural, aesthetic, recreational or ecological significance. Ordinance #12/98, Amended, Section 201(oo).[22]

The Band's change at Ordinance #12/98, Amended, Section 201(t) removes ORRWs from being included in the definition of Exceptional Resource Waters. This change reflects the fact that, under Fond du Lac's antidegradation policy, ORRWs are subject to separate, more stringent antidegradation requirements. Section 105(a)(5) of Fond du Lac's antidegradation policy continues to require that water quality in ORRW waters "shall be maintained and protected without degradation." Ordinance #12/98, Section 105(a)(5).

In contrast, the Band's existing WQS provided that a lowering of water quality may be allowed in Exceptional Resource Waters "where lower water quality is determined to be necessary to support important social and economic development." Ordinance #12/98, Section 105(a)(4). The

[21] Due to the insertion of new definitions to Section 201, the Band's existing definition of "High Quality Waters" was renumbered as Section 201(bb).

[22] In the Band's existing WQS, Outstanding Reservation Resource Waters are defined in the same way. Ordinance #12/98, Section 201(mm).

antidegradation implementation procedures regarding Exceptional Resource Waters at Ordinance #12/98, Amended, Section 105(b)(4) pertain to the process by which a lowering of water quality may be allowed in those waters. Since no lowering of water quality is allowed in ORRWs, it is appropriate to not apply those procedures to ORRWs. Consequently, EPA concludes that the removal of ORRWs from the definition of Exceptional Resource Waters serves to clarify the Band's classification of waters and is consistent with the Band's antidegradation policy and federal requirements at 40 CFR § 131.12(a).

b. Expansion of current Tier 2 antidegradation implementation procedures to "other pollutants"

Section 105(b)(4) of Fond du Lac's antidegradation implementation procedures for Exceptional Resource Waters provides that an antidegradation review is not required for "changes in loadings of any [bioaccumulative chemical of concern (BCC)] within the existing capacity and processes and that are covered by the existing applicable control document." Ordinance #12/98, Section 105(b)(4). Fond du Lac's revisions extend this provision to other (non-BCC) pollutants: "For BCCs or other pollutants known or believed to be present in a discharge. . . ." Ordinance #12/98, Amended, 105(b)(4).

As provided by Section 105(b)(4) of the Band's antidegradation implementation procedures, an antidegradation review is required for any action resulting in a lowering of water quality. The Band's antidegradation implementation procedures continues to define a lowering of water quality as:

> 1) the projected or observed diminished chemical or biological integrity of Reservation surface waters as established by the Fond du Lac Environmental Program through the collection and analysis of baseline biological data, and the determination of reference conditions for such surface waters; or, 2) a new or increased loading of a pollutant from any regulated existing or new facility, either point source or nonpoint source, for which there is a control document or reviewable action, as a result of any activity including, but not limited to:
>
> A. Construction of a new regulated facility or modification of an existing regulated facility such that a new or modified control document is required;
>
> B. Modification of an existing regulated facility operating under a current control document such that the production capacity of the facility is increased;
>
> C. Addition of a new source of untreated or pretreated effluent containing or expected to contain any pollutant to an existing wastewater treatment works, whether public or private;
>
> D. A request for an increased limit in an applicable control document; and

E. Other deliberate activities that, based on the information available, could be reasonably expected to result in an increased loading of any pollutant to any waters of the Fond du Lac Reservation. Ordinance #12/98, Section 105(b)(1).

Thus, as defined by the Band's antidegradation implementation procedures, a lowering of water quality does not include modifications to existing regulated facilities that would not require a new or modified control document. Ordinance #12/98, Section 105(b)(4). This approach is consistent with the definition of a "significant lowering of water quality" included in federal antidegradation requirements for BCCs in the Great Lakes Basin at 40 CFR Part 132, Appendix E. The Band's definition of a lowering of water quality, which would trigger an antidegradation review, is not based on the type of pollutant but only on whether a proposed activity is expected to increase loading rates beyond what is currently authorized by the existing control document.

Because the Band's definition of a lowering of water quality is based on the nature of the proposed activities rather than the nature of the pollutant, it is reasonable to apply the same definition of a lowering of water quality to BCCs and non-BCCs. Consequently, EPA concludes that the Band's revision to Section 105(b)(4) to include "other pollutants" is consistent with the Band's antidegradation policy and 40 CFR § 131.12(a).

c. Expansion of Tier 2 antidegradation monitoring requirements to non-BCC pollutants

Section 105(b)(4) of Fond du Lac's antidegradation implementation procedures for Exceptional Resource Waters includes an existing requirement that "[f]or BCCs known or believed to be present in a discharge, from a point or nonpoint source, a monitoring requirement shall be included in the control document." Fond du Lac's revisions extend this requirement to "other pollutants." Ordinance #12/98, Section 105(b)(4).

Federal antidegradation regulations and guidance do not specify any monitoring requirements applicable to antidegradation policies or implementation procedures for non-bioaccumulative pollutants. The federal regulations at 40 CFR § 131.12(b) provide that state and tribal antidegradation implementation policies are acceptable if they are consistent with the State's or Tribe's antidegradation policy and 40 CFR § 131.12(a). 40 CFR § 131.12(a) states that an antidegradation review is required when an activity or action is proposed that would lower water quality but is silent on the specifics of how that lowering of water quality is to be quantified for purposes of triggering antidegradation review. Discharge monitoring is used routinely in water quality management to evaluate the effects of a discharge on water quality (e.g., *see* EPA's *Technical Support Document for Water Quality-based Toxics Control* (March 1991)).

For the reasons described above, EPA concludes that the Band's provision requiring a monitoring requirement to be included in control documents for "other pollutants" as set forth in revised Ordinance #12/98, Amended, Section 105(b)(4) is consistent with the Band's antidegradation policy and 40 CFR § 131.12(a).

d. Revision of short-term, temporary exemption for Outstanding Reservation Resource Waters (Tier 3)

Section 105(b)(3) of Fond du Lac's existing EPA-approved antidegradation implementation procedures (which generally correspond with the "Tier 3" requirements of 40 CFR § 131.12(a)(3)) allow that "a short-term, temporary exemption may be permitted." The Band's WQS revisions modify this provision by requiring that:

> an entity seeking to engage in such discharge demonstrate that such discharge will arise entirely from one of the following and meets the Outstanding Reservation Resource Waters Antidegradation Demonstration requirements below:
>
> > a. Maintenance or repair of existing roads, bridges, culverts, boat landings, septic systems, or other similar structures: construction of buildings, wells, roads, or other similar structures.
> >
> > b. Response actions undertaken to alleviate a release into the environment of hazardous substances, pollutants, or contaminants which may pose an imminent and substantial threat to public health or welfare.
> >
> > c. Actions undertaken to restore culturally important species and their habitats. Ordinance #12/98, Section 105(b)(3).

EPA has explained that it is consistent with federal antidegradation requirements pertaining to Outstanding National Resource Waters (40 CFR § 131.12(a)(3)) for states and authorized tribes to allow "some limited activities that result in temporary and short-term changes in the water quality of ONRWs." 48 *Fed. Reg*. 51400, 51403 (Nov. 8, 1983); *see also* EPA's WQS Handbook at 12-13. The Band's revisions have the effect of restricting its existing provision for temporary and short-term changes in the water quality of ORRWs by limiting the exemption to the specific types of activities listed in rule. The Band's modifications thus increase the level of protection provided for ORRWs.

Consequently, EPA concludes that Fond du Lac's revisions to Ordinance #12/98, Amended, Section 105(b)(4) regarding activities that would have only short-term, temporary effects on water quality in ORRWs are consistent with 40 CFR § 131.12(a) and Fond du Lac's antidegradation policy.

e. Designation of Five Lakes as ORRWs

Fond du Lac's WQS revisions designate five lakes (Perch Lake, Rice Portage Lake, Dead Fish Lake, Jaskari Lake, and Wild Rice Lake) as ORRWs. Ordinance #12/98, Amended, Section 105(b)(3). Section 105(a)(5) of the Band's antidegradation policy requires that "[w]ater quality in ORRWs shall be maintained and protected without degradation" and, thus, designation as ORRW provides the highest level of antidegradation protection within the Band's antidegradation policy. Ordinance #12/98, Section 105(a)(5).

Fond du Lac's antidegradation policy provides that "[w]aters may be designated an ORRW because of exceptional cultural, aesthetic, recreational or ecological significance. … [O]ther waters may be designated ORRW as determined by the Reservation Business Committee after at least one public hearing." Ordinance #12/98, Section 105(a)(5). As discussed in Section II.F below, Fond du Lac followed these procedures in making its ORRW designation for the five lakes: the Band held a public hearing on December 6, 2018 to discuss and provide an opportunity for the public to comment on the proposed WQS revisions, which included the designation of the five lakes as ORRWs, and the Reservation Business Committee approved and adopted the WQS revisions on July 8, 2020. Fond du Lac's Triennial Review Submission includes a discussion of this process and the Band's supporting documents. Consequently, EPA concludes that Fond du Lac's designation of five lakes as ORRWs is consistent with 40 CFR § 131.12(a) and Fond du Lac's antidegradation policy.

f. Antidegradation requirements for wetlands

Fond du Lac's revisions add antidegradation requirements specific to wetlands. To develop the wetland narrative criterion, the Band used EPA's Wetland WQS Templates.

As seen in Table 2 below, the antidegradation requirements for wetlands in Chapter 7 of the Band's WQS correspond directly to the Band's antidegradation policy, but account for functions and attributes specific to wetlands. As discussed in EPA's Narrative Template FAQs,

> wetlands are different from other surface water systems in that they provide different functions and have different vulnerabilities. Without specific recognition of these attributes and functions—along with statements to protect and maintain those attributes and functions—it is possible to lose or impair these features. Wetland-specific standards provide for more robust wetland protection when implementing the Clean Water Act and other resource protection programs. Narrative Template FAQs at 3.

Table 2. Comparison of Fond du Lac's wetland antidegradation requirements added at Chapter 7 with the Band's existing, EPA-approved antidegradation policy at Section 105(a) (italics showing emphasis added).

New Wetland antidegradation requirements (Chapter 7)	**Existing Antidegradation policy (Section 105(a))**
Tier I: For all wetlands, using the Cowardin classification scheme, *there shall be no degradation of existing uses*. Ordinance #12/98, Amended, Section 703 (paragraph 1).	Existing instream water uses, as defined pursuant to 40 C.F.R. Part 131, and the level of water quality necessary to protect existing uses shall be maintained and protected. *No further water quality degradation which would interfere with or become injurious to existing or designated uses shall be permitted*. Ordinance #12/98, Section 105(a)(1).

New Wetland antidegradation requirements (Chapter 7)	**Existing Antidegradation policy (Section 105(a))**
Tier II: Using the Cowardin classification scheme: *there shall be no net loss to the water quality*, functions, area, or ecological integrity of high quality lacustrine, lacustrine fringe, palustrine, riverine, and slope wetlands, *unless, after satisfying applicable antidegradation provisions including avoidance, minimization, and mitigation/replacement requirements, the authorized tribe determines that allowing degradation is necessary to accommodate important social or economic development in the area in which the wetlands are located*. Ordinance #12/98, Amended, Section 703 (paragraph 2).	For waters identified as high quality under 105.a.2 of this Ordinance, the Fond du Lac Reservation Business Committee, after appropriate public notice and intergovernmental coordination requirements and after due consideration of such technical, economic, social and other criteria in the area in which the water is located, *may choose to allow lower water quality, where lower water quality is determined to be necessary to support important social and economic development.* Ordinance #12/98, Section 105(a)(4).
Tier III: There shall be no loss to the water quality, functions, values, area, or ecological integrity of wetlands designated as Outstanding Reservation Resource Waters (ORRW), as per applicable Tier III requirements. Ordinance #12/98, Amended, Section 703 (paragraph 3).	Waters proposed in this Ordinance as Outstanding Reservation Resource Waters (ORRW) shall be designated as such upon approval of this Ordinance and maintained and protected. Waters may be designated an ORRW because of exceptional cultural, aesthetic, recreational or ecological significance. Upon approval of this Ordinance, other waters may be designated ORRW as determined by the Reservation Business Committee after at least one public hearing. *Water quality in ORRWs shall be maintained and protected without degradation*. Ordinance #12/98, Section 105(a)(5).

On the basis of the discussion above, EPA concludes that Fond du Lac's revised wetland antidegradation requirements in Chapter 7 are consistent with 40 CFR § 131.12(a) and Fond du Lac's antidegradation policy.

2. Whether the Tribe provided an opportunity for public involvement during the development and any subsequent revisions of the implementation methods and has made the methods available to the public. (40 CFR § 131.12(b))

Federal regulations at 40 CFR § 131.12(b) require that a state or authorized tribe "provide an opportunity for public involvement during the development and subsequent revisions of the implementation methods, and shall make the methods available to the public." As described in Section II.D below, Fond du Lac held a public hearing consistent with 40 CFR § 25.5 and provided an opportunity for public comment during the development of these rules. Fond du Lac

also prepared a response to public comments received. Fond du Lac provided information regarding its public process, comments received, and response to comments in its Triennial Review Submittal to EPA. Additionally, the Band duly adopted its revisions into Ordinance #12/98 through its legislative process. Ordinance #12/98, Amended, is posted on the Band's website and, thus, is available to the public. Consequently, EPA concludes that the Band has satisfied the public involvement requirements at 40 CFR § 131.12(b).

3. Conclusion

For the reasons described above, EPA concludes that Fond du Lac's revisions to its antidegradation implementation procedures at Ordinance #12/98, Amended, Section 703 are consistent with 40 CFR § 131.12.

D. Whether the State or Authorized Tribe has followed applicable legal procedures for revising or adopting standards. (40 CFR § 131.5(a)(6))

In a letter dated August 4, 2020 and received by EPA on August 6, 2020, Kevin R. Dupuis, Sr. of Fond du Lac's Reservation Business Committee certified that the rules were duly adopted in accordance with the laws of the Band.

In adopting the rules, Fond du Lac also provided opportunities for public input consistent with federal requirements at 40 CFR § 131.20(b) and 40 CFR Part 25. On September 28, 2018, Fond du Lac published a public notice and a copy of the draft rules on its website, requesting comments by November 19, 2018. Fond du Lac also published a public notice in the *Duluth News Tribune* and mailed electronic copies of the public notice and the draft rules to all interested parties. The Band subsequently extended the deadline for comments until December 7, 2018. The Band held a public hearing on December 6, 2018, in Cloquet, Minnesota. Fond du Lac publicized the public hearing more than 45 days prior to the date of the hearing, recorded the hearing and met other requirements for public hearings specified at 40 CFR § 25.5.

The Band received more than 500 written comments during this comment period and 16 individuals provided comments at the public hearing. Fond du Lac considered and responded to the public comments before adopting the rules. Fond du Lac proposed amendments to the rules in response to some of the comments. EPA reviewed the comments and Fond du Lac's responses in deciding whether to approve the Band's new and revised WQS, and nothing in those comments causes EPA to conclude that the Band's WQS revisions are not based on sound scientific rationale or do not protect applicable designated uses. Consequently, EPA concludes that the Band satisfied the public participation requirements of 40 CFR § 131.20(b) and 40 CFR § 25.5.

E. Whether the Tribal submission meets the requirements included in §131.6 of this part and, for Great Lakes States or Great Lakes Tribes (as defined in 40 CFR § 132.2) to conform to section 118 of the Act, the requirements of 40 CFR 132. (40 CFR § 131.5(a)(8))

40 CFR § 131.6 identifies the minimum requirements of a WQS submission. As described below, Fond du Lac's submittal meets all the relevant requirements of 40 CFR § 131.6.

1. Minimum requirements for WQS submission (40 CFR § 131.6)

a. Use designations consistent with the provisions of sections 101(a)(2) and 303(c)(2) of the Act (40 CFR § 131.6(a))

The Band's WQS revisions establish a wetland designated use and designate all wetlands with that use. As discussed in Section II.A.2 above, the wetland use includes aquatic life and recreation protections consistent with Section 101(a)(2) of the CWA.

b. Methods used and analyses conducted to support WQS revisions (40 CFR § 131.6(b))

The Band submitted the following documents in support of these rules:

- Fond du Lac Reservation Business Committee Certification of Proper Adoption of Tribal Water Quality Standards, as amended (August 4, 2020 and received August 6, 2020);
- Transmittal Letter from Nancy Schuldt, Fond du Lac, to Tera Fong (August 5, 2020 and received August 6, 2020);
- Fond du Lac Band of Lake Superior Chippewa Water Quality Standards of the Fond du Lac Reservation Ordinance # 12/98, as amended by Resolution #1321/20 of the Fond du Lac Reservation Business Committee on July 8, 2020;
- Fond du Lac Reservation Ordinance #12/98, with revisions shown in redline/strikeout format;
- Resolution #1821/20 Amending the Water Quality Standards for the Fond du Lac Reservation, Fond du Lac Ordinance #12/98;
- Public Notice for Water Quality Standards Public Meeting held January 12, 2018;
- Public Notice Seeking Public Comment on Revised Water Quality Standards, published September 28, 2018;
- Transcript of public hearing held December 6, 2020;
- Public comments received;
- Fond du Lac Water Quality Standards Triennial Review Final Report and Summary of Responses (December 2019);
- Devin Edge, Adam Frankiewicz, Jacob Fredrickson and Audrey Huff, University of Minnesota Duluth, *An Evaluation of the Specific Conductivity and Benthic Invertebrate Population in the Streams of the Fond du Lac Band of Lake Superior Chippewa Reservation* (May 6, 2020);
- Bruce L. Johnson and Maureen K. Johnson for WaterLegacy, *An Evaluation of a Field-Based Aquatic Life Benchmark for Specific Conductance in Northeast Minnesota* (November 2015);
- Susan M. Cormier, Ph.D., EPA Office of Research and Development, *Review: "An Evaluation of a Field-Based Aquatic Life Benchmark for Specific Conductance in Northeast Minnesota" (November 2015) Prepared by B.L. Johnson and M.K. Johnson for WaterLegacy* (February 4, 2016);
- Patricia Soranno, Associate Professor, Michigan State University, *Development of Lake-specific Numerical Nutrient Criteria for Water Quality Standards in Reservation Lakes* (May 20, 2011);

- Ann St. Amand, PhycoTech, Inc., *Development of Lake-specific Numerical Nutrient Criteria for Water Quality Standards in Fond du Lac Reservation Lakes: Analysis of the Phytoplankton Rapid Assay Results 1998-2012 Compared to Southern Minnesota Lakes* (August 20, 2015);
- *Expanding the Narrative of Tribal Health: The Effects of Wild Rice Water Quality Rule Changes on Tribal Health, Fond du Lac Band of Lake Superior Chippewa Health Impact Assessment* (undated);
- Earth Economics, *The Food that Grows Out of the Water: The Economic Benefits of Wild Rice in Minnesota* (2018);
- S. LaFond-Hudson, Johnson, N.W., Pastor, J., Dewey, B., *Iron sulfide formation on root surfaces controlled by the life cycle of wild rice (*Zizania palustris*)*, Biogeochemistry 141: 95-106 (2018);
- Sophia LaFond-Hudson, *Iron and Sulfate Cycling in the Rhizosphere of Wild Rice (*Zizania palustris*)* – A thesis submitted to faculty of the University of Minnesota (May 2016); and
- Minnesota Pollution Control Agency, *Wild Rice Sulfate Standard – Summary of Findings and Preliminary Recommendations, Legislative Briefing Document* (February 2014).

c. Water quality criteria sufficient to protect the designated uses (40 CFR § 131.6(c))

The WQS revisions include the adoption of several numeric and narrative criteria. As discussed in Section II.B above, the revisions are consistent with 40 CFR § 131.11.

d. An antidegradation policy consistent with 40 CFR 131.12 (40 CFR § 131.6(d))

The Band's WQS revisions modify several of the Band's existing EPA-approved antidegradation rules. These revisions do not modify the Band's existing, approved antidegradation policy but only affect the implementation of that policy. As described in Section II.C above, these revisions are consistent with Fond du Lac's existing antidegradation policy and 40 CFR § 131.12.

e. Certification by the State or Authorized Tribe's Attorney General or other appropriate legal authority within the State or Tribe that the WQS were duly adopted pursuant to State or Tribal law (40 CFR § 131.6(e))

Fond du Lac's Reservation Business Committee certified the rules in a letter from Kevin R. Dupuis, Sr. to Kurt Thiede, dated August 4, 2020.

f. General information which will aid the Agency in determining the adequacy of the scientific basis of the standards which do not include uses specified in section 101(a)(2) of the Act as well as information on general policies applicable to State or Authorized Tribe's standards which may affect their application and implementation (40 CFR § 131.6(f))

The Fond du Lac WQS revisions establish a wetland designated use and designate all wetlands of the Fond du Lac Reservation for that use. As discussed in Section II.A.2, the wetland designated use includes the uses specified in Section 101(a)(2) of the CWA. The WQS revisions

do not modify Fond du Lac's existing, effective designated uses as they are applied to specific Fond du Lac surface waters.

The adopted revisions include rule revisions that affect the application and implementation of Fond du Lac's antidegradation policy. See Section II.C for EPA's review of these implementation procedures for consistency with 40 CFR § 131.12(b).

2. Requirements of 40 CFR Part 132

The adopted revisions affect the entire Fond du Lac Reservation, a majority of which is located within the Lake Superior Basin. Therefore, the Band's WQS revisions apply to waters in the Great Lakes Basin and the requirements of 40 CFR Part 132 apply to the adopted revisions.

Federal WQS requirements in 40 CFR Part 132 that apply to waters in the Great Lakes System do not specifically address how states and authorized tribes may designate and modify uses. Therefore, there are no designated use requirements of 40 CFR Part 132 that are applicable to EPA's review of the Band's cultural use designation and wetland designated use, discussed in Section II.A above.

As discussed in Section II.B of this document, Fond du Lac's WQS revisions include the adoption of numeric criteria for nutrients, ammonia and specific conductance and narrative criteria to protect wild rice and hydrologic conditions. Federal regulations specific to the Great Lakes System in 40 CFR Part 132 do not include specific requirements regarding narrative criteria and, thus, there are no requirements of 40 CFR Part 132 that are applicable to EPA's review of the Band's adopted narrative criteria. Phosphorus (nutrients), ammonia, and dissolved solids (specific conductance) are included in Table 5 of 40 CFR Part 132 as pollutants subject to federal, state and tribal requirements. For pollutants listed in Table 5 of 40 CFR Part 132, 40 CFR § 132.4(g)(1) requires Great Lakes states and tribes to "[a]pply any methodologies and procedures acceptable under 40 CFR Part 131 when developing water quality criteria or implementing narrative criteria." As discussed in Section II.B above, the Band's numeric nutrient criteria, ammonia criteria, and specific conductance criterion are consistent with 40 CFR § 131.11.

State and tribal antidegradation rules applicable to the discharge of BCCs within the Great Lakes basin must be consistent with 40 CFR Part 132, Appendix E. Fond du Lac's existing antidegradation rules at sections 105(a) and (b) apply to the discharge of BCCs. EPA previously approved these as being consistent with 40 CFR Part 132 and nothing in the adopted revisions removes or modifies these antidegradation requirements. Consequently, EPA concludes that the Band's revisions to its antidegradation implementation procedures discussed in Section II.C of this document are consistent with 40 CFR Part 132, Appendix E.

F. Other items that EPA is approving

In addition to the revisions discussed above, Fond du Lac made several other revisions to the Band's WQS. EPA reviews each of these below.

1. Provisions clarifying the intent of Fond du Lac's WQS

Section 102 of Fond du Lac's existing WQS rules establish the purpose of the Band's WQS, which is to "protect the health and welfare of the Fond du Lac Band and other residents of the Fond du Lac Reservation." Ordinance #12/98, Section 102 also includes a list of methods by which the WQS shall achieve this purpose (e.g., "[t]he designation of uses for which the waters of the Fond du Lac Reservation shall be protected").

Fond du Lac's WQS revisions add the following two items to the list of methods by which the Band's WQS shall achieve its stated purpose:

d. The prevention of degradation of existing water quality; and

e. The protection of the Fond du Lac Band's political integrity, economic security, and health and welfare.

Ordinance #12/98, Amended, Section 102(d)-(e). Federal regulations at 40 CFR § 131.2 describing the purpose of WQS states that states and authorized tribes "adopt water quality standards to protect public health or welfare, enhance the quality of water and serve the purposes of the Clean Water Act." The Band's added purposes for their WQS are consistent with 40 CFR § 131.2 in that they establish the Band's intention to use WQS to enhance the quality of water and protect public health or welfare. Consequently, EPA concludes that the Band's revisions to Section 102 are consistent with the CWA and 40 CFR parts 131 and 132.

2. Provisions clarifying the intent of designated uses and water quality criteria

Fond du Lac's WQS revisions add language to sections 302 and 601 of the Band's WQS defining designated uses and water quality criteria.

As seen in Table 1 below, the Band's definitions of designated uses and criteria are consistent with federal regulations at 40 CFR § 131.3 and, thus, EPA concludes that Fond du Lac's revisions to sections 302 and 601 of its WQS are consistent with the CWA and 40 CFR parts 131 and 132.

Table 3. Comparison of Fond du Lac's definitions of designated uses and water quality criteria with federal regulations in 40 CFR Part 131.

Term	Fond du Lac Definition	Federal Regulation
Designated Use	Waters of the Reservation are assigned designated uses to serve the purposes defined in Sections 101(a)(2) and 303(c) of the Clean Water Act: to ensure that water quality standards should provide, wherever attainable, water quality sufficient for the protection of fish, shellfish, and wildlife, recreation in and on the water, as well as considering the use and value of waters for cultural purposes, public water supplies, industrial purposes, and navigation. Designated uses are assigned to individual waterbodies in order to protect water quality appropriate for each use. Ordinance #12/98, Amended, Section 302.	States adopt water quality standards to protect public health or welfare, enhance the quality of water and serve the purposes of the Clean Water Act (the Act). "Serve the purposes of the Act" (as defined in sections 101(a)(2) and 303(c) of the Act) means that water quality standards should, wherever attainable, provide water quality for the protection and propagation of fish, shellfish and wildlife and for recreation in and on the water and take into consideration their use and value of public water supplies, propagation of fish, shellfish, and wildlife, recreation in and on the water, and agricultural, industrial, and other purposes including navigation. 40 CFR § 131.2.
Criteria	Criteria are elements of the Fond du Lac water quality standards, expressed as constituent concentration, levels, or narrative statements, representing a quality of water that supports a particular use. When criteria are met, water quality will generally protect the designated use. When criteria are not met, the designated uses may be affected adversely. Ordinance #12/98, Amended, Section 601.	*Criteria* are elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use. When criteria are met, water quality will generally protect the designated use. 40 CFR § 131.3(b).

3. Provisions clarifying the applicability of Fond du Lac's WQS

Section 103 of Fond du Lac's existing WQS establish that the Band's WQS apply to all "waters of the Fond du Lac Reservation" and provide a list of the types of activities to which WQS will be applied. The Band's revisions modify this section by adding "the physical alterations of waterbodies including wetlands" to the list of activities to which WQS will be applied. Ordinance #12/98, Amended, Section 103. Section 101(a) of the CWA establishes that "[t]he objective of this Act is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Additionally, the addition is consistent with implementation of EPA approved WQS within CWA Section 401 certifications. Consequently, EPA concludes that Fond du Lac's revisions to Section 103 of its WQS are consistent with the CWA and 40 CFR parts 131 and 132.

Fond du Lac's WQS revisions also add the following definition of "Waters of the Fond du Lac Reservation" at Section 201(ccc):

> Waters of the Fond du Lac Reservation shall mean all waters within the exterior boundaries of the Fond du Lac Reservation, including but not limited to lakes, ponds, reservoirs, springs, streams, flowages, rivers, wetlands, and any subterranean waters having a demonstrable hydrologic connection with the surface. Ordinance #12/98, Amended, Section 201(ccc).

As discussed above, Section 103 of the Band's WQS require that the Band's WQS apply to all "waters of the Fond du Lac Reservation" and, thus, this definition affects the waterbodies to which the Band's WQS apply. Ordinance #12/98, Section 103. The Band's definition of "Waters of the Fond du Lac Reservation" does not exclude any surface waters and, thus, allows the Band to apply its WQS to all navigable waters. Consequently, EPA concludes that Fond du Lac's definition of "Waters of the Fond du Lac Reservation" at Ordinance #12/98, Amended, Section 201(ccc) is not inconsistent with the CWA and 40 CFR parts 131 and 132.

The CWA and federal regulations implementing the CWA extend only to waters of the United States. Application of the Band's WQS to waters outside the definition of waters of the United States is under Fond du Lac's own inherent authority and outside of EPA's authority under Section 303(c) of the CWA to approve or disapprove.

Additionally, EPA approves these WQS for the surface waters within the exterior boundaries of the Fond du Lac Reservation that are included in EPA's May 16, 1996 approval to obtain authorization for a WQS program. Application of these WQS by the Band to waters other than those specifically described above is under the Band's own inherent authority and outside of EPA's authority under CWA 303(c) to either approve or disapprove.

4. Non-substantive revisions to the Tribe's WQS

Fond du Lac also made numerous non-substantive revisions to revise or replace existing definitions, rename terms, clarify intent, add tribal names to definitions and lakes, and make grammatical edits. EPA reviewed these non-substantive revisions and concluded that these revisions do not change the meaning or implementation of the Band's existing federally-approved WQS. Therefore, EPA concludes that these reorganizational revisions are consistent with the CWA and 40 CFR parts 131 and 132.

G. Items that EPA has determined are not new or revised WQS

As described in Section II above, EPA has authority and duty to review state and tribal rules under Section 303(c) of the CWA if those rules constitute new or revised WQS. The EPA document entitled *What is a New or Revised Water Quality Standard Under CWA 303(c)(3)? Frequently Asked Questions* (October 2012) describes the criteria by which EPA determines whether a provision constitutes a new or revised WQS, one of which is whether the provision "address[es] designated uses, water quality criteria (narrative or numeric) to protect designated

uses, and/or antidegradation requirements for waters of the United States." *What is a New or Revised Water Quality Standard Under CWA 303(c)(3)? Frequently Asked Questions* at 3.

Fond du Lac's revisions include several revisions to the Band's list of documents for Sample Collection, Preservation and Analysis in Section 501. Ordinance #12/98, Amended, Section 501. These revisions address the documents and methods the Band uses to collect, preserve and analyze samples. These revisions do not address designated uses, water quality criteria or antidegradation requirements and, thus, EPA concludes that these revisions are not new or revised WQS and is taking no action under Section 303(c) of the CWA on these revisions.

Additionally, Fond du Lac's revisions add language at Section 301(m) specifying the methods that the Band will use to assess waters based on its existing narrative biological criterion. Ordinance #12/98, Amended, Section 301(m). Nancy Schuldt, Fond du Lac Water Projects Coordinator, clarified in an email to Aaron Johnson, EPA Region 5, Watersheds and Wetlands Branch, on June 5, 2020, that the provision only addresses the methods the Band will use to conduct condition assessments based on the narrative biological criterion and does not revise the narrative criterion itself. Therefore, EPA concludes that this revision only addresses implementation of the existing narrative criterion and does not address designated uses, water quality criteria or antidegradation requirements. Consequently, EPA concludes that the Band's revision of Section 301(m) is not a new or revised WQS and is taking no action under Section 303(c) of the CWA on this revision.

H. Conclusion

For the reasons described above, EPA concludes that the Band's WQS revisions adopted as part of its WQS triennial review are consistent with the CWA and federal WQS regulations in 40 CFR parts 131 and 132 and approves these revisions.

III. Endangered Species Act (ESA) Requirements

Consistent with Section 7 of the ESA and federal regulations at 50 CFR Part 402, EPA is required to consult with FWS on any action taken by EPA that may affect federally-listed threatened or endangered species or designated critical habitat. Actions are considered to have the potential to affect listed species if listed species are present in the action area.

According to the FWS Section 7 consultation assistance webpage[23], the listed threatened or endangered species in Carlton and St. Louis counties, Minnesota that could possibly be in the action area include Canada lynx, gray wolf, northern long-eared bat, piping plover and rufa red knot. Additionally, critical habitat for piping plover is located in St. Louis County.

Based on a review of the available information for these species, EPA concluded that Canada lynx, piping plover and rufa red knot are not located in the action area, and therefore, the WQS revisions will have no effect on those species. EPA also determined that critical habitat for piping plover is located more than 20 miles downstream of the Fond du Lac Reservation and,

[23] Accessed by EPA staff September 3, 2020, https://ecos.fws.gov/ipac/ and/or https://www.fws.gov/midwest/endangered/lists/minnesot-cty.html.

thus, the WQS revisions will not affect any critical habitat. However, based on the potential presence of aquatic, aquatic-dependent, and/or wetland species in the action area, EPA decided that consultation under Section 7 of the ESA is required. EPA drafted a BE during its review of the Band's WQS revisions and concluded that its approval of the Band's WQS revisions may affect, but is not likely to adversely affect, the gray wolf and northern long-eared bat. EPA sent its BE to FWS on September 18, 2020, seeking concurrence on the Agency's conclusion.

IV. Tribal Consultation

On May 4, 2011, EPA issued the "EPA Policy on Consultation and Coordination with Indian Tribes" to address Executive Order 13175, "Consultation and Coordination with Indian Tribal Governments." The EPA Tribal Consultation Policy states that "EPA's policy is to consult on a government-to-government basis with federally-recognized Tribes when EPA actions and decisions may affect tribal interests." EPA consulted the location of tribal lands in Minnesota and determined that the Fond du Lac Reservation is located within and upstream of ceded territory where 12 federally-recognized tribes (including Fond du Lac) have treaty rights.

On August 12, 2020, EPA sent letters outlining the proposed WQS revisions and offering government-to-government consultation to the tribal leaders of the 11 federally-recognized tribes that are party to the 1854 Treaty. The consultation letter further clarified that if EPA did not receive a response from the Tribe within 30 days of the date of the letter (September 11, 2020), as either written comments or an attempt to schedule a conference call, EPA would conclude that the Tribe did not wish to engage in consultation and EPA could therefore move forward with a decision.

None of the 11 identified tribes responded to the letter in written or verbal means by September 11, 2020. EPA therefore provided substantive opportunity for the 11 tribes to provide input on EPA's decision-making process and has therefore fulfilled its duty to consult on a government-to-government basis with federally-recognized tribes on actions that may affect tribal interests.

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 29

MPCA, S-5 Implementing the Aquatic Life Narrative Standard, SONAR for Proposed Class 3 and 4 Rule Revisions, December 14, 2020 (excerpt).

Implementing the Aquatic Life Narrative Standard

1. Policy: Implementing the Aquatic Life Narrative Standard

A. Background

During the development of revisions to the Class 3 and Class 4 water quality standards, Tribal partners and stakeholders expressed serious concerns about the protection of aquatic life. Many felt that the numeric values in the existing Class 3 and, especially, Class 4A water quality standards were providing some degree of protection to aquatic life, particularly from the impacts of ionic pollutants such as bicarbonates, total dissolved salts, specific conductance, and sulfate. However, commenters also noted that the values in the existing Class 3 and 4 water quality standards are not sufficient to protect aquatic life.

The choice of values in a water quality standard is inextricably linked to the beneficial use that the standard is designed to protect. The values in the existing Class 3 and Class 4 water quality standards were designed to protect the Class 3 and Class 4 beneficial uses – industrial consumption and agriculture. The values in the existing Class 2 water quality standards were designed to protect aquatic life beneficial uses. Values cannot simply be moved between use classes. The MPCA agrees that additional water quality standards are needed to fully protect Class 2 aquatic life beneficial uses from the impacts of certain pollutants – particularly ionic or salty parameters. There is active research around the appropriate magnitude or level of those Class 2 standards, specifically around chloride and sulfate, that MPCA anticipates being the foundation for a future Class 2 rulemaking. Because this present rulemaking is to revise Class 3 and Class 4 standards to protect industrial consumption and agriculture beneficial uses, the consideration of aquatic life beneficial use protection is not relevant.

While not relevant to the current Class 3 and Class 4 rulemaking, it may be helpful to share information on steps the MPCA is taking related to Class 2 aquatic life and ionic pollutants. This document lays out an interim approach to protecting aquatic life from the adverse impacts of ionic pollutants, until numeric standards for those pollutants are developed and incorporated through future rulemaking into Minnesota's Class 2 water quality standards.

B. Narrative Standard to Protect Aquatic Life

This interim approach is grounded in Minnesota's Class 2 narrative water quality standard to protect aquatic life. The main expression of the narrative standard is in Minn. R. 7050.0150, Subp. 3. This states that "For all class 2 waters…the normal aquatic biota and the use thereof shall not be seriously impaired or endangered, the species composition shall not be altered materially, and the propagation or migration of aquatic biota normally present shall not be prevented or hindered by the discharge of any sewage, industrial waste, or other wastes to the waters."

In addition, Minn. R. 7050.0222 contains narrative statements that the quality of each surface water with a Class 2 designation should be "such as to permit the propagation and maintenance of a health community of…aquatic biota and their habitats[,]" as appropriate to the Class 2 subclass (Class 2A cold water, Class 2B warm or cool water, Class 2D wetlands).

While a narrative standard provides a clear statement of the conditions that should be present in waterbodies, it does not provide numeric values that must be met to ensure those conditions. It therefore is less easily used to craft permit conditions, and an additional step is needed in order to implement narrative standards in discharge permits.

C. Implementing Narrative Standards

The additional step(s) needed to implement a narrative standard in a facility permit include the concept of a "translator." A "translator" is a process or method to regulate a permitted point source discharger to ensure compliance with a narrative standard. The EPA offers guidance on the use of translators and they are used by many states. A translator often results in a numeric effluent limit for a specific pollutant which, if met, ensures that the narrative standard is met in the waterbody. Although a translator can be developed as part of the design of a narrative standard, it can also be developed as part of separate implementation procedures.1 Minnesota's Class 2 narrative standard to protect aquatic life has been in place for some time, but has not had separate implementation procedures.

Stakeholders and Tribal partners have asked the MPCA to develop a mechanism to implement the Class 2 narrative standard in 7050.0150 in permits – namely by figuring out a way to "translate" the narrative standard into numeric effluent limits that can be applied to permitted facilities that discharge to Minnesota's waters. Key pollutants of concern that stakeholders have raised for potential development of translators are "salty" or ionic parameters (such as specific conductance and sulfate) and nitrate.

The MPCA agrees that clearer implementation procedures for the Class 2 narrative aquatic life standard are warranted. This document lays out those procedures, which may ultimately result in one or more of a wide range of permit conditions – ranging from monitoring requirements to effluent limits based on water quality conditions and goals. Although this document is specific to protecting aquatic life from salty parameters, a general process could be extrapolated to any pollutant likely to have an impact on aquatic life, depending on the available data and information. If numeric standards for protecting aquatic life are adopted through rulemaking, the translator process would no longer be needed for those pollutants.

There are some exceptions to the permitting framework described below. Waterbodies that are currently identified as impaired for chloride, are known to have naturally high background levels of chloride, or are determined to have chloride as the primary stressor will not be subject to this narrative translator, as aquatic life standards for chloride already exist.

[1] More information can be found in EPA's Water Quality Standards handbook, chapter 3.

2. Permitting Framework for Protecting Aquatic Life from Salty Parameters

The remainder of this document lays out a framework for implementing the Class 2 aquatic life narrative standard. The process is designed to identify the Class 2 waterbodies that are potentially impacted by ionic or salty parameters; and then support a case-specific determination of permit conditions necessary to ensure that the Class 2 aquatic life narrative standard is maintained.

A. Determining Waterbodies Impacted by Specific Conductance

The first step in the process is to determine those waterbodies most likely to have aquatic biology that is adversely impacted by salty pollutants, as indicated by specific conductance. Specific conductance was chosen as the surrogate indicator for multiple individual ionic pollutants.

Developing Metrics to Evaluate Impacts

First, specific conductance is a known stressor to aquatic life. Although the impact of a specific individual ion may be more important to certain aspects of the biological community, the generalized impact of specific conductance to the biological community and aquatic ecosystem health is well documented (Cañedo-Argüelles, et. al. 2013, Dunlop, et. al. 2008, Nielsen, et. al., 2003) . Second, while it would be ideal to have indicators reflective of individual ions, or ion mixtures, these standards are not yet available, and even when available they may not be sensitive to all life stages of sensitive native taxa. Third, conductivity is well known to be correlated with anthropogenic stress, including urban development, agriculture, and mining activity. The ion mixture associated with each of these disturbance categories may differ, but, again, the generalized impact of conductivity is well documented. Finally, conductivity is one of the most commonly collected water quality parameters, and the MPCA has a very large dataset in which both biological data and specific conductance are collected concurrently. This large dataset has allowed for a robust approach to the development of tools to support this narrative translator, including calculation of regional benchmarks, as well as developing the relationship between aquatic life use support and conductivity.

The MPCA collects biological and water quality data throughout the state to determine if waterbodies are meeting aquatic life use goals. The primary biological indicators used in assessment of aquatic life are fish and macroinvertebrates. Macroinvertebrates are well known to be sensitive to many of the constituent ions that comprise specific conductance, and thus are the focus of this screening tool (Clements and Kotalik, 2015; Kefford, 1998; Hart et. al., 1990).

To determine if a waterbody is potentially adversely impacted by specific conductance, the MPCA proposes a weight of evidence approach that considers three metrics that represent different ways of looking at the relationship between specific conductance and biological response. All metrics were considered based on the last 10 years of information, in keeping with MPCA's assessment window.

- **MIBI** - The macroinvertebrate index of biotic integrity (MIBI) scores that are used in assessing aquatic life in rivers and streams. The MIBI was designed and calibrated to be an indicator of overall stress on the biological community, and is therefore our ultimate endpoint in determining if anthropogenic stressors are impacting aquatic life. It was not designed to

respond to any one stressor, but it is capable of showing a response to a single stressor, if that stressor is the overwhelming influence impacting aquatic health. When attempting to understand if the aquatic life of a stream is being impacted by a suspected stressor, the first step is to look at the MIBI score.

- **Conditional Probability** - A conditional probability approach based on a relationship between specific conductance and attainment of the MIBI General Use criterion. The conditional probability model was developed to reflect the extent to which conductivity measurements may be in alignment with impairment of the biological community, and allow us to make an inference about the potential impact of specific conductance when biological data is not available.

- **Regional Benchmarks** - Regional benchmarks based on the Criterion Continuous Concentrations (CCC). - An approach comparing measures of specific conductance to draft "benchmark" values that were calculated using a field-based method for the determination of water quality criteria (Cormier and Suter, 2013; US EPA, 2011). The benchmark values were developed as ecotoxicological endpoints to reflect the response of taxa that are sensitive to specific conductance. These values represent the point at which 5% of sensitive taxa are no longer present. These benchmark values were calculated for the purpose of supporting waterbody screening using data collected by the MPCA biological monitoring program from 1996 through 2018.

Evaluating Waterbodies Based on Metrics

After developing these three metrics, the MPCA reviewed individual waterbodies (lakes and stream reaches) and analyzed their conditions relative to each of the three metrics. A summary of the evaluation is provided in Attachment 1.[2]

1) Attainment of aquatic life use based on macroinvertebrate index of biotic integrity (MIBI) scores.

The MPCA currently has biological indicator data collected from 6800 monitoring locations, representing 3390 waterbodies, or stream segments, throughout Minnesota. Each waterbody is assigned a reference number called the Waterbody Identification number, or WID; there may be multiple monitoring locations within a WID.

The MPCA regularly assesses waterbodies to determine whether they fully support the aquatic life beneficial use based on fish and macroinvertebrate indices of biotic integrity (MIBI) scores. Assessment of biological condition is done at the waterbody level, and is the result of a weight of evidence approach that considers all assemblage-specific information collected in the 10-year window associated with the assessment. The MPCA's detailed methods for assessment can be found in the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List.*

When considering the potential for adverse impacts of specific conductance on aquatic life, aquatic life use support can be analyzed at both the waterbody level (WID), or reach level.

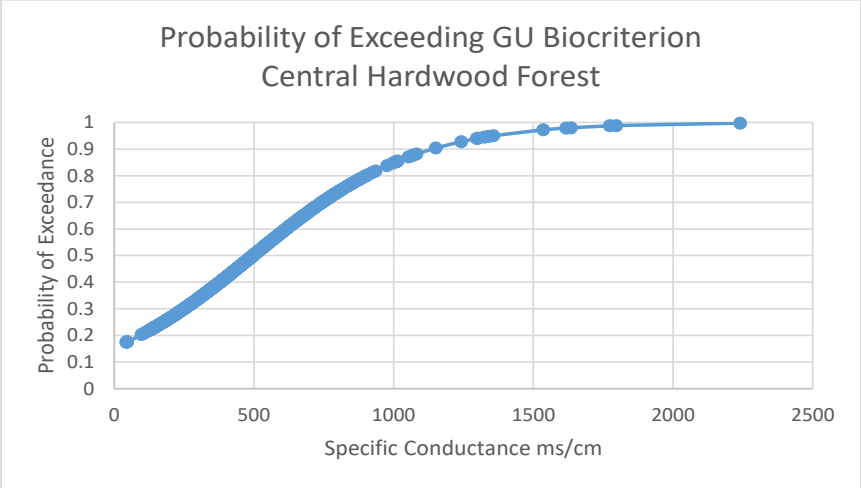
[2] This data is available in tabular format to allow for a straightforward interpretation of both summarized and site-specific data. It can be provided in more detail upon request.

Initial screening of aquatic life use should be done based on waterbody level assessment results. Reach level information can be analyzed if a more granular approach is needed to determine impacts of specific conductance on aquatic life.

2) Conditional probability of meeting general aquatic life use (GU) goals based on measurements of specific conductance.

Binary logistic regression was used to determine the probability of meeting the macroinvertebrate index of biotic integrity (MIBI) general use biocriterion based on measured values of specific conductance, for the purpose of determining potential biological impacts in areas where no biological data was present. Binary logistic regression is a modeling tool used to determine the probability of a binary event occurring (pass/fail) for a given predictive variable. In this case, that is the probability of meeting the biological standard, as demonstrated by the MIBI, based on the known specific conductance data. Conditional probability equations were derived based on datasets grouped at the level 3 ecoregion. Pass/fail outcomes were based on support/non-support of the relevant station-specific biocriterion; the predictive variable used was specific conductance. Coefficient values, constant values, and the equation used in the calculation of regional conditional probabilities are included below in Table 1.

Figure 1. Example conditional probability plot



Measures of specific conductance and associated conditional probabilities can be considered at both the waterbody and station levels. Aggregating specific conductance data at the waterbody level is done by taking the average values by month/year when multiple data points are present. Site specific and daily values are available for a more granular approach to understanding waterbody conditions. Similar to waterbody values, site-based specific conductance values are averaged values by month/year when multiple data points are present.

The logistic regression outputs for most ecoregions suggest that a more conservative (high) value be used to infer a likelihood of impairment for any given waterbody. For the purposes of this tool, any waterbody or station with a conditional probability value of 75% or higher should be flagged for further investigation of biological stress related to specific conductance.

Note on use of ecoregions. Ecoregions are biogeographic regions that reflect a recurring pattern of ecosystems associated with a characteristic combination of geology, soil, landform, vegetation, climate, land use, wildlife, and hydrology (Omernik 1987, 1995). Ecoregions are defined at four, hierarchical levels. Level 3 ecoregions are commonly used by the EPA and other

states to define regions for the development of water quality criteria (EPA, 2019). Minnesota has seven level three ecoregions.

3) Attainment of regionally derived benchmarks for specific conductance.

Criterion continuous concentration (CCC) values are intended to be used as a surrogate for chronic (long-term) exposure criteria and are designed to be protective of 95% of the native genera for a region. CCCs were derived at the level 3 ecoregion level from a field-based relationship between specific conductance and macroinvertebrate data (U.S. EPA, 2011; Cormier and Suter, 2013; Cormier, Zheng, and Flaherty, 2018). Regional benchmarks based on updating these CCCs were calculated by the MPCA using a statewide dataset collected by its biological monitoring program from 1996-2018. CCCs are based on the derivation of two relationships, one at the genus level and one at the community level. The genus-based relationship identifies the extirpation concentration (XC_{95}) for specific conductance for each genus in the ecoregion. The XC_{95} is the specific conductance value associated with the 95^{th} percentile of the distribution of occurrence of each genus. The community level relationship identifies the 5^{th} percentile hazard concentration (HC_{05}), and is the value used for the CCC. The HC_{05} is based on the cumulative rank distribution of XC95 values for the region. It reflects the specific conductance value that is protective of 95% of native regional macroinvertebrate genera. The taxa that disappear first are those considered most sensitive to increases in specific conductance. For each ecoregion, sensitivity values were determined for each genera that occurred a minimum of 20 times. These values can be made available for a more refined analysis of community level data at the site specific level.

These CCCs serve as regional benchmarks used to interpret measures of specific conductance. These values are present in the summary table, and are listed in Table 1 below.

Table 1. Regional specific-conductance benchmarks, regional coefficient and constant values, and equation for calculation of conditional probabilities.

Minnesota Ecoregion	Regional Benchmark For Specific Conductance	Coefficient for conditional probability calculation	Constant for conditional probability calculation
46 – Northern Glaciated Plains	1333 µS/cm	0.001021	0.095666
47 - Western Cornbelt Plain	1117 µS/cm	0.001349	0.080323
48 – Lake Agassiz Plain	859 µS/cm	0.002758	-2.06005
49 – Northern Minnesota Wetlands	405 µS/cm	0.003147	-1.74711
50 – Northern Lakes and Forests	329 µS/cm	0.001938	-1.40971
51 – North Central Hardwood Forests	488 µS/cm	0.003426	-1.70203
52 – Driftless Area	628 µS/cm	0.003886	-2.71473

Conditional Probability Equation: CB = 1/(1+EXP(-(coefficient*SC)-constant)))

Using these three metrics allows the MPCA to determine those waterbodies that are potentially experiencing aquatic life impacts due to salty parameters.

The clearest demonstration of impacts is a failing MIBI score. Those waterbodies where the MIBI scores indicate that the aquatic life use is not fully supported can be further reviewed using estimates of conditional probability and regional benchmarks, to determine if conductivity is likely to be the reason for the concern. If the conditional probabilities suggest a high likelihood (i.e. > 75%) that the specific conductance levels would cause the waterbody to "fail" the general use biocriterion and/or the specific conductance is above the regional benchmark, then the waterbody should be further investigated at the station level to determine if specific conductance values are problematic throughout the waterbody.

If no MIBI score is available, then reviewing the conditional probability and specific conductance compared to the benchmark alone will provide an indication. Prior to reaching conclusions about the impacts of specific conductance, it should be determined if there is additional information available. For instance, a stressor identification report for the associated waterbody could provide a more detailed assessment of the specific stressors on the aquatic community, perhaps differentiating between specific conductance and other pollutants. Similarly, if a biological effluent review has been completed for any effluent present in the waterbody it may describe potential impacts related to an effluent, and may identify potential causes. More detail is provided in the next section as to how additional information may be used or gathered, if deemed necessary for the next steps.

Note on this evaluation and aquatic life use goals. When assessing streams for aquatic life, two different approaches are used in the determination of appropriate aquatic life use goals.

For streams in which biological and habitat data have been collected, each waterbody segment is given a use class based on the tiered aquatic life use (TALU) approach (MPCA, 2016). TALU criteria differ based on habitat, channel, and biological characteristics. This use class approach is only applied to the direct interpretation of biological data. When interpreting MIBI scores in the context of aquatic life use support, it is best to maintain the tiered use approach, as this is ultimately the manner in which aquatic life use support is determined. Therefore, for waterbodies in which biological data was available, review of biological condition was done using the weight of evidence-based assessment and associated tiered aquatic life use (TALU) criterion.

When assessing aquatic life use based on non-biological water quality parameters, there is typically only a single use applied, the general use (GU). The general use is the middle tier in the tiered use approach; prior to the implementation of the TALU approach the general use was the only use applied to biological data. When making translations between specific conductance and aquatic life use for the conditional probability model, it was determined that it would best to make the general use the benchmark for comparing biological data and specific conductance. Therefore, conditional probabilities were developed using the TALU general use criteria, which makes no provision for habitat or stream channel modifications, and is way to compare all stream segments similarly. The water quality benchmarks could be considered as a surrogate for water quality criteria, and as a means to compare regional water quality conditions to a level of pollution that is likely protective of aquatic life.

Note on non-invertebrate aquatic life.

This evaluation was constructed to evaluate benthic macroinvertebrates, as they are generally the most sensitive to salty pollutants. They are more sensitive than fish species. However, some commenters raised questions about the protection of aquatic plants, particularly wild rice. MPCA scientists have done some investigation of Minnesota wetland plant response to salinity stressors: conductivity, chloride, and sulfate. They note that "aquatic plants are sensitive to specific conductance, chloride and sulfate and their response should be considered in

development of any aquatic life salinity related criteria or standards development". The MPCA therefore would consider the response of wetland plants to these pollutants as we proceed in future rulemakings to develop aquatic life based water quality standards.

Although the review notes that additional data and analysis regarding wetland plant responses are needed, the MPCA scientists did construct preliminary XC95 values for select wetland plant species related to conductivity both statewide and in three ecoregions. Extirpation response benchmark or XC95 (extirpation concentration at 95%) represents the concentration below which 95% of observations of specific species occur. This included estimates of XC95 values with conductivity for wild rice, statewide and in the mixed wood plains ecoregion. These respective XC95 values for wild rice were 407 µS/cm statewide and 398 µS/cm in the mixed wood plains ecoregion. These values are roughly similar to those constructed for macroinvertebrate response to conductivity. Therefore, the interim approach to protecting aquatic life should be sufficient for both macroinvertebrates and wetland plants.

Identifying Dischargers

If available indicators point to a potential problem with specific conductance for a waterbody, then a plan needs to be developed for approaching permitting for sources that discharge to those waters.

The next step is to identify dischargers and determine which dischargers are likely to be discharging levels of ionic pollutants that are contributing to high levels of specific conductance. If dischargers are unlikely to be contributing to high levels of specific conductance (demonstrated either through monitoring of their effluent or based on knowledge of the type of discharger), those dischargers may not need to be further evaluated.

Some dischargers in Minnesota do monitor for levels of ions in their effluent, and we have general knowledge of the types of industries and activities that are likely to have high ionic strength effluent. Based on data currently available, looking at:

- Facilities with elevated effluent salt concentrations; and
- Facilities with likely ions in their discharge and that have a continuous wastewater discharge to low dilution ratio stream.

The MPCA has developed an initial list (Attachment 2) of facilities that are discharging to waterbodies that are potentially impacted by specific conductance and that may have effluent characteristics that mean they are likely contributing to the levels of specific conductance. This list is based on current information, but should be considered as screening level information and analysis. Facility design flow rates, which are shown in the table, are usually much higher than actual flows from the facility. Some discharges may no longer be active. The MPCA will consider refined facility-specific information during the permitting process. In addition, other dischargers – or new facilities – that meet the requirements may also need to be considered in this process. It is particularly likely that facilities that do not currently monitor ions are not on the list of dischargers.

Permitting Process

In these cases, a permitting plan will be developed to, as needed, refine our understanding of the sources and impacts of specific conductance in the waterbody and determine what actions need to be taken to help improve conditions. We intend to focus on individual permit holders, not those with general permits. Once the MPCA has identified a facility with the potential to discharge salts that may negatively impact aquatic life, further evaluation and appropriate permit conditions will be considered during the process of the next permit issuance.

When a permit for one of the dischargers identified above is being revised (or if a new permit is being issued for a discharge including ions that impacts one of the identified water bodies), the MPCA's permitting process will consider the need to review and gather additional information. If information to complete the types of analyses listed in the "additional analysis and review" column is not available, a first step may be to establishing permit conditions to require collection of additional information. The MPCA may also establish permit conditions or a permit limit for specific conductance (or one or more of the pollutants that contribute to specific conductance) in order to protect aquatic life.

Potential actions that could be taken during permitting would depend on the condition of the waterbody and the characteristics of the permitted facility.

MPCA envisions a transparent process that includes engagement with the permittee, Tribes, and stakeholders or interested parties. That process will include a case-by-case evaluation, depending on the specific situation and the characteristics of the permitted facility. In some cases, limits required for other standards or other reasons may be deemed sufficient to protect aquatic life in the identified reaches where specific conductance may be a concern. In some cases, more data gathering and monitoring may be needed. Or, permit conditions that limit specific conductance (or a component thereof) may be needed to ensure aquatic life is protected.

The following table lays out some potential actions based on conditions.

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 30

EAW, U.S. Steel Keetac Tailings Storage Facility Project, August 7, 2025.

Environmental Assessment Worksheet

This most recent Environmental Assessment Worksheet (EAW) form and guidance documents are available at the Environmental Quality Board's website at**:** **https://www.eqb.state.mn.us/.** The EAW form provides information about a Project that may have the potential for significant environmental effects. Guidance documents provide additional detail and links to resources for completing the EAW form.

Cumulative potential effects can either be addressed under each applicable EAW Item or can be addressed collectively under EAW Item 21.

Note to reviewers: Comments must be submitted to the responsible governmental unit (RGU) during the 30-day comment period following notice of the EAW in the *EQB Monitor*. Comments should address the accuracy and completeness of information, potential impacts that warrant further investigation and the need for anEnvironmental Impact Statement (EIS).

1. **Project Title:** U. S. Steel Keetac Tailings Storage Facility Project

2. **Proposer: United States Steel Corporation, Minnesota Ore Operations – Keetac Mine**

   Contact person: Chrissy Bartovich

   Title: Sr. Director – Environmental

   Address: United States Steel Corporation – Keetac Mine

   1 Mine Road

   City, State, ZIP: Keewatin, MN 55753

   Phone: (218) 749-7364

   Email: clbartovich@uss.com

3. **RGU: Minnesota Department of Natural Resources (DNR)**

   Contact person: Becky Horton

   Title: Project Manger

   Address: 500 Lafayette Road, Box 25

   City, state, ZIP: St. Paul, MN 55155-4032

   Phone: 651-259-5122

   Email: becky.horton@state.mn.us

4. **Reason for EAW Preparation:** (check one)

   Required:

   Discretionary:

   EIS Scoping **Citizen Petition**

X Mandatory EAW **RGU discretion**

X Proposer initiated

If EAW or EIS is mandatory give EQB rule category subpart number(s) and name(s):

The Project requires a mandatory EAW under Minnesota Rules part 4410.4300, subpart 11, (Metallic mineral mining and processing) Item B (expansion of a stockpile, tailings basin, or mine by 320 or more acres).

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Appendix I	Revised Wetland Delineation and Functional Assessment Report (Barr 2023)
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Appendix K	IPaC
Appendix L	Cultural Resource Literature Review
Appendix M	Mining Area Boundary Revisions

Appendix N	Greenhouse Gas Calculation Spreadsheet
Appendix O	DNR Permit to Mine Notice of Decision (Wetland Boundary or Type) (DNR 2023)

5. Project Location:

U. S. Steel owns and operates the Keetac Mine in Keewatin, Minnesota. The tailings storage facility (TSF) is located approximately two miles south of the Keetac Processing Facility (Figure 6.1).

The specific location details of the Project are as follows:

Watershed (81 major watershed scale): St. Louis River Watershed (3) and Mississippi River- Grand Rapids Watershed (9) (Figure 12.1)

County: St. Louis and Itasca Counties

City/Township: Cities of Hibbing and Nashwauk/Township of Lone Pine

GPS Coordinates: 47.337136, -93.064939

PLS Location (¼, ¼, Section, Township, Range): See Table 5.1.

Table 5.1 summarizes the Public Land Survey (PLS) location, project components, and tax parcel numbers for the Project which make up the Project Location.

Table 5.1: Project Location

Project Component	PLS Location	Tax Parcel Number
Permanent Impacts	T56 R21W Section 17, T56 R21W Section 18, T56 R21W Section 4, T56 R21W Section 8, T56 R21W Section 9, T56 R22W Section 1, T56 R22W Section 11, T56 R22W Section 12, T56 R22W Section 13, T56 R22W Section 2, T57 R21W Section 32, T57 R21W Section 33	25-001-1100,25-001-1200,25-001-1300,25-001-2100,25-001-2400,25-001-3100,25-001-3200,25-001-3300,25-001-3400,25-002-4303,25-002-4304,25-002-4400,25-011-1100,25-011-1203,25-011-1204,25-011-1301,25-011-1302,25-011-4201,25-011-4202,25-011-4300,25-011-4400,25-012-3300,25-013-1100,25-013-1200,25-013-1300,25-013-1400,25-013-2100,25-013-2200,25-013-2400,25-014-1100,141-0040-00870,141-0040-01560,141-0040-00890,141-0040-01550,141-0040-00820,141-0040-00830,141-0040-00860,141-0040-01730,141-0040-01740,141-0040-00850,141-0040-01720,141-0040-03110,141-0040-00880,141-0040-03280,141-0040-00800,141-0040-00840,141-0040-03080,141-0050-06490,141-0050-06210,141-0040-03230,141-0040-03270,141-0050-06390
Temporary Impacts	T56 R21W Section 17, T56 R21W Section 18, T56 R21W Section 4, T56 R21W Section 8, T56 R21W Section 9, T56 R22W Section 1, T56 R22W Section 11, T56 R22W Section 13, T56 R22W Section 2, T57 R21W Section 32, T57 R21W Section 33	25-001-1100,25-001-1200,25-001-2100,25-001-2400,25-002-4303,25-002-4304,25-011-1204,25-011-3101,25-011-3102,25-011-4201,25-011-4202,25-011-4300,25-013-1300,25-013-1400,25-013-2100,25-013-2200,25-013-2300,25-013-2400,141-0040-01560,141-0040-00890,141-0040-01550,141-0040-00860,141-0040-01730,141-0040-01740,141-0040-00850,141-0040-01720,141-0040-03110,141-0040-03280, 141-0040-03080,141-0050-06490,141-0050-06520,141-0050-06210,141-0040-03230,141-0050-06390
Pipeline (for Separation and/or Dewatering Infrastructure)	T56 R22W Section 1, T56 R22W Section 2, T57 R22W Section 36	25-002-1103,25-002-1401,25-002-1402,25-002-4100,25-002-4200,25-002-4303,25-002-4400,95-036-1301,95-036-1401,95-036-3400,95-036-4200,95-036-4300,25-001-2203,25-001-2100
Separation and/or Dewatering Infrastructure	T56 R22W Section 1	25-001-2100, 25-001-2203

Project Component	PLS Location	Tax Parcel Number
Stage 2 Exterior	T56 R21W Section 17, T56 R21W Section 18, T56 R21W Section 4, T56 R21W Section 5, T56 R21W Section 7, T56 R21W Section 8, T56 R21W Section 9, T56 R22W Section 1, T56 R22W Section 11, T56 R22W Section 12, T56 R22W Section 13, T56 R22W Section 2	25-001-1200,25-001-1300,25-001-2400,25-001-3100,25-001-3300,25-001-3400,25-001-4201,25-001-4202,25-001-4301,25-001-4302,25-002-4400,25-011-1100,25-011-1203,25-011-1301,25-011-1302,25-011-4201,25-011-4202,25-011-4300,25-011-4400,25-012-1100,25-012-1201,25-012-1202,25-012-1301,25-012-1302,25-012-1400,25-012-2100,25-012-2300,25-012-2401,25-012-2402,25-012-3101,25-012-3102,25-012-3200,25-012-3300,25-012-3400,25-012-4100,25-012-4200,25-012-4300,25-012-4400,25-013-1100,25-013-1200,25-013-2100,25-013-2200,141-0040-00870,141-0040-01000,141-0040-01080,141-0040-01520,141-0040-01560,141-0040-01450,141-0040-01460,141-0040-01550,141-0040-00830,141-0040-00970,141-0040-01730,141-0040-01740,141-0040-00990,141-0040-01360,141-0040-03110,141-0040-00880,141-0040-03280,141-0040-00800,141-0040-00840,141-0040-03230,141-0040-03270

Overall Project Location: See Table 5.1 above and Figure 6.1.

Watershed (81 major watershed scale): 07010103 (HUC8) and 04010201 (HUC8)

GPS Coordinates: 47.346003, -93.061772

Tax Parcel Number: See Table 5.1 above and Figure 6.2

At a minimum attach each of the following to the EAW:

- **County map showing the general location of the Project**. Attached as Appendix A.
- **U.S. Geological Survey 7.5 minute, 1:24,000 scale map indicating Project boundaries (photocopyacceptable)**. Attached as Appendix B.
- **Site plans showing all significant Project and natural features. Pre-construction site plan and post-construction site plan**. Pre- and post-construction depictions are provided as figures. Figure 6.3 depicts existing conditions (pre-construction). Figure 6.4 depicts the Project components and mining area (post-construction).
    - **List of data sources, models, and other resources (from the Item-by-Item Guidance: *Climate Adaptation and Resilience* or other) used for information about current Minnesota climate trends and how climate change is anticipated to affect the general location of the Project duringthe life of the Project (as detailed below in Item 7. Climate Adaptation and Resilience).** A list of sources, models, and resources used for this analysis is provided in Part 7 of the bibliography.

6. Project Description:

a. Provide the brief Project summary to be published in the *EQB Monitor*, (approximately 50words).

U.S. Steel is proposing to modify its existing Tailings Storage Facility for its Keetac taconite mining operation in St. Louis and Itasca Counties. Activities would involve vertically raising the existing dams and dikes using downstream and modified centerline construction methods, that would extend the dam and dikes beyond the current tailings storage facility's footprint. The Project would also involve constructing a new access road, as well as new industrial building and infrastructure for tailings separation and tailings dewatering. The infrastructure would produce coarse tailings for use in dam and dike construction and thickened fine tailings for discharge to the tailings storage facility. The project proposes revisions to the existing tailings basin, but there are no proposed revisions to mining activities or taconite processing facilities.

b. Give a complete description of the proposed Project and related new construction, including infrastructure needs. If the Project is an expansion include a description of the existing facility. Emphasize: 1) construction, operation methods and features that will cause physical manipulation of the environment or will produce wastes, 2) modifications to existing equipment or industrial processes, 3) significant demolition, removal or remodeling of existing structures, and 4) timing and duration of construction activities.

The Keetac Mine extracts taconite (low-grade magnetic iron ore) from open pit mines in the sub-crop of the Biwabik Iron Formation of the Mesabi Iron Range. Taconite generally contains iron oxides, quartz, iron silicates, and iron carbonate minerals. Taconite is processed on-site to concentrate iron content and form taconite pellets that can be sold and shipped to steel mills to be melted down into steel.

Tailings are a byproduct from processing. Tailings produced at Keetac are piped to an existing TSF (Figure 6.1).Tailings were first discharged to the TSF in 1967. The TSF has subsequently been developed in 3 stages, each one leveraging natural topography, supplemented by constructed perimeter dikes. Stage 1 comprised approximately 1,560 acres and was the sole tailings deposition location from 1967 until the Stage 2 Exterior was constructed in the 1980s. The Stage 2 Exterior expanded the TSF to the south by constructing clay core perimeter dams and created a new approximately 4,300-acre deposition area. Stage 2 Exterior was utilized for tailings storage for 10+ years until it was idled in 1993. During that time, the Stage 2 Interior was constructed, which raised portions of the Stage 1 area and the Stage 2 area to create an internal basin (i.e., the Stage 2 Interior). The Stage 2 Interior is 2,500 acres and has been the active TSF since that time. Most of the Stage 2 Interior dike was constructed upon tailings that had been deposited into the Stage 2 Exterior. An additional area was originally planned for Stage 3 that has not been used. Stage 3 is reflected in the mining area, and all stages described above are shown on Figure 6.3.

The TSF operates under Minnesota Department of Natural Resources (DNR) Dam Safety Permit No. 2022-0721. The permit authorizes construction and operation of the TSF to its safe design parameters. Stage 1 is near the design storage capacity and cannot accept additional tailings. Currently, tailings are mostly discharged to the Stage 2 Interior with some strategic placement in the Stage 2 Exterior.

The current operation delivers total tailings at a rate of approximately 16,000 gallons per minute (GPM) via a 22-inch diameter pipeline that can deliver total tailings around the entire perimeter of Stage 2 Interior. Only one discharge location is active at any one time. During direct reduction (DR)-grade pellet production an additional 10 percent of tailings are generated and are discharged to the northern portion of the facility via a dedicated DR tailings line. The tailings slurry is discharged via spigot and settles within the TSF according to particle size. Coarse material deposits near the discharge point while the fines travel downstream toward the center of the TSF. Keetac uses this natural segregation process to provide coarse borrow material which is used for upstream construction of the dikes.

At current mining rates, the Stage 2 Interior is anticipated to soon reach its designed and permitted height. U. S. Steel was approved via the 2022 Permit to Mine amendment to raise the Stage 2 Exterior dikes and construct an internal diversion berm within the Stage 2 Exterior footprint (referred to as Phase 1 in the Permit to Mine amendment application). These features, constructed in 2022, created freeboard and allowed for short-term, controlled deposition of tailings into the Stage 2 Exterior, with the intent to improve the stability of the Stage 2 Interior basin embankments. U. S. Steel began discharging tailings into the Stage 2 Exterior as Phase I in July 2023.

The current design of the Stage 2 Interior and permitted Stage 2 Exterior is expected to be at full capacity by 2028. A second phase of vertical development of the Stage 2 Exterior is proposed to provide longer term storage to align with the Keetac life of mine (Phase 2).

The Project assessed in this document represents Phase 2 (Figure 6.4). Phase 2 is designed to vertically raise the Stage 2 Exterior dams and dikes to allow for long-term controlled deposition of tailings into the existing Stage 2

Exterior. Vertically raising the existing dams and dikes would be achieved using downstream and modified centerline construction methods, that would extend the dam and dikes beyond the current TSF footprint. Downstream dams and modified centerline dikes are described by their construction methods. In this context, dams are considered to be hydraulic retaining features designed to store water while dikes are features designed to store tailings. Downstream dams are built in stages, starting with a foundation and then adding layers of material downstream. This method ensures that the entire dam is on a stable foundation and is robust enough to store large amounts of water. Modified centerline dikes are also built in stages starting with the foundation but are raised vertically from the centerline of the original dam. This method ensures the entire dam footprint is supported by a firm foundation while minimizing downstream impacts.

The Phase 2 water retention dam would be constructed using downstream methods to vertically raise the existing embankment. The water retention dam would be constructed primarily of coarse tailings material. The design of the water retention dam includes a seepage reduction feature along the upstream face of the dam to lower the phreatic surface and limit seepage through the dam. The seepage reduction feature would consist of either a linear low-density polyethylene (LLDPE) geomembrane or an inclined mechanically placed soil-cement blanket consisting of a mixture of coarse tailings and cement. The Phase 2 dike would be constructed using modified centerline methods and be constructed of coarse tailings. The Phase 2 dikes and dams are shown on Figure 6.5.

Site preparation activities would need to be completed prior to vertically raising the dams and dikes. Typical site preparation activities would include grubbing any vegetation, stripping (removal of debris, loose rock, organic material, and unsuitable material), topsoil excavation (stockpile for progressive reclamation), and clearing. Site preparation would be completed using mechanical equipment common for such activities. This could include dozers, excavators, haul trucks, logging equipment, and loaders.

Once the foundational site is prepared both the water retention dam and the dike would be mechanically raised in lifts using typical construction equipment that could include haul trucks, dozers, graders, sheepsfoot rollers, and excavators.

During construction Keetac would establish and maintain erosion control features until the Project is completed. General practices below would be used, where applicable:

1. Minimize disturbed areas and sequence work to minimize exposure time.
2. Use temporary vegetation, mulch, or other cover to protect areas during construction.
3. Utilize stone check dams, haybale dikes, or sit fence to trap sediment.
4. Reduce volume and velocity of water crossing disturbed areas by using diversion dams, berms, or other facilities.

Additionally, site stabilization measures would be ongoing as applicable. For example, once final grade is reached for any one construction stage, topsoil would be placed to a minimum depth of six inches on the slope then fertilized, seeded, and mulched. In some cases, hydroseeding may be used for greater effectiveness.

The intent of Keetac Phase 2 Project is to not only to align the TSF with Keetac's mine life but also to reduce risk and improve the safety of the TSF while minimizing impacts to the environment - with the ultimate goal of reducing the risk of dam failure. While the DNR does not specify factor of safety criteria for analysis, U. S. Steel along with GEI (Engineer of Record) have selected a minimum factor of safety criteria for evaluation of Phase 2 that meets or exceeds industry standards and is defensible to independent review. Results from stability analysis throughout the life of Phase 2 have factors of safety higher than the minimum criterion and provide further evidence of the robustness of design. Keetac currently has over 190 piezometers, 40 inclinometers, and 3 shape accelerator arrays (SAA) to help measure the performance of the facility. During the life of Phase 2, continual improvement of geotechnical monitoring would take place. Additional geotechnical investigations, piezometers

(to measure pore pressure), inclinometers and SAA (to measure horizontal deformations), observation wells (to measure water levels and water quality), settlement monitoring devices (to measure vertical displacements), and adoption of new technologies would be installed to monitor the health and performance of the facility as per USS Tailings Management System.

The Project would occur in stages to align with the Keetac life of mine predicted from permitted reserves through 2048 which includes time for reclamation and closure. At current mining rates, total tailings delivered to the TSF are anticipated to be approximately 340 million long tons. However, the ultimate dam configuration was designed conservatively to accommodate greater storage volume generated from potential lower head grades (would lead to more tailings tonnage), nearby mineral resources which are in the current permitted footprint but require in-fill drill spacing and/or mineral leases to be converted to reserve, or possible variations in in-situ tailings characteristics (this proposal does not involve any change in mining or processing from what has been permitted). At full design capacity the project could safely contain 590 million long tons of tailings, the Stage 2 Exterior dikes and dams would be 1,580 feet elevation (5 feet lower than the height of the Stage 2 Interior dike) and accommodate 225,000 acre-feet of fine tailings storage. This Project does not propose to increase the permitted life of the mine.

The Project would also involve building new infrastructure for tailings separation and tailings dewatering (Figure 6.6). The infrastructure would produce coarse tailings for use in dam and dike construction and thickened fine tailings for discharge to the TSF. The infrastructure would include an industrial building housing hydroseparators, screw classifiers, and dewatering screens necessary to separate and dewater the tailings by size. Inside the industrial building, it is also proposed to include a workers dry and meeting space. A fine tailings thickener, conveyors, load-out bin, and minimal haul truck service area would be located near the building. The building and associated infrastructure is proposed to be constructed north of Reservoir No. 6 to minimize new environmental impacts.

Site preparation for the industrial building and associated infrastructure would include grubbing any vegetation, stripping, topsoil excavation, and clearing. Site preparation will be completed using mechanical equipment common for such activities. This could include dozers, excavators, haul trucks, logging equipment, and loaders.

Using the dewatered coarse fraction of the tailings for construction would have a smaller environmental footprint than developing off-site natural borrow sources to obtain dam and dike construction materials, reduce the amount of tailings storage required within the TSF footprint, and enhance water management for the Keetac facility. The addition of the fine tailings thickener allows for increased water recycling (by reducing water loss to pore space during deposition) and provides better management for fugitive dust (by increasing trafficability of fine tailings and reducing surface area per discharge point).

A new permanent road would be built around the Stage 2 Exterior for access and maintenance. The road would be mechanically built using coarse tailings using the same equipment for site preparation and dam/dike construction (see Figures 6.4 and 6.5). Tailings would be piped to the TSF from the point of separation in pipelines laid on wooden blocks one to two feet above ground and along existing infrastructure corridors. Fixed frame haul trucks would convey the coarse tailings from the separation and dewatering infrastructure to the TSF 24 hours a day, seven days a week. The exact size of the haul trucks is to be determined. Preliminary haulage assessments indicate five Cat 785 mining trucks would adequately handle the coarse tailings material and dam construction while reducing the environmental impacts when compared to fewer but larger haul trucks.

The Project would permanently impact 608.6 acres and would temporarily impact 89.7 acres of land (Figure 6.4). However, most impacts would occur within the existing mining area. Of the 608.6 acres of permanent impacts, only 108.1 acres are located outside of the existing mining area. Of the 89.7 acres of temporary impacts, only 30.6 acres are located outside of the existing mining area.

The Project impact acreages and components are shown in Table 6.1 and Table 6.2. TSF stages and dike and dam heights are shown in Table 6.3.

Table 6.1: Project Impact Acreages

Area of Impact*	Permanent Impact Areas			Total Permanent Impact Area	Total Temporary Impact Area	Total Impact Area
	Permanent Impacts (Dike and Dam footprints)	Pipeline and Separation and tailings Dewatering Infrastructure	Permanent Access Road			
Portion inside of the Permit to Mine (acres)	434.6	28.2	37.7	500.5	59.1	**559.6**
Portion outside of the Permit to Mine (acres)	81.8	13.3	12.9	108.1	30.6	**138.7**
Total Acres	**516.4**	**41.5**	**50.7**	**608.6**	**89.7**	**698.3**

**Acreage of disturbance outside of current TSF or other Keetac Operational footprint.*

Construction is proposed to begin in the winter of 2026-2027 and would take 2 years. Vegetation clearing would occur during the winter months to minimize potential impact on bats and migratory birds. The TSF would be built in stages throughout operations. Similarly, temporary workspaces would be utilized in stages of six months or less. Outside of site preparation, it is anticipated construction would occur throughout the entire calendar year.

The Project does not require any demolition and no new waste streams would be generated. Water would be managed consistent with current TSF operations.

Table 6.2: Project Components

Project Component	Notes
New Permanent Footprint Impacts*	Up to 608.6 acres would be permanently impacted to create the additional dams and the separation and/or dewatering infrastructure of the 608.6 acres, only 108.1 acres are located outside of the mining area.
Vertically Raising Existing Retention Dikes	Dikes would be constructed using a modified centerline construction method completed in staged lifts.
Vertically Raising Existing Water Dams	Dams would be built using downstream construction methods including a seepage reduction feature completed in staged lifts.
New Tailings Separation and/or Dewatering Infrastructure	Located near the TSF in mostly upland area. The infrastructure would separate coarse tailings for dike and dam construction. The enclosed infrastructure would include machinery to separate the tailings (as needed), dewater the coarse tailings, and load coarse tailings into haul trucks. The building would have parking, potable water, and sewage (septic holding tank meeting the requirements of the MN Statute 7080) facilities. Maintenance facilities for trucks and machinery and fuel storage.
Power	Powerline upgrades may need to be constructed to connect the separation and/or dewatering infrastructure to the grid. Minnesota Power would perform this. Two 10-15 HP mobile generator units would be used 12 hours per day for lighting around the TSF as needed. They would be powered by Ultra Low Sulphur Diesel #2, except in the winter a blend of #1 and #2 will be used to avoid cloud and pour point issues.
Pipelines	New pipelines would be required to convey fine tailings from the separation and/or dewatering infrastructure to the TSF. These would be above ground lines, raised on blocks, and routed along existing roads and corridors.

Project Component	Notes
Roads	A new road along the exterior of proposed dams and dikes would be constructed for access and maintenance.
Temporary Footprint Impact*	Up to 89.7 acres, of which only 30.6 acres are located outside of the existing mining area.
Temporary Construction Areas	Needed to support construction of the dikes, dams, and separation and/or dewatering infrastructure. Located in upland areas as much as possible and reclaimed following use.
Other Activities and Controls (no new direct footprint impacts)	
Tailings disposal	Tailings stored within the existing active Stage 2 Exterior (brownfield), retained by the vertically raised dikes and dams through the life of mine. The ultimate height of the Stage 2 Exterior would be 1,580 feet. (similar to Stage 2 Interior).
Water management and treatment	Tailings water would drain to the Stage 2 Exterior Pond and eventually be gravity fed into Reservoir No. 6 to be pumped for use as process water. Stormwater would be managed under the Stormwater Pollution Prevention Plan, which would include best management practices.
Waste management	Waste would be hauled to approved facilities per Keetac operational management.
Transport and mobile machinery	Haul trucks used to transport coarse tailings from the separation and/or dewatering infrastructure to the TSF, mobile construction equipment, and staff vehicles.
Lighting	Lighting would be required at the separation and/or dewatering infrastructure and the TSF for safe 24-hour operation.
Dust control	Dust would be mitigated in accordance with the Dust Control Plan.
Employment	The Project would require approximately 10 new employees through construction and operation.

**Acreage of disturbance outside of current TSF or other Keetac Operational footprint.*

Table 6.3: TSF Stages and Dike and Dam Heights

Stage	Current Permitted Height (feet)	Current Actual Height (feet)	Proposed Maximum Height (feet)	Estimated Date Maximum Height Would Be Reached
Stage 1	1,500	1,500	1,500	at capacity
Stage 2 Interior	1,585	1,553-1,580	1,585	2028
Stage 2 Exterior	1,470 South 1,510 East	1,465 South 1,495 East	1,580	2063*

**The Project's proposed design would accommodate tailings through the current 2022 Permit to Mine period (2048) and allow for additional capacity for potential increased tailings generation.*

Reclamation

Reclamation techniques such as grading, disking, seeding or planting, fertilizing, and mulching would be used in the establishment of vegetation. Vegetation would be established on exposed soils along roads, TSF, dikes, and dams. Waste rock and coarse tailings stockpiles' exterior slope lifts would be designed not to exceed 30 feet in height, or 40 feet in height if covered with overburden and vegetation.

Progressive reclamation activities in the TSF would be conducted on the interior of the TSF and on the exterior portion of the dikes and dams (meaning these areas would be reclaimed as soon after initiation of the operations as practical and as continuously as practical throughout the life of the operation). The TSF would be designed and constructed according to Minnesota Rules, part 6130.3000 and in accordance with the Dam Safety Permit. The

dust generation on the TSF would be minimized by maximizing the water pond area, vegetating exposed surfaces (either permanently or temporarily), through non-vegetative methods described in Minnesota Rules, part 6130.3700, and by modifying TSF operations. This operational modification would allow for more water retention and would move the beach area from the middle of the TSF, where it was inaccessible, to the outside edges of the TSF, where it would be accessible for the establishment of vegetation. These changes would reduce fugitive dust emissions from the TSF.

Fertilizing, seeding and mulching would occur to expedite revegetation and to minimize erosion. Herbaceous plants would be seeded using a hydro-seeder or other methods. Seed mixes would be designed to achieve early stabilization and long-term cover. When necessary to control dust, temporary seeding may be used. In areas where erosion is a concern, mulch may be used to hasten stabilization. Removal of equipment, facilities, and structures would be accomplished, and provisions would be made for subsequent use and continued maintenance where necessary. Areas exposed during such removal (i.e., the building sites) would be vegetated. After three growing seasons (five growing seasons if it is a south or west facing slope) the surface would be repaired or replaced if 90 percent ground cover, consisting of living vegetation and its litter, has not been established. The repair or replacement would take place during the next normal planting period after it is determined that 90 percent ground cover has not been established.

Within ten growing seasons, established vegetation consistent with subsequent land use is required before a release from the Permit to Mine can be granted (Minnesota Rules, part 6130.3600, subpart 4, Item B). The reclamation process would include creation of wetlands where feasible, replacing some of the wetland functions and values lost through mining activities. Post-mining land uses would be presented to the commissioner of the DNR for approval at least two years prior to the deactivation of the mining area. The proposed land uses would be selected pursuant to Minnesota Rules, part 6130.4100, subp. 2. The deactivation activities for final closure of the mine would be fulfilled as prescribed in Minnesota Rules, part 6130.4100.

c. Project magnitude:

The specific footprint acreages of the Project components are shown in Table 6.4.

Table 6.4: Project Footprint

Project Component	Size
Stage 2 Exterior*	2,236.1 acres
Dam and Dike Footprint	516.4 acres
Pipeline and Separation and/or Dewatering Infrastructure	41.5 acres
Permanent Access Road	50.6 acres
Number and Type of Residential Units	None
Residential Building Area	None
Commercial Building Area	None
Industrial Building Area*	19,600 square feet
Institutional Building Area	None
Other Uses—specify	None
Structure Height(s)	70 feet: separation and/or dewatering infrastructure 1,580 feet: TSF

**This is a disturbed brownfield area with historic and current tailings deposition. This portion of the TSF is included in the Project description because it will be raised higher than what was previously permitted.*

d. Explain the Project purpose; if the Project will be carried out by a governmental unit, explain the need for the Project and identify its beneficiaries.

The Keetac Mine has taconite reserves to support mining through 2048 (at current mining rates) as approved under the Permit to Mine. There are also additional taconite resources beyond the Permit to Mine reserves that, in the future, may also be economical to mine. Taconite mined at Keetac is processed and tailings are stored in an existing TSF. At current mining rates, the existing TSF is estimated to meet its design safe storage capacity by approximately 2028.

The Permit to Mine was issued following the completion of the Keetac Mine Expansion Environmental Impact Statement (EIS) in 2010. At that time, it was planned that Keetac would raise Stage 2 Interior vertically using an upstream construction method with hydraulically placed tailings. Since that time however, U. S. Steel has undertaken measures to assess the risk associated with the Tailings Facilities it operates; it was identified that continuing to vertically raise Stage 2 Interior at Keetac in an upstream method was not sustainable. Option evaluations to reduce risk prompted Keetac Phase I and the proposed Keetac Phase II.

Keetac Phase 1 began by U. S. Steel communicating to the DNR that it would like to reduce the risk of the Stage 2 Interior first by buttressing and followed by a new robust design change (Keetac Phase II) that would allow additional capacity and strengthen the existing Stage 2 Interior. During those communications U. S. Steel and its Engineer of Record recommended that the Stage 2 Interior does not raise higher than 1585 feet on the south dike without substantial work (requiring additional permitting activity beyond the Permit to Mine and Dam Safety Permit). This language was then adopted in permits as a constraining height limit, which is estimated not to support tailings disposal past 2028.

Thus, U. S. Steel needs a longer-term solution to safely manage tailings generated by the Keetac Mine under the existing Permit to Mine, and with capacity for the ultimate life of mine.

e. Are future stages of this development including development on any other property planned or likely to happen? ☐ Yes X No

If yes, briefly describe future stages, relationship to present Project, timeline and plans forenvironmental review.

The Project is intended to fulfill tailings storge requirements for the Keetac life of the mine. No future phases are anticipated.

While the Project would result in a TSF capacity that could accommodate tailings beyond the current Permit to Mine (2048), this Project does not propose any expansion of mining or processing. U. S. Steel has not proposed future expansion of mining or processing . Mineral resources have not been properly evaluated, and there is no mine plan beyond what is currently approved.

f. Is this Project a subsequent stage of an earlier Project? X Yes ☐ No

If yes, briefly describe the past development, timeline and any past environmental review.

Below is a brief history of milestones regarding the Keetac TSF and the associated references:

1967	Tailings deposition into Stage 1 began. Taconite mining and taconite pellet production initiated. Keetac began production using rotary hearth technology, which was later abandoned for grate kiln technology.
1969	The original Phase I grate kiln pellet line began operation.
1977	The Phase II expansion added a second grate kiln pellet line.
1980	The Phase I facility was idled; Stage 2 constructed in the 1980's

1986	Permit to Mine issued to the National Steel Pellet Company #1 for areas including the Proposed TSF
1993	Permit to Mine Amendment issued to National Steel Pellet company authorizing a new "tailings stacking method" i.e., upstream construction of Stage 2 Interior. Stage 2 Exterior idled.
2003	The former National Steel Pellet Company facility was purchased by U. S. Steel and renamed Keetac.
October 2003	The DNR issued permit 65-1138 authorizing appropriation of water from a well located in the SW1/4 NW1/4, Section 19, Township 57 North, Range 21 West for potable and sanitary use and emergency pellet process cooling at the Keewatin Taconite Plant. This permit was issued to Hannah Mining Company October 11, 1965. The permit was amended in 2003.
2008	Scoping Environmental Assessment Worksheet and a Draft Scoping Decision Document was submitted to provide information about the Keetac Expansion Project. This served as the blueprint for the Environmental Impact Statement submission (see 2010 for Final Environment Impact Statement).
October 2010	Minnesota Pollution Control Agency (MPCA) approved the Water Management Study Plan for the Keetac facility which evaluates water discharge and water consumption alternatives.
October 2010	MPCA approved the Sulfate Reduction Strategy Study Plan for water quantity and quality data review, and evaluation of source control strategies and sulfate treatment technologies.
November 2010	Final Environmental Impact Statement was submitted with the intent to restart an idled production line and expand sections of the open pit iron ore mine at the Keetac Mine and processing facility. The intent of the Project would increase the taconite pellet production capacity by expanding the mine pit, adding stockpile areas, upgrading the concentrating and agglomerating process, and restarting the Phase I line.
November 2011	MPCA issued NPDES/SDS Permit No MN0055948 allowing for the construction, installation, and operation of a disposal system at the Keetac facility and to discharge from the facility to Reservoir 2, Welcome Creek.
January 2012	DNR approved Keetac's Wetland Permit Application for impacts due to the Keetac Mine Expansion Project with revised Palisade Mitigation Plans. 75.9 credits were debited from the Thompson Site, and remaining credits from Palisade Wetland Mitigation Site.
October 2012	U.S. Army Corps of Engineers (USACE or the Corps) approved the modification of permit 2008-02481-JCP, which included the discharge of dredged or fill material into 553.31 acres of wetlands at the Keetac Mine site, permanent dewatering of 24.96 acres of deep water habitat at the mine site for the expansion of the east mine pit, south mine pit, east stockpile, and south stockpile and the discharge of dredged and fill material into 36.76 acres of wetlands for the construction of upland berms at the Palisade I mitigation site.
October 2012	A Programmatic Agreement was developed between the Corps, State Historic Preservation Office (SHPO), the Ojibwe Bands, and U. S. Steel, agreeing that if a permit is issued for the Keetac Expansion, stipulations would be implemented which consider historic properties.

November 2012	USACE issued approval for the discharge of dredged and fill material into 75.89 acres of wetlands for the construction of an eastern stockpile and for the structural reinforcement of an existing TSF at the Keetac Mine. Known as “Keetac Phase 1 Permit”.
September 2014	MPCA issued Air Emission Permit Major Amendment No 13700063-005 for an administrative amendment. The request served two purposes, first to revise the form of the mine fleet mobile source limit and associated monitoring and recordkeeping to mitigate impacts in Class I areas from operation of the expansion line, and second, to incorporate an 18-month extension of the construction deadline (authorized until October 2014).
September 2015	MPCA issued NPDES/SDS Permit No MN 0031879 for the operation of a disposal system at the Keetac facility and to discharge at Welcome Lake.
April 2022	DNR issued a Permit to Mine amendment for the purpose of raising the exterior dikes at the Keetac Stage 2 exterior TSF to a maximum elevation of 1,500 feet, and the construction of an interior diversion dike.
September 2022	DNR approved the Keetac Wetland Replacement Plan for impacts at the Keetac TSF for tailings basin modifications and deposition (Phase I). The wetland delineation and incidental determination were approved by the DNR on January 24, 2022. A total of 127.31 acres of wetlands regulated under WCA were debited from Palisade Project Specific Wetland Mitigation Site surplus credits.
October 2022	USACE made an approved jurisdictional determination for impacts at the Keetac TSF. The area contained 119.96 acres of approved compensatory wetland mitigation areas used to satisfy previous compensatory mitigation requirements as part of the Keetac mine expansion (MVP-2008-02481). 120.0003 credits were debited from Palisade III Mitigation Bank.
May 2023	DNR approved Permit to Mine Amendment which granted U. S. Steel approval to construct a plant expansion for the purpose of producing Direct Reduced Pellets. The expansion increased the plant by approximately one acre and added approximately 13,400 feet of additional tailings pipeline.
July 2023	U. S. Steel began construction of a buttress against Stage 2 interior that extends into the Stage 2 Exterior as Phase I.
January 2024	USACE provided a jurisdictional determination of the 2021 Study Area and 2023 Study area.
January 2025	MPCA reissued Keetac’s Title V air emission permit 13700063-102, which included an updated Fugitive Dust Control Plan
February 2025	DNR clarified the mining area in the Permit to Mine TSF mining area based upon more accurate mapping tools and historical documents to include Reservoir 6, among other areas (Appendix N)
July 2025	NPDES/SDS permits were placed on public notice by the MPCA; permits include compliance schedule for sulfate.

7. Climate Adaptation and Resilience:

a. Describe the climate trends in the general location of the Project (see guidance: *Climate Adaptation and Resilience*) and how climate change is anticipated to affect that location during the life of the Project.

Climate Trends Summary

The area of Minnesota where the Project is located has been increasing in annual average temperature, along with rising minimum and maximum temperatures overall (Minnesota Climate Trends; MPCA 2023). Throughout the next century, the Intergovernmental Panel on Climate Change (IPCC) projects an increase in mean-average temperature under three of the IPCC Coupled Model Intercomparison Project Phase 6 climate scenarios: SSP2-RCP4.5, SSP3-RCP7.0, and SSP5-RCP8.5. These scenarios were developed by the IPCC and correspond with climate change trends projected by over 30 global climate models which incorporate Shared Socioeconomic Pathways (SSPs).

- SSP2-RCP4.5 is a lower emissions scenario where warming stays below 3°C.
- SSP3-RCP7.0 is a high emissions scenario where average warming will likely be higher than 3°C.
- SSP5-RCP8.5 is a very high emissions scenario resulting in warming above 4°C.

Projection data in the following sections utilizes the climate output corresponding to the above scenarios for both St. Louis and Itasca Counties.

The climate in the Project Area is projected to have increasing temperatures over the next 30 years (MNDNR 2023). Northern Minnesota has experienced an increase of 7.5°F in nightly winter temperatures over the last century (IPCC 2021). Snowfall is expected to decrease, though Minnesota is expected to experience more frequent and severe rainfall events (get wetter) (MPCA 2023). Heavy rains and severe rain events have increased in frequency. Long-term monitoring has revealed significant increases in rainfall events greater than 1 to 3 inches (MPCA 2023). Rains that previously would have been in the 98th percentile annually have seen a significant uptick since 2000 in Minnesota. Historically, the total precipitation in 24 hours during a 10-year storm event is 3.08 inches, a 50-year event is 4.53, and a 100-year event is 5.28 (Hibbing Power Substation, NOAA station ID USC00213727). This area is unlikely to be impacted by extreme winds (First Street Foundation 2023). According to the 2018 Planning for Climate & Health Impacts in Northeast Minnesota, there is increased fire risk in this area due to projected higher frequency of late growing season drought, reduced snowpack, and elevated temperatures (Minnesota Climate & Health Program 2018).

Historical Climate

Historical climate data for Itasca and St. Louis counties were selected using the DNR "Minnesota Climate Explorer" tool from 1895-2024 and are presented below.

Temperature

The average temperature in St. Louis and Itasca Counties is increasing at a rate of 0.29°F per decade (Figure 7.1).

The maximum average annual temperature for St. Louis and Itasca Counties has been increasing at a rate of 0.21°F per decade (Figure 7.2).

The minimum average temperature has been increasing at a greater rate than maximum annual average temperature at 0.37°F per decade (Figure 7.3).

The average annual precipitation has been increasing by 0.19 inches per decade (Figure 7.4).

The Palmer Drought Severity Index is based on soil water balance and estimates relative soil moisture conditions. Values below -3 indicate a severe drought and positive values indicate greater soil moisture (Dai 2012). The average Palmer Drought Severity Index in July for Itasca and St. Louis counties is increasing at 0.18 per decade

indicating wetter soils over time (Figure 7.5) July was chosen as a representative of the wettest months in Minnesota, which are typically May through September (MNDNR 2024).

Projections

Temperature

Projected climate trends indicate that temperatures within both counties will continue to increase. Figure 7.6 illustrates projected average temperatures for the counties. Several climate models are shown in the projected temperature analysis. The model mean, shown in blue, illustrates the average of all models included in the analysis. Figure 7.6 shows the modelled present conditions, mid-century (2040-2059) at Representative Concentration Pathway (RCP) 4.5, late-century (2080-2099) at RCP 4.5, and late-century (2080-2099) at RCP 8.5. RCP is a greenhouse gas concentration scenario used by the IPCC in the fifth assessment report. RCP 4.5 is an intermediate scenario in which emissions decline after peaking around 2040 and RCP 8.5 represents a worst-case scenario in which emissions continue rising through the 21st century. Under the RCP 4.5 scenario, the annual temperature is anticipated to increase within the counties from a modeled present mean of 45.4°F (1980-1999) to a mid-century (2040-2059) model mean of 49.0°F and a late-century (2080-2099) model mean of 51.4°F. Under the RCP 8.5 worst-case scenario, the counties would experience a late-century (2080-2099) model mean temperature of 55.1°F. Under RCP4.5 and RCP8.5 the number of days over 100°F will from 0 days in 2010 to 2 days and 6-8 days respectively by 2081 as shown on Figure 7.7.

Precipitation

Projected climate trends indicate that precipitation within both counties will continue to increase. Figure 7.8 illustrates projected average precipitation for the counties. Like the temperatures, the precipitation climate models are shown in the projected temperature analysis. The model mean, shown in blue, illustrates the average of all models included in the analysis. Figure 7.9 shows the modeled present conditions, mid-century (2040-2059) at RCP 4.5, late-century (2080-2099) at RCP 4.5, and late-century (2080-2099) at RCP 8.5. RCP is a greenhouse gas concentration scenario used by the IPCC in the fifth assessment report. RCP 4.5 is an intermediate scenario in which emissions decline after peaking around 2040 and RCP 8.5 represents a worst-case scenario in which emissions continue rising through the 21st century. Under the RCP 4.5 scenario, the annual precipitation is anticipated to increase within the counties from a modeled present mean of 0.87 inches (1980-1999) to a mid-century (2040-2059) model mean of 0.94 inches, and a late-century (2080-2099) model mean of 1.04 inches. Under the RCP 8.5 worst-case scenario, the counties would experience a late-century (2080-2099) model mean precipitation of 1.16 inches.

Flooding

According to the Federal Emergency Management Agency Flood Plain Map Service Center, there are no mapped floodplains within or in the vicinity of the Project Area (FEMA 2021). Flooding frequency in the vicinity of the Project Area is derived from the Natural Resource Conservation Service SSURGO database (Figure 7.10). If unmapped floodplains are present in the Project Area, they could be impacted by soil compaction. Impacts associated with compaction and mitigation measures that would be implemented to minimize such impacts are identified in Section 4.9-Soils.

7b: Project Interaction with Climate Trends The climate risk for construction, operation, and closure of the Keetac TSF is considered below. U. S. Steel has an emergency action plan that would be implemented in the event of dam or dike break or overtopping.

Construction Climate Interactions

The initial construction phase of the Project is anticipated to take two years and begin 2026. It is not expected that climate would be significantly different during this period than today's conditions, and construction should

be able to work around weather events. The dams and dikes would be built in stages throughout operations, which is discussed below.

The separation and/or dewatering infrastructure is located in predominantly upland area. Construction of the separation and/or dewatering infrastructure would permanently impact 0.06 acres of WCA-regulated deep marsh wetlands, 1.08 acres of WCA-regulated fresh (wet) meadow wetlands, and 0.15 acres of shallow marsh (1.29 acres total). However, since the separation and/or dewatering infrastructure would be constructed at a higher elevation (i.e., why there are few delineated wetlands in this location), it would be less prone to flooding. Access to the separation and/or dewatering infrastructure does not cross any waterways susceptible to flooding.

Construction would result in loss of wetlands and associated flood storage within the proposed Project footprint. Loss of vegetated areas has the potential to increase stormwater runoff. The Project would adhere to the Stormwater Pollution Prevention Plan (SWPPP) that U. S. Steel is currently operating under for the existing TSF. Potential wetland mitigation measures could include the purchase of wetland bank credits, Palisade Wetland Mitigation Site or restoration of wetlands elsewhere on-site.

Operation Climate Interactions

The relevant potential climatic hazards for operations include increased precipitation and extreme weather events which may result in flooding and water stress/drought. Extreme rainfall and flooding are potential major hazards that could last for long periods of time and have an impact on the Project.

Twenty-five percent of global tailings dam failures between 1917 and 2006 were caused by heavy precipitation events (Rico et.al 2008). The purpose of the Project is to increase stability of the TSF. It has been designed to have more stable embankments and accommodate extreme weather events. Analysis was completed for 100-year rainfall event based on past precipitation and a probable maximum precipitation event. The 100-year storm modeled was for 6.35 inches of rainfall in a 24-hour period. Probable maximum precipitation (PMP) was also modeled for the dam design and was estimated at 28.5 inches of rainfall in a 24-hour period.

The analysis exercise also considered the impact that climate change would have on the hydrologic response of the basin. When determining the PMP depth, the potential effects of climate change was considered. An atmosphere that is subject to warmer weather may be more susceptible to an increase in atmospheric moisture; however, the relationship between a warming climate and the dynamics of a storm is not known. An increase in temperature may affect the frequency or intensity of a storm, but the evidence that has been gathered does not show a significant trend in data regarding PMP depth. Climate change should not be considered when estimating the rainfall depths for PMP events (WMO 2009, Section 1.1.1). Similar climate change conclusions were recently discussed in the report “Site-Specific Probable Maximum Precipitation Study for Tittabawasse River Basin, Michigan Final Report” by Applied Weather Associates (AWA). This analysis exercise selected the runoff from the 24-hour PMP event as the basis for design of Keetac Phase 2. That is, Phase 2 is designed to store all runoff generated from a 24-hour PMP event (including wave run-up) until water can be safely discharged.

Water within the TSF would be discharged in a controlled manner to Reservoir No. 6, which has designed outfalls to accommodate emergency events and maintain the integrity of the TSF. The stability of the TSF is monitored and reported to the DNR in accordance with the Dam Safety Permit. The TSF design is progressively updated to accommodate anticipated operational needs, and to accommodate the updated knowledge base including anticipated climatic conditions.

Extreme rainfall can also impact the soil and ground surface integrity, shifting or altering existing construction materials. Along with flooding, landslides can also pose a high construction risk. In addition to being a hazard to workers, they can block roads and cause construction delays. Soils may become loosened by rains and can co-occur with more intense rainfall events.

Alternatively, water stress may have some impacts on the Project due to the decreased snowfall in the winter leading to more dust. The Project can adapt to increase and extend dust control measures as identified in the Fugitive Dust Emission and Control Plan. Roadside fires could increase under dry conditions during operations if vehicles are close to dry vegetation. Additionally, a fire in the area could cause a hazardous working environment due to unhealthy air quality conditions. Extreme heat can similarly cause hazardous working conditions and fatigue. These hazards may influence operating costs due to increased maintenance, safety measures, and other expenditures.

Closure and Post Closure Interactions

The TSF is not planned for closure until the end of life of the mine (mining at Keetac is currently permitted through 2036 but has stated reserves well beyond). Some portions of the TSF could be progressively reclaimed prior to that, and land areas would be seeded and vegetated with native species as appropriate for the TSF conditions to minimize erosion, and for safe maintenance. Closure of the TSF would be managed according to the reclamation and closure procedures outlined in the Dam Safety Permit, Permit to Mine, and Minnesota Rules 6130.4100. Additionally, best practices, stakeholder input, any requirements in the NPDES permit for cessation, and current conditions at the time of closure would be incorporated. The current dam safety permit requires perpetual maintenance on all components to ensure integrity of all structures. Prior to the ultimate termination of the dam, a review by the DNR would be conducted to establish any perpetual activities necessary and financial responsibility is adequate by the owner.

Post-mining land uses and a detailed closure plan would be presented to the DNR for approval two years prior to deactivation. The permitted post-closure plan framework states within three years after deactivation or within a longer period that may be reasonable, the surface water will be drained via a channel cut through the Stage 2 Interior Dike draining water safely to the Stage 2 Exterior. The Stage 2 Interior would be vegetated for dust control, wildlife habitat or other purposes permitted by the DNR. Where necessary, the TSF would be shaped and contoured to ensure proper drainage in a manner that would not adversely affect structural stability of the drainage channel or result in erosion. All closure and reclamation procedures would adhere to Minnesota Rules and take necessary input from industry best practices, stakeholder engagement, and current conditions at time of closure.

Long-term climatic conditions, watershed restoration, and vegetation responses would be considered in reclamation planning. Site conditions and needs would be monitored in post closure.

b. For each Resource Category in the table below: Describe how the Project's proposed activitiesand how the Project's design will interact with those climate trends. Describe proposed adaptations to address the Project effects identified.

The Project has been designed with consideration for potential climate change impacts and trends. Table 7.1 outlines the key resource categories that may be affected by climate change and how the Project's design and proposed activities would interact with and adapt to these climate trends.

Table 7.1: Proposed Climate Adaptation

Resource Category	Climate Considerations (as identified in 7a)	Project Information (what features of resource category addresses vulnerabilities of/due to climate and climate trend)	Adaptations (effect on the feature)
Project Design	Increase in annual precipitation Reduction in snow cover	Dams and dikes height relative to potential increased rainfall / extreme events. Possible increase in tailings exposure throughout the winter.	Dams and dikes have enhanced designs to improve overall structural integrity. Dams, dikes, and seepage control / water management infrastructure is designed with future precipitation trends in mind. Increase/extend the dust control measures outlined in the Fugitive Dust Emission and Control Plan. Separate coarse and fine tailings would allow for more strategic deposition with respect to fugitive emissions.
Land Use	Increased temperatures and precipitation	Conversion of open space to tailings storage would result in loss of wetlands and associated flood storage within proposed Project footprint. Loss of vegetated areas may increase stormwater runoff.	Wetland mitigation measures would include use of surplus credits from the Palisade Wetland Mitigation Site. Stormwater management practices would be implemented as identified in the Stormwater Pollution and Prevention Plan.
Water Resources	Addressed in Section 12	Addressed in Section 12	Addressed in Section 12
Contamination/ Hazardous Materials/Wastes	Not applicable	Not applicable	Not applicable
Fish, wildlife, plant communities, and sensitive ecological resources (rare features)	Addressed in Section 14	Addressed in Section 14	Addressed in Section 14

8. Cover types: Estimate the acreage of the site with each of the following cover types before and after development:

Table 8.1 provides detail of the cover types for the Stage 2 Exterior, separation and/or dewatering infrastructure and pipeline, temporary impact areas, and permanent impact areas, using cover type data sourced from the National Land Cover Database (NLCD). The Stage 2 Exterior is currently being filled with tails and converted to barren land. An additional 1,200.6 acres within the Stage 2 Exterior, which is composed of anthropogenically disturbed land, would be categorized as barren lands as tails continue to be pumped into the area. The separation and/or dewatering infrastructure and pipeline would convert 37 acres to impervious surfaces. The footprint for the dams, dikes, and supporting roads would convert 536.6 acres to barren land. Temporary construction areas outside of wetlands would be restored to pre-construction conditions. Tree clearing and grubbing would occur in temporary workspaces prior to construction. Forested and shrub/scrub land cover types in temporary construction areas would be reseeded, resulting in 62.9 acres of herbaceous land cover. Figure 8.1 illustrates the existing NLCD land cover types.

Table 8.1: Existing and Proposed Cover Types for the TSF

Cover Types	National Land Cover Data Classifications	Before (acres)	After (acres)
Wetlands and shallow lakes (<2 meters deep)*	Emergent Herbaceous Wetlands	133.7	2.2
	Woody Wetlands	461.8	14.7
Deep lakes (>2 meters deep)	Open Water	420.3	0.5
Wooded/forest	Deciduous Forest	433.2	0
	Evergreen Forest	4.6	0
	Mixed Forest	115.8	0
Rivers/streams	N/A	0	0
Brush/grasslands	Shrub/Scrub	225.2	0
	Herbaceous	58.0	62.9
Cropland	N/A	0	0
Livestock rangeland/pastureland	N/A	0	0
Lawn/landscaping	N/A	0	0
Green infrastructure TOTAL	N/A	0	0
Impervious surface	N/A	0	37.0
Developed or barren land	Developed, Low Intensity	1.9	0.8
	Developed, Medium Intensity	0.2	0.2
	Developed, Open Space	2.6	1.6
	Barren Land	1,077.3	2,814.5
Other (none)	N/A	0	0
TOTAL		**2,934.4**	**2,934.4**

* The NLCD data is remotely sensed at a 30-meter spatial resolution wetland acreages may vary from field delineated acreages, as shown in Table 12.6. Table 8.1 includes acreages for the conversion of wetlands in the Stage 2 Exterior that is currently being filled with tails, as well as the Project Area.

Table 8.2 details proposed green infrastructure that would be incorporated. For the proposed Project, green infrastructure would not be applicable.

Table 8.2: Existing and Proposed Green Infrastructure

Green Infrastructure	Before (acreage)	After (acreage)
Constructed infiltration systems (infiltration basins/ infiltration trenches/ rainwater gardens/ bioretention areas without underdrains/ swales with impermeable check dams)	0	0
Constructed tree trenches and tree boxes	0	0
Constructed wetlands	0	0
Constructed green roofs	0	0
Constructed permeable pavements	0	0
Other (describe)	0	0
TOTAL	0	0

Table 8.3 details proposed canopy cover changes. Approximately 1,015.3 acres of the Project Area are estimated to be covered by canopy according to the NLCD. In the construction phase, all trees within the Project Area will be removed. No additional tree planting is anticipated.

Table 8.3: Existing and Proposed Canopy Cover

Trees	Percent	Number
Percent tree canopy removed, or number of mature trees removed during development	100%	1,015.3
Number of new trees planted	0	0

9. Permits and approvals required: List all known local, state and federal permits, approvals, certifications and financial assistance for the Project. Include modifications of any existing permits, governmental review of plans and all direct and indirect forms of public financial assistance including bond guarantees, Tax Increment Financing and infrastructure. *All these final decisions are prohibiteduntil all appropriate environmental review has been completed. See Minnesota Rules, Chapter 4410.3100.*

Table 9.1 lists the local, state, and federal permits, approvals, and certifications for the Project.

Table 9.1: Applicable Regulatory Authorities and Required Permits

Unit of Government	Type of Application	Status
U.S. Army Corps of Engineers (USACE)	Clean Water Act Section 404 Individual Permit	To be applied for
	Section 7 Endangered Species Act Consultation with the U.S. Fish & Wildlife Service	Consultation led by the USACE
	National Historic Preservation Act Section 106 Determination for Historic Properties	Consultation led by the USACE
U.S. Fish and Wildlife Service	Federal Endangered Species Permits	Coordination led by USACE
Minnesota Department of Natural Resources (DNR)	Permit to Mine Amendment	Expires in 2048 An amended Permit to Mine will be required prior to starting Project work.
	Dam Safety Permit	Permit No. 2022-0721 To be amended
	Public Waters Work Permit	To be applied for, if needed
	Wetland Replacement Plan for Wetland Conservation Act	To be applied for

Unit of Government	Type of Application	Status
	Burning Permit (land clearing)	To be applied for, if needed
	Takings Permit (for Endangered or Threatened Species)	Coordination with DNR
Minnesota Pollution Control Agency	Air Emissions Permit (Prevention of Significant Deterioration/Title V Air Permit)	Permit No. 13700063-102 To be amended, if needed
	Clean Water Act Section 401 Water Quality Certification	To be applied for
	National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit for Industrial Wastewater Discharge and Storm Water Discharge for Industrial Activity—Tailings Basin	Permit No. MN0055948 Pending reissuance
	Storage Tank Permits (fuel tanks)	Not required, Keetac is under MN Rules Chapter 7151
	Hazardous Waste Generator License	Keetac is a small quantity generator and complies with U.S. Environmental Protection Agency's (USEPA's) and Minnesota Pollution Control Agency's (MPCA's) waste management rules
City of Hibbing	Building Permit	To be applied for, if needed
	Shoreland Alteration Permit for construction in a shoreland management district	To be applied for, if needed
	Rezoning, Zoning Variance or Conditional Use Permit (CUP)	To be applied for in sections zoned as open space in the TSF
City of Nashwauk	Zoning Permit	To be applied for, if needed (Section 17.2 local ordinance)
Itasca County	Septic Permit	To be applied for, meeting the requirements of MN Statute 7080
	Extractive Use Permit/CUP	To be applied for, if needed (Section 3.13.1-3.13.11 local ordinance) Per Section 3.13 CUP is required if there is a residence within 1,000 feet of an extractive use operation
	Shoreland Alteration Permit for the movement of more than 10 cubic yards of material on steep slopes or within shore/bluff impact zones or 50 cubic yards or greater outside abovementioned zones.	To be applied for, if needed

10. Land Use:

a. Describe:

i. Existing land use of the site as well as areas adjacent to and near the site, including parks and open space, cemeteries, trails, prime or unique farmlands.

Existing Conditions

The Project is located on the border of St. Louis and Itasca Counties, south of Highway 169 East in Minnesota. The cities of Hibbing and Nashwauk are partially located within the Project Area boundary, and the city of Keewatin is located approximately two miles north of the Project Area. The mine and associated process facility is located within the city of Keewatin; however, the Project Area is located outside the city's jurisdiction.

Land within and surrounding the Project Area is privately owned by U. S. Steel, as shown on Figure 6.2 (Itasca County Parcel Information System 2023; St. Louis County Land Explorer 2018).

The Project Area does not contain any known cemeteries, trails, or publicly designated open space.

Recreational areas in the vicinity of the Project Area include the O'Brien Reservoir Recreation Area, the Mesabi Trail, and various snowmobile trails (including the Lawron Trail), as shown on Figure 10.1.

The Project area is entirely within the 1855 Ceded Territory, which was created by the 1855 Treaty of Washington. In this treaty the Mississippi, Pillager, and Lake Winibigoshish Bands of Ojibwe ceded the lands contained within the Ceded Territory to the United States Government. Among others the Treaty created the Mille Lacs Reservation and Leech Lake Reservation, the latter being approximately 80 miles west of the Project site. The location of the Project Area within the 1855 boundary is shown in Figure 10.2.

The O'Brien Reservoir Recreation Area encompasses approximately 192 acres and is owned by the City of Keewatin. The O'Brien Reservoir Recreation Area is located approximately 3 miles northwest of the Project Area, and includes a DNR boat ramp, a fishing dock, and a public beach.

The Mesabi Trail is a paved recreational trail, currently under construction, that would stretch nearly 165 miles along the length of the Mesabi Range from Grand Rapids to Ely, Minnesota when completed. Currently, over 135 miles of trail have been constructed. A section of the Mesabi Trail is located approximately two miles from the Project Area, beginning in Nashwauk, and extending eastward past O'Brien Lake to the City of Keewatin. From Keewatin, the trail extends along Trunk Highway 169 (TH 169) for three miles, north to Kelly Lake, and east to the City of Hibbing.

Minnesota snowmobile trails border the Project Area to the south, east, and west. The Lawron Trail is located approximately one mile to the west of the Project Area and extends south from Highway 169 for five miles to the Itasca #1 Greenway Trail. The Itasca #1 Greenway is situated approximately two miles to the south of the Project Area. It extends southeast from the Lawron Trail for two miles and connects with the Chisholm/Side Lake/Hibbing Spur. The Chisholm/Side Lake/Hibbing Spur runs north-to-south and is located approximately 0.5 mile from the Project Area. It extends seven miles along the eastern side of the Project Area and continues to Highway 169, where it continues east of Keewatin.

Minnesota's iron ore deposits are concentrated in the northeastern "Iron Range," encompassing the Vermilion, Mesabi, and Cuyuna Ranges. The Project Area is located within the Mesabi Range, which extends from near Grand Rapids, Minnesota to Birch Lake, Minnesota. The Keetac Mine is a conglomeration of taconite mine pits established in the early 1900s and is now the third largest mine in the Iron Range. The existing TSF has been in operation and development since the 1960s and has undergone numerous modifications as tailings are deposited and its perimeter walls are raised, as stated in the Project Description.

The Project Area encompasses several key components: the existing Stage 2 Exterior of the TSF, planned dam and dike construction areas to the southwest and adjacent to the Stage 2 Exterior, an area near an unnamed road on the northwest side of the TSF, approximately 13 acres of forested land adjacent to the road, the separation and/or dewatering infrastructure, and supporting infrastructure footprints. In addition to deposited tails, the Stage 2 Exterior contains previously disturbed areas that facilitated the creation of incidental wetlands. Initial disturbance of Stage 2 Exterior began in the 1980s with construction of perimeter dams and deposition of tailings up to 20 feet deep, continuing until the year 2000. Beginning in 2022, some additional enhancement work and tailings deposition was restarted in Stage 2 Exterior as part of Phase 1 enhancements (Section 1.3).

The areas immediately southwest and adjacent to the Stage 2 Exterior are composed of forest, wetlands, and water bodies. The area south of the Stage 2 Exterior was previously disturbed for construction of the perimeter of the TSF, which has resulted in the creation of incidental wetlands. Several waterbodies surround the TSF, including Reservoir No. 2, Reservoir 2 North, Reservoir No. 6, Hay Lake, Swan Lake, Hay Creek, and Swan River.

The area within the TSF has been the site of historic logging and mining activities since the early 20th century. Disturbance from these activities have facilitated the creation of primarily shallow marsh, deep marsh, wet/sedge meadow, and alder thicket wetland types. The National Land Cover Database classifies most of the

land use within the Stage 2 Exterior area of the Project Area. Dominant land cover types included barren land (54 percent), with some woody wetlands (17 percent) and scrub shrub (8 percent) and deciduous forest (8 percent). A wetland delineation was conducted in November 2021. The report provides photographic documentation of these wetlands and the land cover at that time. Land use classification within the Stage 2 Exterior portion of the Project Area is shown in Section 8 – Cover Types, Table 8.1 (USGS 2016).

Farmland classifications are shown in Table 10.1. Approximately 85.4 percent of the Project Area is Not Prime Farmland (596.5 acres). Approximately 9.6 percent (66.7 acres) of the Project Area is classified as Farmland of Statewide Importance (does not meet Prime Farmland characteristics but is important for agricultural production), 3.1 percent (21.8 acres) is classified as Prime Farmland if Drained (meets Prime Farmland characteristics except depth to seasonal high water table and are suitable for drainage). The remaining 1.9 percent (13.3 acres) are Prime Farmland (prime characteristics for agricultural production).

Table 10.1: Farmland Classification Within the Project Area

Farmland Classification	Permanent Impacts			Temporary Construction Impacts	Total Acres
	Dam/Dike Construction	Permanent Access Road	Pipeline and Separation and/or Dewatering Infrastructure		
Not Prime Farmland	451.1	38.8	39.9	66.7	596.5
Farmland of Statewide Importance	38.2	7.9	0.0	20.6	66.7
Prime Farmland If Drained	17.3	2.2	0.0	2.4	21.9
All Areas Are Prime Farmland	9.8	1.9	1.7	0.0	13.3
Total acres*	**516.4**	**50.6**	**41.5**	**89.8**	**698.3**

**Total acreages may not reflect sum of farmland classification types due to rounding.*

ii. Plans. Describe planned land use as identified in comprehensive plan (if available) and any other applicable plan for land use, water, or resources management by a local, regional, state, or federal agency.

The Project Area straddles the City of Hibbing (Saint Louis County), Nashwauk City, and Lone Pine Township (Itasca County) (Figure 10.3).

The City of Hibbing adopted its current comprehensive plan December 19, 2018. The Hibbing comprehensive plan identifies community goals, visions, and land use and zoning maps with designated associated zones. The city lists mining as one of the top two industries employing Hibbing workers. The existing land use regulations (Section 11.05) of the Ordinance identifies both mineral exploration and gravel pits as permitted uses within the I-2 zoning district. While most of the Project Area is zoned I-2, a permitted use, there are small portions that traverse the mine that have a designation of O (Open Space), O-1 (Open Space), A-R (Agricultural-Rural Residential), and R-R (Rural Residential). Rezoning, and/or a comprehensive plan Amendment may be necessary to align the zoning with the future land use maps found within the comprehensive plan.

The City of Nashwauk adopted its current comprehensive plan October 2014. The plan itself describes its current land use, and desired future conditions. The proposed land use map is comprised of three land use areas: mining, industrial park (heavy, moderate, light industrial, business park, commercial, and timber), and multi-use (residential, multi-family, cluster, retail, schools, parks and light commercial). The intent of the designations is to guide community development decisions and ensure land use and development occur in harmony. As stated in the plan, Nashwauk is looking to preserve tradition and embrace progress. The zoning map itself designates the Project Area as M-3, or Heavy Industrial Mining. This aligns with the intent of the comprehensive plan and zoning map.

The Itasca County Comprehensive Land Use Plan was adopted May 23, 2000, with updates on April 9, 2013. The intent of the comprehensive plan is to guide the county's land use activities over a 20-year period. The comprehensive plan, includes a mining objective, which states: "Support the continuation and expansion of the mining industry." Methods identified to provide this support include establishing a mining industrial zone, with multiple overlay districts that prioritize mining. In addition, the plan states to "designate adjacent lands necessary for processing minerals and storing overburden, lean ore, tailings and other mining activities." The plan focuses on cooperative partnerships, cooperative planning, and facilitating the process to ensure successful outcomes. Identified within the zoning map, this Project is zoned for an Industrial designation. Within the Industrial Zoning District, Mining and associated activities are considered a permitted use.

The St. Louis County's comprehensive future land use plan does not include the Project Area.

Overall, the Project Area is included within two One Watershed One Plan boundaries: the Upper Mississippi-Grand Rapids and the St. Louis River. While the Upper Mississippi- Grand Rapids is currently in the planning stage (initiating the effort in 2022), St. Louis does have an approved Comprehensive Watershed Management Plan. The approved plan is broken up and prioritized based off planning areas. The Project Area is identified within the St. Louis River North planning area (Swan River Watershed). This planning area includes the headwaters of the St. Louis and Sand Rivers, East and West Swan Rivers, East and West Two Rivers and the Embarrass River. The planning area is classified by both active and historic mining operations. Identified priority issues within this area include surface water quality degradation (related to impairments of aquatic life); drinking water quality and quantity threats; impacts to watershed health from urbanization, development and road expansion; altered hydrology leading to channel instability, excess sedimentation and loss of water storage; forest fragmentation and loss impacting habitat and water resources. The 10-year goals for the St. Louis River North planning area focus on reducing bacteria, chlorides, and other pollutants in surface waters; protecting drinking water; implementing stormwater management and low impact development; improving stream connectivity and habitat; restoring wetlands and shorelines; and protecting privately owned forests.

Future land use of the Project Area will be important given the proximity of the Project Area to the city of Keewatin. Any evaluation of potential future land use would consider the goals and objectives of the cities of Keewatin, Nashwauk, and Hibbing, the township of Lone Pine, and Itasca and St. Louis counties.

iii. Zoning, including special districts or overlays such as shoreland, floodplain, wild and scenic rivers, critical area, agricultural preserves, etc.

The state's Shoreland Management Rules, specifically Minnesota Rules, part 6120.3300, subp. 12, indicate that taconite mining within shoreland is a permitted use provided the provisions of the Mineland Reclamation Act are satisfied. The state Mineland Reclamation Rules, which implement that Act, states that shorelands are avoidance areas for mining and that mining will only be allowed within shorelands when there is no feasible and prudent alternative (Minnesota Rules, part 6130.1300, subp. B (2008)). In addition, Minnesota Rules 6130.1000 requires that all mining sites must incorporate setbacks or separations needed to comply with local land use regulations and requirements of other appropriate authorities. Finally, state Water Law (Minnesota Statute 103F.221, subd. 5 (1990)) allows municipalities, including counties, to adopt shoreland controls that are stricter than state standards.

Several local units of government have regulatory authority within the proposed Project vicinity, including the City of Nashwauk, the City of Hibbing, Itasca County, and St. Louis County. The City of Nashwauk does not have a shoreland zoning ordinance. Language stated in Section 15b.1 of the local zoning ordinance states that the Heavy Industrial and Mining District "shall not be used in any shoreland district, except water filled mining pits." When applying for zoning permits with the City of Nashwauk, the shoreland district rules would be discussed.

Within St. Louis County, the entirety of the Project lies within the regulated boundary of the City of Hibbing. These shoreland management districts are based on zoning ordinance information from the respective

governments. The City of Hibbing's Shoreland Ordinance designates shoreland zones within 1,000 feet and 300 feet of the ordinary high water level (OHW) of lakes and streams, respectively. A shoreland alteration permit is required from the City of Hibbing for any grading/filling or excavation within the Shoreland Overlay District established under the city zoning ordinance.

Itasca County classifies certain public waterbodies by use. Within, and immediately downstream of the Project Area, several waterbodies have been assigned Natural Environment (NE) or Tributary classifications, as shown in Table 10.2. NE waterbodies are often shallow lakes with limited capacities for assimilating the impacts of development and recreational use. They often have adjacent lands with substantial constraints for development such as high water tables, exposed bedrock, and soils unsuitable for septic systems. These waterbodies do not typically have much existing development or recreational use.

Itasca County designates shoreland overlay districts in its zoning ordinance for county public waters to implement the current shoreland standards described in Minnesota Rules, Chapter 6120 for lakes and streams identified in the DNR Public Waters Inventory (PWI). These shoreland zones are designated within 1,000 feet and 300 feet of the OHW of lakes and streams, respectively. Within shorelands, the county zoning ordinance requires a 200-foot setback for mining-related activities. A zoning variance request may be required for portions of the Project Area that are unable to meet the 200-foot setback requirement. Itasca County Zoning Ordinance Article 5 – Shoreland Overlay Districts defines specific lake classifications and zoning provisions enacted by the county (see Table 10.2).

Table 10.2: Water-Related Land Use Management District Impacts

Name	LGU Jurisdiction	LGU Classification	DNR PWI Status	Proposed Zoning Impacts
Hay Creek	Itasca County	Tributary	Public Water Stream	A portion of the Project Area is within a shoreland impact zone.
West Swan River	City of Hibbing	R-R, A-1, O-1, A-R	Public Water Stream	No shoreland zoning impacts anticipated.
O'Brien Diversion Channel	Itasca County	Tributary	Public Water Stream	No shoreland zoning impacts anticipated.
Welcome Creek	City of Keewatin	No shoreland zoning	Public Water Stream	No shoreland zoning impacts anticipated.
Reservoir No. 2	Itasca County	Not Listed	31103900	A portion of the Project Area is within a shoreland impact zone.
Reservoir No. 6	Itasca County	Not Listed	31122900	A portion of the Project Area is within a shoreland impact zone.
Reservoir 2 North	Itasca County	Not Listed	31122800	A portion of the Project Area is within a shoreland impact zone.

iv. If any critical facilities (i.e. facilities necessary for public health and safety, those storing hazardous materials, or those with housing occupants who may be insufficiently mobile) are proposed in floodplain areas and other areas identified as at risk for localized flooding,describe the risk potential considering changing precipitation and event intensity.

No critical facilities are proposed to be constructed within floodplain areas or areas identified as at risk for localized flooding.

b. Discuss the Project's compatibility with nearby land uses, zoning, and plans listed in Item 10a above concentrating on implications for environmental effects.

The proposed Project appears to align with the identified goals found within each community's comprehensive plan, as they relate to mining. Rezoning requests may be needed to align the existing zoning designation and shoreland management areas identified in the zoning ordinances of each applicable local government unit.

c. Identify measures incorporated into the proposed Project to mitigate any potential incompatibility as discussed in Item 10b above and any risk potential.

Impacts to waterbodies within shoreland management areas would be mitigated or prevented through use of erosion control measures and BMPs, and minimization of the duration of impacts, as required by applicable permits.

The following mitigation measures, described in Table 10.3, would be implemented to reclaim land impacted throughout the Project.

Table 10.3: Tailings Basin Reclamation Mitigation

Mining Impact	Description	Reclamation Mitigation Practice
Erosion/sedimentation	Bare soil and sloped ground at TSF or haul roads increase erosion and sedimentation potential.	▪ Temporary vegetation of inactive areas ▪ Regrading ▪ Revegetation ▪ Mulching ▪ Dust control
Wetland impacts	Direct wetland losses resulting from the Project.	▪ Minimize watershed modifications ▪ Creation of wetlands within revegetated TSF ▪ Mitigation of unavoidable impacts
Changes in vegetation cover types	Removal of existing vegetation during construction.	▪ Revegetation ▪ Vegetation/land use approval
Wildlife	Loss of wildlife habitat resulting from changes in cover types. Potential barriers to travel in steep-sloped areas created by mining.	▪ Revegetation ▪ Regrading
Changes in surface water quality and quantity	Increase in runoff (and potential increase in pollutant transport in runoff) due to exposed, compacted soils and steep slopes.	▪ SWPPP ▪ Revegetation ▪ Regrading ▪ Mulching
Changes in ground water quality and quantity	The Project is not expected to have an increase in overall potential for seepage of process water into groundwater. The total volume of ponded water would remain the same as current conditions. Furthermore, the dams in contact with ponded water would include a seepage reduction feature intended to limit seepage through the dam. Additionally, the project proposes adding additional thickeners to recycle more water in the tailings prior to discharge.	▪ Use of an engineered seepage reduction feature is projected to minimize seepage rate and total seepage volume. ▪ Monitoring plan in development
Air quality (dust)	Bare soil increases wind transport of soil particles.	▪ Watering or dust suppressant treatment of exposed soil to minimize dust ▪ Temporary vegetation in inactive areas

Mining Impact	Description	Reclamation Mitigation Practice
		▪ Revegetation of exposed soils

As stated in Minnesota Rules, part 6130.2200, altered watersheds would be returned to pre-mining conditions when possible. Vegetation establishment would be initiated within the first growing season after an area, according to the Permit to Mine, is no longer scheduled to be disturbed or used in a manner that would interfere with the establishment and maintenance of vegetation.

The Project's existing SWPPP and the Spill Control and Countermeasure Plan (SPCC) plans incorporate several measures and best management practices (BMPs) that align with the goals outlined in the St. Louis River Watershed Management Plan including:

- Use of settling ponds and basins to treat stormwater runoff and reduce sediment loads before discharge, which aligns with the goal of reducing pollutants like sediment to address surface water quality degradation.
- Secondary containment for all outdoor aboveground storage tanks to prevent spills of fuel oil, lube oil, etc. from contaminating stormwater runoff. This aligns with the goals of protecting surface and drinking water quality.
- Covering and containing hazardous and non-hazardous waste storage areas to prevent exposure to stormwater, which supports goals of protecting surface and drinking water quality.
- Diverting stormwater and railcar deluge water away from surface waters and into settling basins for treatment, supporting the goal of reducing pollutant loads to surface waters.
- Managing mine stockpiles to minimize erosion through measures like establishing vegetation, maintaining perimeter berms, sloping benches inward, and limiting lift heights/slope angles. This aligns with goals of reducing sedimentation and erosion to protect surface water quality.
- Conducting regular facility inspections, preventative maintenance, good housekeeping practices, spill prevention and response procedures, and employee training to proactively identify and address potential stormwater contamination issues. These measures broadly support the plan's water quality protection and pollution prevention goals.
- Keetac's NPDES permits incorporate requirements related to the downstream wild rice sulfate impairments, further tying the facility's water management to the St Louis River Watershed plan's goals.

In addition to the SWPPP and SPCC plans, the Project includes wetland mitigation measures that further contribute to meeting the watershed management goals. These measures include minimizing watershed modifications and creating new wetlands within the revegetated TSF, thus supporting and maintaining water storage capacity, reducing sedimentation, and improving water quality. The new wetlands would also provide valuable habitat for wildlife, offsetting some of the impacts of forest fragmentation and loss in the planning area.

Through the implementation of the SWPPP, SPCC plans, and wetland mitigation measures, the Project would actively work towards meeting the 10-year goals set forth in the St. Louis River Watershed Management Plan. These efforts would contribute towards ultimately supporting the overall health and sustainability of the watershed.

11. Geology, soils and topography/landforms:

a. Geology - Describe the geology underlying the Project Area and identify and map any susceptiblegeologic features such as sinkholes, shallow limestone formations, unconfined/shallow aquifers, or karst conditions. Discuss any limitations of these features for

the Project and any effects the Project could have on these features. Identify any Project designs or mitigation measures to address effects to geologic features.

The Project Area is located within the late Cenomanian Age Coleraine Formation, which is characterized by conglomerate, lignite, sandstone, and shale. Regional maps of depth-to-bedrock show that most of the Project Area contains soils for which depth to bedrock is approximately 275 feet (Minnesota Natural Resources Atlas 2023).

The perimeter dike embankment is underlain by a dense, Quaternary Period (less than 2.6 million years old), matrix-dominated, red clayey till, deposited by the St. Louis sub lobe, which is generally less than 10 feet thick (Jennings and Reynolds 2005). These young Quaternary sediments were deposited on top of the Mesozoic Coleraine Formation (600 million years old), consisting of conglomerate, lignite, sandstone, and shale, and Precambrian Period (1.6 to 1.7 billion years old) granite, quartzite, iron formation, argillite, and gabbro (Jirsa et al. 2011; Winter 1973).

There are no unique geological features that have received state or federal protection within the Project Area.

Based on review of the U.S. Geological Survey (USGS) Quaternary Faults and Folds database, no faults were active in the Quaternary Period near the Project Area, and no earthquakes have been recorded in the region (USGS 2022a; Chandler 1994). Based on the tectonic history of the region and the absence of active faults and significant earthquakes, seismic activity in the Project Area is unlikely.

Mineral Resources

The Project Area does not overlap with any active mineral operations (USGS 2011; Esri 2021; USGS 2022b). U. S. Steel has surface and mineral rights in the Project Area. As shown on Figure 11.1, the closest active mining area, aside from the Keetac Mine, is the Cleveland-Cliffs Hibbing Taconite Pit, which is located approximately seven miles northeast of the Project Area.

Paleontology

The Cenomanian (Upper Cretaceous) Coleraine Formation contains numerous fossils from the Western Interior Seaway and its shores, including fossilized teleost fish scales, shark teeth, clams, snails, and crocodile parts (Minnesota Geological Survey undated). As such, the Project may encounter paleontological resources.

Construction Impacts and Mitigation

No unique geological features that have received state or federal protection would be disturbed by the Project. Project construction would result in permanent impacts to topography through the buildup of the dams and dikes. Direct permanent impacts would result from raising the Stage 2 Exterior basin. Topsoil would be removed for construction and for temporary construction areas, but the underlying geology would not be impacted by the Project. Construction of a permanent access road, and grading or leveling of land in temporary construction areas are required to create safe and level equipment staging, site access, and preparation areas. These impacts would occur over the course of approximately two years. No mitigation activities are proposed for the geological resources since no unique geological features would be impacted by the Project. Additionally, no impacts to mineral resources are expected.

Operations Impacts and Mitigation

Operational impacts to topography, bedrock, or surface geology would include the continued deposition of tailings into the Stage 2 Exterior. Deposition would cover the existing geological features with tailings over time. Ultimately reaching a height of approximately 1,580 feet at the end of mine life, creating a plateau-like feature in the landscape. No other impacts to topography, bedrock, or surface geology would occur during operations.

There is minimal risk of earthquake-related impacts on the dam, dikes, separation and/or dewatering infrastructure, and access roads or other infrastructure during operations due to the limited potential for large,

seismically induced ground movements. Any potential risks to bedrock or surface geology would be mitigated by accepted dam construction industry specifications and adherence to DNR dam safety permit design requirements, as well as routine safety monitoring and analysis. Further, the Dam Safety Permit requires annual monitoring reports and submittal of an operation and maintenance plan.

b. Soils and topography - Describe the soils on the site, giving NRCS (SCS) classifications and descriptions, including limitations of soils. Describe topography, any special site conditions relating to erosion potential, soil stability or other soils limitations, such as steep slopes, highly permeable soils. Provide estimated volume and acreage of soil excavation and/or grading. Discuss impacts from Project activities (distinguish between construction and operational activities) related to soils and topography. Identify measures during and after Project construction to address soil limitations including stabilization, soil corrections or other measures. Erosion/sedimentation control related to stormwater runoff should be addressed inresponse to Item 12.b.ii.

The sections below detail soils and topography associated with the Project Area. Table 11.1 below provides soil characteristics within the Project Area.

Table 11.1: Soil Characteristics Within the Project Area

Soil Map Unit Symbol	Soil Map Unit Name	Hydric Rating	Drainage Class	Hydrologic Soil Group	Soil Erodibility Factor (K)	Acres
TSF Perimeter						
B28B	Buhl loam, 1 to 5 percent slopes	No	Somewhat poorly drained	C/D	0.27	38.2
A1B	Eagleview and Menahga soils, 1 to 8 percent slopes	No	Somewhat excessively drained	A	0.02	88.1
A1C	Eagleview and Menahga soils, 3 to 15 percent slopes	No	Somewhat excessively drained	A	0.02	0.8
549	Greenwood-Greenwood, ponded, complex, 0 to 1 percent slopes	Yes	Very poorly drained	A/D	0	7.5
619	Keewatin silt loam	No	Somewhat poorly drained	D	0.39	17.3
B27A	McQuade-Buhl complex, 0 to 3 percent slopes	Yes	Poorly drained	C/D	0.27	25.4
B33A	McQuade-Fayal, depressional, complex, 0 to 2 percent slopes	Yes	Poorly drained	C/D	0.27	18.1
797	Mooselake and Lupton soils, 0 to 1 percent slopes	Yes	Very poorly drained	A/D	0	6.7
622B	Nashwauk fine sandy loam, 1 to 10 percent slopes	No	Moderately well drained	D	0.40	9.8
B67A	Rifle soils, Hibbing catena, 0 to 1 percent slopes	Yes	Very poorly drained	A/D	0	0.8
995	Seelyeville-Seelyeville, ponded, complex, 0 to 1 percent slopes	Yes	Very poorly drained	A/D	0	1.4
1050	Tailings basin	Unranked	Unknown	Unknown	0	72.4

Soil Map Unit Symbol	Soil Map Unit Name	Hydric Rating	Drainage Class	Hydrologic Soil Group	Soil Erodibility Factor (K)	Acres
1003B	Udorthents, loamy (cut and fill land)	No	Well drained	Unknown	0	59.1
1043C	Udorthents, nearly level to rolling	No	Well drained	A	0.43	82.9
Pipeline and Separation and/or Dewatering Infrastructure						
A1B	Eagleview and Menahga soils, 1 to 8 percent slopes	No	Somewhat excessively drained	A	0.02	9.6
622B	Nashwauk fine sandy loam, 1 to 10 percent slopes	No	Moderately well drained	D	0.40	1.6
1043C	Udorthents, nearly level to rolling	No	Well drained	A	0.43	29.9
Permanent Access Road						
B28B	Buhl loam, 1 to 5 percent slopes	No	Somewhat poorly drained	C/D	0.27	7.9
A1B	Eagleview and Menahga soils, 1 to 8 percent slopes	No	Somewhat excessively drained	A	0.02	7.8
549	Greenwood-Greenwood, ponded, complex, 0 to 1 percent slopes	Yes	Very poorly drained	A/D	0	1.4
619	Keewatin silt loam	No	Somewhat poorly drained	D	0.39	2.2
B27A	McQuade-Buhl complex, 0 to 3 percent slopes	Yes	Poorly drained	C/D	0.27	4.6
B33A	McQuade-Fayal, depressional, complex, 0 to 2 percent slopes	Yes	Poorly drained	C/D	0.27	3.2
797	Mooselake and Lupton soils, 0 to 1 percent slopes	Yes	Very poorly drained	A/D	0	1.2
622B	Nashwauk fine sandy loam, 1 to 10 percent slopes	No	Moderately well drained	D	0.40	1.9
B67A	Rifle soils, Hibbing catena, 0 to 1 percent slopes	Yes	Very poorly drained	A/D	0	0.8
995	Seelyeville-Seelyeville, ponded, complex, 0 to 1 percent slopes	Yes	Very poorly drained	A/D	0	0.2
1050	Tailings basin	Un-ranked	Unknown	Unknown	0	2.0
1003B	Udorthents, loamy (cut and fill land)	No	Well drained	Unknown	0	8.3
1043C	Udorthents, nearly level to rolling	No	Well drained	A	0.43	1.8
Temporary Construction Impacts						
B28B	Buhl loam, 1 to 5 percent slopes	No	Somewhat poorly drained	C/D	0.27	20.6

Soil Map Unit Symbol	Soil Map Unit Name	Hydric Rating	Drainage Class	Hydrologic Soil Group	Soil Erodibility Factor (K)	Acres
A1B	Eagleview and Menahga soils, 1 to 8 percent slopes	No	Somewhat excessively drained	A	0.02	10.6
619	Keewatin silt loam	No	Somewhat poorly drained	D	0.39	2.4
B27A	McQuade-Buhl complex, 0 to 3 percent slopes	Yes	Poorly drained	C/D	0.27	24.3
1050	Tailings basin	Un-ranked	Unknown	Unknown	0	1.5
1043C	Udorthents, nearly level to rolling	No	Well drained	A	0.43	5.5

General Soil Composition

The Project Area occurs in the Land Resource Region K: Northern Lake States Forest and Forage Region. Within this region, the Project Area is entirely within Major Land Resource Area (MLRA) 57: Northern Minnesota Gray Drift. This MLRA is characterized by a complex pattern of end moraines; ground moraines; outwash plains; drumlins; small, isolated lake plains; and drainages associated with Wisconsin-age gray calcareous drift of the Des Moines and Wadena Lobes. The dominant soil orders are Alfisols, Entisols, and Histosols with a frigid temperature regime, an aquic or udic moisture regime, and mixed or smectic mineralogy. These soils are generally very deep and generally sandy to loamy textures (USDA NRCS 2022).

Soil mapping units and characteristics within the Project Area were identified using the USGS Soil Survey Geographic (SSURGO) database, as shown in Table 11.1 and on Figure 11.2 (USDA NRCS 2023).

The soil erodibility factor quantifies susceptibility of soil particle detachment by water (K value). Soils high in clay content are resistant to detachment and have lower K values (about 0.05 to 0.15), with coarse textured soils having a higher K value (about 0.05 to 0.20), and silty loam soils in between producing moderate runoff (MSU 2002). The western portion of the Project Area ranges in soil erodibility from low (0.0) to moderately high (0.43). The eastern portion of the Project Area has a lower erodibility of approximately 0.27.

The hydric rating classifies whether a soil is hydric based on conditions of saturation, flooding, or ponding during the growing season. The drainage class identifies natural drainage conditions based on frequency and duration of wet periods. Hydrologic Soil Groups A, B, C, and D (as well as dual classes A/D, B/D, and C/D) are used to classify soils by runoff potential and correspond to soils with low, moderately low, moderately high, and high runoff potential (Ross et al. 2018). Hydrologic Soil Groups are assigned based on similar physical and runoff characteristics. Most of the western portion of the Project Area (generally portions of the Project Area within the Hay Creek watershed) is classified as Group A, soils of deep, well drained, or gravelly sands with high infiltration and low runoff rates, with a small amount of Group D, soils with very slow infiltration rates and high runoff potential on the southern side of the Stage 2 Exterior. The eastern half of the Project Area (generally within the Upper West Swan River Watershed) is classified as Group C/D, soils with a very slow infiltration rate due to a high water table, with a slow infiltration rate when drained.

Topography in the Project Area is relatively flat due to the grinding actions of the St. Louis glacial sublobe, which occurred approximately 14,000 years ago during the Pleistocene epoch. Elevations in the Project Area range from approximately 1,440 to 1,460 feet above mean sea level (AMSL) (USGS 2022c).

Construction Impacts and Mitigation

Soils in the Project Area could be compacted, eroded, or contaminated during the construction of the Project. During construction, approximately 225,000 cubic yards or less of soil would be excavated/graded.

Temporary construction areas would be cleared of trees and graded to establish level workspaces for construction equipment and materials. Soil impacts in these areas would include compaction due to heavy machinery use and construction-related traffic, erosion due to exposure to stormwater from vegetation removal, and potential contamination from equipment leaks or spills of petroleum-based products, coolants, or antifreeze.

Earth disturbance of one acre or more requires a construction stormwater permit issued by the MPCA and the development of a SWPPP. A SWPPP would be prepared that would identify potential pollutant discharges associated with construction activities and describe prevention techniques to minimize the risk of non-point source pollution, erosion, and sedimentation, as well as spill response plans. Dikes and dams would be constructed from coarse tailings and would be periodically seeded to establish vegetative cover. Stormwater runoff would be managed in compliance with the SWPPP and applicable BMPs. Implementation of the practices outlined in the SPCC (as well as stormwater BMPs, would avoid or minimize risks and impacts of soil contamination). Additionally, the Dam Safety Permit (2022-0721) requires that erosion control measures be installed in accordance with the *Minnesota Stormwater Manual* by the MPCA prior to Project commencement and maintained throughout the Project. The Dam Safety Permit also requires that all exposed soils must be stabilized as soon as possible and no later than 72 hours after completion of the Project.

Soil compaction would be reduced by keeping construction staging areas to the minimum amount required for safe and efficient construction work and having specified machinery paths. Timber matting or other stabilization materials would be placed in wetlands and wet areas during construction.

Following their use, temporary construction areas would be tilled and supplemented with organic material that was stripped prior to construction as appropriate to mitigate compaction. Exposed soils would be stabilized, seeded, and monitored until they reach 70 percent vegetative cover, as required by the MPCA construction stormwater permits, to prevent soil erosion and sediment runoff from construction work areas. Ultimately, the areas would be required to meet standards within the Permit to Mine (i.e., 90 percent vegetative cover). The Dam Safety Permit requires that topsoil be used to re-dress disturbed soil areas and native plant species be used for revegetation of disturbed areas when possible.

Operations Impacts and Mitigation

Within the Stage 2 Exterior, any soils that were not previously affected by tailings deposition would be permanently impacted through the continued deposition of tailings. Soils would be permanently inundated with water and tailings.

Impacts to soils outside of the Stage 2 Exterior during operations would be limited to sporadic and temporary disturbance during maintenance activities in discrete locations. If excavation is required during maintenance activities, soils would be restored upon completion. Compaction would be minimized by limiting traffic and machinery access to previously established roadways. There is a potential for soil contamination from equipment leaks or spills of petroleum-based products, coolants or antifreeze. Implementation of the practices outlined in the SPCC, as well as applicable stormwater BMPs, would avoid or minimize risks and impacts of spills and any other operational impacts on soils. Slopes of the dikes and dams would be maintained consistent with the current practice in the Stage 2 Interior – inspected regularly for erosion, repaired (and maintained as needed), and vegetated periodically to reduce erosion due to stormwater runoff. Stormwater runoff would be managed in accordance with the SWPPP. Soil erosion from slope runoff would be mitigated through the deposition of coarse tails or planting of vegetative cover.

12. Water Resources:

a. Describe surface water and groundwater features on or near the site in a.i. and a.ii. below.

i. Surface water - lakes, streams, wetlands, intermittent channels, and county/judicial ditches.Include any special designations such as public waters, shoreland classification and floodway/floodplain, trout stream/lake, wildlife lakes, migratory waterfowl feeding/resting lake, and outstanding resource value water. Include the presence of aquatic invasive species and the water quality impairments or special designations listed on the current MPCA 303d Impaired Waters List that are within 1 mile of the Project. Include DNR PWI number(s), if any.

The Project Area is divided between the Upper Mississippi Region and the Great Lakes Region watersheds. Most of the Project Area is in the Upper Mississippi Region, HUC 02 (07). It drains to the southwest, ultimately to the Mississippi River (via Reservoir No. 2, O'Brien, Little O'Brien, and Swan Lake to Swan River). The eastern edge of the Project Area drains to the Great Lake Region, HUC 02 (04), to the southeast, ultimately to Lake Superior (via West Swan River to the St. Louis River) (USGS 2023).

The Project Area watersheds are further broken down into the following subregions:

- HUC 02 (07) – The Upper Mississippi Region is approximately 190,000 square miles and stretches from Minnesota in the North to Kentucky in the South, and from Indiana to South Dakota.
    - HUC 04 (0701) – Mississippi Headwaters subregion is approximately 20,200 square miles and includes the Mississippi River Basin above its confluence with the St. Croix River, excluding the Minnesota River Basin.
    - HUC 06 (070101) – Mississippi Headwaters Basin encompasses approximately 11,700 square miles and includes the Mississippi River Basin above Blanchard Dam (in Royalton, MN).
- HUC 02 (04) Great Lakes Region is approximately 238,000 square miles and incorporates all the great lakes reaching from Minnesota to Maine.
    - HUC 04 (0401) – The Western Lake Superior subregion encompasses approximately 2,260 square miles and includes the drainage into Lake Superior from the Ontario-Minnesota international boundary to and including the Montreal River Basin.
    - HUC 06 (040102) – St. Louis Basin is approximately 796 square miles and includes the Mississippi River Basin above its confluence with the St. Croix River, excluding the Minnesota River Basin.

The DNR has delineated Minnesota into a set of 81 Major Watersheds (8-digit HUCs). The Project Area is located within the Lake Superior St. Louis River (Major Watershed 3, HUC 04010201) and Mississippi River Grand Rapids (Major Watershed 9, HUC 07010103) (MNDNR undated). While they provide a guide to the extent of the watershed, they do not accurately reflect the current boundary conditions.

Based on field observations and review of topology, there is a mapping error in the DNR HUC watershed boundary separating the Lake Superior St. Louis River and Mississippi River Grand Rapids on the eastern side of the TSF. The current watershed boundary follows the outer limit of all historical TSF features, whereas the DNR HUC watershed boundary excludes a portion of the existing Stage 2 Exterior. This portion of the TSF had been used for tailings disposal approximately in the 1980s, and the landscape has not been significantly altered since that time, so watershed flow regimes are likely to have stayed the same since then. Figure 12.1 depicts a more accurate alignment of the current watershed boundary as compared to the HUC boundary.

Waterbodies

Lakes/Reservoirs

There are five lakes/reservoirs located in, or immediately downstream of, the Project Area, including: Reservoir 2 North, Reservoir No. 6, Reservoir No. 2, Hay Lake, and Swan Lake (Table 12.1). Lakes/reservoirs within the Project vicinity downstream of the Project area are shown on Figure 12.2. O'Brien Lake and Little O'Brien Lake are in the vicinity, however, they are not downstream of the TSF.

Table 12.1: Lakes/Reservoirs Downstream of the Project Area

Lake	DNR Lake/Stream ID	Watershed Size (acre)	Lake Area (acre)	Major Inflow	Outlet
Reservoir 2 North	31122800	333.39	60.47	Welcome Creek	Drainage Ditch to Reservoir No. 2
Reservoir No. 6	31122900	749.04	171.57	Outer Tailings Basin Second Stage Pond	Plant Make-up and Drainage Ditch between Reservoir 2 North and Reservoir No. 2
Reservoir No. 2	31103900	1,234.51	418.75	Drainage Ditch from Reservoir 2 North	O'Brien Diversion Channel
Hay Lake	31003700	309.70	38.83	Hay Creek	Hay Creek
Swan Lake	31006702	7,365.09	2,143.72 2	Hay Creek	Upper Swan River

Source: MNDNR 2023

Reservoir 2 North

Reservoir 2 North is a roughly 60-acre basin located south of TH 169 and immediately adjacent to the northwest corner of the TSF. It receives inflows from the City of Keewatin stormwater flows and Welcome Creek, which flows south of Welcome Lake near the main Keetac plant in the City of Keewatin (MNDNR 2010). Reservoir 2 North outlets to a non-regulated drainage ditch that connects to Reservoir No. 6 and Reservoir No. 2. Reservoir 2 North is included in the mining area, as defined under the current mining area.

Reservoir No. 6

Reservoir No. 6 is an approximately 172-acre basin located downstream of Reservoir 2 North and upstream of Reservoir No. 2. Reservoir No. 6 receives surface water from the TSF. It serves as the main source of water for the Keetac Processing Plant (MNDNR 2010). Reservoir No. 6 connects to a drainage ditch located between Reservoir No. 2 and Reservoir 2 North (SD 005 of Permit No. MN0055948). Water flows between Reservoir No. 6 and Reservoir No. 2 via the drainage ditch are dependent on the water levels in Reservoir No. 6 (MNDNR 2010).

If water levels become too low in Reservoir No. 6, water can be pumped from Reservoir No. 2 into Reservoir No. 6 to provide make-up water for the plant. Additionally, if water levels become too high in Reservoir No. 6 there is an emergency overflow from Reservoir No. 6 to Reservoir No. 2. Reservoir No. 6 is part of the Keetac operational process and is a public water regulated by the DNR.

Reservoir No. 2

Reservoir No. 2 is an approximately 419-acre basin that receives inflows from Reservoir 2 North and Reservoir No. 6 via a non-regulated drainage ditch. Reservoir No. 2 also receives wastewater flows from the combined Wastewater Treatment Plant (WWTP) of the Cities of Nashwauk and Keewatin, while also serving as the routine discharge and emergency overflow route for Reservoir No. 6 (MNDNR 2010). Reservoir No. 2 outlets to the O'Brien Diversion Channel.

Hay Lake

Hay Lake is an approximately 39-acre basin located along Hay Creek, downstream of the confluence of Hay Creek and the O'Brien Diversion Channel, and 3.5 miles upstream of Swan Lake. Inflows and outflows are via Hay Creek. Per the MPCA and 2010 FEIS (MNDNR 2010), Hay Lake is a wild rice-producing waterbody (Barr 2009).

Swan Lake

Swan Lake is an approximately 2,144-acre basin that receives inflow from 6 sources: Oxhide Creek, Pickerel Creek, O'Brien Creek downstream of TH 169, Hay Creek, Hart Creek, and Lebron Creek. The portion of O'Brien Creek upstream of O'Brien Lake (north of TH 169) is diverted into the O'Brien Diversion Channel and routed into Hay Creek, which then flows into Swan Lake. Per the MPCA and 2010 FEIS, Swan Lake is also a wild rice-producing waterbody (Barr 2009).

Stream

There are five streams located downstream of the TSF with potential to be impacted by the Project, including: Hay Creek, Swan River, West Swan River, the O'Brien Diversion Channel, and Welcome Creek. Table 12.2 describes the five streams nearest to the Project Area, as shown on Figure 12.2.

Table 12.2: Streams Downstream of the Project Area

Stream	Public Waters Inventory ID	Flow Regime	Stream Length (mi)	Inflow
Hay Creek	Public Water Stream	Perennial	8.5	O'Brien Diversion Channel (Receives inflows from Reservoir 4 and Reservoir No. 2)
Swan River	Public Water Stream	Perennial	87.07	Hay Creek
West Swan River	Public Water Stream	Perennial	41.74	Potential groundwater seepage from TSF
O'Brien Diversion Channel	Public Water Stream	Perennial	11.11	O'Brien Creek (Reservoir 4) and Reservoir No. 2
Welcome Creek	Public Water Stream	Perennial	1.5	Welcome Creek Weir

Source: 2010 and MNDNR 2024

Hay Creek

Hay Creek runs south from the existing TSF. Though National Hydrography Dataset (NHD) and PWI data depict that Hay Creek begins within the existing TSF, the landscape is historically affected from the existing Stage 2 Exterior embankments, as well as old borrow pits adjacent to the embankment. Wetlands and waterbodies within the Project's dam/dike footprint were delineated in August of 2021. In the field delineation, the stream features in the Project Area mapped in the NHD and PWI as Hay Creek were characterized as shallow marsh wetlands that formed in depressions resultant from previous anthropogenic disturbance (construction of the TSF) rather than a stream channel or identifiable waterway. The delineation results were field-verified during a site visit with the DNR and USACE and were confirmed by the DNR via a wetland determination (a Minnesota Wetland Conservation Act Notice of Decision) in August 2023, and by the USACE in a January 2024 Approved Jurisdictional Determination.

Hay Creek flows southwest from the headwaters for approximately 3.5 miles where the O'Brien Diversion Channel flows into Hay Creek. The creek then continues south for 1.5 miles where it enters Hay Lake. The creek exits Hay Lake and then flows southwest for an additional 3.5 miles into the southeast corner of Swan Lake (FEIS 2010). Some datasets, including the DNR PWI, label Hay Creek as Swan River beginning at its headwaters. This review classifies Hay Creek as the watercourse that extends from south of the TSF (and south of the Project Area) to the southeast corner of Swan Lake.

Swan River

Swan River begins at Swan Lake and exits the southwest corner of the lake before flowing south, eventually discharging into the Mississippi River (MNDNR 2010). Per the MPCA and 2010 MNDNR, Swan River is a wild rice-producing waterbody (Barr 2009).

West Swan River

West Swan River's headwaters begin at Kelly Lake, northeast of the Project Area near the Keetac Processing Plant. It flows along the east side of the TSF perimeter before eventually ending at its confluence with the East Swan River, approximately 12 miles southeast of the TSF.

O'Brien Diversion Channel

The Hanna Mining Company created the O'Brien Diversion Channel in approximately 1978. It receives dewatering flows from the west mine pits, O'Brien Creek, Reservoir 4, and the plant process water that is discharged ultimately through Reservoir No. 2. The O'Brien Diversion Channel flows into Hay Creek, which eventually flows into Swan Lake (MNDNR 2010).

Welcome Creek

The headwaters of Welcome Creek begin at the Welcome Creek weir (SD002 of Permit No. MN 0031879). Welcome Creek starts approximately one mile south of the Keetac Processing Plant and flows south to its outlet into Reservoir 2 North. Between its headwaters and discharge into Reservoir 2 North, additional flows from the City of Keewatin storm sewer system occur. Over time, Welcome Creek has been straightened and has experienced changes in watershed boundaries due to previous mining activities (MNDNR 2010).

Water Quality

Where available, water quality data were retrieved from the MPCA Lakes and Stream water quality dashboard (v. 1.0.4) for the water bodies located in or immediately downstream of the Project Area and with potential to be impacted by the Project.

Table 12.3 below presents water quality and trophic status data for lakes and reservoirs in the Project Area, based on a 10-year average of summer samples from 2005 to 2021. The Trophic State Index (TSI) is used to assess the nutrient richness of these water bodies, ranging from oligotrophic (clear, low in nutrients) to hypereutrophic (green, very high nutrient levels).

Among the five lakes/reservoirs in the Project Area, limited water quality data were available only for Hay Lake, and Swan Lake (Table 12.3). Based on data averaged over 10 years, from 2005 to 2014, the lakes showed varying trophic statuses, ranging from mesotrophic (i.e., moderately clear) to eutrophic (i.e., green). Hay Lake is classified as eutrophic, indicating high nutrient levels. Swan Lake is classified as mesotrophic, suggesting moderate nutrient levels and intermediate water quality conditions. While Hay Lake had relatively high total phosphorus concentrations (830 ppb), consistent with its eutrophic status, Swan Lake, by comparison, had appreciably lower phosphorus levels (17 ppb), consistent with its mesotrophic status and indicative of overall acceptable water quality conditions. Water transparency was found to be comparatively higher in Swan Lake at 4 meters, compared to Hay Lake (1 meter) indicating better water quality conditions in the two mesotrophic lakes.

Hay Lake has the highest TSI value of 81, falling above the expected range of 38 to 53 for lakes in the same ecoregion. This high TSI confirms its eutrophic status and suggests that Hay Lake is nutrient-rich compared to other lakes in the region. Swan Lake has TSI values of 44, which fall within the expected range for the ecoregion.

Although Swan Lake has good clarity and recreational use it is reported to be impaired based on mercury concentrations in fish tissue.

Table 12.3: Water Quality and Trophic Status for Lakes and Reservoirs in the Project Area Based on a 10-Year Average of All Summer Samples

Lakes	Identification No.	Water Transparency (m)	Chlorophyll a (ppb)	Total Phosphorus (ppb)	Trophic Status	Overall Trophic Status Index	Expected TSI Range in the Same Ecoregion
Reservoir 2 North*	07010103-576	n/a	n/a	n/a	n/a	n/a	n/a
Reservoir No. 2*	07010103-580	n/a	n/a	n/a	n/a	n/a	n/a
Reservoir No. 6	07010103-578	n/a	n/a	n/a	n/a	n/a	n/a
Hay Lake	31-0037-00	1	n/a	830	Eutrophic	81	38–53
Swan Lake	31-0067-02	4	5	18	Mesotrophic	44	38–53

**Water chemistry values are based on data collected from 2005-2014 and TSI values are calculated based on data collected from 2008–2017.*

Two streams downstream of the Project Area were surveyed in 2015 for various water quality parameters, including nitrogen, total phosphorus, total suspended solids (TSS), ammonia, dissolved oxygen, and pH (Table 12.4). Additionally, fish and invertebrate communities were sampled to obtain Index of Biotic Integrity (IBI) scores that would be indicative of overall ecological integrity in the streams. No data were available for West Swan River and Welcome Creek.

Total phosphorus and nitrogen concentrations at all streams were relatively low, indicating low nutrient pollution from sources such as wastewater discharges or development and therefore a reduced risk of eutrophication. Dissolved oxygen levels were relatively high in Hay Creek (8.51 mg/L) indicating well-oxygenated conditions. Based on the IBI scores, Hay Creek is classified as 'good' and 'fair' for fish and invertebrate community structure, respectively, suggesting that this stream has a relatively healthy aquatic ecosystem that could be affected by temporary, indirect impacts from construction activities, such as increased turbidity and localized sedimentation due to vegetation clearing and other construction activities. These impacts, however, are planned to be mitigated through the implementation of erosion control measures and BMPs and therefore, are not expected to cause any substantial impacts to the water quality. Like Hay Creek, Swan River has a 'good' and 'fair' rating based on fish and invertebrate IBIs, respectively. This stream, however, is classified as impaired based on mercury concentrations in sampled fish tissue and sulfate impairment affecting wild rice production.

Table 12.4: Water Quality and Index of Biotic Integrity Scores for Streams in the Project Area, 2015 survey*

Stream	Identification No.	Biological Stream Station ID	Nitrogen (mg/L)	Total Phosphorus (mg/L)	TSS (mg/L)	Ammonia (mg/L)	Dissolved Oxygen (mg/L)	pH	Fish IBI Score	Invertebrate IBI Score
Hay Creek	07010103-545	99UM061	n/a	0.039	4.8	< 0.1	8.51	8.02	60—good	60—Fair
Swan River	07010103-753	10EM194	< 0.05	0.03	< 4	< 0.1	n/a	n/a	68—good	65—Fair
O'Brien Creek	07010103-583	15UM069	< 0.05	0.022	8.8	< 0.1	9.85	7.3	59—good	63—Fair
Welcome Creek	07010103-581		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

**No data were available for the West Swan River.*

Impaired and Infested Waters

States are required to inventory water quality standards and submit a list of impaired and threatened waters every two years to the USEPA, per Clean Water Act Section 303(d). There are no infested waterbodies within five miles of the Project Area (MNDNR 2022a). Impaired waterbodies within five miles downstream of the Project Area are shown in Table 12.5 (MPCA 2024).

Table 12.5: Impaired Waterbodies Within 5 Miles Downstream of Project Area

Waterbody	Public Waters Inventory ID	Impairment	TMDL
Swan River	07010103-753	Mercury Sulfate	E. coli, Aquatic consumption— mercury in fish tissue N/A
Swan Lake (Main Basin)	31-0067-02	Mercury	Aquatic consumption— mercury in fish tissue
Swan Lake (West Bay)	31-0067-01	Mercury	N/A
Swan Lake (Southwest Bay)	31-0067-03	Sulfate, Mercury	N/A
Hay Lake	31-0037-00	Sulfate	N/A

Ecologically Significant Waterbodies

There are no trout streams or lakes, designated wildlife lakes, migratory waterfowl feeding/resting lakes, or outstanding resource value waters located in, or immediately downstream of, the Project Area.

Floodplains

According to the Federal Emergency Management Agency Flood Plain Map Service Center, there are no mapped floodplains within or in the vicinity of the Project Area (FEMA 2021). Flooding frequency in the vicinity of the Project Area is derived from the Natural Resource Conservation Service SSURGO database, which provides an estimate of the likelihood of flooding each year, based on a soil's likelihood to be inundated by surface water from overflowing streams or from adjacent slopes (Figure 7.10). The flooding frequency classifications range from non (no reasonable possibility of flooding) to very frequent (more than 50 percent chance of flooding in all months in any year). West Swan River and Hay Creek (outside of the Project Area) experience "frequent" flooding indicating that there is more than a 50 percent chance of flooding in any year, but less than a 50 percent chance of flooding in all months in any year (USDA NRCS 2023).

If unmapped floodplains are present in the Project Area, they could be impacted by soil compaction. Impacts associated with compaction and mitigation measures that would be implemented to minimize such impacts are identified in Section 11b-Soils.

Shoreland classifications are discussed in Table 10.2 – Shoreland Zoning Classifications within Section 10 – Land Use.

Wetlands

Formal field-focused wetland and waterbody delineations were conducted to identify the extent and characteristics of aquatic resources situated in the Project Area. Based on the delineations, the following wetland/water types were identified in the Project Area: deep water, shallow marsh, deep marsh, fresh (wet) meadow, coniferous bogs, shrub-carr, alder thicket, and hardwood swamp. Wetlands were identified and mapped in accordance with the Routine On-Site Determination Method as specified in the 1987 USACE Wetlands Delineation Manual and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (Version 2.0) (USACE 1987, 2012).Delineated jurisdictional wetlands and waters within the permanent and temporary impact footprints are shown on Figure 12.3 (parts 1-4).

Wetlands and waterbodies within the Stage 2 Exterior were delineated in May of 2021. The resulting Wetland Assessment and Delineation was submitted to the DNR in July 2021 to demonstrate that most of the wetlands in the TSF should be considered "incidental wetlands" and not regulated under the Minnesota Wetland Conservation Act (WCA). According to Minnesota Rules 8420.0930, Subp. 1,

> *Impacts to wetlands that the landowner can demonstrate, to the satisfaction of the local government unit, were created by pits, stockpiles, or tailing basins, and by actions the purpose of which was not to create the wetland according to part 8420.0105, subpart 2, Item D, are not regulated under this chapter.*

Later in July 2021, a WCA Notice of Decision (NOD) was issued by the DNR that approved the incidental status of 237.09 acres within the Stage 2 Exterior of the TSF, confirming that these wetlands were not regulated under WCA. Additional evidence to support the incidental status of 322.10 acres of wetlands within the TSF was submitted following the July 2021 NOD. These 322.10 acres were deemed incidental in a January 2022 NOD, leaving 127.31 acres of regulated wetlands within the Stage 2 Exterior. In a September 2022 NOD, the DNR approved the use of 127.31 surplus credits from the previously approved Palisade Project (Bank Service Area 5). As all wetlands within the Stage 2 Exterior have been deemed incidental or mitigated for, they are not included in this discussion of existing wetlands or in subsequent wetland impact discussions.

Wetlands and waterbodies within the Project's dam/dike footprint were delineated in August of 2021. Wetlands and waterbodies within the temporary construction areas, the pipeline footprint, and the separation and/or dewatering infrastructure footprint were delineated in August of 2023. On August 11, 2023, the DNR issued a formal wetland determination (a Minnesota Wetland Conservation Act Notice of Decision) for the dam/dike footprint that was delineated in August of 2021. A revised wetland delineation report was submitted to the DNR for jurisdictional review in October of 2023. The revised delineation report included the original 2021 dam/dike footprint (2021 Study Area), as well as the pipeline footprint, the separation facility footprint, temporary workspace footprints, and minor augmentations to the dam/dike footprint (2023 Study Area)**.** At the time of EAW submission to the DNR, the DNR has not made a determination regarding the jurisdictional status of additional wetland and waterbody features included in the revised delineation report. Figure 12-4 depicts the spatial extent of the portion of the Project Area for which the jurisdictional determination has been completed (364.8 acres) and the portion of the Project Area for which the jurisdictional extent of wetland and waterbody features remains under review (333.5 acres).

Table 12.6 below provides acreages of all WCA-jurisdictional wetlands in the Project Area (including areas for which a determination has been made and areas that are currently under review by the DNR). These acreages exclude incidental wetlands (which totaled 71.12 acres).

Minnesota's WCA does not regulate impacts to "incidental" wetlands. Incidental wetlands are defined as "…wetlands that the landowner can demonstrate, to the satisfaction of the local government unit, were created by pits, stockpiles, or tailings basins, and by actions the purpose of which was not to create the wetland…" (M.R. 8420.0930, Subp. 1). In addition, incidental wetlands are further defined in M.R. 8420.0105, Subp. 2.D. as follows:

This chapter does not regulate impacts to incidental wetlands. "Incidental wetlands" are wetland areas that the landowner can demonstrate, to the satisfaction of the local government unit, were created in nonwetland areas solely by actions, the purpose of which was not to create the wetland. Incidental wetlands include drainage ditches, impoundments, or excavations constructed in nonwetlands solely for the purpose of effluent treatment, containment of waste material, storm water retention or detention, drainage, soil and water conservation practices, and water quality improvements and not as part of a wetland replacement process that may, over time, take on wetland characteristics.

Some delineated wetlands, detailed in the delineation reports, were created by grading, excavating, or the tailings basin, or for drainage purposes and therefore, may be considered "incidental." These wetlands are excluded from Figure 12.3 (parts 1-4) and Table 12.6 and were not included in the impact analysis for the Project.

Table 12.6: Field Delineated Potentially Direct WCA-Regulated Wetlands Impacts Within Project Area*+

Wetland Type	Proposed Stage 2 Exterior Dam and Dike Footprints (Permanent Impact; acres)	Permanent Access Road (acres)	Separation and/or Dewatering Infrastructure and Pipeline (Permanent Impact; acres)	Temporary Construction Areas (acres)	Total (acres)
Alder Thicket	11.01	3.44	0.00	0.00	14.45
Coniferous Bog	8.25	1.84	0.00	0.00	10.09
Deep Marsh	6.69	0.32	0.06	2.17	9.25
Deep Water	21.88	4.75	0.00	0.00	26.63
Fresh (wet) Meadow	0.78	0.16	1.08	0.11	2.14
Hardwood Swamp	0.74	0.96	0.00	1.07	2.77
Shallow Marsh	26.26	2.73	0.15	2.80	31.95
Shrub-carr	4.95	1.41	0.00	3.60	9.95
Total	80.55	15.62	1.30	9.75	107.22

**If wetland type sums don't match totals exactly, it is due to rounding in GIS.*

+Wetland acreages in Table 12.6 reflect only the field delineated acreages in the proposed Stage 2 Exterior dams and dikes, access road, separation infrastructure, and temporary construction acres.

Indirect wetland analyses were performed by Barr and 0.58 acre of wetlands are expected to be impacted by Project activities. Additionally, 0.39 acre of wetlands will be indirectly impacted temporarily and 0.19 acre of indirect impacts will come from access road construction. Temporary impacts to wetlands would take place in under 6 months. The wetland types that would be indirectly impacted are fresh (wet) meadow and hardwood swamp, as shown in Table 12.7.

Table 12.7: Field Delineated Potentially Indirect WCA-Regulated Wetland Impacts Within Project Area*^

Wetland Type	Proposed Stage 2 Exterior Dam and Dike Footprints (Indirect Impact; acres)	Permanent Access Road (Indirect impact; acres)	Separation and/or Dewatering Infrastructure and Pipeline (Indirect Impact; acres)	Temporary Construction Areas (Indirect Impact; acres)	Total (acres)
Alder Thicket	0.00	0.0	0.00	0.00	0.00
Coniferous Bog	0.00	0.0	0.00	0.00	0.00
Deep Marsh	0.00	0.0	0.00	0.00	0.00
Deep Water	0.00	0.0	0.00	0.00	0.00
Fresh (wet) Meadow	0.00	0.08	0.00	0.00	0.08
Hardwood Swamp	0.00	0.11	0.00	0.39	0.50
Shallow Marsh	0.00	0.0	0.00	0.00	0.00
Shrub-carr	0.00	0.0	0.00	0.00	0.00
Total	**0.00**	**0.19**	**0.00**	**0.39**	**0.58**

**If wetland type sums don't match totals exactly, it is due to rounding in GIS.*

Based on information with the wetland delineation reports, wetlands within the Project Area have overall wetland functional assessment ratings ranging from high to low based on an abbreviated version of the *Minnesota Routine Assessment Method for Evaluating Wetland Functions, Version 3.4*. These include evaluation of vegetative diversity, outlet configuration, upland condition, wildlife habitat, and public value.

ii. Groundwater – aquifers, springs, seeps. Include: 1) depth to groundwater; 2) if Project is within a MDH wellhead protection area; 3) identification of any on-site and/or nearby wells,including unique numbers and well logs if available. If there are no wells known on-site or nearby, explain the methodology used to determine this.

The Project Area overlies several groundwater aquifers including the Cretaceous Bedrock Aquifer, the Biwabik Iron Formation Aquifer, the Quaternary water-table aquifer, and the Quaternary buried artesian aquifer.

The Quaternary water-table aquifer is an unconfined surficial aquifer consisting of unconsolidated sediments while the Quaternary buried artesian aquifer is a confined aquifer underlying a layer of low-permeability material, known as an aquitard (MNDNR 2021).

The Cretaceous bedrock aquifer consists of sandstone layers interbedded with thick layers of shale. The Cretaceous Aquifer is located near the ground surface, with finished wells in the area ranging generally from 7 to 1,437 feet in depth. Aquifer recharge mainly occurs through infiltration and precipitation through overlying drift.

Wells in vicinity to the Project Area have been completed within the Quaternary water-table aquifer and Quaternary buried artesian aquifer with observed static water levels generally ranging from 3 to 20 feet below ground surface (bgs) for the Quaternary water-table aquifer and 20 to 35 feet bgs in the Quaternary buried-artesian aquifer (Minnesota Department of Health 2025). The Biwabik Iron Formation Aquifer is a sedimentary bedrock aquifer composed of iron-rich chert (Adolphson et al., 1981). Drinking water for the City of Keewatin is sourced from the Biwabik Iron Formation Aquifer via two municipal wells located to the north and upgradient of the TSF (Well Nos. 1 and 3).

There are no springs or seeps within the Project Area.

1) Depth to groundwater: Shallow groundwater at the Project Area is estimated to be approximately 3 to 30 feet below ground surface, according to a review of available Minnesota Department of Health well logs in the area.
2) Project location in relation to MDH wellhead protection area: The Project Area is not located within any wellhead protection areas and the nearest Wellhead Protection Areas (Keewatin and Keetac) are situated northwest and up gradient of the Project Area.
3) Identification of on-site and/or nearby wells:
    - On-Site Wells:
        - There are no active water monitoring wells within or adjacent to the Project Area.
        - Some historical wells (referred to as MW-1, MW-11 and MW-12) were located at the south-west boundary of the Stage 2 Exterior. A Groundwater Sensitivity analysis performed in support of the Project Phase I Wetland Conservation Act Wetland Replacement Plan (WRP) found that groundwater quality adjacent to the TSF was within acceptable ranges when compared to the applicable standards (Barr 2022). The DNR decision document agreed with this conclusion. U. S. Steel is developing a groundwater monitoring plan to address a condition of the DNR WCA Decision document.

- U. S. Steel maintains internal geotechnical monitoring (instrument) wells within the existing TSF to monitor conditions related to the structural integrity of the TSF. Additional instrument wells would be installed to continue monitoring the stability of the TSF.

o Nearby Wells: A review of the Minnesota Well Index and the USGS National Water Information System Mapper indicates that two domestic wells exist within 0.5 mile of the Project Area, shown on Figure 12.5. The closest domestic well to the Project Area is 0.3 miles to the east. Several historical 'other wells' are located near the Project Area. These other wells are abandoned and used for non-potable purposes.

The methodology used to determine the presence of on-site and nearby wells included a review of the Minnesota Well Index and the USGS National Water Information System Mapper.

b. Describe effects from Project activities on water resources and measures to minimize or mitigate the effects in Item b.i. through Item b.iv. below.

i. Wastewater - For each of the following, describe the sources, quantities and composition of all sanitary, municipal/domestic and industrial wastewater produced or treated at the site.

The monitoring parameters in the facility's industrial wastewater, which is discharged through NPDES Permit No. MN0055948 outfall SD-005, include sulfate, pH, flow, specific conductance, selenium, mercury, dissolved iron and, suspended solids. Levels of mercury and other heavy metals are relatively low based on historical monitoring. The average discharge volume recorded during 2024 was 4.7 million gallons per day (MGD). The design of the water retention dam includes a seepage reduction feature along the upstream face of the dam to lower the phreatic surface and limit seepage through the dam. The seepage reduction feature would consist of either a linear low-density polyethylene (LLDPE) geomembrane or an inclined mechanically placed soil-cement blanket consisting of a mixture of coarse tailings and cement. In addition to the design features of the dam, the project proposes to add additional thickeners as part of the classification system allowing for the recycling of more water to the plant prior to tailings disposal.

1) If the wastewater discharge is to a publicly owned treatment facility, identify any pretreatment measures and the ability of the facility to handle the added water andwaste loadings, including any effects on, or required expansion of, municipal wastewater infrastructure.

The facility does not discharge any wastewater to a publicly owned treatment facility.

2) If the wastewater discharge is to a subsurface sewage treatment system (SSTS), describe the system used, the design flow, and suitability of site conditions for sucha system. If septic systems are part of the Project, describe the availability of septage disposal options within the region to handle the ongoing amounts generated as a result of the Project. Consider the effects of current Minnesota climate trends and anticipated changes in rainfall frequency, intensity and amount with this discussion.

There are no SSTSs on-site.

3) If the wastewater discharge is to surface water, identify the wastewater treatment methods and identify discharge points and proposed effluent limitations to mitigateimpacts. Discuss any effects to surface or groundwater from wastewater discharges,taking into consideration how current Minnesota climate trends and anticipated climate change in the general location of the Project may influence the effects.

Water from the TSF flows into Reservoir No. 6 where it could be pumped for use in process, or flow into Reservoir 2 North that has the permitting outfall: SD005 (Figure 12.8). From SD005, water flows to Reservoir No. 2, the O'Brien Diversion Channel, Hay Creek, Hay Lake and Swan Lake. Discharges are subject to NPDES permit limits that are based on water quality standards. The NPDES Permit No. MN0055948 is in the process of reissuance. The draft NPDES/SDS permit is currently on public notice (July 8 – September 8, 2025) and contains a compliance schedule for U.S Steel to attain compliance with the final sulfate effluent limits. This permit reissuance actions include updating sulfate compliance schedules.

To minimize impacts, the process facility employs several mitigation measures:

- Use of recirculating wet scrubber and lime treatment to remove sulfate (prior to discharge into the TSF)
- Oil/water separators to remove oil (prior to discharge into the TSF)
- Settling ponds to remove suspended solids prior to discharge
- Compliance with NPDES permit limits

The State of Minnesota has been experiencing a warming trend, with warmer winter lows and summer highs, and more frequent extreme precipitation events (MNDNR 2024). These trends are expected to continue in the coming decades because of climate change (MPCA 2017, 2023). Climate change in Northern Minnesota, characterized by increased precipitation, heavy rainfall events, warmer temperatures, and altered evaporation rates, could substantially influence the Keetac facility's wastewater management. These changes may lead to higher wastewater volumes, increased erosion and contaminant loads, altered water balance in the TSF, and challenges in meeting NPDES discharge limits. Additionally, the timing and quantity of runoff and stream flows could affect the receiving waters' capacity to assimilate wastewater, while warmer temperatures and changes in hydrology and water chemistry could potentially exacerbate mercury methylation and sulfide formation downstream. To mitigate these impacts, the facility may need to adjust its treatment systems, holding reservoir capacities, settling pond maintenance, and the timing and volume of discharges to match the changing conditions.

ii. Stormwater - Describe changes in surface hydrology resulting from change of land cover. Describe the routes and receiving water bodies for runoff from the Project site (major downstream water bodies as well as the immediate receiving waters). Discuss environmental effects from stormwater discharges on receiving waters post-construction including how the Project will affect runoff volume, discharge rate and change in pollutants.Consider the effects of current Minnesota climate trends and anticipated changes in rainfall frequency, intensity and amount with this discussion. For projects requiring NPDES/SDS construction stormwater permit coverage, state the total number of acres that will be disturbed by the Project and describe the SWPPP, including specific BMPs to address soil erosion and sedimentation during and after Project construction. Discuss permanent stormwater management plans, including methods of achieving volume reduction to restore or maintain the natural hydrology of the site using green infrastructure practices or other stormwater management practices. Identify any receiving waters that have construction-related water impairments orare classified as special as defined in the Construction Stormwater permit. Describe additional requirements for special and/or impaired waters.

Changes in surface hydrology resulting from change of land cover:

The construction of the Project would require vegetation clearing and earthworks, which would have a localized impact on the natural surface hydrology and drainage patterns within its footprint. For example, site preparation for the separation facility would have engineered stormwater design, and construction of dams and dikes would introduce additional slope to areas that are currently low relief. Precipitation falling within the Stage 2 Exterior would continue to be retained within the basin, as part of the ponded water. The exterior slopes of the dikes/dams themselves could generate some runoff; however, much of the rainfall that falls on the embankments is expected to infiltrate. Any surface runoff would be managed through the SWPPP to prevent erosion and downstream impacts.

Routes and receiving water bodies for runoff from the Project site:

The Upper West Swan River and Hay Creek watershed boundary runs along the eastern crest of the existing Stage 2 Exterior berm (Figure 12.1). The Project has been designed to maintain the same preexisting crest alignment as the dikes are elevated, so stormwater runoff would continue to flow to the same watersheds as it did pre-construction (Figure 12.6). Therefore, even though construction of the dikes will encroach into the Upper West Swan watershed, the Project's dikes will not change the watershed boundary.

Currently, process water (not slurry) is discharged into the historic Stage 1 impoundment when an East tailings pipeline needs to be drained. This water drains to the south-east corner of the impoundment and then flows south into the Stage 2 Exterior via culvert under a road and the existing berm. As described below, the Stage 2 Exterior basin outflows into Reservoir No. 6 (a process water waterbody) which has a permitted outfall that is part of the Mississippi River watershed.

The Project would raise the dikes around Stage 2 Exterior and the culvert currently allowing water from the historic Stage 1 impoundment area would need to be removed. U. S. Steel would cease discharging all process water into the historic Stage 1 impoundment, so any new water would be rainfed. Rainwater from the Stage 1 impoundment would then naturally flow to the east and into the Upper West Swan River watershed similar to pre-mining conditions. The changes to the watershed boundary as a result of the Project are shown in Figure 12.7.

Construction of the Project and this change in rainwater runoff flow into the Upper West Swan would result in a net increase in catchment for the Great Lakes watershed of 669.9 acres. The catchment for the Hay Creek watershed (part of the Mississippi River watershed) would be reduced by an equivalent amount. However, the loss of water to the Mississippi would be negligible given the proportion of the watershed that this represents; it would be partially offset by process water remaining within the TSF, including the additional water added through ongoing tailings deposition, and because the removed area was flowing into Reservoir No. 6 which is used for mine process water as discussed below.

The Stage 2 Exterior basin is designed to be a closed system with no direct discharges to surface waters. Runoff from within the basin would be directed to the interior pond and ultimately to Reservoir No. 6 via a decant structure. This allows for settling of suspended tailings particles before the water is released.

The only potential routes for basin water to reach downstream water bodies are through the existing permitted outfall from Reservoir No. 6 via Reservoir No. 2 North - SD005 (culvert outfall) and into Reservoir No. 2, as shown on Figure 12.8. The outfall is monitored and has specific discharge limits and requirements set in the facility's NPDES/SDS permit.

From Reservoir No. 2, the flow path to downstream waters includes the O'Brien Diversion Ditch, Hay Creek, Hay Lake and Swan Lake. Swan Lake is the culminating receiving water body for the Project site, located several miles downstream, and ultimately discharges into the Mississippi River.

Environmental effects from stormwater discharges on receiving waters post-construction:

The Project's alteration of natural runoff patterns has the potential to have a minor change to flows to downstream water bodies compared to pre-construction conditions. There would be some change to the Upper West Swan and Hay Creek watershed boundaries as noted in the *Routes and receiving water bodies for runoff from the Project site* section above. This may result in a small increase in flow to the Upper West Swan.

To manage the increased runoff rates and volumes from the exterior slopes of the new dikes/dams, the SWPPP would implement several BMPs outlined in the existing plan. These include installation of silt fence, routine inspections of site conditions and stormwater runoff to identify any issues or maintenance needs. Erosion would be prevented on dike/dam slopes through the deposition of coarse tails or planting of vegetative cover, with slopes maintained and inspected regularly.

The Project may have minor impacts on flow variability of the waterbodies in the system because of the loss of wetlands within the Project footprint, but within the greater context of the watershed, ecological function and ecosystem services are unlikely to be altered.

To address the potential impacts of climate change on stormwater management, the SWPPP would be updated to include provisions for more frequent site inspections, especially during snowmelt and precipitation runoff events. As outlined in the SWPPP, the plan would be reviewed at least annually and modified as necessary to reflect any changes in site conditions, monitoring results, or regulatory requirements.

NPDES/SDS construction stormwater permit requirements:

The need for an NPDES/SDS construction stormwater permit is triggered by the proposed land disturbance exceeding the one-acre threshold. For this Project, approximately 608.6 acres would be permanently impacted and 89.8 acres would be temporarily impacted. A total of approximately 225,000 cubic yards of soil is expected to be excavated or graded, representing a substantial disturbance footprint. The construction stormwater permit for this Project was obtained in April 2024.

An important component of the construction stormwater permit is the development and implementation of a construction phase SWPPP. Its purpose is to identify all potential sources of stormwater pollution from the construction activities and prescribe appropriate BMPs to minimize erosion, sedimentation and other impacts.

Specific elements that would be addressed in the construction SWPPP include:

- Detailed erosion and sediment control plans showing the locations and types of BMPs to be installed, such as silt fences, check dams, sediment basins, inlet protection, etc. The Dam Safety Permit also has explicit requirements for erosion control measures to be installed and maintained in accordance with the *Minnesota Stormwater Manual*.
- Procedures for stabilizing exposed soils during and after construction, including temporary and permanent seeding, mulching, erosion control blankets, etc. The Dam Safety Permit requires all exposed soils to be stabilized within 72 hours of completion.
- Pollution prevention measures for activities such as vehicle fueling and maintenance, concrete washout, storage of hazardous materials, etc. This includes having adequate spill kits on-site and training personnel on their use.
- Inspection and maintenance schedules for all BMPs to ensure they remain effective over time. This will involve more frequent inspections than the routine industrial SWPPP due to the active nature of construction.
- Corrective action procedures to address any failures or deficiencies identified during inspections.

- Documentation and recordkeeping requirements, including site maps, BMP specifications, inspection reports, corrective actions, etc.

Overall, the construction SWPPP represents a comprehensive plan that is tailored to the specific conditions and risks associated with the Stage 2 Exterior basin construction. Its effective implementation would prevent substantial adverse impacts to downstream receiving waters during the active disturbance phase.

NPDES/SDS industrial stormwater requirements:

Facilities in certain industries that store materials, waste, or equipment outdoors are subject to industrial stormwater regulations administered by the MPCA. Approximately 6,000 acres of the TSF contain industrial activities or significant materials that may come in contact with stormwater. The primary Standard Industrial Classification (SIC) code which applies to operations at Keetac is 1011- Iron Ores, but the ancillary activities primarily taking place at the TSF include outdoor storage of significant materials, dust or particulate-generating processes, and wastewater treatment and solid waste management. Keetac currently operates under two NPDES permits that contain stormwater conditions/requirements– NPDES/SDS Permit MN0031879 governs water discharged from the plant and mining activities, while NPDES/SDS Permit MN0055948 governs water discharged from the TSF. After construction of the Stage 2 Exterior basin is completed, stormwater management would transition to the post-construction or operational phase. At this point the construction SWPPP would no longer be applicable, and stormwater would be managed under Keetac's updated industrial SWPPP as part of the NPDES/SDS Permit. Permit reissuance for MN0055948 is in progress and will include industrial stormwater requirements.

Permanent stormwater management plans:

The existing SWPPP already outlines a range of stormwater control measures and BMPs that will continue to be implemented. These include good housekeeping practices, preventative maintenance, employee training, and spill prevention and response procedures. The SWPPP also includes regular inspections of the site to identify any issues or maintenance needs.

In the long-term, temporary construction areas and the slopes of the completed portions of the dam and dikes would return to vegetated cover, which would help to stabilize soils and reduce erosion potential. The detention effect of the interior basin pond would serve as a primary BMP for capturing and slowly releasing runoff from the Stage 2 Exterior. This detention would allow for settling of suspended tailings particles and help to regulate discharge rates to Reservoir No. 6 and downstream waters. Regular maintenance, including removal of accumulated sediments back to the TSF deposition areas would help sustain its stormwater treatment function over time.

Operations of the TSF will not be changed by the Project construction. Therefore, changes to water quality post-construction are not anticipated. No change to the overall watershed health scores is anticipated because of the operation of the TSF.

As with the construction phase SWPPP, the post-construction stormwater management plan would be periodically reviewed and updated to reflect any changes in site conditions, regulatory requirements, or climate patterns.

Receiving waters with construction-related impairments or special classification:

Hay Lake and the southwest bay of Swan Lake are identified as impaired waters for wild rice sulfate but do not have any construction-related impairments or special classifications. Active construction stormwater management activities are unlikely to impact the impairment of the receiving waters. It is anticipated there would be no material change in water quality from the no action alternative.

In addition to the wild rice sulfate impairment, Swan Lake is also listed as impaired for mercury in fish tissue. This impairment is not directly related to construction activities but is still relevant for the facility's overall stormwater management and NPDES/SDS permit compliance. Discharges from the Keetac site will continue to be monitored in accordance with permit requirements.

Additional requirements for special and/or impaired waters:

Keetac's NPDES/SDS permits are subject to the requirements of the Statewide Mercury TMDL due to the mercury impairment in Swan Lake. The TMDL allows for a wasteload allocation of 4 kg/year of mercury for the Northeast Region of Minnesota, which includes the Keetac site. However, the TMDL does not include any specific stormwater control requirements related to industrial discharges.

For the wild rice sulfate impairment in Hay Lake and the southwest bay of Swan Lake, a permit reissuance is in progress and will include updated compliance schedules for sulfate. Average sulfate concentration in the discharge from the tailings basin (SD 005) which flows to Hay Lake is 120 mg/L in 2024. The standard is 10 mg/L.

While the existing SWPPP does not outline any specific stormwater control measures or BMPs related to mercury or sulfate discharges, it does include general measures for minimizing pollutant loading in stormwater runoff, as follows:

- Regular inspections of the site to identify any issues or maintenance needs.
- Implementation of spill prevention and response procedures.
- Employee training on stormwater pollution prevention.
- Ongoing maintenance of stormwater control structures and equipment.

The above measures will help reduce the potential for mercury and sulfate loading from the site. The SWPPP will be reviewed and updated annually to reflect any changes in regulatory requirements or site conditions. If additional mercury or sulfate control measures are deemed necessary based on monitoring results or regulatory changes, they will be incorporated into an updated SWPPP at that time.

iii. Water appropriation - Describe if the Project proposes to appropriate surface or groundwater (including dewatering). Describe the source, quantity, duration, use and purpose of the water use and if a DNR water appropriation permit is required. Describe anywell abandonment. If connecting to an existing municipal water supply, identify the wells tobe used as a water source and any effects on, or required expansion of, municipal water infrastructure. Discuss environmental effects from water appropriation, including an assessment of the water resources available for appropriation. Discuss how the proposed water use is resilient in the event of changes in total precipitation, large precipitation events, drought, increased temperatures, variable surface water flows and elevations, and longer growing seasons. Identify any measures to avoid, minimize, or mitigate environmental effects from the water appropriation. Describe contingency plans should theappropriation volume increase beyond infrastructure capacity or water supply for the Project diminish in quantity or quality, such as reuse of water, connections with another water source, or emergency connections.

The proposed Project will not require water appropriation.

iv. Surface Waters

a) Wetlands - Describe any anticipated physical effects or alterations to wetland features such as draining, filling, permanent inundation, dredging and vegetative removal. Discuss direct and indirect environmental effects from physical modification of wetlands,

including the anticipated effects that any proposed wetland alterations may have to the host watershed, taking into consideration how current Minnesota climate trends and anticipated climate change in the general location of the Project may influence the effects. Identify measures to avoid (e.g., available alternatives that were considered), minimize, or mitigate environmental effects to wetlands. Discuss whether any required compensatory wetland mitigation for unavoidable wetland impacts will occur in the same minor or major watershed and identify those probable locations.

Construction Impacts and Mitigation

Construction of the Project would result in both permanent and temporary impacts to potentially WCA-regulated wetlands. Temporary impacts would take place in under six months. Wetland acreages in Tables 12.6 and 12.7 represent Project-related impacts except those listed for pipeline construction, as pipeline construction would occur aboveground and would not impact existing WCA-regulated wetlands. As mentioned previously, the DNR had not made a determination regarding the jurisdictional status of wetlands and waterbodies mapped during the August 2023 delineations (i.e., those included in the Project Area). Thus, the pending determination may require updates, which would affect both impact and mitigation acreages. The Project would permanently impact 80.55 acres of WCA-regulated wetlands because of dam and dike work, and 15.62 acres of WCA-regulated wetlands for the construction of the permanent access road. The access road is also expected to indirectly impact 0.19 acre of WCA-regulated wetlands. Construction of the separation and/or dewatering infrastructure would permanently impact 1.30 acres of WCA-regulated wetlands. In total, 97.47 acres of WCA-regulated wetlands would be permanently and directly impacted with an additional 0.19 acre of indirect impacts. The Project would temporarily impact 9.75 acres of WCA-regulated wetlands because of equipment staging and temporary site access. Temporary construction areas are also anticipated to indirectly impact 0.39 acre of wetlands. Construction of the pipeline would occur above 0.25 acre of wetlands but would result in no permanent or temporary impacts. The pipeline would be placed on wooden blocks several feet above the ground. The blocks would be placed outside of wetlands. Construction of the pipeline would occur along the footprint of the existing access road and the newly constructed permanent access road. Wetlands within the dam and dike footprint (and associated permanent access road) would be permanently filled using clay and coarse tails during construction. Impacts resulting from the construction of the separation and/or dewatering infrastructure, dam, dike, and permanent access road would be mitigated for through the credits available at U. S. Steel's Palisade Mitigation Wetland Site and purchase of mitigation credits, discussed further below.

Wetlands that are not proposed to be permanently or temporarily impacted by the Project would be protected using sediment and erosion control methods and best practices to prevent sediment or other contaminants from entering the wetlands. To minimize impacts to WCA-regulated wetlands, the Project has been designed to avoid wetlands where possible. Where the removal of trees or shrubby vegetation occurs within wetlands, U. S. Steel would use the least intrusive method possible to clear the corridor. Hand-cutting of vegetation would be conducted, where possible, to avoid and minimize impacts on streams and/or wetlands. There would be no change in contours or redirection of water flow, and the amount of spoil from foundation installation and structure placement would be minimal. Mats would be used for construction equipment to travel over wetlands, as appropriate. Staging activities would avoid wetlands to the greatest extent feasible. PFO/PSS wetlands would be cleared of trees and shrubs during the winter season and would be permanently converted to PEM/PSS wetlands over time.

Where tree clearing within wetlands in temporary workspaces is necessary, forested wetlands would be permanently converted to scrub shrub or emergent wetlands after construction. Wetlands, particularly forested wetlands, provide ecological functions, such as peak flood flow reduction, nutrient and sediment capture, filtration of pollutants to adjacent waterbodies, and diversity of habitat. The conversion of forested wetlands would reduce or eliminate some of these functions. Required tree removal adjacent to waterbodies would reduce riparian buffer functions, such as stream bank stabilization and erosion control, nutrient and sediment

filtration, floodwater storage and peak flow reduction, and water temperature modification from shading. Vegetation within temporary workspaces would be allowed to return after construction is complete, which would provide some filtration stabilization to help protect waterbodies from pollutants.

To compensate for the loss of WCA-regulated wetlands, U. S. Steel would use available surplus wetland mitigation credits at a 1-to-1 mitigation ratio from the Palisade Wetland Mitigation Site, which is located within the same watershed as the Project Area (Major Watershed 9, HUC 07010103). Since wetland mitigation would take place within the same HUC 08 watershed as the Project, no substantial effects to the host watershed are anticipated. As of April 2024, this Project specific wetland mitigation site contained approximately 79 acres of fresh wet sedge credits available for use as surplus wetland credits and approximately 10 shrub-carr credits available for use as surplus wetland credits. A credit release request was submitted to the USACE and the DNR in April of 2024. After the 2024 and 2025 growing season, another credit release request would likely be created for the inclusion of more in-kind credits.

Operations Impacts and Mitigation

Operational impacts to wetlands in the Project Area were evaluated through wetland delineation and functional assessment studies conducted in 2021 and 2023 following guidance for evaluation of wetland functions from the *Minnesota Routine Assessment Method for Evaluating Wetland Functions, Version 3.4*. Field functional assessments allow for an evaluation of potential direct and indirect impacts from Project development based on a series of metrics that include but are not limited to topographic settings, vegetative diversity, wildlife habitat and human disturbance factors (e.g., roads stockpiles, mine pits, soil removal). Ratings for each metric result in an overall classification of the wetland as 'high quality' (characterized by a high diversity of native plant species and little to no disturbance), 'medium quality' (dominated by native or non-native species with variable species diversity and variable disturbance) and 'low quality' (characterized by low species diversity, high non-native cover and high levels of disturbance).

Results of an abbreviated function assessment on each of the 55 wetlands delineated in 2021 showed that 13 wetlands were rated as high quality, 31 as medium quality and 11 as low quality. A similar assessment conducted on 50 additional wetlands that were delineated in 2023 showed that 5 of the 50 delineated wetlands were rated as high quality, 24 as medium quality, and 21 as low quality. The difference in the number of high and medium quality wetlands between the two years was attributed to the relatively higher level of disturbance observed in the 2023 survey area compared to the 2021 survey area. Based on these results and attribution of low-quality wetlands to mining operations, it can be concluded that approximately 30 percent of wetlands are directly or indirectly impacted because of operations in the Project Area. A revised delineation to include the 2023 delineation was submitted in October 2023 to the USACE and DNR. USACE completed their jurisdictional review of delineated wetlands in January 2024. A jurisdictional decision from the DNR is pending.

During operations, the TSF is managed under its SWPPP. There are no newly proposed sources of discharge and the TSF would operate in the same way that it operated prior to the construction of the Project. Therefore, no additional impacts are anticipated to wetlands during operations.

Hydrology monitoring data, collected as part of the wetland monitoring plan, would be evaluated to determine if adverse impacts are occurring resulting from the Project. Criteria for identifying impacts include changes in wetland hydrology criteria, reduction in wetland size, shifts in wetland community type, and decreased vegetation quality. Other factors, including wetland delineations, precipitation, and local climate trends would also be considered. If adverse impacts are found, they will be documented in annual reports submitted to USACE and DNR.

b) Other surface waters- Describe any anticipated physical effects or alterations to surface water features (lakes, streams, ponds, intermittent channels, county/judicial ditches) such as draining, filling, permanent inundation, dredging, diking, stream diversion, impoundment, aquatic plant removal and riparian alteration. Discuss direct and indirect

environmental effects from physical modification of water features, taking into consideration how current Minnesota climate trends and anticipated climate change in the general location of the Project may influence the effects. Identify measures to avoid, minimize, or mitigate environmental effects to surface water features, including in-water BMPs that are proposed to avoid or minimize turbidity/sedimentation while physically altering the water features. Discuss how the Project will change the number or type of watercraft on any water body, including current and projected watercraft usage.

Construction Impacts and Mitigation

Lakes/Reservoirs

Reservoir 2 North

A tailings pipeline that transports tailings from the processing plant to the separation and/or dewatering infrastructure is proposed to be placed on the west side of Reservoir 2 North, an impoundment of Welcome Creek. Approximately 0.8 mile of pipeline would be constructed upgradient of Reservoir 2 North. The pipeline would run along existing infrastructure corridor and would be above ground on raised blocks. Therefore, there would not be notable ground disturbing activities associated with the installation of the pipeline. At its nearest point, the pipeline would be over 100 feet from the shoreline, with dense vegetation separating the construction impact area from the reservoir. Erosion control measures and BMPs would be implemented downgradient of land disturbing activities to mitigate these impacts in accordance with the SWPPP. As a result, construction-related impacts to Reservoir 2 North would not be substantial.

Reservoir No. 6

The proposed separation and/or dewatering infrastructure would be constructed on the north of Reservoir No. 6 and tailings pipelines running along the north side to the separation and/or dewatering infrastructure, and west side to the TSF would be laid above ground on blocks along existing infrastructure corridors. Reservoir No. 6 could potentially be impacted by erosion and sedimentation from laying the pipeline, but erosion control measures and BMPs would be implemented downgradient of land disturbing activities to mitigate these impacts in accordance with the SWPPP. Construction of the separation and/or dewatering infrastructure would take place on the west side of a private access road separating it from the reservoir; substantial construction-related impacts would not be expected.

A water retention dam with a seepage reduction feature would be constructed between the Stage 2 Exterior Pond and Reservoir No. 6. A gravity reinforced concrete drop decant structure would be designed to include bulkheads and a sluice/roller gate to control the basin pond elevation, and gravity would convey water into the downstream polishing pond prior to returning to the plant (Figure 6.6). The proposed dam would permanently impact 38.7 acres of Reservoir No. 6 and approximately 5,242 linear feet of shoreline. These impacts would be mitigated or prevented through use of erosion control measures and BMPs, such as a floating silt curtain, and minimization of the duration of impacts. Temporary, indirect impacts on water quality, such as increased turbidity and localized sedimentation, could occur during construction because of vegetation clearing and other construction activities around and within the waterbody. The construction of the water retention dam would result in some minor impacts to Reservoir No. 6 due to placement of fill.

Flows into Reservoir No. 6 are likely to be different as a result of the project given the design features, removal of flows from Stage 1, and ongoing tailings deposition into the Stage 2 Exterior.

Reservoir No. 6 is used for mine process makeup and is an impoundment of Welcome Creek.

Reservoir No. 2

Reservoir No. 2, an impoundment of Welcome Creek, through impacts to Reservoir No. 6, may be impacted during construction of the proposed dam between Reservoir No. 6 and the Stage 2 Exterior Pond. Temporary, indirect impacts on water quality, such as increased turbidity and localized sedimentation, could occur during

construction because of vegetation clearing and other construction activities around and within the waterbody. These impacts would be mitigated or prevented through use of erosion control measures and BMPs, and minimization of the duration of impacts. No substantial impacts to Reservoir No. 2 are anticipated during construction.

Hay Lake

Hay Lake, through impacts to Hay Creek watershed (discussed below), may be impacted during construction. Temporary, indirect impacts on water quality, such as increased turbidity and localized sedimentation, could occur during construction because of vegetation clearing other construction activities upstream of the waterbody. These impacts would be mitigated or prevented through use of erosion control measures and BMPs, and minimization of the duration of impacts. No substantial impacts to Hay Lake are anticipated during construction.

Swan Lake

Swan Lake would not experience any direct discharges from the Project and as a result, is not anticipated to be substantially impact the construction of the Project.

Streams

Hay Creek

The Project Area is within the Hay Creek Watershed; however, there is no defined stream in the Project Area. Refer to section *12.a.i Streams, Hay Creek* above for more detail. Construction of the Stage 2 Exterior dike would extend into the Hay Creek watershed, but the stream channel would not be directly affected. Approximately 466.06 acres of the 37,255-acre Hay Creek watershed would be permanently constructed on and impacted (1.3 percent of the total watershed) and approximately 43.3 acres of the Hay Creek watershed would be temporarily impacted (0.1 percent of the total watershed).

Construction of the dike would mostly retain the current watershed boundaries, so while the gradient within the Project Area would be altered (e.g. steeper slopes on the dike), the watershed acreage for Hay Creek above the confluence with O'Brien Diversion Channel (Ditch) would remain the same.

Water downstream of the confluence of the O'Brien Diversion Channel (Ditch) may experience a negligible change in flow as a result in the loss watershed area. As shown on Figure 12.7 and discussed in section 12.b.ii *Routes and receiving water bodies for runoff from the Project site*, construction of the Project would result in stormwater from the historic Stage 1 area flowing into the Upper West Swan River watershed. Currently, water in Stage 1 (including pumped process water) flows into the Stage 2 Exterior, then into Reservoir No. 6 where it is used for process water or eventually flows into O'Brien Diversion Channel (Ditch) and into Hay Creek. Impacts on flow are expected to be negligible because water coming from Stage 1 currently includes process water that is occasionally flushed (as needed in winter operations) into Stage 1 area, and flushing would no longer be needed once the Project is implemented, so that process water would remain within the TSF watershed. Only stormwater runoff in the Stage 1 Area would change from the Hay Creek watershed to the Upper West Swan River watershed. The loss of this stormwater would be expected to be offset through the additional water added to the Stage 2 Exterior through thickening of tailings. Thickening of tailings prior to discharge reduces the water loss to void space.

Temporary, indirect impacts on water quality, such as increased turbidity and localized sedimentation, could occur during construction because of vegetation clearing and other construction activities in the headwaters. These impacts would be mitigated or prevented through use of erosion control measures and BMPs, and minimization of the duration of impacts, as required by applicable permits.

Swan River

Swan River receives inflows from Hay Creek, impacts to which are discussed above. The construction footprint within the Hay Creek watershed reflects less than 1.2 percent of the watershed for Swan River at the confluence with Hay Creek.

Temporary, indirect impacts on water quality, such as increased turbidity and localized sedimentation, could occur during construction because of vegetation clearing other construction activities around and within the Hay Creek watershed. These impacts would be mitigated or prevented through use of erosion control measures and BMPs, and minimization of the duration of impacts.

West Swan River

The West Swan River is located to the east of the TSF and would not be directly impacted by construction of the Project.

Construction of the dike would retain the majority of the current watershed boundaries, so while the gradient within the Project Area would be altered (e.g. steeper slopes on the dike), the watershed for the Upper West Swan would largely remain unchanged where the dikes are. However, as shown on Figure 12.7 and discussed in section 12.b.ii *Routes and receiving water bodies for runoff from the Project site*, construction of the Project would result in stormwater from the historic Stage 1 area flowing into the Upper West Swan River watershed instead of the Stage 2 Exterior. Construction of the Project and this change in rainwater runoff flow into the Upper West Swan would result in a net increase in catchment of 669.9 acres.

Temporary, indirect impacts on water quality, such as increased turbidity and localized sedimentation, could occur during construction because of vegetation clearing and other construction activities in the headwaters. These impacts would be mitigated or prevented through use of erosion control measures and BMPs, and minimization of the duration of impacts, as required by applicable permits.

While it is possible that there would be some groundwater interaction between the West Swan River and the TSF, surface level construction activities are not expected to have a substantial impact on the flow of the river.

O'Brien Diversion Channel

The O'Brien Diversion Channel receives inflows from Reservoir No. 2, which may be impacted by construction activities occurring in and around Reservoir No. 6. As discussed in the Hay Creek section above, flows into O'Brien Diversion Channel may experience a negligible change as a result of stormwater from the historical Stage 1 area changing to flow into the Upper West Swan River watershed.

Flows to the O'Brien Diversion Channel are not anticipated to be substantially affected by upstream construction, and any temporary sedimentation impact in Reservoir No. 6 would not be expected to reach the O'Brien Diversion Channel. Impacts to O'Brien Diversion Channel are not anticipated during construction.

Welcome Creek

Welcome Creek outlets into Reservoir 2 North (upstream of the TSF). Some project infrastructure (pipeline) would be constructed along an existing road corridor that already crosses Welcome Creek.

Temporary, indirect impacts on water quality, such as increased turbidity and localized sedimentation, could occur during construction along the existing road; however, these impacts would be mitigated or prevented through use of erosion control measures and BMPs, and minimization of the duration of impacts.

Welcome Creek would not receive direct discharge from areas affected by the Project, and as a result, no substantial construction impacts are anticipated.

Operations Impacts and Mitigation

Following impacts during construction, general operations of the Project would be consistent with existing operations at the TSF. There are no proposed water appropriations, or new discharges, and the overall water balance and/or water quality at the TSF is not expected to change from pre-existing conditions. Therefore, no substantial impacts are anticipated on any lake or stream during operation of the Project. A water quality and quantity monitoring plan would be developed for DNR approval in accordance with the requirement of the previous WCA Decision document for phase 1 of the Project.

13. Contamination/Hazardous Materials/Wastes:

a. Pre-Project site conditions - Describe existing contamination or potential environmental hazardson or near the Project site such as soil or ground water contamination, abandoned dumps, closed landfills, existing or abandoned storage tanks, and hazardous liquid or gas pipelines. Discuss any potential environmental effects from pre-Project site conditions that would be caused or exacerbated by Project construction and operation. Identify measures to avoid, minimize or mitigate adverse effects from existing contamination or potential environmental hazards. Include development of a Contingency Plan or Response Action Plan.

The MPCA's What's in My Neighborhood contamination database identifies potentially contaminated or historical contamination sites, and environmentally permitted sites within 0.5 mile of the Project Area, as shown in Table 13.1 and on Figure 13.1 (MPCA 2023). The status indicates if the site is active or inactive. Inactive sites are those in which the activity that the MPCA was interested in no longer exists. This could mean a closed leak site, or a permit is no longer in force. Within 0.5 mile of the Project, there are 3 active projects. The active projects are sites that the MPCA has interest in, meaning there is an ongoing investigation into a potential leak or there is an active permit. The active projects within 0.5 miles of the Project are all permitted projects (Figure 13.1). The water quality and stormwater sites within the Project Area are Keetac's construction stormwater and NPDES/SDS permits. There are no pre-Project site conditions that would be caused or exacerbated by Project construction and operation. Therefore, measures to avoid, minimize, or mitigate effects from existing contamination or potential environmental hazards are not proposed.

Table 13.1: MPCA Permitted Facilities, Contamination, and Leak Sites Within 0.5 Mile of the Project Area

MPCA Program(s)	Site Name	MPCA ID(s)	Status	Industry Classification
Hazardous Waste	Deane Morrow Trucking Inc	84898	Inactive	Specialized Freight (except Used Goods) Trucking, Local
Aboveground Tanks; Air Quality; Construction Stormwater; Hazardous Waste; Wastewater, Industrial SDS Permit	ERP Iron Ore LLC - Plant 1	126163	Active	Iron Ore Mining
Construction Stormwater; Industrial Stormwater; Solid Waste, Permitted Solid Waste Facility; Wastewater	General Waste and Recycling LLC	99174	Active	Recyclable Material Merchant Wholesalers
Aboveground Tanks; Hazardous Waste, Minimal quantity generator; Industrial Stormwater	Olsons Body Shop	5091	Active	Used Car Dealers; All Other Automotive Repair and Maintenance
Underground Tanks	Ron Peterson	109686	Inactive	N/A
Investigation and Cleanup	Keewatin Dump Site	185474	Inactive	N/A
Leak Site	Keewatin Taconite former Natl Steel Pellet	LS0016602	Closed	N/A

b. Project-related generation/storage of solid wastes - Describe solid wastes generated/stored during construction and/or operation of the project. Indicate method of disposal. Discuss potential environmental effects from solid waste handling, storage and disposal. Identify measures to avoid, minimize or mitigate adverse effects from the generation/storage of solidwaste including source reduction and recycling.

Solid and hazardous waste that could be produced during Project construction and the proposed disposal methods are listed in Table 13.2. The Project would not generate wastes during operation. Therefore, measures to avoid, minimize, or mitigate effects from the generation/storage of solid wastes during operations are not proposed.

Table 13.2: Potential Solid and Hazardous Wastes Within the Project Boundary

Source	Disposal Method
Construction	Trucked to landfill
Scrap metal	Removed for recycling
Demolition/Industrial Waste	Trucked to landfill
Waste tires	Removed for recycling
Vehicle batteries	Removed for recycling
Used oil/oil filters	Removed for recycling
Antifreeze	Removed for recycling
Electronics	Removed for recycling
Fluorescent and HID lamps	Removed for recycling
Lithium and nickel cadmium batteries	Removed for recycling
Mercury switches and bulk mercury-containing equipment	Sent to waste facility
Aerosol cans	Sent to waste facility
Solvents	Sent to waste facility

c. Project-related use/storage of hazardous materials - Describe chemicals/hazardous materials used/stored during construction and/or operation of the project including method of storage. Indicate the number, location and size of any new above or below ground tanks to store petroleum or other materials. Indicate the number, location, size and age of existing tanks on the property that the project will use. Discuss potential environmental effects from accidental spill or release of hazardous materials. Identify measures to avoid, minimize or mitigate adverseeffects from the use/storage of chemicals/hazardous materials including source reduction and recycling. Include development of a spill prevention plan.

Hazardous materials used and stored on-site for Project construction would include diesel fuel storage within the separation and/or dewatering infrastructure (for fueling haul trucks), other hazardous materials would be limited to fuels (diesel/gasoline), lubricant (engine oil), or coolant for equipment/vehicle maintenance. Potential environmental impacts resulting from an accidental spill or release of these hazardous materials may contaminate soil or surface water, and may have deleterious impacts on plants, insects, and animals. Spills would be avoided and mitigated with the implementation of BMPs, such as secondary containment and sediment protections around wetlands and waterbodies. Specific BMPs are detailed in the SPCC.

Within the Project Area, potential contaminants associated with future operations would include fuels (diesel/gasoline), lubricants (engine oil), and coolant and antifreeze for use in equipment and vehicle fueling and maintenance. Potential contaminants or hazardous materials at the TSF are managed as required by the SPCC,

which provides plans and requirements for the storage of petroleum products and the containment and cleanup of spills. The SPCC is updated every 3 years and is certified by a licensed professional engineer.

The Project would have a maintenance facility for trucks, as well as a fuel storage facility, associated with the separation and and/or dewatering infrastructure (Figure 6.6). The maintenance facility would likely be a two-bay small facility used only for preventative maintenance and small repairs. The second bay would be used for fueling purposes.

d. Project-related generation/storage of hazardous wastes - Describe hazardous wastes generated/stored during construction and/or operation of the project. Indicate method of disposal. Discuss potential environmental effects from hazardous waste handling, storage, anddisposal. Identify measures to avoid, minimize or mitigate adverse effects from the generation/storage of hazardous waste including source reduction and recycling.

The Project would not generate or require storage of hazardous wastes during construction or operation.

14. Fish, wildlife, plant communities, and sensitive ecological resources (rare features):

a. Describe fish and wildlife resources as well as habitats and vegetation on or in near the site.

Existing Wildlife

Wildlife, including mammals, birds, fish, reptiles/amphibians, and invertebrates, may be present within the Project Area. Table 14.1 includes non-protected species with potential to occur.

Table 14.1: Non-Protected Wildlife Species with Potential to Occur Within the Project Area

	Common Name	Scientific Name
Mammals	Beaver	*Castor canadensis*
	Black Bear	*Ursus americanus*
	Bobcat	*Lynx rufus*
	Coyote	*Canis latrans*
	Fisher	*Pekania pennanti*
	Mink	*Neovison vison*
	Pine Marten	*Martes martes*
	Red Fox	*Vulpes vulpes*
	Red Squirrel	*Tamiasciurus hudsonicus*
	Snowshoe Hare	*Lepus americanus*
	White-Tailed Deer	*Odocoileus virginianus*
Birds	Belted Kingfisher	*Megaceryle alcyon*
	Common Snipe	*Gallinago gallinago*
	Great Blue Heron	*Ardea herodias*
	Killdeer	*Charadrius vociferus*
	Peregrine Falcon	*Falco peregrinus*
	Ruffed Grouse	*Bonasa umbellus*
	Sharp-tailed Grouse	*Tympanuchus phasianellus*
	Swamp Sparrow	*Melospiza georgiana*

	Common Name	Scientific Name
Fish	Bluegill	*Lepomis macrochirus*
	Black Crappie	*Pomoxis nigromaculatus*
	Largemouth Bass	*Micropterus salmoides*
	Northern Pike	*Esox lucius*
	Rock Bass	*Ambloplites rupestris*
	Walleye	*Sander vitreus*
Reptiles/Amphibians	Bullfrog	*Lithobates catesbeianus*
	Common Garter Snake	*Thamnophis spp.*
	Gray Treefrog	*Dryophytes versicolor*
	Northern Leopard Frog	*Lithobates pipiens*
	Painted Turtle	*Chrysemys picta*
	Redbelly Snake	*Storeria occipitomaculata*
	Snapping Turtle	*Chelydra serpentina*
Invertebrates	Dark Fishing Spider	*Dolomedess pp.*
	Tricolored Bumblebee	*Bombus ternarius*

Source: MNDNR 2010

Existing Vegetation Conditions

North America is divided into ecoregions of similar environmental characteristics that contribute to the natural vegetation in the area, such as geology, vegetation, climate, soils, land use, wildlife, and hydrology (USEPA 2023). The Project Area occurs in the Northern Lakes and Forests Level III Ecoregion of the United States (USEPA 2013). The Northern Lakes and Forests ecoregion is characterized by its humid continental climate (warm summers and severe winters) with no marked dry season. Vegetation is dominated by coniferous and northern hardwood forests (maple, birch, spruce, fir, and pine) with black spruce, tamarack, and northern white cedar in wetter and cooler areas. This region also has widespread wetlands.

Within Minnesota, four provinces have been defined based on the major climate zones, native vegetation, and biomes. Within the provinces, sections and subsections are defined by glacial deposit origins, regional elevation, plant distribution, and regional climate. Under Minnesota's Ecological Classification System, the ecoregion corresponds to the Northern Superior Uplands section of the Laurentian Mixed Forest Province (MNDNR undated).

The Project Area is located within the Nashwauk Uplands Subsection (212Lc), with medium-to-coarse textured soils, forest communities of white pine, red pine, balsam fir, white spruce, and aspen-birch. Historically, this region was comprised of red and white pine forests, with aspen, paper birch, spruce, and balsam fir. Logging in the late 1800s and early 1900s left forests dominated by quaking aspen and paper birch, with jack pine present in droughty and exposed bedrock and sandy outwash areas (MNDNR undated). Peatlands and wet forests are present within broader upland forest areas. Additionally, the Stage 2 Exterior was anthropogenically disturbed prior to TSF development.

Existing Aquatics

There are five lakes and five streams in or immediately downstream of the Project Area, as shown in Tables 14.2 and 14.3. These waterbodies are home to a variety of fish species (MNDNR 2010). The DNR prepares Lake Management Plans for lakes that are actively managed for fishing and recreational activity. Each plan provides a summary of the fish population assessments conducted on the lake, fisheries management information such as

stocking reports, historical background, and future management plans. Of the lakes evaluated in this assessment, lake management plans were available for Swan Lake. In the absence of a lake management plan, information about the fisheries resources, aquatic habitat, and recreational uses for the other lakes are limited. As a result, the discussion of potential impacts to these lakes is general. However, based on similarities between some of the lakes and on other sources of information available, reasonable inferences can be made on fish resources and aquatic habitat.

Five lakes occur downstream of the Project Area: Swan Lake, Hay Lake, Reservoir No. 2, Reservoir 2 North, and Reservoir No. 6. Their distances from the Project Area are shown in Table 14.2. Descriptions of these waterbodies can be found in Item 12. The lakes are home to littoral, benthic, and pelagic species, such as walleye, northern pike, black crappie, pumpkinseed, rock bass, yellow perch, white sucker, brown bullhead, bluegill, and largemouth bass (MNDR 2010).

Table 14.2: Lake Distances from the Project Area

Lake	Distance from Project Area (miles)
Hay Lake	3.4
Reservoir No. 6	0
Reservoir No. 2	0
Reservoir 2 North	0
Swan Lake	4.1

Five streams occur downstream of the Project Area: Hay Creek, Swan River, West Swan River, the O'Brien Diversion Channel, and Welcome Creek. Their distances from the Project Area are shown in Table 14.3. Descriptions of these streams can be found in Item 12. These streams contain fish, such as largemouth bass, northern pike, black crappie, pumpkin seed, yellow perch, and rock bass (MNDNR 2010).

Table 14.3: Stream Distances from the Project Area

Stream	Distance from Project Area (miles)
Hay Creek	0
O'Brien Diversion Channel	0.4
Swan River	6.6
Welcome Creek	0
West Swan River	0

b. Describe rare features such as state-listed (endangered, threatened or special concern) species, native plant communities, Minnesota Biological Survey Sites of Biodiversity Significance, and other sensitive ecological resources on or within proximity to the site. Provide the license agreement number (LA-1051) and/or correspondence number (MCE2023-00649) from which the data were obtained and attach the Natural Heritage Review letter from the DNR. Indicate if any additional habitat or species survey work has been conducted within the site and describe the results.

The Minnesota DNR completed a NHIS review under MCE 2023-00649 (Appendix C). According to the DNR, state-listed plant species with the potential habitat in and documented near the Project Area are shown in Table 14.4.

Table 14.4: State-listed Plant Species with Potential Habitat in and Documented near the Project Area

Common Name	Scientific Name	State Status[a]	Federal Status
Tubercled Rein Orchid	*Platanthera flava var. herbiola*	T	No Status
St. Lawrence Grapefern	*Botrychium rugulosum*	SC	No Status

Source: MN NHIS 2024

[a] State Status Codes: T = threatened; SC = Special Concern

In July of 2022, a rare plant survey was conducted in the proposed dam/dike footprint. No state-listed threatened or endangered species were identified during the survey, however a species of special concern, *Botrychium (Sceptridium) rugulosum* was found (Barr 2022). In November of 2023, the DNR provided concurrence based on their review of the 2022 rare plant survey and determined that no state-listed threatened or endangered species were likely to be in the dam/dike footprint, and that a take permit would not be warranted. In April of 2024, U. S. Steel requested concurrence from the DNR to confirm that no additional rare plant surveys are warranted in all other portions of the Project Area. DNR determined that an additional field survey is needed. The additional survey would be conducted from late June to early July in 2026.

The USFWS protects special species on the federal level under the Endangered Species Act. To assess the potential for federally listed species to occur in the Project Area, an Information for Planning and Consultation review was conducted. Table 14.5 lists federal and state-listed species with potential to occur in the Project Area.

Table 14.5: Federal and State-Listed Species with Potential to Occur in the Project Area

Common Name	Scientific Name	State Status[a]	Federal Status[b]	Suitable Habitat in the Project Area	Habitat Description in Minnesota
Canada Lynx	*Lynx canadensis*	none	LT	Yes	Canada Lynx are primarily found in the Arrowhead region of Minnesota. They travel and hunt between patches of boreal and mixed conifer-hardwood forest. They particularly favor boreal forests that have a high-density of snowshoe hare. Den sites that offer thermal cover such as large areas with downed logs and woody debris are preferred.
Gray Wolf	*Canus lupus*	D	LT	Yes	Although this species prefers large areas of contiguous forest, they are habitat generalists, therefore they are dependent on prey availability (e.g. deer and hare) rather than land cover. Their den sites are typically located near the core of their territories and are surrounded by upland trees and close to lowland shrubs. Dens may vary from a dug-out burrow, a hollow log, to an overturned tree.
Monarch Butterfly	*Danaus plexippus*	none	PT	Yes	Preferred habitats include fields, meadows, parks, and other open areas where milkweed, native plants, and breeding season nectar sources are located.
Northern Long-eared Bat	*Myotis septentrionalis*	SC	LE	Yes	This species overwinters in natural caves or mines and spends the rest of the year in forested habitats. Preferred sites consist of minimal airflow, high humidity levels, and constant temperatures. In the summer, NLEB occupy any dead or live tree with cavities or crevices greater than 3 inches diameter. They tend to roost and forage in wooded habitats with a variety of densities and canopy closures and seem to travel in intact forest with sparse to medium vegetation density. However, they may travel and forage in areas with adjacent wetlands and agricultural areas.
Suckley's Cuckoo Bumble Bee	*Bombus suckleyi*	none	PE	Yes	This species has been found in various habitat types including prairies, grasslands, meadows, woodlands, boreal forests, urban areas, and agricultural areas. The Suckley's Cuckoo Bumble Bee relies on other *Bombus* species to rear their young and they are dependent on other species' colonies for survival.
Tricolored Bat	*Permyotis subflavus*	SC	PE	Yes	In general, this species prefers mesic hardwood forest, fire dependent forest, and subterranean habitats. In the winter, these bats occupy mines, tunnels, and caves where airflow is minimal, the temperature and humidity are constant. In the summer, the bats roost in trees, and some even in their winter hibernaculum. They forage over water and avoid open fields and deep woods.

[a] State Status Codes: D = delisted; SC = special concern

[b] *Federal Status Codes: LE = listed endangered; LT = listed threatened; PE = proposed endangered; PT = proposed threatened*

Source: MN NHIS 2024; MNDNR 2018a, b; MNDNR 2024a, b, c, d

There are no native plant communities within the Project Area. The nearest native plant community is 4.9 miles south of the Project Area.

The Project Area is not included in the Minnesota Biological Survey area. In general, northeastern Minnesota has areas of outstanding, high, and moderate biodiversity significance (MNDNR 2014).

Wild rice (*Zizania palustris*) an important aquatic plant found throughout Minnesota, providing food for waterfowl, as well as cultural and economic benefits to many Minnesotans is present in three waterbodies downstream of the Project Area – Swan Lake, Swan River, and Hay Lake.These are shown in Figure 14.1.

A wild rice and stream survey conducted by MNDNR in 2009 found approximately three acres of wild rice in medium to abundant density in Hay Lake; the crop appeared severely damaged and likely not harvestable. In Hay Creek, wild rice was found to be abundant at the outlet of Hay Lake becoming increasingly sparse and unhealthy further downstream except for a moderately dense 200-foot section between 0.6 and 0.8 mile downstream of the lake. Based on survey results wild rice health in this area is likely affected by increased water levels and elevated sulfate concentrations in the lake.

c. Discuss how the identified fish, wildlife, plant communities, rare features and ecosystems may be affected by the project including how current Minnesota climate trends and anticipated climate change in the general location of the project may influence the effects. Include a discussion on introduction and spread of invasive species from the project construction and operation. Separately discuss effects to be known threatened and endangered species.

Wildlife

Project construction would cause both temporary and permanent loss of habitat. This loss of habitat, along with the noise of construction, could potentially drive species from the area. The disturbance of soil may increase erosion, which could further deteriorate habitat. For common wildlife species, impacts to populations would be expected to be minor. Tree clearing would result in a loss of forested habitat, causing a loss of nesting habitat for some migratory birds, which could result in impacts to populations at a local level.

Additionally, construction vehicles could introduce invasive species through either introduced materials or attachment to vehicles and workers. Mortality or injury could also occur to individual animals impacted by unintended vehicle strikes.

Potential Impacts to Federal listed Species

Canada lynx. If Canada lynx were to occur in the Project Area*,* potential effects could include temporary noise and/or physical disturbance of habitat from construction activities. As a result, disturbance may prompt lynx to vacate the area for a short period. However, because the lynx is a highly mobile species that may disperse long distances (movements can be greater than 60 miles) (Mowat et al. 1999), lynx may move away from the local area of disturbance for a short period and may begin using the area again shortly after cessation of activities. Apart from the construction of the separation and/or dewatering infrastructure, the Project largely represents augmentation and continued operation of an existing operating TSF. Therefore, construction is unlikely to impede lynx movement and displace individuals.

Studies demonstrate that lynx may tolerate daily human use and presence in an area (Mowat et al. 1999). As the Project Area is near an already existing mine and contains a TSF which are disturbed, it is unlikely that Project operations would result in a major impact on lynx. Along with the patchy nature of suitable lynx habitat in the Project Area, the prevalence of similar habitat in adjacent areas, the mobility of lynx, and their large home ranges, impacts to lynx or lynx populations are not expected.

Gray wolf. Noise or physical disturbance because of Project construction may prompt wolves to vacate the area for a short period. However, because the wolf is a mobile species, it is anticipated that any wolf would move away from the local area of disturbance and may begin using the space again shortly after cessation of activities. Apart from the construction of the separation and/or dewatering infrastructure, the Project largely represents augmentation and continued operation of an existing operating TSF. Therefore, construction is unlikely to impede wolf movement and displace individuals. If it does, the impact would be minimal and temporary.

Humans and human activities are the primary cause of wolf mortality, vehicle collision being a primary source. Although driving alert during operation would be advised when transporting throughout the area (e.g., maintenance activities), it is unlikely that a wolf would be harmed by a vehicular traffic due to their infrequent occurrence in the Project Area, the continued disturbance of the Project Area, and lack of collisions in the past. Project operations could have a minor effect on wolves through increased disturbance that would result in wolves avoiding the Project Area; however, this effect is expected to be minor because the Project Area has been and continues to be disturbed.

Monarch butterfly. The Project may temporarily impact habitat, including nectar-bearing wildflowers, on which adult monarch butterflies might feed. Project construction activities also create an opportunity for introducing and spreading noxious weeds and invasive plant species within the Project Area. Noxious weeds and invasive plants can outcompete native forbs that provide food and/or sources for egg laying for the monarch butterfly. Weed control measures and treatment methods may be incorporated into the Project to reduce the threat of introducing or spreading noxious weeds and invasive plant species within the Project Area. With the proposed mitigation measures, construction would not jeopardize the continued existence of the species.

Visual or physical disturbances from the physical presence of people, maintenance activities, and moving vehicles may impact the monarch butterfly. The disturbance could cause individuals to move from resting/nectaring locations or alter the flight paths of adults. However, given the amount of available habitat adjacent to the Project Area, operations would not jeopardize the continued existence of the monarch butterfly.

Northern long-eared bat. Project impacts could occur if construction activities were to displace roosting or foraging bats from nearby habitats due to increased noise and human activity in the area. Bats would likely move to surrounding undeveloped treed areas surrounding the Project Area. There are large, forested habitats in the vicinity of the Project Area, along with small patches of trees along riparian corridors, which could provide suitable roosting trees. To minimize impacts to the NLEB, all tree clearing would occur outside of roosting season (which extends from April 14 to November 1).

During operations, human activity, noise, and vibration from operations may occasionally disturb NLEB habitat and nearby roosting sites. However, this effect is expected to be minor as the Project Area is already disturbed.

Tricolored bat. Impacts could occur if construction activities were to displace roosting or foraging bats from nearby habitat due to increased noise and human activity in the area. Bats would likely move to surrounding undeveloped treed areas surrounding the Project Area. There are large, forested habitats in the vicinity of the Project Area, along with small patches of trees along riparian corridors which could provide potentially suitable roosting trees. To minimize impacts to the tricolored bats, all tree clearing would occur outside of roosting season (which extends from April 14 to November 1).

During operations, human activity, noise, and vibration from operation activities may occasionally disturb tricolored bats habitat and nearby roosting sites. However, this impact is expected to be minor as the Project Area is disturbed. Therefore, operation would not jeopardize the continued existence of the tricolored bat.

Suckley's Cuckoo Bumble Bee. Impacts to the Suckley's Cuckoo Bumble Bee would be similar to those of the Monarch Butterfly as construction activities would temporarily remove flowering plants that the bees rely on for nectar and pollen. Project Construction could introduce invasive species and noxious weeds that could outcompete native species and reduce forage. Ground disturbances during construction may remove the nests of

other *Bombus* species that the Suckley's Cuckoo Bumble Bee rely on. Weed control measures and treatments may be incorporated into the Project to reduce the spread of invasive species and reduce impacts. There is suitable habitat within the vicinity of the Project Area and nests may relocate outside of the Project Area. Construction would not jeopardize the continued existence of the species Suckley's Cuckoo Bumble Bee.

During operations, the physical presence of people, maintenance activities, and moving vehicles may impact the Suckley's Cuckoo Bumble Bee. The bee may alter flight paths and change foraging patterns in response to the disturbance. Suitable habitat is found within the vicinity of the Project Area and the Project operations would not jeopardize the continued existence of the Suckley's Cuckoo Bumble Bee.

State-listed Species

The 2022 survey did not result in observations of state-listed plant species within the surveyed area (the dam/dike footprint), thus impacts to state-listed are not expected within this area. Surveys are proposed to occur in 2026 in areas that have not been previously surveyed.

Aquatic Species

Construction of the proposed dam would directly impact Reservoir No. 6, both temporarily and permanently. Construction activities have the potential to adversely impact fish populations through loss of habitat and the spawning area along the eastern side of the reservoir, where dam construction would occur. The construction in the waterbody could cause an increase in turbidity through the disturbance and introduction of sediment, which can reduce gill function, degrade spawning beds, and decrease lake productivity (MPCA 2008). The connected lakes and streams could be indirectly affected during construction of the proposed dam because of temporary increase in turbidity downstream of Reservoir No. 6.

The Hay Creek watershed would also be directly impacted as construction would likely cause the loss of habitat at the headwaters of the creek. Relative to the total watershed, the impacted area would be small. This could also cause a temporary increase in turbidity that could negatively affect fish downstream.

General operations of the Project would be consistent with existing operations at the TSF. There are no proposed water appropriations, or new discharges, and the overall water balance or water quality at the TSF is not expected to change from pre-existing conditions.

Vegetation

Project construction would require vegetation clearing in both temporary and permanent impact areas, which would result in an overall loss of vegetated areas. Any potential impacts to vegetation during operations would be limited to potential localized dust cover, or vegetation maintenance to keep rights-of-way and work areas clear and safe.

Invasive Species

It is possible that construction vehicles could introduce invasive species through either introduced materials or attachment to vehicles and workers.

Minnesota Climate Trend

The Project would have a direct and unavoidable impact on vegetation and less mobile species within the Project Area. Increased activity at the Project Area may further deter some wildlife species from the site.

The climate within the Project Area is projected to become warmer and wetter. This could help minimize dust at the site, could offset the impact of the relatively small loss in watershed to downstream flows.

Closer planning will consider climate trends in determining appropriate seed mixes and revegetation planning.

Overall, the effects of the Project are unlikely to be exacerbated by climate change.

d. Identify measures that will be taken to avoid, minimize, or mitigate the adverse effects to fish,wildlife, plant communities, ecosystems, and sensitive ecological resources.

Wildlife

All vegetation clearing (including tree clearing) would occur in the winter to avoid the nesting bird and roosting bat seasons.

Impacts to habitats would be mitigated for by the replanting of vegetation in temporary construction areas. To mitigate for potential increases in erosion, soil control devices would be installed, and topsoil conservation methods would be implemented. In addition, accidental spills of oil or mechanical fluid could negatively impact species in the Project Area. Any spilled fluids would be cleaned up and a containment/prevention plan would be implemented. To minimize impacts to bats, all tree clearing would occur outside of roosting season (which extends from April 14 to November 1).

Vehicle collisions with wildlife can be mitigated with alert driving.

Aquatic Species

Changes in turbidity due to construction activities would likely be temporary and would decrease again once construction ceases. Additionally, a silt curtain would be installed to protect the western portion of the reservoir. The eastern portion of the reservoir, where permanent impacts would occur, would be stacked with rock prior to the placement of tailings to minimize potential impacts to aquatic habitats and water quality.

By implementing erosion control measures, impacts would not substantially impact water quality downstream of Reservoir No. 6.

Vegetation and Invasive Species

Upon construction completion, temporary construction areas would be returned to pre-construction contours to the extent practicable. Temporary erosion control measures would be implemented during construction and disturbed areas would be seeded with a native seed mix and/or would return to a permanent vegetated state naturally.

The spread of invasive species could be prevented or minimized by inspecting vehicles, clothing, and equipment before moving to new sites. In addition, sourcing vehicles and equipment locally could minimize the likelihood of introduction. Vehicles used for Project construction would be existing Keetac facility equipment. Additionally, the added material used in the construction would be sourced locally to prevent the introduction of invasive species.

Per the conditions of the Project's Dam Safety Permit (No. 2022-0721), all equipment used must be free of prohibited invasive species and aquatic plants prior to being transported into or within the state and placed into state waters. All applicable conditions pertaining to equipment would be adhered to. Minnesota Rules Chapter 6130 requires the reclamation of mined lands following completion of mining activities. Reclamation requirements include re-establishment of vegetation in areas disturbed by mining activities.

Wild rice

Any potential impact on wild rice would be associated with changes to water conditions. The Project is not anticipated to affect the overall water balance or water quality at the TSF. Downstream waterbodies are not expected to experience substantial change from pre-existing conditions.

15. Historic properties:

Describe any historic structures, archaeological sites, and/or traditional cultural properties on or near the site. Include: 1) historic designations, 2) known artifact areas, and 3) architectural features. Attach letter received from the State Historic Preservation Office (SHPO). Discuss any

anticipated effects to historic properties during project construction and operation. Identify measures that will be taken to avoid, minimize, or mitigate adverse effects to historic properties.

U. S. Steel sponsored a Cultural Resource Literature Review (In Situ, 2021) to inform this phase in 2021. In June 2025, U. S. Steel reviewed the Minnesota Statewide Historic Inventory Portal (MnSHIP) and Office of the State Archaeologist Portal (OSA) public maps to note any additions to these databases since 2021, with focus on areas proposed for direct impacts. No cultural resources surveys have been conducted for the Project.

No archaeological sites, historic structures, or historic districts are located within the project area. One archaeological site has been identified east of the Project boundary, and has not been evaluated for inclusion on the National Register of Historic Places (NRHP). The TSF has not been identified as historical property that has been evaluated for eligibility for under the NRHP.

Operations would not impact the archaeological site or any other known archaeological or historic structure sites since all operational activities would occur within the interior portion of the dams and dikes.

Since no archaeological sites, historic structures, or historic districts are within the project area, no impacts to such resources are anticipated during Project construction or operations. Accordingly, no avoidance, minimization, or mitigation of effects are expected. Although unanticipated finds are unlikely given land use history within the phase construction footprint, the inadvertent discovery of heretofore unknown cultural resources or human remains is possible. In the event of inadvertent discovery of a cultural resource, U. S. Steel would adhere to state and federal requirements to identify cultural resources, assess Project impacts, and develop treatment plans to avoid, minimize, or mitigate adverse impacts to such resources. Should human remains be identified, U. S. Steel would advise the applicable county sheriff and the Office of the State the OSA, in accordance with the Private Cemeteries Act (MS 307.08). This coordination is consistent with the (expired) 2012 Programmatic Agreement.

16. Visual: Describe any scenic views or vistas on or near the project site. Describe any project-related visual effects such as vapor plumes or glare from intense lights. Discuss the potential visual effects fromthe project. Identify any measures to avoid, minimize, or mitigate visual effects.

The visual assessment uses above mean sea level (AMSL) to be consistent with the digital elevation model (DEM) analysis documented in the 2010 Final EIS. The Project Area is located approximately 0.75 mile south of Trunk Highway 169. The Stage 2 Interior dike crest ranges between 1,553 and 1,580 feet AMSL. The Stage 2 Exterior dike crest is currently approximately 1,470 feet AMSL in the south and west, and approximately 1,500 feet AMSL in the east. The perimeter dikes do not extend to the north of the TSF because the natural topography is higher in this area and provides a natural barrier for tailings.

Topography within the TSF generally slopes downhill in the southern, western, and eastern portions of the site, and slightly upward in the north. The entire Project Area is surrounded with forested vegetation. Currently, the TSF is visible from Highway 169, the City of Keewatin, and several surrounding residences. From these vantage points, the TSF appears as a large man-made hill with vegetated (grassy) slopes. The TSF has been present at this location and slowly growing since the 1960s. The area has an extensive mining history and several other mine related areas (pits, waste rock stockpiles, TSFs) exist throughout the iron range.

Construction Impacts and Mitigation

Due to the vegetative buffer around the Project Area and the presence of the existing TSF, visual impacts during the construction period are not anticipated. The construction of the separation and/or dewatering infrastructure is not anticipated to impact the general aesthetic of the area. As such, mitigation is not proposed.

Operations Impacts and Mitigation

A DEM analysis was completed as part of the 2010 Final EIS to evaluate visual impacts to the surrounding landscape. In 2010, the Stage 2 Interior dike stood at approximately 1,530 feet in height with an annual elevation increase of approximately 2.7 feet per year and an anticipated final height of 1,612 feet by 2036. The 2010 visual impacts analysis modeled visual impacts to locations surrounding the TSF at the final height of the 2010 project (1,612 feet). Locations evaluated for visual impacts in the 2010 Final EIS included: the northwest and west shore of Swan Lake; north and south points in the City of Nashwauk; the northwest, northeast, southwest, and southeast corners of the City of Keewatin; the intersection of Old Highway 169 and Highway 169; and points around Kelly Lake along West Swan River (Figure 16.1). The DEM evaluated whether the TSF would be visible from these locations using 1,554 and 1,612 feet as reference heights for the TSF and using a worst-case scenario methodology that disregarded vegetative and other visual buffers, which accounted solely for elevation in assessing the visual impact (MNDNR 2010).

The Project would raise the elevation of the Stage 2 Exterior dike by approximately 70 to 110 feet, which would be 5 feet less than the final Stage 2 Interior height, at approximately 1,580 feet. Since Stage 2 Exterior is immediately adjacent to the Stage 2 Interior, and the 2010 visual effects analysis included visual impacts from elevations higher than what are proposed for this Project, the results from that study provide a conservative estimate of the visual effects of the Project and are listed below in Table 16.1 (MNDNR 2010).

Table 16.1: 2010 FEIS Visual Impacts Analysis

Location	TSF Elevation (feet AMSL)	Approximate Distance from TSF (miles)	Visible (Yes/No)
NW Keewatin	1,554	2.9	Yes
	1,612		Yes
South Kelly Lake Development	1,554	3.4	Yes
	1,612		Yes
Southeast Keewatin	1,554	2.1	No
	1,612		Yes
Central Kelly Lake Development	1,554	3.6	No
	1,612		No
Intersection of Old Highway 169 and Highway 169	1,554	2.1	No
	1,612		No
Hull Rust Mine View	1,554	7.2	No
	1,612		No
Northeast Keewatin	1,554	2.5	No
	1,612		No
North Kelly Lake Development	1,554	4.3	No
	1,612		No
North Nashwauk	1,554	5.8	No
	1,612		No
Swan Lake (northwest shore)	1,554	7.6	No
	1,612		No
South Nashwauk	1,554	5.6	No
	1,612		No

Location	TSF Elevation (feet AMSL)	Approximate Distance from TSF (miles)	Visible (Yes/No)
SW Keewatin	1,554	2.7	No
	1,612		No
Swan Lake (west central shore)	1,554	8.0	No
	1,612		No

Based on the visual impacts analysis, the TSF is visible at its current elevations from the northwestern portion of the City of Keewatin and the South Kelly Lake Development. The TSF would also be visible in southeastern portions of the City of Keewatin at the assessed height of 1,612 feet (the Project would not reach this height).

The Project would progressively increase the elevation of the Stage 2 Exterior by 70 to 110 feet over the course of 40 years to the ultimate height of 1,580 feet. A comparison of the planned Stage 2 Exterior height to the existing Stage 2 Interior is shown in Table 16.2.

Table 16.2: Current, Authorized, and Proposed Elevations of Stage 2 Interior and Exterior

Perimeter	Current Height (feet)	Increase (feet)	Authorized Final Height (feet)	Proposed Project Height (feet)	Increase (feet)
Stage 2 Interior	1,553 and 1,580	5 - 77	1,585	1,585	0
Stage 2 Exterior	1,470 feet in the south and west to 1,500 feet in the east	10	1,470 – 1,510	1,580	70 - 110

During operations, tailings would continue to be deposited into the Stage 2 Exterior, which would only be visible from locations where the TSF is already visible. It may become visible in southeast Keewatin as it reaches the proposed height of 1,580 feet; however, the proposed height is lower than the height assessed in the 2010 Final EIS which concluded no significant impact. As a result, no major operational impacts to visual resources are anticipated. Upon closure, the TSF would be reclaimed, which would involve further revegetation and consideration for safety, land use and aesthetics.

17. Air

a. Stationary source emissions - Describe the type, sources, quantities and compositions of any emissions from stationary sources such as boilers or exhaust stacks. Include any hazardous air pollutants, criteria pollutants. Discuss effects to air quality including any sensitive receptors, human health or applicable regulatory criteria. Include a discussion of any methods used to assess the project's effect on air quality and the results of that assessment. Identify pollution control equipment and other measures that will be taken to avoid, minimize, or mitigate adverse effectsfrom stationary source emissions.

The Project would use mobile generators for lighting nighttime work. The Project would not have any other stationary source emissions; no mitigation is proposed to offset emissions from the use of the mobile generators. It is anticipated there would be a reduction in exposed beach areas due to changes in deposition of tails, and wind velocities across exposed areas would be reduced during operations resulting in fewer fugitive dust emissions.

b. Vehicle emissions - Describe the effect of the project's traffic generation on air emissions. Discuss the project's vehicle-related emissions effect on air quality. Identify measures (e.g., traffic operational improvements, diesel idling minimization plan) that will be taken to minimize or mitigate vehicle-related emissions.

Air quality impacts from vehicle emissions are expected for this Project from vehicular traffic, construction equipment, logging equipment, coarse tailings haul trucks and water trucks. Approximately 10 employees are anticipated to be hired for the construction of the Project. This would nominally increase the number of vehicle-related emissions in the area. Project emissions from construction equipment would be minimal. Construction equipment would be operated on an as-needed basis, and efforts would be made to maintain the equipment in accordance with the manufacturer's recommendations to minimize equipment emissions. Excavation equipment, vehicles, and other mobile sources may be powered by ultralow sulfur diesel or gasoline engines that are sources of combustion-related emissions, including the criteria pollutants (NO_x, CO, VOCs, SO_2, PM10, and PM2.5) and a minimal number of Hazardous Air Pollutants (HAPs).

Project emissions from operations would be generated by the 24-hour operation of four haul trucks, a water truck, and mobile generators used to provide portable lighting.

U. S. Steel would encourage carpooling and efficient construction time to limit emissions. Haul trucks and other construction equipment would be maintained to avoid additional emissions.

c. Dust and odors - Describe sources, characteristics, duration, quantities, and intensity of dust and odors generated during project construction and operation. (Fugitive dust may be discussed under item 17a). Discuss the effect of dust and odors in the vicinity of the project including nearby sensitive receptors and quality of life. Identify measures that will be taken to minimize ormitigate the effects of dust and odors.

Fugitive dust emissions from wind erosion and material movement caused by land clearing and excavation activities would also likely result from construction activities. The amount of fugitive dust generated would depend on multiple factors, including the duration and type of construction activity, moisture content and nature of material that would be disturbed, wind speed and frequency of precipitation, and the area of disturbance. Fugitive dust emissions during construction and operation would be controlled by water application, dust suppressant application, access road maintenance, and by limiting vehicular and equipment speeds on access roads and in the right-of-way. Fugitive dust control measures are discussed in U. S. Steel's Fugitive Dust Plan which would be updated to reflect actions to minimize fugitive dust from dam construction, including but not limited to the addition of water on haul roads utilized by the haul trucks and reclamation of inactive areas. The deposition of the coarse tails via haul truck is not likely to be a source of fugitive emissions as the coarse tailings are high in moisture content.

18. Greenhouse Gas (GHG) Emissions/Carbon Footprint

a. GHG Quantification: For all proposed projects, provide quantification and discussion of project GHG emissions. Include additional rows in the tables as necessary to provide project-specific emission sources. Describe the methods used to quantify emissions. If calculation methods are not readily available to quantify GHG emissions for a source, describe the process used to cometo that conclusion and any GHG emission sources not included in the total calculation.

Greenhouse gas emissions associated with the Project consist of direct emissions from mobile equipment used during construction, land use changes, and from the haul trucks used to deposit coarse tails during operation. The separation and tailings dewatering infrastructure would generate indirect scope 2 emissions from electricity use.

Emissions were calculated for on-road and off-road equipment proposed to be used in both the construction and operations. Off-road vehicles used for construction would be excavators, loaders, graders, haul trucks, and a water truck. This equipment utilizes AQMD's *Off-road Mobile Source Emission Factors* to determine emission rates for criteria pollutants and GHGs. Expected engine loads were applied to more accurately represent the emissions associated with the Project. On-road vehicles used during construction and operations would be trucks

used for transportation of workers. Four trucks were used to calculate the emissions for construction with an assumed driving distance of 100 miles per day and averaging 20 miles per gallon.

Equipment needed for the construction phase would be logging equipment used in vegetation clearing, and mobile generators used to provide nighttime lighting (assumed 12 hours per day). The logging equipment was assumed to be 8 gasoline powered chainsaws using 3 gallons per day, and 3 large feller bunchers using 90 gallons of fuel per day. This equipment utilizes fuel usage and 40 CFR Part 98 Subpart C's tables C-1 and C-2 to determine GHG emissions (40 CFR § 98).

During operation, five 150-ton haul trucks would carry coarse tailings from the separation and/or dewatering infrastructure and deposit them along the TSF, with a sixth not running and on standby. A water truck would be used during operation to suppress dust in summer months (assumed six months of operation).

Scope 2 emissions would be generated from the operation of the separation and tailings dewatering infrastructure. A list of equipment associated with Project operations was used to estimate power demand. U.S. eGrid emission factors were used to convert that electric demand to emissions (USEPA 2024).

The construction of the separation and tailings dewatering infrastructure, dams and dikes, and other permanent infrastructure would permanently alter existing land cover including forests, wetlands, and shrub/scrub areas (Table 8.1 and Figure 8.1). The alteration of these land types would remove a carbon sink. Land cover is based on the NLCD (refer to section 8). Emission factors for the GHG emissions from land use conversion are based on the values found in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2024).

Emissions of CO_2 from developed areas are calculated based on IPCC 19R V4 Ch02 Generic Methods Table 2.2. CO_2 is generated from burning litter and dead wood when clearing the land for development. Emission factors are given in total carbon, which has to be converted to CO_2 by multiplying the molecular weight of CO_2 (44) and dividing by the molecular weight of elemental carbon (12). The amount of litter and dead wood depends on land type, so each type of land developed by the Project was attributed to one of the available Emission Factors and multiplied by acreage to find total carbon cleared. IPCC recommends annualizing construction emissions evenly over a 20-year period.

It is assumed that methane emissions would result from anaerobic digestion of carbon stored in the existing Stage 2 Exterior tailings area as this area becomes more flooded and covered with tailings. The emission factor selected is from IPCC 19R V4 Ch07 Wetlands Table 7.15 for Cool Temperate areas and are given in units of kg CH_4 per hectare per year. The emission factor was multiplied by the area of flooded land (covered by tailings) to determine total annual emission value, which is multiplied by 20 (years) to determine the emissions of methane over the same 20-year period as the CO_2 emissions from clearing the land (per IPCC). Note that this is a conservative approach to methane emissions given the Stage 2 Exterior is already impacted by tailings and deposition of additional tailings may suppress the anaerobic digestion of any residual carbon in the footprint compared to "flooding" that the emissions factor assumes (the majority of the Stage 2 Exterior is mapped as baren land per Figure 8.1).

The following tables provide estimations GHG generated by the construction and operations of the Project (Tables 18.1 and 18.2). The values in Table 18.2 are reported as short tons of CO_2e emissions per year of operation and include the annualized emissions from table 18.1 because those annualized emissions would be occurring during both construction and operational periods. All emissions reported in both tables follow the general methods from Minnesota's *2024 EAW Climate Guidance*, such as including IPCC 4th Assessment report GWPs, sources required to be included, and all applicable GHGs. Other specific resources were utilized in calculating these emissions and are noted in the tables.

Table 18.1: Estimated Construction Emissions

Scope	Type of Emission	Emission Sub-Type	Project-Related CO_2e Emissions (tons/year)	Calculation Method(s)
Scope 1	Combustion	Diesel non-road Equipment	3,559	AQMD *Off-road Mobile Source Emission Factors*
Scope 1	Combustion	Logging Equipment	1,198	Fuel usage and 40 CFR Part 98 Subpart C Emission Factors.
Scope 1	Combustion	Passenger Vehicles	71	Fuel usage and 40 CFR Part 98 Subpart C Emission Factors.
Scope 1	Land Use Change	Conversion	4,413	Represents one year of annualized emissions over 20 years from IPCC Guidelines for National Greenhouse Gas Inventories (2019)
TOTAL			9,241	

Table 18.2: Operational Emissions

Scope	Type of Emission	Emission Sub-type	Existing facility CO_2e Emissions (tons/year)	Project-related CO_2e Emissions (tons/year)	Total CO_2e Emissions (tons/year)	Calculation method(s)
Scope 1	Combustion	Mobile Equipment		71		Fuel usage and 40 CFR Part 98 Subpart C Emission Factors.
Scope 1	Combustion	Non-Road Diesel Equipment		9,790		AQMD *Off-road Mobile Source Emission Factors*
Scope 2	Off-Site Electricity	Grid-based		45,931		eGRID EFs from MROW area.
Scope 1	Ongoing Land Use	Conversion		4,413		Represents one year of annualized emissions over 20 years from IPCC Guidelines for National Greenhouse Gas Inventories (2019))
Scope 1	Annualized Construction Emissions	Combustion Emissions		178		Annualized emissions over 20 years.
TOTAL				60,383		

b. GHG Assessment

i. Describe any mitigation considered to reduce the project's GHG emissions.

The project design reduced unnecessary vegetation clearing. Vehicles would be maintained for efficiency and equipment would be running only as needed. No other mitigation measures related to GHG emissions is proposed. U. S. Steel.

ii. Describe and quantify reductions from selected mitigation, if proposed to reduce theproject's GHG emissions. Explain why the selected mitigation was preferred.

No additional mitigation measures are proposed.

iii. Quantify the proposed projects predicted net lifetime GHG emissions (total tons/#of years) and how those predicted emissions may affect achievement of the Minnesota Next Generation Energy Act (MNGEA) goals and/or other more stringent state or local GHG reduction goals.

MNGEA requires a statewide 80 percent reduction of greenhouse gas emissions by 2050. The closest interim goal is a 30 percent reduction by 2025. The 2023 biennial greenhouse gas emissions report inventoried state emissions from 2005 to 2020. This report found that GHG emissions declined 23 percent from 2005-2020, and the state is on track to reduce GHG emissions by 2050.

A total of 4,828 tons of GHG emissions from construction equipment would be produced. Additionally, 4,413 tons of GHG would be produced from the land use conversion in the first year. The overall anticipated GHG emissions from construction would be 9,241 tons.

Following construction, the Project is expected to generate 60,383 tons/ year of GHG from operational activities. The 2020 estimate of CO2e for the state of Minnesota was 137,238,222 tons (MPCA 2023). The 9,241 tons generated by construction and land conversion are 0.01 percent of CO2e emissions that were emitted in Minnesota in 2020. The 60,883 tons/year generated by operations are 0.045 percent of Minnesota's total state emissions in 2020. While the Project does introduce some additional sources of GHG, these would be partially offset by the reduction in activity at the Stage 2 Interior.

19. Noise

Describe sources, characteristics, duration, quantities, and intensity of noise generated during project construction and operation. Discuss the effect of noise in the vicinity of the project including

1) existing noise levels/sources in the area, 2) nearby sensitive receptors, 3) conformance to state noise standards, and 4) quality of life. Identify measures that will be taken to minimize or mitigatethe effects of noise.

Existing Conditions

Mining activities have been occurring at the project location for over 50 years. Long time residents maybe accustomed to the sounds caused by normal mining activities within the general area.

Existing Noise Sensitive Areas (NSAs) are located mainly to the east of the Project Area along Highway 73 and North Leighton Road. The NSAs comprise single family residences. The nearest NSA to the Project Area is a single residence located on Karkas Road, approximately 0.18 miles east of the Project Area. An additional NSA is located on Townline Road, approximately 0.25 miles east/northeast of the Project Area. The majority of NSAs are located farther away from the Project Area along Highway 73 and North Leighton Road. Table 19.1 provides a summary of the existing NSAs and the approximate distance to and direction from the Project Area.

Table 19.1: Existing NSAs

NSA	Distance (miles/feet)—Direction from Closest Portion of the Project Area	Distance(miles/feet)—Direction from Farthest Portion of the Project Area
Karkas Road	0.18/950–East	4.17/22,000–Southwest
Townline Road	0.25/1,320–East/Northeast	4.36/23,000–Southwest
Highway 73	0.72/3,800–Southeast	3.79 20,000–Northwest
North Leighton Road	0.76/4,000–East	4.55/24,000–West/Southwest

U. S. Steel would comply with the noise requirements outlined in its air emissions permit. The State of Minnesota recognizes the MPCA as the authority to regulate noise disturbance through the implementation of local noise ordinances (MPCA 2015). The current Minnesota noise standards are in Minnesota Administrative Rules, Part

7030.0040, Subpart 2. Maximum allowable sound levels for various land use categories are provided in Table 19.2.

Table 19.2: Minnesota Noise Standards

Noise Area Classification	Daytime		Nighttime	
	L10 (dBA)	L50 (dBA)	L10 (dBA)	L50 (dBA)
1 (Residential)	65	60	55	50
2 (Retail, commercial, recreational)	70	65	70	65
3 (Industrial and agricultural)	80	75	80	75

Source: Minnesota Rules 7030.0040, Subpart 2 (2003)

The state standard evaluates noise via L_{10} and L_{50} sound levels. These parameters represent the sound levels that are exceeded 10 percent and 50 percent of the time, respectively. The L_{50} is often considered comparable to the L_{eq} (equivalent sound level), which is a more widely recognized parameter. Additionally, construction noise is typically measured with the L_{eq} parameter.

Construction Impacts and Mitigation

Table 19.3 provides anticipated noise levels that would be associated with the Project's construction activities.

Table 19.3: Noise Levels of Typical Mine Equipment

Equipment	Maximum Noise Level at 50 feet (dBA)
Chainsaw	85
Skidder (Grapple)	85
Excavator	85
Backhoe	78
Dozer	82
Trucks	77

Source: FHWA 2006

Notably, construction of the dams and dikes would occur over a large area, and construction-related noise levels impacting any NSA would be a function of distance. As such, no existing residence would be exposed to the same sound levels over an extended period, as construction would occur progressively in stages around the TSF. Table 19.4 details construction equipment sound levels operating at maximum throttle at the reference distance of 50 feet, as well as the calculated sound levels at various distances from the nearest Project boundary to the identified NSA areas. The calculated sound levels were determined by utilizing the procedures found in the International Organization for Standardization standard ISO-9613-2. This standard provides the method to extrapolate sound levels from a known reference distance (in this case 50 feet) to a more distant location by considering the additional distance to the receiver (i.e., the 6 dBA reduction with every doubling of distance) plus the additional reduction due to the absorption of sound by the atmosphere, which over large distances is significant.

Exhaust noise from diesel engines that power the equipment is usually the predominant source of construction equipment noise. The Project would ensure that functional mufflers are installed on all diesel-powered equipment. Table 19.5 presents the calculated sound levels for all notable noise generating equipment, when equipment is operating at the farthest Project Area boundary line from the same NSAs.

Table 19.4: Construction Noise Levels at NSAS Closest to the Project Area (dBA)

Equipment	Construction Noise Levels (dBA)				
	50 feet	Karkas Road 950 feet	Townline Road 1,320 feet	Highway 73 3,800 feet	North Leighton Road 4,000 feet
Chainsaw	85	59	55	44	44
Skidder (Grapple)	85	59	55	44	44
Excavator	85	59	55	44	44
Backhoe	78	52	48	37	37
Dozer	82	56	52	41	41
Trucks	77	51	47	36	36

Table 19.5: Construction Noise Levels at NSAS Farthest from the Project Area (dBA)

Equipment	Construction Noise Levels (dBA)				
	50 feet	Karkas Road 22,000 feet	Townline Road 23,000 feet	Highway 73 20,000 feet	North Leighton Road 24,000 feet
Chainsaw	85	17	16	19	15
Skidder (Grapple)	85	17	16	19	15
Excavator	85	17	16	19	15
Backhoe	78	10	9	12	8
Dozer	82	14	13	16	12
Trucks	77	9	8	11	7

Construction sound levels at the closest NSA would be expected to be below the Minnesota Noise Standard during daytime hours, even when equipment is in operation in portions of the Project Area that are situated closest to the NSA. The noise limits may be exceeded during nighttime hours at the 2 nearest NSAs when multiple machines are operating, and when that equipment is operated in portions of the Project Area that are situated closest to the NSA. Construction noise levels at the remaining NSAs, and especially the NSA areas along Highway 73 and North Leighton Road, would be below the noise standard during both daytime and nighttime hours.

Operations Impacts and Mitigation

Noise levels following completion of Project construction are anticipated to be less than noise levels during the active construction phase, however, there would be ongoing use of haul trucks and mobile equipment twenty-four hours a day, seven days a week, (24/7) to support the staged construction of the dikes and dams. The current operations intermittently extend 24/7, so this could be seen as a change in noise to NSAs. No additional operational noise impacts are anticipated from Project operations, no mitigation is proposed.

The separation and/or dewatering infrastructure would be located on the western side of the Project Area. Noise generated by pumps and equipment associated with the infrastructure would be inside and the distance from receptors would minimize impacts.

20. Transportation

a. Describe traffic-related aspects of project construction and operation. Include: 1) existing and proposed additional parking spaces, 2) estimated total average daily traffic generated, 3) estimated maximum peak hour traffic generated and time of occurrence, 4) indicate source of

trip generation rates used in the estimates, and 5) availability of transit and/or other alternativetransportation modes.

Roads

The Project Area would be accessed via existing roadways to Keetac (public and private roads), and specifically around the Stage 2 Exterior dikes and dams via the permanent access road that would be constructed as part of the Project. There is an existing private road adjacent to where the separation and/or dewatering infrastructure would be built which would be used for construction access to that site.

Construction activities associated with the Project may result in short-term impacts to transportation infrastructure and traffic. The traffic volume along roads close to the TSF entrances could briefly increase due to the movement of construction equipment and materials. Temporary road closures during construction are not anticipated and any impacts on local traffic during construction would be temporary and minor.

Railroads

No increased use of railroads is anticipated for the construction or continued operation of the Project; therefore, no impacts are anticipated.

Airports

No increased use of the airport is anticipated for the construction or continued operation of the Project; therefore, no impacts are anticipated.

b. Discuss the effect on traffic congestion on affected roads and describe any traffic improvementsnecessary. The analysis must discuss the project's impact on the regional transportation system.*If the peak hour traffic generated exceeds 250 vehicles or the total daily trips exceeds 2,500, a traffic impact study must be prepared as part of the EAW.* Use the format and procedures described in the Minnesota Department of Transportation's Access Management Manual, Chapter 5 *(available at: http://www.dot.state.mn.us/accessmanagement/resources.html)* or a similar local guidance,

The Project does not anticipate measurable effect on traffic congestion on roads accessing Keetac mine or TSF, therefore no traffic improvements are necessary.

c. Identify measures that will be taken to minimize or mitigate project-related transportation effects.

Roads

Road functions would be restored after construction including, but not specifically limited to, repair of any unlikely but possible damage to the road surface caused by construction, and removal and restoration of access points installed to facilitate ingress/egress to the construction workspace. Construction impacts to roads and public road users are not anticipated to be substantial.

No long-term impacts are expected on roads used to access the Project Area. U. S. Steel would also mitigate and restore any temporary road impacts that may result from the Project maintenance or other ongoing operational activities that occur through regular operation of the TSF.

Railroads

No increased use of railroads is anticipated for the construction or continued operation of the TSF; therefore, no impacts are expected, and mitigation isn't warranted.

Airports

No increased use of the airport is anticipated for the construction or continued operation of the TSF; therefore, no impacts are expected, and mitigation isn't warranted.

21. Cumulative potential effects: (Preparers can leave this item blank if cumulative potential effects are addressed under the applicable EAW Items)

a. Describe the geographic scales and timeframes of the project-related environmental effects thatcould combine with other environmental effects resulting in cumulative potential effects.

The overall geographic scale for assessing cumulative potential effects of the Project includes the Mississippi River - Grand Rapids / Hay Creek watershed, which encompasses the tailing separation and/or dewatering infrastructure and 88 percent of the Stage 2 Exterior dikes and dams; and the Lake Superior - St. Louis / Upper West Swan River HUC 12 watershed, which contains the rest of the TSF, dikes and dams on the east edge of the Project Area.

Potential effects include a temporary timeframe effect during construction from 2025-2028, staged cessation of tailings deposition into Stage 2 Interior Basin part of the tailings basin with subsequent reclamation activities, and an operation impact timeframe while tailing processing and deposition continue over the approved mine lifespan (2048), potentially spanning to 2063, as described in Section 6a.

Environmental effects from the proposed project are listed below and discussed in detail within the relevant topic areas of the EAW, avoidance, minimization, and mitigation measures are also discussed within each topic.

b. Describe any reasonably foreseeable future projects (for which a basis of expectation has been laid) that may interact with environmental effects of the proposed project within the geographicscales and timeframes identified above.

Staff from local government units including the cities of Hibbing, Nashwauk, Itasca County, the North St. Louis Watershed District, and the Itasca Soil and Water Conservation District were contacted to inquire about current planned projects within the same geographic area and timeframe as the proposed project. No reasonably foreseeable future projects for which a basis of expectation has been laid were identified at the time of publication.

c. Discuss the nature of the cumulative potential effects and summarize any other available information relevant to determining whether there is potential for significant environmental effects due to these cumulative effects.

There are no reasonably foreseeable future projects for which an expectation has been laid that could combine with the environmental effects from the proposed project within the same geographic scales and timeframe of the proposed project to create potential effects greater than those from the proposed project.

Land Use and Human Settlement

The primary long-term impacts of the Project stem from the permanent land type modification of 608.6 acres, resulting in habitat loss. Temporary impacts would occur on an additional 89.8 acres for staging and site access during construction. These impacts, represent an incremental augmentation of the existing disturbed area rather than introduction of new impacts to an undisturbed landscape. Mitigation measures, such as progressive reclamation of temporary impact areas, compliance with construction permit requirements, and the use of timber matting or other stabilization methods to minimize impacts on wetlands, would help to reduce the Project's overall environmental footprint.

The TSF would extend slightly beyond the mining area by approximately 700 feet to the east and 500 feet to the west. This represents a relatively small incremental augmentation in the context of the existing mine operations,

with over 95 percent of the surrounding landcover remaining unaffected. The Project is not expected to impact nearby residential, commercial, or recreational areas, as it is located within an industrial mining site.

The project would contribute incremental losses of forests and wetlands at a localized scale. The Project would not introduce substantially new stressors or impact types, and the conversion of additional landcover represents a continuation of established land use impacts considering the existing level of disturbance associated with the long-term, ongoing mining operations, , which is partially offset by initiation of reclamation activities in the Stage 2 Interior Basin part of the tailings facility. Given the industrial nature of the existing land use, the limited extent of new permanent and temporary impacts, and the proposed mitigation measures, the Project is not anticipated to substantially alter land use patterns or human settlement in the region.

Visual

Visual analysis indicates that while the 70-to-110-foot increase in TSF height from this Project may make it visible from some new vantage points in southeast Keewatin, this represents an incremental change rather than introduction of a new visual impact. The surrounding area has an established mining/industrial landscape with existing tailings piles and waste rock piles visible. The proposed increase falls within the maximum height evaluated in prior studies which previously found no significant impacts. Given the context of it expanding an existing visual condition in this mining district, Other than reclamation and re-vegetation plans upon closure would further minimize long-term aesthetic impacts.

Air Quality

Air quality impacts would be temporary and localized during the construction phase from sources like fugitive dust, vehicle emissions, and construction equipment. Impacts on receptors within .25 miles are expected to be minimal and typical of an industrial construction site with proper dust suppression and engine maintenance practices. During operations, the expanded TSF footprint may generate some incremental fugitive dust compared to existing conditions as activities in the Stage Interior Basin are phased out, this represents an incremental change consistent with the area's longstanding mining and tailings management activities. Minimal degradation of air quality and no exceedances of NAAQS are anticipated from the Project's emissions sources. Mitigation through the implementation of BMPs such as those outlined in U. S. Steel's Fugitive Dust Plan, should minimize the air quality impacts given the Project's context within an established mining/industrial area.

Noise

Impact of noise levels associated with construction activities is expected to be temporary and offset by existing noise levels generated from ongoing operations, including the phase-out of the Stage 2 Interior Basin. Operations stemming from the Project are not expected to increase existing noise levels to any substantial degree.

Transportation

Transportation impacts would be limited to a temporary increase in road traffic volumes around the Project Area during the construction phase from worker commutes and equipment/material deliveries. These impacts are expected to be minor and short-lived, with no road closures anticipated. No impacts to rail or air transportation are expected, as the Project will not require increased use of these modes during construction or operations. The Project’s transportation effects represent a localized short-term impact consistent with typical construction activities. With mitigation practices like road maintenance and traffic management, impacts to the local or regional transportation network are anticipated to be minimal from this Project, which is accessed via existing private roads serving the established mining activities in the area.

Contamination and Hazardous Waste

The Project's construction phase would generate some solid wastes like scrap metal, demolition debris, and oil/antifreeze from equipment maintenance, etc., that would be stored properly in containers and transported to

appropriate disposal or recycling facilities off-site per regulations. Any hazardous wastes like solvents or lead acid batteries would also be packaged for proper off-site disposal. During operations, the potential for contamination exists from fuel/oil use and storage on-site; these substances would be managed in accordance with the site's SPCC plan to prevent releases and mitigate any incidental spills. Given the Project's relatively small scale, adherence to hazardous materials handling protocols, and the absence of any major contaminated sites in the area, impacts related to contamination or hazardous waste releases are not anticipated. The risks are typical of a construction/industrial operation and would be managed through BMPs that include secondary containment, worker training, and emergency response procedures as outlined in the SPCC plan.

Geology

While the vertical augmentation of the TSF by up to 110 feet would represent a permanent topographic modification over the existing condition, this impact occurs within the context of an area that has experienced extensive topographic disturbance from decades of large-scale mining activity. The underlying geology and soils have been previously impacted, with no state or federally protected geological features present in the Project Area. The primary permanent impact is modification of the existing man-made topography created by previous tailings deposition in the TSF. Some temporary grading impacts may occur during construction for access roads and staging areas; these are minor alterations to an already disturbed industrial landscape. Given the absence of sensitive geological resources and the Project's context as an incremental augmentation of existing large-scale industrial disturbance, impacts to geological resources are anticipated to be minimal. Standard mitigation practices for dam construction, safety monitoring, and stormwater management are proposed that would ensure topographic changes are properly controlled.

Soils

Within the expanded TSF area, soils would be permanently impacted as they are inundated and covered by the deposition of tailings over the life of the Project. However, this represents an incremental augmentation of existing impacts, as soils in the current TSF area have already experienced similar disturbance. During construction, temporary soil impacts like compaction from heavy equipment, erosion from vegetation clearing, and potential contamination from leaks/spills are possible in staging and work areas. These temporary impacts would be mitigated through BMPs outlined in the SWPPP, SPCC, and other permit requirements. This includes practices like silt fencing, stabilization with matting, dust control, vegetation reseeding, and proper material storage/handling. Given the currently disturbed nature of the site and with proposed mitigation measures, impacts to soil resources are anticipated to be minimal beyond the permanent conversion within the expanded tailings footprint itself. Operational soil impacts outside the TSF are expected to be minor and infrequent, related to maintenance activities.

Groundwater

The Project would increase the overall potential for seepage of process water into the groundwater system. This impact is expected to be minimal due to the offsetting effect of using a finer tailings mixture that would act as a less porous barrier compared to the coarser tailings currently in place. While some continued seepage into groundwater is anticipated as an ongoing condition, the use of less porous tailings is projected to result in negligible increases in seepage rates or total volumes despite the larger basin size and higher water content of the tailings. The installation of new monitoring wells would allow for an evaluation of any unforeseen changes to seepage conditions and groundwater quality that may arise during operations versus the current established baseline. With proper management practices already in place, minor impacts to groundwater resources are expected from the incremental augmentation of tailings disposal activities. The draft NPDES/SDS permit on public notice addresses seepage to groundwater by requiring a "Functional Equivalent Evaluation". The purpose of this evaluation is to better understand the potential effects of seepage from the tailings basin. Additional water quality monitoring is required in nearby surface waters as well as in the tailings basin for the evaluation

Floodplains

There are no mapped floodplains within or in the vicinity of the Project Area. If unmapped floodplains are present in the Project Area, they could be impacted by soil compaction; however, given that the site is currently disturbed because of ongoing operations, effects are expected to be minimal to floodplains because of the Project.

Watersheds

Construction of the expanded TSF and associated infrastructure would permanently convert approximately 554 acres of forested and wetland areas to barren land/impervious surfaces across the two watersheds. This loss of vegetative cover, hydrologic storage capacity from wetlands, and increased impervious areas could incrementally impact factors like hydrology, habitat, and water quality at the watershed scale. The projected changes constitute less than two percent of the total land cover in the Mississippi River watershed and less than seven percent in the Lake Superior watershed. When viewed in the context of the watersheds' overall extents, these localized impacts are expected to result in negligible changes to the aggregated metrics that determine overall watershed health scores. The Project's impacts, though notable at the immediate site level, represent an incremental augmentation of existing large-scale industrial disturbance rather than introduction of new stressors to an undisturbed landscape. With proper mitigation practices like stormwater management and wetland restoration/offsets, watershed impacts are anticipated to be minimal from this Project.

Wetlands

The construction of the proposed Project would lead to both permanent and temporary impacts on WCA-regulated wetlands. Direct permanent WCA-regulated impacts, totaling 97.47 acres, would result from dam and dike work, as well as the construction of a permanent access road and separation and/or dewatering infrastructure. Indirect permanent wetland impacts would total 0.19 acre. Temporary impacts, affecting 9.75 acres directly and 0.39 acre indirectly, would be caused by equipment staging and temporary site access. Where tree clearing within wetlands is necessary, forested wetlands would be permanently converted to scrub shrub or emergent wetlands, leading to a reduction or elimination of some ecological functions, such as peak flood flow reduction, nutrient and sediment capture, and habitat diversity. To mitigate these impacts, the Project has been designed to avoid wetlands where possible, and BMPs would be employed to minimize disturbance. Additionally, U. S. Steel would use available surplus mitigation credits at a 1-to-1 ratio from the Palisade Wetland Mitigation Site to compensate for the loss of regulated wetlands. During the operational phase, the TSF would be managed under its existing SWPPP, and no additional impacts on wetlands are anticipated. Considering the proposed mitigation measures, including wetland avoidance, minimization of impacts, and the use of surplus wetland credits, the impacts of the Project on wetlands are not expected to be substantial.

Waterbodies

The construction of the proposed water retention dam would result in direct, permanent impacts to Reservoir No. 6, including the loss of 38.7 acres of surface area and 5,242 linear feet of shoreline. The loss of a substantial portion of this reservoir is notable. Several other waterbodies in the Project Area, such as Reservoir 2 North, Reservoir No. 2, Hay Lake, Hay Creek, and Swan River, could potentially experience temporary, indirect impacts on water quality, such as increased turbidity and localized sedimentation, during construction activities. These impacts would be mitigated through the implementation of erosion control measures, BMPs, and minimization of the duration of disturbance. Additionally, adhering to the requirements of the modified NPDES/SDS permits (which regulate water treatment and disposal systems and require monitoring of various water quality parameters, including sulfate), would mitigate impacts. During the operational phase, the Project is not expected to substantially alter the overall water balance or water quality at the TSF compared to pre-existing conditions especially considering the proposed mitigation measures and the regulatory requirements for

water quality monitoring, the impacts of the Project on waterbodies is not expected to be substantially different than existing conditions.

Vegetation

The construction of the proposed Project would involve the clearing of vegetation within both temporary and permanent impact areas, resulting in a loss of forested, herbaceous, and wetland habitats. However, the Project is not anticipated to impact any federal or state-listed plant species. Upon completion of construction, temporary impact areas would be restored to pre-construction contours, and erosion control measures would be implemented. These areas would be seeded with native seed mixes or allowed to naturally revegetate. Additionally, the Project would adhere to the conditions of the Dam Safety Permit, ensuring that all equipment is free of prohibited invasive species and aquatic plants before being transported into the Project Area. During the operational phase, potential impacts to vegetation would be limited to localized dust accumulation and routine maintenance of rights-of-way and work areas. Furthermore, Minnesota Rules Chapter 6130 requires the reclamation of mined lands, which includes the re-establishment of vegetation in disturbed areas. Considering the proposed mitigation measures and the regulatory requirements for reclamation, the impacts of the Project on vegetation are not expected to be substantial.

Wildlife

The construction and operation of the proposed Project are expected to result in minimal impacts on most of the wildlife species analyzed, including the Canada lynx, gray wolf, monarch butterfly, northern long-eared bat, and tricolored bat. The Canada lynx and gray wolf are unlikely to be substantially affected due to their mobility and the availability of adjacent habitats, while the monarch butterfly is expected to find suitable habitats nearby. The implementation of tree clearing restrictions during the roosting season would help minimize impacts on the northern long-eared bat and tricolored bat. However, migratory birds may face impacts, particularly due to the permanent loss of some forested nesting habitat, which could have long-term effects on their local populations. Although preconstruction surveys and nest buffers would be implemented to reduce these impacts, the loss of nesting habitat remains a concern. To further mitigate the potential impacts on migratory birds, U. S. Steel would prioritize the implementation of the proposed mitigation measures and consider additional measures, such as habitat restoration or compensation, to ensure the long-term conservation of these species within the Project Area and its surroundings. Additionally, all vegetation clearing (including tree clearing) would occur in the winter.

Aquatic Species

The construction of the proposed dam would directly impact Reservoir No. 6, both temporarily and permanently, potentially affecting fish populations and aquatic habitats. The loss of habitat and spawning areas along the eastern side of the reservoir, as well as increased turbidity due to sediment disturbance, could adversely impact aquatic species. However, these impacts would be mitigated by replanting aquatic plants and creating suitable environments for the re-establishment of native species on the western side of the reservoir. Additionally, a silt curtain would be installed to protect the western portion of the reservoir, and the eastern portion, where permanent impacts would occur, would be stacked with rock to minimize potential impacts on aquatic habitats and water quality. The Hay Creek watershed would also be directly impacted, with the loss of habitat at the headwaters of the creek, but the impacted area would be relatively small compared to the total watershed. Construction vehicles could potentially introduce terrestrial invasive species to the banks of affected waterbodies; this risk would be mitigated by inspecting vehicles, clothing, and equipment before any interaction with the water and sourcing construction materials locally. During the operational phase, no substantial impacts on aquatic species are anticipated, as there are no proposed water appropriations or new discharges, and the overall water balance and water quality at the TSF are not expected to change from pre-existing conditions. Considering the proposed mitigation measures and the limited scope of impacts relative to the overall watershed, the impacts of the Project on aquatic species are not expected to be substantial.

Cultural Resources

The construction of the proposed Project could potentially impact one known cultural resource site, which is located within the Project's Direct APE. The site, which has an undetermined eligibility for listing on the NRHP, is situated in a temporary impact area where staging activities could occur. To mitigate potential impacts, the Project plans to avoid the site by implementing a 200-foot avoidance buffer. If avoidance is not possible, U. S. Steel would be required to consult with the parties listed in the Programmatic Agreement, and additional investigations may be necessary to determine the site's eligibility for NRHP listing. If the site is found to be eligible and adversely affected, a Phase III data recovery investigation would be conducted to resolve the adverse effects. Additionally, archaeological monitoring during construction in areas near the cultural site and the implementation of a terrestrial post-review discoveries plan would help reduce potential impacts on any previously undiscovered archaeological resources encountered during construction. While it is possible that an undiscovered archaeological site could be impacted during construction, state and federal requirements for identifying, assessing, and mitigating impacts on cultural resources would limit the extent, scale, and magnitude of any such impacts. Considering the proposed mitigation measures and regulatory requirements, the impacts of the Project on cultural resources are not expected to be substantial

22. Other potential environmental effects:

If the Project may cause any additional environmental effects not addressed by Items 1 to 19, describe the effects here, discuss the how the environmentwill be affected, and identify measures that will be taken to minimize and mitigate these effects.

The Project is not anticipated to cause any additional environmental effects beyond those discussed in items 1 to 19.

RGU CERTIFICATION. *(The Environmental Quality Board will only accept **SIGNED** Environmental Assessment Worksheets for public notice in the EQB Monitor.)*

I hereby certify that:

- The information contained in this document is accurate and complete to the best of myknowledge.
- The EAW describes the complete Project; there are no other projects, stages or components other than those described in this document, which are related to the Project as connected actions or phased actions, as defined at Minnesota Rules, parts 4410.0200, subparts 9c and 60,respectively.
- Copies of this EAW are being sent to the entire EQB distribution list.

Signature s/s Becky Horton Date August 25, 2025

Title Project Manger

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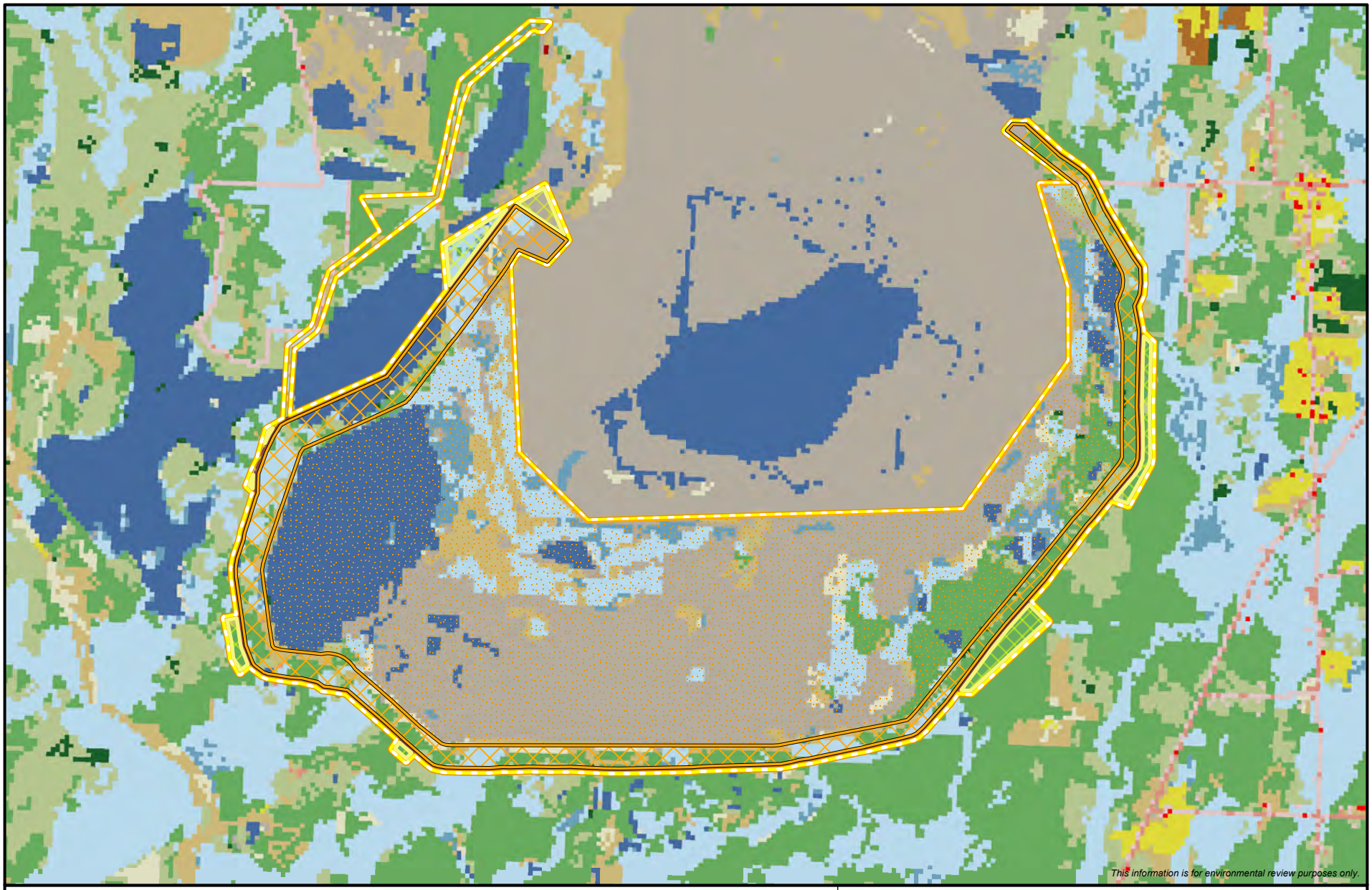
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NLCD Landcover
Keetac TSF Project
United States Steel
Keewatin, MN

ERM

MPLS M:\US\Projects\S-U\US_Steel\Keetac\ArcGIS\2024\Keetac_EA_EAW\Keetac_EA_EAW.aprx\F312_NLCD | REVISED: 08/16/2024 | SCALE: 1:36,000 DRAWN BY: RMR

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 31

U.S. Steel Corp., Minnesota Ore Operations, Keetac Tailings Basin
NPDES/SDS Permit Application, December 2009.

UNITED STATES STEEL CORPORATION
MINNESOTA ORE OPERATIONS-KEETAC TAILINGS BASIN
NPDES/SDS PERMIT APPLICATION
PERMIT #MN0055948

Prepared for:

UNITED STATES STEEL CORPORATION

December 2009

Prepared by:

Liesch Companies

Minneapolis • Chicago • Los Angeles • Madison • Milwaukee • Phoenix

UNITED STATES STEEL CORPORATION
MINNESOTA ORE OPERATIONS
KEETAC

TAILINGS BASIN
NPDES/SDS PERMIT APPLICATION
PERMIT #MN0055948

December 2009

Prepared by:
Liesch Associates, Inc.
for
United States Steel Corporation

This application was prepared by me or under my direct supervision:

Michael Johnson, P.E.
Project Manager
Chemical Engineer

Mat Knutson
Environmental Engineer

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Chemtreat P-817E
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1.0 INTRODUCTION

Liesch Associates, Inc. (Liesch) was retained by United States Steel Corporation (U. S. Steel) to assist Minnesota Ore Operations - Keetac (Keetac) in preparation of this application to modify their existing National Pollution Discharge Elimination System/State Disposal System Permit (NPDES/SDS Permit #MN0055948). This NPDES/SDS Permit was issued on March 10, 2006 by the Minnesota Pollution Control Agency (MPCA) and is associated with discharges from Keetac's Tailings Basin operations. Keetac is located just north of the town of Keewatin, Minnesota (see Figure 1 in Appendix A for a site overview). The application to modify this permit is being submitted to request construction associated with, and discharge authorization from the tailings basin system following, a proposed expansion at Keetac that will increase pellet production from 6.0 million tons per year (MTY) to 9.6 MTY. The expansion is planned for 2012. An Environmental Impact Statement (EIS) for the proposed expansion is currently being developed.

There are two significant changes the expansion will have on discharge waters and water quality from the tailings basin system. The first is an increase in tailings slurry flow associated with the increased taconite pellet production. This increased tailings slurry flow will result in increased treated surface water discharge volumes from the tailings basin system. The second significant change is the proposed installation of additional sulfate treatment on the existing scrubber blow-down treatment system. The additional sulfate treatment will reduce the sulfate loadings into the tailings basin system and consequently will reduce the tailings basin sulfate concentration. More detailed information regarding the proposed additional sulfate treatment system and non-degradation review can be found in Section 6.0. The proposed expansion includes dry-scrubber technology on the exhaust from the expanded operations and will therefore not contribute additional sulfate to discharge waters.

Information provided for this NPDES/SDS permit application is associated primarily with the proposed Keetac expansion project with a focus on constituents of concern identified by MPCA. However, modeling of facility discharge rates, sulfate concentrations, and mercury concentrations were conducted for studies required during the EIS process for the next 25 years (2012 through 2036). Information on anticipated flow rates, sulfate concentrations/loadings, and mercury concentrations/loadings throughout the 25 year timeframe were included within this permit application where relevant.

Keetac maintains a separate NPDES/SDS Permit (#MN0031879) for discharges associated with mining and processing activities. An application for permit modification to this permit has also been submitted to the MPCA to address the changes associated with the proposed facility expansion on those discharges.

U. S. Steel conducted various projects in support of the environmental review and permitting process in preparation for the proposed expansion. Many of the projects/studies have been conducted to support the EIS being developed cooperatively by the Minnesota Department of Natural Resources (MNDNR) and the United States Army Corps of Engineers (USACE) with the Bois Forte Band of Chippewa acting as a cooperating agency. Through the EIS process, a significant amount of work was been conducted to better understand and predict the potential impacts of the proposed plant expansion on surface water discharges and receiving water bodies. Results from this work that are directly related to the NPDES/SDS permit application process are included/referenced within this application. However, there is a significant amount of data available for review from the EIS process that can provide more detail (if required) regarding specific aspects of the proposed expansion to evaluate this permit application. This information can be made available by a request for public documents from the MNDNR. Documents that provide additional information regarding water use, facility discharges, downstream receiving waters, sampling results, and predicted downstream impacts include:

- *Water Balance/Mine Yield Study – Keetac Expansion Project (Liesch, February 2009)*
- *Keetac Expansion Project Predicted Water Quantity and Quality Cumulative Impacts Evaluation (Liesch, April 2009)*
- *No Action Alternative Analysis for the Keetac Expansion EIS Memorandum (Liesch, August 2009)*
- *2009 Water Quality, Hydrology, and Wild Rice Monitoring - Swan Lake, Hay Lake, Moose Lake, Hay Creek, and Hart Creek (Barr, September 2009)*

This application is being submitted for modifications that will occur due to the Keetac Expansion Project.

This application is organized as follows:

Section 1: Summarizes significant modifications / requested changes.

Section 2: Provides a regulatory review of applicable MN Rules.

Section 3: Provides a description of the process being permitted, details regarding activities impacting the discharges, discharge locations, and other pertinent information required by the NPDES/SDS Permit Application.

Section 4: Provides information regarding water quality standards review.

Section 5: Provides information regarding non-degradation review.

Section 6: Provides information regarding discharges to impaired waters.

Section 7: Includes the required MPCA NPDES/SDS Permit Application forms.

Appendices: Provide figures, tables, and other supporting information.

1.1 SUMMARY OF SIGNIFICANT MODIFICATIONS / REQUESTED CHANGES

U. S. Steel is requesting to modify their current NPDES/SDS Permit authorization to discharge process wastewater and associated stormwater from the tailings basin facility following the proposed expansion of the Keetac facility. Changes in discharge flow rates and water quality characteristics are expected due to the expansion of the plant. However, the existing limits in the NPDES/SDS permit for the tailings basin for both water quantity and quality do not require modification based on predicted discharge rates and water quality characteristics throughout the 25-year timeframe of the project. U. S. Steel is proposing the following significant changes to current operations that may impact discharges from the tailings basin due to the proposed Keetac expansion project:

- A second taconite processing line will be started and expand plant production capabilities from 6 million tons per year to 9.6 million tons per year.
- The existing sulfate wastewater treatment system will be upgraded to remove 50% of the sulfate load in the effluent from the existing system. This installation

will occur concurrent with the Keetac expansion project and will address nondegradation concerns.

- Dry scrubbers are planned to be installed on the expanded line and will not increase sulfate discharge loadings.
- The expansion will increase water discharge rates, although the predicted rates are expected to stay within existing permit limits. Increased mining depth and extent will require higher dewatering rates in the future which will result in higher discharge rates from the tailings basin system.
- Chemical usage associated with taconite processing will increase due to the increased production.
- A third tailings discharge line will be added to facilitate greater tailings slurry discharge rates associated with the increased production.
- Increased return water volumes will be pumped back to the plant as needed for the increased production rates.
- A new discharge point into Reservoir 2 will be created to provide the option of routing mine dewatering discharges from the Sargent Pit to Reservoir 2. This outfall will include a new monitoring location for this permit. This will provide flexibility in the Sargent Pit dewatering discharge location based on operational needs. Sargent Pit would have the potential to discharge to Mesabi Chief Pit, Russell Pit, or Reservoir 2 (with the Mesabi Chief Pit and Russell Pit discharges being covered under NPDES/SDS Permit MN0031879).

2.0 REGULATORY REVIEW

The following subsections provide a detailed review of applicable Minnesota Administrative Rules in regards to this NPDES/SDS permit application. Specific citation of the applicable rule is provided along with a brief discussion regarding the applicability or further information regarding each requirement. The applicable Minnesota Rules included within this section are:

- MN Rules Chapter 7001.0050 (Permits and Certifications – Written Applications)
- MN Rules Chapter 7001.1050 (Permits and Certifications – NPDES/SDS Permits)
- MN Rules Chapter 7050.0185 (Waters of the State – Nondegradation for All Waters)
- MN Rules Chapter 7050.0180 (Waters of the State – Nondegradation for Outstanding Resource Value Waters)

Please note that a water quality standards review is provided in Section 3.0 of this application (MN Rules 7050.0220-.7050.0227) and an impaired waters review is provided in Section 4.0 of this application (40 CFR, Chapter 122).

2.1 MN RULES 7001.0050 – WRITTEN APPLICATION

A person who requests the issuance, modification, revocation and reissuance, or reissuance of a permit shall complete, sign, and submit to the commissioner a written application. The person shall submit the written application in a form prescribed by the commissioner. The application shall contain the items listed in items A to I unless the commissioner has issued a written exemption from one or more of the data requirements. After receiving a written request for an exemption from a data requirement, the commissioner shall issue the exemption if the commissioner finds that the data is unnecessary to determine whether the permit should be issued or denied. The application must contain:

A. the name, address, and telephone number of the owner of the facility for which the application is submitted and identification of the status of the owner as a federal, state, public, private, or other entity;

B. if the operator of the facility for which the application is submitted is different from the owner, the name, address, and telephone number of the operator and identification of the status of the operator as a federal, state, public, private, or other entity;

C. the name, address, and telephone number of the person who prepared the application;

This information is included in the MPCA "Water Quality Transmittal Form" included in Section 7.0.

D. a description including the location of the business, plant, system, facility, or activity for which a permit is sought;

This information can be found in the MPCA forms included in Section 7.0 as well as within the facility description in Section 3.0.

E. a general description of the materials handled, processed, stored, or disposed of by the applicant that are pertinent to the application; and a statement of the nature and quantity of the materials proposed to be stored, processed, discharged, emitted, or disposed of during the period of the required permit, and proposed methods for control of these materials;

This information can be found on the MPCA forms included in Section 7.0 as well as within the facility description in Section 3.0. In addition, material safety data sheets for products discussed in the facility description are included within Appendix C.

F. a topographic map, or other map if a topographic map is unavailable, that shows the facility and the area surrounding the facility for a distance of at least one mile in all directions of the facility; and all structures that relate to the proposed discharge, emission, storage, processing, or disposal activity;

This information is included on Figure 4 and Figure 5 in Appendix A.

G. a copy of a draft or final environmental impact statement that has been prepared under the National Environmental Policy Act, United States Code, title 42, sections 4331 et seq. as amended through December 31, 1982, or a copy of an environmental assessment or environmental impact statement prepared under the rules of the Minnesota Environmental Quality Board, chapter 4410;

As mentioned in Section 1.0, the MNDNR (in cooperation with the USACE and the Bois Forte Band of Chippewa) is currently drafting an EIS for the proposed Keetac expansion project. The Draft EIS is being prepared concurrently with this NPDES/SDS Permit application. Due to the size of the Draft EIS, it is not included with this application, but is available upon request.

H. additional information determined by the commissioner to be relevant to a decision as to permit issuance, including but not limited to plans, specifications, or other technical information that is necessary to determine whether the facility will meet all applicable Minnesota and federal statutes and rules; and

Information regarding compliance with water quality standards is included in Section 4.0. A non-degradation review is included in Section 5.0. A review of potential impacts to downstream impaired waters is included in Section 6.0. The MPCA has indicated during meetings and conference calls that additional information (not already included in this application) is not required at this time for their permit application review.

I. other information relevant to the application as required by parts 7001.0550 to 7001.0640, 7001.1050, 7001.1290, 7001.3175 to 7001.3475, 7001.4200, or 7041.0700.

MN Rules 7001.0550 to 7001.0640 apply to hazardous waste storage, treatment, or disposal facility permit applications and are therefore not applicable to this permit application.

MN Rule 7001.1050 is discussed below within this section.

MN Rule 7001.1290 was renumbered as MN Rule 7023.9020 has been repealed.

MN Rules 7001.3175 to 7001.3475 apply to land treatment and disposal and to solid waste management facility permit applications and therefore are not applicable to this permit application.

MN Rule 7001.4200 applies to above ground storage tank permit applications and is therefore not applicable to this permit application.

MN Rule 7041.0700 applies to sewage sludge land application permit applications and is therefore not applicable to this permit application.

2.2 MN RULES 7001.1050 – CONTENTS OF NPDES PERMIT APPLICATIONS

Subpart 1. Publicly owned treatment works. If the applicant is requesting the issuance, modification, revocation and reissuance, or reissuance of a national pollutant discharge elimination system permit for a publicly owned treatment works, the applicant shall submit the following information to the commissioner: [further Subpart 1 omitted]

Not applicable. This application is not for a publicly owned treatment works.

Subp. 2. Manufacturing, commercial, mining, and silvicultural discharges. If the applicant is requesting the issuance, modification, revocation and reissuance, or reissuance of a national pollutant discharge elimination system permit for a manufacturing, commercial, mining, or silvicultural discharge, the applicant shall submit the following information to the commissioner:

A. The information required by part 7001.0050.

The required information from 7001.0050 is previously discussed within this section.

B. The name of the receiving water of the discharge.

The permit application requests discharge authorization to Reservoir 2. Further information is included in the *MPCA Attachment for Industrial Surface Water Discharge Wastewater Treatment Facilities NPDES Permit Form* included in Section 7.0 and within the facility description in Section 3.0.

C. The exact location of the outfall, including the latitude and longitude of the location to the nearest 15 seconds.

This information is included on Figure 4 in Appendix A.

D. A line drawing of the water flow through the facility with a water balance, showing process and treatment operations contributing to the effluent. The water balance must show approximate average flows at intake and discharge points and between units, including treatment units. If a water balance cannot be determined, the applicant shall provide a pictorial description of the nature and amount of the sources of water and the collection and treatment measures.

This information is included on Figure 2 and Figure 3 in Appendix A.

E. A narrative identification of each type of process, operation, or production area which contributes or will contribute wastewater to the effluent for each outfall. This identification must include process wastewater, cooling water, and storm water runoff contributions to each outfall; the average flow that each process contributes; a description of the treatment the wastewater receives; a discussion of any disposal, other than by discharge, of solid or fluid wastes generated in the process; and the discharge frequency.

This information is included within the facility description in Section 3.0 and in the *MPCA Attachment for Industrial Surface Water Discharge Wastewater Treatment Facilities NPDES Permit Form* included in Section 7.0. A brief discussion of other disposal/re-use option other than discharge is provided in the MPCA *NPDES Permit Application – Appendix A* Form in Section 7.0.

F. A statement as to the product that is or will be manufactured, processed, or produced at the facility and a statement as to the quantity of the product actually manufactured, processed, or produced at the facility. If a technology-based effluent guideline is applicable to the discharge, the applicant shall express the quantity of product in the same measure as that used in the applicable effluent limitation guideline.

This information is included in the *MPCA Attachment for Industrial Surface Water Discharge Wastewater Treatment Facilities NPDES Permit Form* included in Section 7.0.

G. If the applicant is subject to a requirement or compliance schedule for construction, upgrading, or operation of waste treatment equipment, an identification of the requirement, a description of the project, and a listing of the required and projected final compliance dates.

Not applicable. There is no compliance schedule requirement for the facility associated with this NPDES/SDS Permit.

H. The results of analyses and other information required by part 7001.1060.

MN rule 7001.1060 establishes the required parameters for permit applicants to sample for inclusion within the permit application. The MPCA was consulted during the development of the permit modification application and specific parameters were

identified by the MPCA that were required for review of this application. The MPCA indicated that a minimum of three samples from the discharge outfalls would be required for each of the identified parameters. The results from the sampling events are included in Table 3 and Table 4 in Appendix B.

The Sargent Pit dewatering water quality characteristics were assumed to be similar to the Mesabi Chief Pit dewatering. The Mesabi Chief dewatering discharges were sampled the requisite three times and those results are included in Table 3 and Table 4 of the Plant/Mine NPDES/SDS Permit #MN0031879 application submitted concurrently with this application. The MPCA requested that one sample be collected from the Sargent Pit to confirm the similarity of water quality between the two dewatering discharges. The results from Sargent Pit sampling validated this assumption and are included in Table 3 and Table 4.

Sargent Pit information is included in this application as Keetac is proposing to have the capacity to discharge to Reservoir 2 under this permit authorization. This will provide flexibility in the Sargent Pit dewatering discharge location based on operational needs. Sargent Pit would have the potential to discharge to Mesabi Chief Pit, Russell Pit, or Reservoir 2 (with the Mesabi Chief Pit and Russell Pit discharges being covered under NPDES/SDS Permit MN0031879).

I. If the analyses required by part 7001.1060 were performed by a contract laboratory or consulting firm, the name and address of the laboratory or firm, and an identification as to which analyses were performed by the laboratory or firm.

All analyses provided in Table 3 and Table 4 in Appendix B of this application were performed by Northeast Technical Services, Inc., 315 Chestnut Street, Virginia, MN 55792 (MDH Lab Certification #027-137-157).

J. A list of any toxic pollutants that the applicant uses or manufactures or expects that it will use or manufacture during the next five years, including manufacturing as an intermediate or final product or by-product.

Information regarding chemical products used during taconite processing that have the potential to impact wastewater flowing to the tailings basin is included in the facility description in Section 3.0 and within the material safety data sheets included in Appendix C.

K. A description of the expected levels of and the reasons for any discharge of pollutants that the applicant knows or has reason to believe will in the next five years exceed two times the values reported under part 7001.1060.

No current discharge pollutants are anticipated to increase two times the values reported in this application.

L. An identification of biological toxicity tests that the applicant knows or has reason to believe have been made within the last three years on any of the applicant's discharges or on a receiving water related to the applicant's discharge.

There are no known toxicity tests within the past the three years.

M. If the applicant proposes to construct or operate a new or existing concentrated animal feeding operation or aquatic animal production facility, the information required in Code of Federal Regulations, title 40, section 122.21(h).

Not applicable. This application is not for any of these listed activities.

N. If the applicant wishes to request that the commissioner, in establishing a technology-based effluent limitation to be included in the conditions of the permit, establish an effluent limitation which is different than the effluent limitation which would result from the normal application of the relevant effluent limitation guideline, then the applicant shall submit, either in the application or in a supplement to the application filed no later than the last day of the comment period established in part 7001.0100, subpart 4, the following information: [remainder omitted]

Not applicable. The applicant is not requesting a variance from applicable effluent limitation guidelines.

O. If the applicant desires to request an extension from the statutory deadline established in section 301(b)(2)(A) of the Clean Water Act, United States Code, title 33, section 1311(b)(2)(A), on the grounds that the applicant proposes to replace existing production capacity with an innovative production process which will meet the standards in section 301(k) of the Clean Water Act, United States Code, title 33, section 1311(k), the applicant shall submit an explanation and documentation supporting this claim.

Not applicable. The applicant is not requesting a variance.

2.3 MN RULES 7050.0185 - NONDEGRADATION FOR ALL WATERS

The intent of Minnesota nondegradation rules is to "protect all waters from significant degradation from point and nonpoint sources and wetland alterations and to maintain existing water uses and aquatic and wetland habitats." It is the policy of the MPCA that water quality conditions must be maintained and protected when possible, even when those conditions are better than applicable water quality standards or better than levels necessary to support the beneficial uses.

Subp. 3. Minimum treatment. Any person authorized to maintain a new or expanded discharge of sewage, industrial waste, or other waste, whether or not the discharge is significant, shall comply with applicable

water quality standards of this chapter and effluent limits in chapter 7053 and other applicable federal and state point source treatment requirements. Nonpoint sources of pollution shall be controlled as required by this chapter, chapters 7020 and 7080, and any other applicable federal or state requirements. All existing beneficial uses shall be maintained in the receiving waters.

A water quality standards review is included in Section 4.0. An impaired waters review is included in Section 6.0. Discharges from the Keetac facility must comply with federal effluent limitation guidelines (ELGs) established under 40 CFR 440 (Ore Mining and Dressing Point Source Category, Subpart A – Iron Ore). Three parameters have ELGs established for this category, which are:

- Iron, dissolved – 2.0 mg/l daily maximum/1.0 mg/l 30-day average
- Total Suspended Solids (TSS) – 30 mg/l daily maximum/20 mg/l 30-day average
- pH – Between 6.0 and 9.0

As can be seen in Table 1 and Table 2 in Appendix B, historic monitoring of these parameters has indicated that discharges from the Keetac facility have been in compliance with the federal ELGs. The proposed expansion is not anticipated to affect compliance with these parameters, therefore it is expected that Keetac will continue to comply with the ELGs.

Additional detailed information regarding the proposed Keetac expansion project and the potential effects on waters of the state is included with the draft EIS developed by the MNDNR and available to the MPCA upon request.

Subp. 4. Additional requirements for significant discharges. If a person proposes a new or expanded significant discharge from either a point or nonpoint source, the agency shall determine whether additional control measures beyond those required by subpart 3 can reasonably be taken to minimize the impact of the discharge on the receiving water. In making the decision, the agency shall consider the importance of economic and social development impacts of the project, the impact of the discharge on the quality of the receiving water, the characteristics of the receiving water, the cumulative impacts of all new or expanded discharges on the receiving water, the costs of additional treatment beyond what is required in subpart 3, and other matters as shall be brought to the agency's attention.

Subp. 5. Determination of significance. A person proposing a new or expanded discharge of sewage, industrial waste, or other wastes shall submit to the commissioner the information required to determine whether the discharge is significant under subpart 2. If the discharge is sewage, the flow rate used to determine significance under this part is the design average wet weather flow for the wettest 30-day period. For discharges of industrial and other wastes, the flow rate to be used is the design maximum daily flow rate. In determining the significance of a discharge to a lake or other nonflowing receiving water, a mixing zone may be established under the guidelines of part 7050.0210, subpart 5.

The discharge associated with the Keetac Expansion Project from the tailings basin facility is not considered a “new” or an “expanded” discharge as defined in MN Rules

7050.0185 Subp.2. A ("New Discharge") & B ("Expanded discharge"). This is largely due to the proposed upgrade to the existing scrubber wastewater treatment system. See Section 5.0 for a detailed review of non-degradation applicability.

Subp. 6. Baseline quality. If an existing discharge to a water of the state is eliminated or significantly reduced, baseline quality for purposes of this part shall be adjusted to account for the water quality impact associated with that particular discharge. If no data are available to determine baseline quality or the data collected after January 1, 1988, are of better quality, then the commissioner shall authorize the use of data collected after January 1, 1988. If no data are available, the person proposing the discharge may collect new data in accordance with agency protocols.

Not applicable. No existing discharges to waters of the state are anticipated to be eliminated or significantly reduced to the Keetac Expansion Project.

Subp. 7. Incremental expansions. If a new or expanded discharge is proposed in increments, the increments must be added together to determine whether the discharge is a significant discharge. Once the criteria for a significant discharge are satisfied by adding together the increments, the requirements of this part shall apply to the discharge.

Not applicable. The discharge associated with the Keetac Expansion Project from the tailings basin facility is not considered a "new" or an "expanded" discharge as defined in MN Rules 7050.0185 Subp.2. A ("New Discharge") & B ("Expanded discharge"). This is largely due to the proposed upgrade to the existing scrubber wastewater treatment system. See Section 5.0 for a detailed review of non-degradation applicability, which included analysis through all five phases of the mining expansion project (2012-2036).

Subp. 8. Determination of reasonable control measures for significant discharges. The person proposing a new or expanded significant discharge of sewage, industrial waste, or other wastes shall submit to the commissioner information pertinent to those factors specified in subpart 4 for determining whether and what additional control measures are reasonable. The commissioner shall provide notice and an opportunity for a public hearing in accordance with the permit requirements in chapter 7001 before establishing reasonable control requirements for a new or expanded significant discharge.

Not applicable. The discharge associated with the Keetac Expansion Project from the tailings basin facility is not considered a "new" or an "expanded" discharge as defined in MN Rules 7050.0185 Subp.2. A ("New Discharge") & B ("Expanded discharge"). This is largely due to the proposed upgrade to the existing scrubber wastewater treatment system. See Section 5.0 for a detailed review of non-degradation applicability.

Subp. 9. Physical alterations of wetlands. The permit or certification applicant shall comply with part 7050.0186 if there is a proposed physical alteration that has the potential for a significant adverse impact to a designated use of a wetland and that is associated with a project that requires a National Pollutant Discharge Elimination System (NPDES) permit, a 401 certification under parts 7001.1400 to 7001.1470, or a state disposal system permit.

Future mining activities planned with the Keetac Expansion Project will require physical alterations of wetlands. Keetac will comply with MN Rule 7050.0186 when mining activities progress to the extent that wetland impacts are required. Additional information regarding wetland impacts due to the proposed expansion can be found in the Draft EIS document previously referenced.

2.4 MN RULES 7050.0180 - NONDEGRADATION FOR OUTSTANDING RESOURCE VALUE WATERS

Subp. 3. Prohibited discharges. No person may cause or allow a new or expanded discharge of any sewage, industrial waste, or other waste to waters within the Boundary Waters Canoe Area Wilderness; those portions of Lake Superior north of latitude 47 degrees, 57 minutes, 13 seconds, east of Hat Point, south of the Minnesota-Ontario boundary, and west of the Minnesota-Michigan boundary; Voyageur's National Park; or Department of Natural Resources designated scientific and natural areas; or to federal or state wild river segments.

Subp. 6. Restricted discharges. No person may cause or allow a new or expanded discharge of any sewage, industrial waste, or other waste to any of the following waters unless there is not a prudent and feasible alternative to the discharge:

A. Lake Superior, except those portions identified in subpart 3 as a prohibited discharges zone;

B. those portions of the Mississippi River from Lake Itasca to the southerly boundary of Morrison County that are included in the Mississippi Headwaters Board comprehensive plan dated February 12, 1981;

C. lake trout lakes, both existing and potential, as determined by the agency in conjunction with the Minnesota Department of Natural Resources, outside the boundaries of the Boundary Waters Canoe Area Wilderness and Voyageurs National Park and identified in parts 7050.0460 to 7050.0470;

D. federal or state designated scenic or recreational river segments; and

E. calcareous fens identified in subpart 6b.

Subp. 6a. Federal or state designated scenic or recreational river segments.

Subp. 6b. Calcareous fens.

Subp. 7. Unlisted outstanding resource value waters.

Subp. 8. Public hearing.

No sewage, industrial waste, or other waste from the Keetac facility directly discharges to an outstanding resource value water (ORVW). Therefore, the limitations under Subpart 3 (prohibited discharges) and Subpart 6 (restricted discharges) do not apply. The subparts

not listed or not listed in their entirety include definitions, ORVW designated waters, and information on requesting a public hearing for ORVW nondegradation concerns.

Subp. 9. Impact from upstream discharges. The agency shall require new or expanded discharges to waters that flow into outstanding resource value waters be controlled so as to assure no deterioration in the quality of the downstream outstanding resource value water.

All discharges from Keetac flow into the O'Brien Diversion Channel, then Hay Creek (and pass through Hay Lake), then Swan Lake, then Swan River, and ultimately the Mississippi River. This portion of the Mississippi is identified as an ORVW. The discharges from Keetac are not expected to adversely impact this downstream ORVW with the modifications requested in this application. Additional information regarding the impact of Keetac discharges on downstream impaired waters is included in Section 6.0 of this application.

Subp. 10. Thermal discharges. If a thermal discharge causes potential water quality impairment, the agency shall implement the nondegradation policy consistent with section 316 of the Clean Water Act, United States Code, title 33, section 1326.

Keetac discharges will not cause potential water quality impairment for thermal conditions.

3.0 FACILITY DESCRIPTION

3.1 EXISTING CONDITIONS

The Keetac tailings basin facility provides the primary method of process water treatment as well as the majority of make-up water for the plant process. This system consists of the Keetac inner tailings basin, outer tailings basin, 2nd Stage Pond, Reservoir 6, a small maintenance building, the drainage areas contributing surface run-off to these basins/reservoirs, and all non-sewage wastewater disposal systems contributing flow to the tailings discharge. The principal activity at the facility is the disposal of taconite tailings and treatment of process water from the Keetac plant. See Figure 1 in Appendix A for a site overview.

Currently, the plant can produce approximately 6.0 million tons per year (MTY) of taconite pellets. The proposed expansion discussed in Section 3.2 below will increase this production to 9.6 MTY.

The tailings and related process water that is treated in the tailings basin are generated by the Keetac plant, which is located north of the town of Keewatin. The plant consists of a series of crushers and screens, a concentrator, and an agglomerator. Information on these processes and the associated chemical usage is provided below as these activities impact the influent to the tailings basin system covered under this NPDES/SDS permit.

The concentrator consists of a series of mills, magnetic separators, hydro separators, hydro clones, screens, and thickeners. A flocculent is added to the concentrator tailings slurry before the thickening stage.

The agglomerator receives the concentrate, which is mixed with limestone/dolomite then dewatered by disc filters. The filter cake is then mixed with bentonite and formed into pellets in balling drums. The agglomerator wastewater, as well as wet scrubber, recirculating non-contact cooling water, and normal floor drain wastewater that is generated at the plant, is recirculated as process water within the plant. The make-up water for the recirculating non-contact cooling water system in the plant is softened. Additional chemicals, such as a corrosion inhibitor, a microbiocide, and a water softener are also added. A corrosion inhibitor/descaler is used in the vacuum seal water system.

Chemicals used in the wet scrubber system include calcium hydroxide for pH control and a clarification/coagulation aid. Diluted hydrochloric acid is used to clean pH. Two types of lime descaler are used to clean lime deposits.

The process water flow to the tailings basin consists of the tailings slurry (which includes associated process water as described above). The current average tailings slurry flow rate is 20 million gallons per day (MGD). The tailings slurry and plant process water is piped under pressure from the plant across Highway 169 and is spigotted into the tailings basin. The dual tailings pipelines have several gravity flow drainage points along their route that are used during routine maintenance, winter operations, and emergency situations such as pump failure. Tailings pipe dump valve drainage points 4, 5, 6W, 6E, 7, and 8 flow by gravity directly to the tailings basin. An average of 13 million long tons per year (MLTY) of dry tailings is disposed of each year in the basin.

Keetac's Tailings Basin is divided into two parts; the inner tailings basin and the outer tailings basin. The tailings slurry is discharged into the inner tailings basin via a spigot system such that course tails are deposited near the outer areas (used to build the containment dike) and fine tails are deposited further from the outer edge and settle out within the tailings pond. The inner tailings basin clear pool is currently being expanded to increase the surface area which will assist with dust suppression. The final extent of the surface area is anticipated to cover approximately 2,000 acres (approximately 80% of the inner tailings basin surface area). This final surface area coverage is expected to be reached in 2011. The elevation of the inner tailings basin increases with time as tails settle within the pond and increase the pond bottom elevation.

Chemical dust suppressants are occasionally used at the facility. Currently, magnesium chloride is used, however, this does not restrict the use of other acceptable dust suppressants at the facility.

Water discharges from the inner tailings basin via a decant tower into the outer tailings basin where it flows to the 2nd stage pond for additional sedimentation. The outer tailings basin dikes are constructed of clay starter dikes with a coarser sand and gravel chimney drain. The tailings basin (outer and inner) is principally underlain by glacial till and glaciofluvial deposits.

Water from the 2nd stage pond is discharged to Reservoir 6 via a discharge structure located in the southwest corner. The majority of the water discharged into Reservoir 6 is re-circulated back to the plant as make-up water. Surface water from Reservoir 6 discharges through Outfall SD005 into a drainage swale and then into Reservoir 2 (Class 2B, 3C, 4A, 4B, 5, and 6). Depending on water elevations, water can flow in reverse through the drainage swale, which will convey water from Reservoir 2 North (Class 2B,

3C, 4A, 4B, 5, and 6) into Reservoir 6. Reservoir 2 North receives water from Welcome Creek (Class 2C, 3C, 4A, 4B, 5, and 6).

Water is occasionally pumped from Reservoir 2 to Reservoir 6 for water-level maintenance at an average rate of 668 million gallons per year (based on data from 2001-2007). This permit application includes the potential for Sargent Pit dewatering discharges to be directed into Reservoir 2, which can then be pumped into Reservoir 6 to augment plant make-up requirements. Figure 2 in Appendix A provides a detailed water flow schematic for the Keetac facility in its current configuration (includes Reservoir 5).

Reservoir 6 is equipped with emergency overflow to Reservoir 2 via siphon outlet SD001 (consists of Outfalls 010, 011, 012, and 013). This discharge point is above the typical water elevation in Reservoir 6 and has not discharged in over eight years. Reservoir 2 discharges into the O'Brien Diversion Ditch (Class 2B, 3C, 4A, 4B, 5, and 6), which flows into Hay Creek (Class 2B, 3C, 4A, 4B, 5, and 6) and ultimately to Swan Lake (Class 2B, 3C, 4A, 4B, 5, and 6). The discharge from Reservoir 6 at SD005 represents the tailings basin system's primary regulatory compliance point from an NPDES/SDS permitting perspective.

Surface water station SW001 is located at the weir outlet of Reservoir 2 and was established at the request of the Permittee. No limits are associated with the SW001 monitoring station.

Precipitation that falls on the outer edge of the exterior tailings basin dike flows as surface runoff away from the basin and has the potential to discharge to various surface waters, including the West Swan River (Class 2C, 3C, 4A, 4B, 5, and 6), unnamed wetlands (Class 2D, 3D, 4C, 5, and 6), Hay Creek, Reservoir 2, Reservoir 2 North, and Welcome Creek.

Repair shops and a garage are located in the southwest ¼ of the southeast ¼ of Section 36, Township 57N, Range 22W. Vehicle and/or equipment maintenance is conducted indoors. Sewage generated at this site is contained in portable units and disposed of in a nearby municipal wastewater treatment facility.

The location of the facility, designated monitoring sites, and water flow schematics are shown in Appendix A. Please also refer to the "Water Balance/Mine Yield Study – Keetac Expansion Project" (Liesch, February 2009) for additional information regarding existing process water flows.

3.2 CHANGES ASSOCIATED WITH PROPOSED EXPANSION

U. S. Steel is proposing to expand the Keetac facility beginning in 2012. As part of the expansion project, an additional production line is being started to increase plant capacity. The proposed expansion would increase taconite pellet production by 3.6 MTY to a total output of 9.6 MTY. The additional increase in mining and processing will result in increased flow to the tailings basin system. The tailings slurry flow is projected to be 29 MGD following the expansion. This will result in approximately 22 MLTY of dry tailings deposition in the tailings basin following expansion. This increase in tailings deposition increases the water loss due to lock-up within the tailings voids. Keetac intends to add an additional tailings discharge line as part of the expansion project.

The production line associated with the expansion will be equipped with dry scrubber technology. Therefore, the scrubber associated with the expansion will not contribute additional sulfate loadings to the system.

This permit application also includes potential discharges from Sargent Pit mine dewatering into Reservoir 2. This has been included in this permit to provide flexibility of discharge from the Sargent Pit and to provide potential make-up water into Reservoir 6 (via Reservoir 2). Figure 6 in Appendix A provides the proposed discharge route from Sargent Pit to Reservoir 2. As mentioned above, water from Reservoir 2 is occasionally pumped to Reservoir 6 to provide additional make-up water for the plant.

Reservoir 5 is planned to be removed, with mine dewatering previously conveyed to Reservoir 5 being routed directly to the plant as make-up water. Figure 3 in Appendix A provides a detailed water flow schematic for the Keetac facility following the removal of Reservoir 5.

A summary table of estimated usages for all approved chemicals is included in Appendix C along with each individual MSDS.

Predicted average and maximum flow rates for the discharge points discussed above are provided within Section 7.0 (MPCA NPDES/SDS Application Forms).

4.0 WATER QUALITY STANDARDS REVIEW

Water quality standards are determined for each of the receiving waters based on appropriate water use classifications, as defined in MN Rules 7050. Table 1 (SD001 – Siphon outfalls from Reservoir 6) and Table 2 (SD005 – Outfall 015 from Reservoir 6) in Appendix B provide Discharge Monitoring Report results from 2001 through 2009 for the discharge monitoring locations covered under the Tailings Basin NPDES/SDS Permit. Table 3 (metals) and Table 4 (non-metals) in Appendix B provide sampling results regarding parameters of concern, as identified by MPCA personnel for the purposes of this permit application.

The MPCA provided U. S. Steel with a list of parameters that were required for the NPDES/SDS Permit application and indicated that three sampling data points would be sufficient to document the concentrations of the identified parameters, unless sampling results indicated a specific concern. The MPCA has reviewed the results from the sampling and agreed that the three sampling events adequately characterized the discharge water quality. Tables 3 and 4 also list the applicable water quality standards for the most stringent water use classification in the downstream receiving waters for each parameter. The concentration for each parameter sampled is below the applicable water quality standard based on the water use classification of the receiving streams, with the exception of the sulfate standard for wild rice. The applicability of the wild rice standard is discussed further below.

4.1 WILD RICE

There are no downstream receiving bodies that are designated as wild rice in MN Rule 7050.0470 However, stands of wild rice have been identified in Hay Lake and Swan Lake. These lakes are downstream of Keetac discharges. MN Rule 7050.0224 states that the sulfate water quality standard of 10 mg/l is to be used as a guide and applies to waters that are used for irrigation of wild rice. The standard is applicable to periods when the wild rice may be susceptible to damage by high sulfate levels. A compilation of scientific studies available from the literature (Walker, 2009[1]) and the existing wild rice stands in Swan and Hay Lakes indicate that wild rice grows in sulfate concentrations considerably higher than the 10 mg/l standard. U. S. Steel is proposing to upgrade the existing sulfate wastewater treatment system to significantly reduce sulfate discharge loadings on

[1] Walker, 2009, Wild Rice and Sulfate References, Barr Engineering, November 11, 2009

downstream receiving waters. Dry scrubbers are planned to be installed on the expanded line and will not increase sulfate discharge loadings. U. S. Steel requests that the MPCA consider these factors when evaluating the applicability of the sulfate standard on Keetac's discharge.

An EIS is being prepared by the MNDNR for the Keetac Expansion Project. Barr Engineering, on behalf of U. S. Steel, has prepared a wild rice study to support the EIS process (*2009 Water Quality, Hydrology, and Wild Rice Monitoring, Barr Engineering, September 2009*). This study includes greater detail and discussion on the wild rice issue and should be reviewed to better understand the current and future predicted conditions due to the proposed expansion. Information regarding this study has been submitted previously to the MPCA as part of the Perry Pit NPDES/SDS permit application.

5.0 NON-DEGRADATION REVIEW

A non-degradation review for an NPDES/SDS permit modification requires a determination of whether previously allowable discharge loadings of certain parameters will be exceeded. Parameters that have current limits in the facility's permit or that hold a special interest to the public are typically required to be analyzed in a non-degradation review. The allowable loading for each parameter is determined by permit limits that were in effect at a specified date depending upon the type of receiving waters. Flow rate limits and/or concentration limits for specific parameters in that permit are used to determine the allowable load. In the absence of specific limits, maximum observed flow rates or concentrations of parameters expected at the specified permit date can be used to determine allowable loads.

The discharge from the Keetac tailing basin is to waters that are classified as "all waters" under Minnesota Rules 7050.0185. There are no outstanding resource value (ORV) classified waters in the direct receiving body or downstream until the water reaches the Mississippi River, which is a substantial distance downstream from the Keetac discharges. As a result, Keetac's contribution to overall flow and load would be negligible. In meetings regarding this permit modification application, MPCA personnel indicated that for the purposes of this application, the MPCA would not apply ORVW non-degradation review, but would rely on the "all waters" classification of the water bodies discharged into and nearby downstream points. Therefore, the permit that was in effect on January 1, 1988 determines the allowable discharge loading from a non-degradation perspective.

After reviewing conditions from the NPDES/SDS permit issued in July of 1986 (and in effect on January 1, 1988), it has been determined that discharge loadings from the Keetac tailings basin following the proposed expansion will be less than the allowable loadings on January 1, 1988 for the parameters reviewed. Therefore a non-degradation analysis on these discharges is not required. Further details regarding this review are included below.

5.1 ALLOWABLE DISCHARGE FLOW RATE

Federal regulations (40 CFR Part 440 Subpart A) specifically allow a discharge volume from taconite plant tailings basins on the Mesabi Iron Range of precipitation minus evaporation (P-E). However, a condition in the 1986 NPDES/SDS Permit that regulated

Keetac's tailings basin discharges on January 1, 1988 limited the tailings basin discharge to less than P-E levels, but also allowed a carry-over volume from the previous year.

For this non-degradation review the maximum allowable annual discharge flow rate was calculated using data from the highest annual precipitation event observed minus the calculated evaporation. Although this high precipitation year may not have occurred in 1988, the permit in effect at that time would have allowed this discharge had those conditions occurred in 1988. The highest precipitation year was observed in 1999. Both the P-E method and the 1986 permit limits were used to calculate the maximum allowable annual discharge flow rate. Table 1 in Appendix D shows the allowable discharge volumes calculated by both methods.

For the typical P-E calculation, the allowable discharge volume was determined based on 1999 precipitation and evaporation values. The P-E allowable discharge flow rate was calculated to be 6,265 million gallons per year. Due to the allowable carry-over component in the 1986 permit, the allowable discharge volume was determined based on year 2000 conditions and utilizing carry-over results from 1999. The 1986 permit allowable discharge flow rate was calculated to be 5,297 million gallons per year. The lower of the two calculated discharges flow rates, the 1986 permit limit, was used to determine the maximum allowable flow rate within the non-degradation review.

5.2 PARAMETER SELECTION

The current NPDES/SDS tailings basin permit contains limits on dissolved iron and suspended solids. An analysis is required to determine if the predicted discharge loadings following expansion would exceed allowable loadings for dissolved iron and suspended solids. In addition, other parameters without specific limits in the current permit that may hold a special interest to the public also require analysis. The anticipated discharge loading of chloride, fluoride, hardness, mercury, sulfate, phosphate, and trace metals were also evaluated against the allowable discharge loadings.

The large size and residence time of the tailings basin system coupled with high dissolved oxygen concentrations allows ample time for iron oxidation to occur. The large residence time promotes effective settling of iron and other suspended solids. Therefore it is anticipated that the tailings basin will continue to discharge water with low levels of dissolved iron and suspended solids. The tailings basin system, which consists of three large pools/ponds in series, will continue to remove dissolved iron and total suspended solids and remain well below the allowable loadings in the effluent.

The proposed expansion will utilize a taconite production process that is very similar to the existing process in terms of impacts to the water except that a dry scrubber is planned. The dry scrubber will not result in the introduction of certain contaminants into the water. Therefore, concentrations of chloride, fluoride, mercury, phosphate, and trace metals are expected to be at or less than current levels in the tailings basin effluent. In addition, modeling has shown the discharge volume from Reservoir 6 will not exceed the allowable discharge flow rate of 5,297 million gallons per year (*Water Balance/Mine Yield Study – Keetac Expansion Project, Liesch, February 2009*). Therefore, the mass loadings of these parameters are expected to remain below the loadings that would have been allowed under the 1986 permit.

Sulfate is a parameter of concern due to the current increases observed in the tailings basin system and the potential impact to downstream water quality. In addition, hardness levels could increase due to the use of hydrated lime within the scrubber wastewater treatment system Therefore a more detailed review of potential non-degradation was conducted on these two parameters and is detailed below.

5.3 SULFATE NON-DEGRADATION REVIEW

Sulfate concentrations have been increasing in the tailings basin. The increase is due to the installation of a wet scrubber on the existing taconite process in 2006 to satisfy maximum achievable control technology (MACT) standards for air quality. The increase has occurred despite a lime precipitation system that was added in 2006 to reduce sulfate concentrations in the scrubber blow-down. Due to the large size of the tailings pond and associated retention time, steady state sulfate concentrations would not be reached for many years after a process change is made, such as the 2006 scrubber addition. Due to the delayed impact of process changes, modeling of the tailings pond sulfate concentrations and discharge loadings was conducted beyond the typical 5 year NPDES/SDS permit term to 2036 (the final phase of the proposed mining plan). This proactive measure was undertaken to determine if a build-up of sulfate in the tailings pond would cause discharge sulfate loadings in the future above the non-degradation threshold allowed based on the 1986 permit. The possible impact of the treatment chemical (lime) from the addition of the 2006 scrubber blow-down treatment system was also evaluated for calcium concentrations, and thus hardness levels, in the tailings basin discharge.

Modeling indicated that sulfate concentrations would build-up slowly in the tailings pond with the operation of the wet scrubbers and the current scrubber wastewater treatment

system. As the mine expands and dewatering flow rates increase, the discharge loading of sulfate during a high precipitation year could cause sulfate loadings in the discharge to exceed what was allowed based on the 1986 permit. It should be noted that, without modifications to the current scrubber wastewater treatment system, modeling indicated that the anticipated sulfate discharge loadings could not have exceeded the allowable discharge loadings until at least 15 years after plant expansion, and even then only during the highest precipitation year evaluated in the water balance study.

To prevent the build-up of sulfate in the tailings basin to these levels, U. S. Steel has proposed to install additional treatment equipment to the scrubber wastewater treatment system that was installed in 2006. A 50 percent reduction in the sulfate load from the existing scrubber wastewater treatment system was determined to be sufficient to prevent future maximum sulfate discharge loads from exceeding the non-degradation threshold.

To determine the allowable sulfate loading, the concentration of sulfate that existed in the discharge from the tailings basin in 1988 was determined. The concentration of sulfate reported in Keetac's tailing basin discharge in 1988 was 58.4, 54, 59, and 77 mg/l resulting in an average concentration 62.1 mg/l (see 1988 Discharge Reports in Appendix D). Using the maximum allowable discharge from the tailings basin of 5,297 million gallons per year, the maximum allowable discharge of sulfate is 1370 tons per year.

Table 2 in Appendix D shows the model outputs for the predicted sulfate concentrations in the tailings basin under normal precipitation years using a 50 percent reduction in the sulfate load being discharged from the existing scrubber wastewater treatment system. Since a request to discharge Sargent Pit dewatering into Reservoir 2 (the outfall receiving water from Reservoir 6) has been made in this application, the loading from that source has been added to the loading from Reservoir 6 for this review. Adding the Reservoir 6 w/out Sargent flow rates (Table 2 in Appendix D) to the Sargent Pit flow rate and using the predicted sulfate concentration for each year, it was determined that the maximum predicted sulfate discharge loadings will be well below the maximum allowable sulfate discharge loadings of 1,370 tons per year.

However, this analysis assumed an average precipitation year, and a high precipitation year would cause an increase in the discharge flow rate, and therefore an increase in sulfate discharge loadings. An analysis of the sulfate discharge loadings that could occur from the tailings pond during a year with high precipitation rates was also conducted. The concentration in the tailings pond would be expected to decrease during a high precipitation year due to the dilution effect of the precipitation. The concentration of

sulfate in the tailings basin was modeled during each of the 5 phases of the expansion (each phase spans 5 years) assuming a high precipitation year occurred. The results of that modeling can be seen in Table 3 through Table 7 in Appendix D. The modeled sulfate concentrations and maximum Reservoir 6 discharge flow rates can be seen in Table 8 in Appendix D for each of the phases. It was determined that removing 50 percent of the existing sulfate load in the discharge from the scrubber wastewater treatment system will enable the worst case sulfate discharge from the tailings basin to stay below the allowable sulfate discharge loading of 1370 tons per year.

5.4 HARDNESS NON-DEGRADATION REVIEW

Hardness is also expected to increase in concentration following the addition of the 2006 scrubber due to the lime addition as a precipitating agent in the associated treatment system. This anticipated increase in hardness concentration requires a more detailed review of potential non-degradation issues.

The baseline concentration of hardness in Keetac's tailings basin discharge in 1988 was 223, 195, 235, and 290 mg/l resulting in an average concentration of 235.8 mg/l. Utilizing the maximum allowable discharge flow rate of 5,297 million gallons per year and the baseline concentration, the maximum allowable hardness discharge loading (from a non-degradation review perspective) is 5,200 tons per year.

Prior to the addition of the scrubber in 2006, no changes were made to the Keetac site that had the potential to significantly affect the hardness concentration in the tailings basin discharge. As a result, the future predicted maximum hardness loading for the expansion is the baseline hardness concentration (235.8 mg/l in 1988) multiplied by the highest predicted flow rate in 2036 plus the estimated hardness loading due to the calcium discharges from the scrubber wastewater treatment system following the planned upgrade. The highest predicted flow was determined by modeling a high precipitation year occurring in 2036 when mine dewatering volumes are at their peak. This resulted in a peak flow rate of 4,160 million gallons per year, as shown in Table 8 in Appendix D. The peak future hardness loadings without the loadings from the scrubber were therefore calculated to be 4,084 tons per year. The existing scrubber and wastewater treatment system adds 596 tons of hardness per year. The wastewater treatment system upgrade will remove 50 percent of the current sulfate ions and it is anticipated that calcium ions would be removed at the same efficiency. The estimated increase in hardness loading due to the scrubber wastewater treatment system with planned upgrades is 298 tons per year (Water Balance/Mine Yield Study – Keetac Expansion Project, Liesch, February 2009). This

predicts a maximum future hardness loading of 4,382 tons per year. This is less than the maximum allowable hardness discharge loading of 5,200 tons per year. It should be noted that, even without the 50 percent calcium removal from the planned wastewater treatment system upgrade, the highest hardness discharge loading over the next 25 years is predicted to be less than the maximum allowable hardness discharge loading of 5,200 tons per year.

5.5 CONCLUSION

The discharge loading of parameters with permit limits will be below levels that were allowed in the permit that was in effect in 1988. In addition, the predicted discharge loading of other parameters of concern such as chloride, fluoride, mercury, phosphate, and trace metals will be below maximum allowable discharge loads without further wastewater treatment. Upgrades to the 2006 scrubber wastewater treatment system are expected to remove 50 percent of the sulfate load being discharged currently. This will ensure that future discharge loadings will be below allowable sulfate loadings, from a non-degradation perspective. Maximum potential hardness discharge loadings have also been shown to be below allowable discharge loadings, from a non-degradation perspective. Based on this information, parameters of concern do not exceed the threshold that would require a formal non-degradation analysis.

6.0 IMPAIRED WATERS REVIEW

There are currently eight impairments identified by the MPCA in various downstream receiving waters from the Keetac facility. None of the impaired waters receive direct discharge from the tailings basin system. The water body and associated impairment are as follows:

- Swan Lake (Main Basin)
  - Mercury in Tissue
- Swan River (to Mississippi)
  - Mercury in Tissue
  - Dissolved Oxygen
- Mississippi River
  - Mercury in Tissue
  - Mercury in Water Column
  - Turbidity
  - Dissolved Oxygen
  - PCB in Fish Tissue
  - Fecal Coliform
  - Fish Bioassessments
  - Perfluorooctane Sulfonate (PFOS) in Fish Tissue

The discharge from the Keetac tailings basin system will meet the water quality standards of the receiving waters for the impairments at the point of discharge and will not cause or contribute to further impairments. Further discussion regarding each of the impairments list above is provided below.

6.1 MERCURY

All three water bodies listed above are impaired for mercury in fish tissue. The Mississippi River is also impaired for mercury in the water column. A total maximum daily load (TMDL) has been approved for these impairments.

The fine tails deposited in the tailings basin adsorb mercury from the wastewater in the tailings slurry. The tailings basin system acts as an extremely efficient mercury removal system due to adsorption and subsequent particle settling. The average mercury concentration measured in Reservoir 6 discharge was less than 1.3 nanograms per liter.

The mercury concentration measured in the Sargent Pit discharge was 1.2 nanograms/liter (see Table 3 in Appendix B). These mercury concentrations are a fraction of typical mercury concentrations observed in rainwater in this area.

The water quality standard for mercury for this area of the state is 6.9 ng/l. The EPA has approved a mercury TMDL for all mercury impaired waters in this region. The increased flow rates predicted from the tailings basin over the five phases of the proposed expansion are included in the table below. The increased mass in mercury discharged from the tailings basin over the timeframe of the proposed expansion has been calculated and is included below, based on the 1.3 ng/l Reservoir 6 concentration.

Increase in Mercury Loadings from Tailings Basin Discharges

	Predicted Reservoir Six Flow Rate* (MGY)	Hg Concentration (ng/l)	Increase in Reservoir Six Discharge Loadings (grams Hg/year)
Pre-expansion	756	1.3	-
Phase I (2012-2016)	1,126	1.3	1.8
Phase II (2017-2021)	1,213	1.3	2.3
Phase III (2022-2026)	1,294	1.3	2.7
Phase IV (2027-2031)	2,156	1.3	6.9
Phase V (2032-2036)	2,247	1.3	7.3

*Pre-expansion rate does not include Sargent Pit water discharging to Reservoir 2 (and ultimately pumped to Reservoir 6), post-expansion flow rates do include Sargent Pit flow.

Effluent monitoring for mercury in the Reservoir 6 discharge is already required and will continue to be conducted. A new monitoring point will be required for the Sargent Pit discharge to Reservoir 2. The effluent from the tailings basin system and Sargent Pit is expected to be consistently below the water quality standard of 6.9 ng/l. The discharge of water from the Keetac tailings basin system or Sargent Pit is not reasonably expected to cause or contribute to mercury impairment in downstream receiving waters.

6.2 DISSOLVED OXYGEN

A TMDL has not been approved for this impairment. Dissolved oxygen is typically depleted in rivers and streams due to elevated phosphorous (which can lead to excessive eutrophication) and/or biological oxygen demand (BOD) levels. Phosphorous concentrations in the tailings basin averaged 15 micrograms/liter. Phosphorous concentrations in the Sargent Pit discharge were measured at less than 4.3 micrograms/liter. The phosphorus water quality standard for the receiving waters are all at or above 30 micrograms/liter. BOD levels were below detection limits for all three

samples taken from the tailings basin and were also non-detect from the Sargent Pit discharge. The increase in low-phosphorus and low-BOD discharges from the proposed expansion project into upstream receiving waters will likely help to increase dissolved oxygen concentration in downstream impaired waters. This is due to the increased flows (with low BOD/phosphorus) that will effectively dilute the downstream oxygen demand from other sources.

6.3 TURBIDITY

A TMDL has not been approved for this impairment. The Reservoir 6 discharge sampling average turbidity was 2.0 NTU. The Sargent Pit discharge sampling turbidity was 0.30 NTU. The receiving waters have a water quality standard of 25 NTU. In addition, the extremely low phosphorous and non-detectable levels of BOD are good indicators that the discharge from the tailings basin system or Sargent Pit will not contribute or cause turbidity impairments downstream. It is likely that the increased flows from the proposed expansion project will help decrease turbidity in the downstream receiving waters.

6.4 FISH BIOASSESSMENTS

A TMDL has not been approved for this impairment. Turbidity would be a likely candidate as a surrogate parameter for fish bioassessments. The impaired water for fish bio-assessments is on the Mississippi water just north of Minneapolis which is several hundred miles away. As is explained in the turbidity section, Keetac discharge water is not expected to contribute to turbidity impairments. Therefore, it is not expected to cause or contribute to fish bioassessment impairments downstream.

6.5 PCBS

A TMDL has not been approved for this impairment. PCBs are not reasonably expected to be present in the effluent from the Keetac tailings basin or from Sargent Pit.

6.6 FECAL COLIFORM

A TMDL has not been approved for this impairment. Fecal coliform is not reasonably expected to be present in the effluent from the Keetac tailings basin system or from Sargent Pit.

6.7 PERFLUOROOCTANE SULFONATE

A TMDL has not been approved for this impairment. Perfluorooctane sulfonate is not reasonably expected to be present in the effluent from the Keetac tailings basin or from Sargent Pit.

7.0 MPCA NPDES/SDS APPLICATION FORMS

Included with this section are the MPCA NPDES/SDS Permit Modification Application Forms required. The forms included are:

- MPCA Water Quality Transmittal Form
- MPCA NPDES/SDS Permit Application – Appendix A
- MPCA Attachment for Industrial Surface Water Discharge Wastewater Treatment Facilities National Pollutant Discharge Elimination System (NPDES/SDS) Permit

W:\ww\94213\NPDES Permit Applications\Tailings Basin\FINAL APPLICATION\Application Tailings Basin 12-23-09.doc

Tailings Basin
WATER QUALITY TRANSMITTAL FORM

Minnesota Pollution Control Agency

MPCA USE ONLY Application Number		
MN		
Date Received		
Month	Day	Year

COMPLETE APPLICATION BY PRINTING OR TYPING.
PLEASE MAKE A PHOTOCOPY FOR YOUR RECORDS.

FACILITY INFORMATION

Facility Owner [X] and/or Operator [X] (Public Entity, City or Business Firm legally responsible for facility operation) [see Minn. R. 7001.0050]

Permittee Name: United States Steel Corporation Phone: ( ) FAX: ( )

Mailing Address: 600 Grant Street City: Pittsburgh

State: PA Zip: 15219 Type of ownership Public [ ] / Private [X]

Facility Location No Post Office Boxes allowed. Actual physical location of facility -- must use actual street or highway address (or Section/Township/Range coordinates). *If applying for a permit that can cover more than one site (e.g. aggregate and/or hot mix asphalt operations), write NA.*

Facility Name: United States Steel Corporation, Minnesota Ore Operations - Keetac Phone: (218)778-8672

Location Address: 1 Mine Road

Facility is located in the N/A quarter of the N/A quarter of section N/A township Various

of Itasca & St. Louis county. Township # 56, 57 Range # 21-22 East [ ] West [X]

City: Keewatin State: MN Zip: 55753

Is the facility located on tribal land? [ ] yes [X] no If yes, apply to EPA Region V, John Coletti; (312) 886-6106.

Technical Agent or Consulting Engineer Michael Johnson, P.E. Title: Sr. Project Engineer

Name of firm or organization: Liesch Associates, Inc.

Mailing Address: 13400 15th Avenue N Phone: (763)489-3100

City: Plymouth State: MN Zip: 55441

Contact Person (Operator, Plant Manager, City Official): Title:

APPLICATION INFORMATION

Reason for Application (check all that apply):

[ ] Expiration of existing permit (reissue) [X] Modification to existing permit [ ] Agency request
[ ] New permit/facility [ ] Land Application Site Approval [ ] Other, please specify

Type of Application (check all that apply):

[ ] Municipal/Domestic / [ ] Sanitary Sewer / [ ] Biosolids / [ ] Pretreatment / [X] Industrial Process Wastewater /
[ ] Industrial By-product Land Application / [ ] Land Disposal Site Approval for Wastewater /
[X] Stormwater / [ ] Water Treatment Plant / [ ] Non-contact Cooling Water / [ ] Ground Water Pump Out /
[ ] Dredge / [ ] Feedlot / [ ] Aquaculture / [ ] Aggregate/Hot Mix

Have you ever applied for, or do you currently have a National Pollutant Discharge Elimination System (NPDES) or State Disposal System (SDS) permit for this facility? ☒ yes ☐ no

If yes, please list permit number(s) MN0055948

Name on existing permit U. S. Steel Corporation

List all current MPCA permits or certificates, and their numbers, which also may apply to this facility:
NPDES/SDS MN0031879 applies to the mining and plant operations; Title V Permit: 13700063-003; Wetland Permits: 96-04859-TWP, 04-00215-TWP, 2006-69-TWP; AST Major Facility Permit: 11153; Waste Tire Storage Permit: WTSF-115; Hazardous Waste Generator ID# MND071344733

If this is a new or expanded facility, has an Environmental Impact Statement or an Environmental Assessment Worksheet been prepared?

yes ☒ no ☐ If yes, note the title and date: Currently in process with DNR

Annual Permit fee invoice should be mailed to ☐ Owner/operator address ☒ Facility location address ☐ Not applicable

Discharge Monitoring Report forms should be mailed to ☐ Owner/operator address ☒ Facility location address ☐ Not applicable

APPLICATION FEES

An application fee is required under Minn. Stat. § 116.07, subd. 4d (1990) and Minn. R. ch. 7002 (Permit Fee Rules). This application fee must be submitted with the application. **The application fee is $350.**

Reminder:

✓ ***Did you sign attachment form(s)?***
✓ ***Attach your $350 application fee?***
✓ ***Enclose completed attachments?***

Applications that are submitted without an authorized signature, the required application fee, and attachments will be returned. Please make your check payable to the Minnesota Pollution Control Agency. Send the completed permit application, attachments (including plans and specifications, if applicable) and check to:

Minnesota Pollution Control Agency
Beckie Olson, MAR/MAJ
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

For more information please contact the Customer Assistance Center at:

In Metro Area: (651) 297-2274
Outside Metro Area: (800) 646-6247

Minnesota Pollution Control Agency

NPDES PERMIT APPLICATION - APPENDIX A

The 1993 Legislature revised the Minnesota Pollution Control Agency's responsibilities in Minn. Stat. § 115.03, subd. 1(e)(10) "Requiring that applicants for wastewater discharge permits evaluate in their applications the potential reuses of the discharged wastewater;"

As a result of this 1993 Law, the Minnesota Pollution Control Agency has been charged with requiring permit applicants to evaluate the reuse potential of their wastewater prior to discharge.

Therefore, please provide in narrative form in the space below, an evaluation of reuse potential of your wastewater prior to discharge to a receiving stream, lake, or storm sewer. Some ideas include water conservation measures, use of cooling tower blowdown for thermal discharges, lawn watering or irrigation of parks and public property, wetland reclamation/development/recharge.

The tailings basin facility serves to provide a means of depositing fine and course tails as well as treating wastewater so that it may be recycled and returned to the main plant operations for re-use. The vast majority of water discharged to the tailings basin in the tailings slurry is re-used within the plant as make-up water.

At the time of permit submittal, Keetac is also in the process of expanding the surface area of the tailings basin inner pool to minimize dusting issues. Therefore, the tailings slurry discharge water is being utilized as a control option to address dusting issues.

Minnesota Pollution Control Agency, 520 Lafayette Road North, St. Paul, Minnesota 55155-4194
(651) 296-6300, toll-free (800) 657-3864, TTY (651) 282-5332 or (800) 657-3864
This material can be made available in alternative formats for people with disabilities.
Printed on recycled paper containing at least 20 percent fibers from paper recycled by consumers.

Tailings Basin

ATTACHMENT FOR

Industrial Surface Water Discharge
Wastewater Treatment Facilities
National Pollutant Discharge Elimination System
(NPDES) Permit

Minnesota Pollution Control Agency

MPCA USE ONLY Application Number		
MN		
Date Received		
Month	Day	Year

COMPLETE APPLICATION BY PRINTING OR TYPING. PLEASE MAKE A PHOTOCOPY FOR YOUR RECORDS.

PERMITTEE:	United States Steel Corporation, Minnesota Ore Operations - Keetac

BASIC INFORMATION

1. Principal Facility Activity:

If established, please indicate what you believe to be the applicable federal effluent limitation guideline(s) for your waste stream(s): 40 CFR Part 440, Subpart A - Iron Ore Subcategory	
Product(s) Produced:	Iron taconite pellets
Raw Material(s) Consumed:	Iron ore taconite, limestone, dolomite, bentonite
*Average and maximum amount of product produced per Unit Time (such as tons/year, kilograms/day):	
Post expansion: 8.1 million tons average, 9.6 million tons max	
*Average and maximum amount of raw material consumed per Unit Time (such as tons/year, kilograms/day):	
Post expansion: 30 million long tons average, 32.7 million long tons max	
Standard Industrial Classification (SIC) Code Number:	1011
*Provide both daily maximum and long-term monthly average expected during the five-year permit term. If an effluent limitation guideline applies and is expressed in terms of production (or other measure of operation) please report the expected actual production rates in the units used in the applicable effluent guideline. Consumptive use and/or production rates should be in sufficient detail so as to aid in the development of technology-based effluent limitations. For new discharges, actual production shall be estimated using projected production.	

STORM WATER

2. Is the facility now covered by an MPCA storm water NPDES permit? ☒ Yes ☐ No
If yes, indicate the permit number (if storm water discharges are authorized under the storm water general permit give unique identifying number rather than general permit number): MN0055948

3. Does storm water contact ANY raw or processed materials, finished products, industrial waste, byproducts, or any other type of significant materials at the facility? ☒ Yes ☐ No

If yes, describe these materials: **Precipitation within tailings basin contacts deposited coarse and fine tails**

4. Is any vehicle maintenance, transportation equipment cleaning, or airport deicing conducted at the facility?
☒ Yes ☐ No

Vehicle maintenance performed indoors

5. Indicate the name of the receiving water body(ies) to which storm water from the facility discharges and attach a site map showing discharge drainage path(s). If storm water discharges to a storm sewer, include a map showing storm sewer route to receiving water body: Reservoir #2, See Application, Appendix A for Figures

WATER SUPPLY

6. What is the source of the intake water supply for the facility?		Rate of supply (gallons/day)?
☐ Municipal water supply, city name:		
☐ Ground water, intake location:	Mine dewatering via tailings slurry	Various
☒ Surface water, name:	Welcome Creek via Reservoir 2 North, Reservoir 2	Various

If this is a surface or ground water intake, please given the
DNR Water Appropriation Permit Number 65-1138, 65-0351
Is the intake water supply chlorinated or otherwise disinfected? ☐ Yes ☒ No

INDUSTRIAL PROCESS WASTEWATER

7. Does the facility generate industrial process wastewater? ☒ Yes ☐ No

8. If yes, the industrial process wastewater from the facility is discharged to: (check all that apply)

☐ Surface water via municipal storm sewer	☐ Surface Water via applicant owned and operated wastewater treatment system
☒ Direct to surface water	☐ Publicly owned treatment works, provide owner/operator name:
☐ On-Site Storm water retention basin	☐ Septic tank/drain field
☐ Land Application (if checked you must complete the Land Application Disposal form)	☐ Other, please describe _____

9. Is the applicant requesting authorization to discharge industrial process wastewater? ☒ yes ☐ no

Provide flow information specific to the industrial process wastewater waste stream:

Maximum flow rate in gallons per day	Average flow rate in gallons per day	Discharge frequency**	Receiving Water/ Disposal Point
3.1 MGD	40 MGD	Continuous	Reservoir 2

Additionally, provide a list of what pollutants are known or can reasonable be expected to be present. All levels (except discharge flow, temperature, and pH) must be given as concentration and total mass.

DISCHARGE FROM INCOMING WATER TREATMENT PROCESSES

10. Does the facility generate wastewater from water treatment process(es) for which discharge authorization is requested? ☐ Yes ☒ No **If no, skip to item 14.**

11. If yes, check all waste stream types that apply: ☐ Reverse Osmosis ☐ Softener ☐ Deionization ☐ Multi-media Filter ☐ Other, explain:

On the water balance (described on page 4 of 6), be sure to provide actual (or estimated for new sources) individual flow contributions for each of these processes.

12. Please indicate to where wastewater from the water treatment process(es) will be discharged: (check all that apply)

☐ Publicly owned treatment works, provide owner/operator name:	☐ Surface Water via applicant owned and operated wastewater treatment system
☐ Direct to surface water	☐ Surface water via municipal storm sewer
☐ On-Site Storm water retention basin	☐ Septic tank/drain field
☐ Land Application (if checked you must complete the Land Application Disposal form)	☐ Other, please describe _____

Provide flow information specific to the water treatment waste stream:

Maximum flow rate in gallons per day	Average flow rate in gallons per day	Discharge frequency**	Receiving Water/ Disposal Point

13. Include as an attachment, test results (new dischargers should provide reasonable estimates) for the following pollutants unless otherwise waived by the permitting authority: pH, Total Chlorides, Specific Conductivity, Total Dissolved Solids, Total Sulfates, Hardness (as CaCO3), Bicarbonates (as HCO3 in meq/L), Boron, Sodium, Total Salinity.

NON-CONTACT COOLING WATER

14. Does the facility generate non-contact cooling water (e.g., power generation, refrigeration, boilers, etc.) for which discharge authorization is requested? ☐ Yes ☒ No

If yes, is this once-through ☐ or recirculating (i.e., cooling towers) ☐ ?

If this is recirculating, what is recycling time and ratio of bleedoff, to evaporation, to make-up?

Are any chemical additives used in conjunction with the cooling operation? ☐ No ☐ Yes **(be sure to complete item 15)**

14a. Provide test results (new dischargers should provide reasonable estimates) for the following pollutants unless otherwise waived by the permitting authority: temperature, pH, total residual chlorine (TRC), total phosphorus, chemical oxygen demand (COD), total organic carbon (TOC), and total dissolved solids (TDS).

Cooling Process (describe the type cooling towers, contact, etc.:	Flow Rate Average (specific to cooling waste stream)	Flow Rate Maximum (specific to cooling waste stream)	Discharge Frequency (if seasonal list months)	Receiving Water (or other disposal point)
N/A				

CHEMICAL ADDITIVES

15. List below all chemical additives that are used or proposed to be used in the waste stream(s) for which discharge authorization is requested.

Product Name	Process in which Used and Purpose for Use	Dosage Frequency (e.g. continuous, slug dosed 2x/week)	Maximum Rate of Use	Average Rate of Use
See Application, Appendix C				

You must attach Material Safety Data Sheets (MSDS) and complete product labels for each additive. If the MSDS does not include information on chemical composition, including percentages for each ingredient totaling to 100%, and aquatic toxicity, human health, and environmental fate for each proposed chemical additive, you must contact the supplier and have the information forwarded to the MPCA. Please note that it is not unusual for MSDSs only to contain ingredients considered hazardous by OSHA for transport and therefore may not list a nonhazardous ingredient such as polyphosphonate commonly used for scale and corrosion control.

WASTEWATER TREATMENT AND/OR WASTE STREAM DISCHARGE(S)

16. How do you dispose of sewage (sanitary wastewater) at the facility? Trucked away to POTW

17. Identify the discharge rate (gallons per day) and other information for each wastewater outfall discharge point:

Outfall point	Type of	Discharge flow	Discharge flow rate,	Discharge Frequency	Route

number	wastewater/ waste stream	rate, average	maximum		to receiving waters
SD001	Tailings Basin Discharge	0 MGD	9.4 MGD	Emergency Overflow	Siphon Outlet to Reservoir 2
SD005	Tailings Basin Discharge	3.1 MGD	40 MGD	Continuous	Drainage Ditch/Creek to Reservoir 2
Sargent Pit	Mine Dewatering	1.3 MGD	4.75 MGD	Continuous	Drainage Ditch to Reservoir 2

18. As an attachment to this application, provide a narrative description of the treatment the wastewater will receive along with all operations contributing wastewater to the effluent, average flow contributed by each operation, and the ultimate disposal of any solid or liquid wastes not discharged (Describe how and where the sediments and sludges removed from the wastewater treatment system at the facility are disposed). Highlight any changes made since permit issuance. Provide a diagram of the wastewater treatment process. See Application, Section 3.0 for Facility Description
See Application, Appendix A, Figure 2 & Figure 3 for Diagram

19. Attach a diagram, chart, or line drawing showing the water flow through the facility, showing operations contributing wastewater to the effluent and treatment units. The water balance must show approximate average flows at the intake, proceed through the plant processes, the wastewater treatment system (if any) and to each discharge point. The line balance should account for any loss between intake and discharge points.

See Application, Appendix A, Figure 2 & Figure 3

20. Attach a U.S. Geological Survey map showing the location of the facility, the wastewater treatment system, each of the discharge outfalls, other surface and ground water sampling points, and the route to the receiving waters. If this a discharge to a storm sewer, you must show the route of the storm sewer to a receiving water body. A map showing only the discharge to a storm sewer is unacceptable. The MPCA must receive a map which shows how and where the facility's waste stream(s) enter a receiving water body.

See Application, Appendix A, Figure 4

GROUND WATER MONITORING

21. Are there ground water monitoring wells or lysimeters at your facility? ☒ Yes ☐ No

If yes, describe where and why they were installed

17 Monitoring wells are located at southwest corner of the tailing pond exterior. These wells were installed to monitor along the clay perimeter dike. Six monitoring wells are located at south and east side of the tailings pond interior. These wells were installed to monitor water elevations in the coarse tailings dike of the interior pond. Five piezometers are located at south and east side of the tailings pond interior. These piezometers were installed to monitor water elevations in the coarse tailings dike.

WATER QUALITY TEST RESULTS

22. In an attachment to this application, please provide test results for all pollutants known or reasonably believed to be present at each of the facility discharge points. Such pollutants may include total suspended solids, biochemical oxygen demand, pH, fecal coliform, temperature (heat), nutrients (phosphorus, ammonia, nitrate, nitrite), metals, salts, cyanide, residual chlorine, fluoride, oil and grease, polychlorinated biphenyls, phenols, polynuclear aromatic hydrocarbons, volatile organic compounds, pesticides and/or radioactivity. Please clearly indicate, with all test results, the specific dates, location where sample was taken, types of wastewater sampled, and method(s) of sampling (e.g. grab, composite).
At a minimum provide test results for total suspended solids (TSS), biochemical oxygen demand (BOD), fecal coliform (if believed present or sanitary wastes will be discharged), pH, and total phosphorus, irrespective of what

might be required by an existing permit.
If this is an application for reissuance of an existing permit, review your existing NPDES/SDS permit to see if it has special testing requirements as part of the application for reissuance process.

23. Name of the laboratory that analyzed samples:	Northeast Technical Services
Indicate the Minnesota Department of Health Laboratory Certification Number for this laboratory:	027-137-157

24. If the system is currently covered under an NPDES/SDS permit, has the system been in compliance with the permit limits during the past five years?

☒ yes	☐ no	If no, please explain.	

MONITORING RESULTS (Checklist)

- ☒ Test results for all other pollutants known or reasonably believed to be present. (See item 9a)
- ☐ Test results from water treatment processes. (See item 13)
- ☐ Test results for BOD, TSS, COD, TOC, fecal, total phosphorus & pH. (See item 22)
- ☐ Test results from cooling water processes (temperature, pH, TRC, total phosphorus, COD, TOC, and TDS). (See item 14a)

ATTACHMENTS (Checklist)

- ☒ Narrative description of the treatment process. (See item 18)
- ☒ Information on chemical composition for all water treatment/chemical additives.
- ☒ MSDS sheets & product labels for all water treatment/chemical additives.

MAPS (Checklist)

- ☒ U.S. Geologic Survey topographic map. (See item 20)
- ☐ Site Map showing storm water conveyance from facility site. (See item 5)

FLOW CHART/DIAGRAMS (Checklist)

- ☒ Route of water flow/water balance from intake through facility and all treatment processes. (See item 19)
- ☐ Wastewater Treatment System. (See item 18)
- ☐ Other, Please list:

**** Discharge frequency shall be given as continuous, controlled, intermittent, or periodic/ seasonal. A year-round, daily discharge (excepting possibly weekends & holidays) is considered a continuous discharge. A controlled discharged is defined as a discharge from a stabilization pond. If the discharge rate given above is other than continuous or controlled, you must please provide an explanation for discharge frequency.**

CERTIFICATION

Federal regulations (Section 309(c)(2) of the Clean Water Act and State regulations (Minn. R. 7001.0070) require the authorized signer to be one of the following:

A. **For corporation, a principal executive officer of at least the level of vice president;**
B. **For a partnership or sole proprietorship, a general partner or the proprietor, respectively; or**
C. **For a municipality, State, Federal, or other public facility, either a principal executive officer or ranking executive official.**
D. **If the operator of the facility is different than the owner, both the operator and the owner according to items A to C.**

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person, or persons, who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."

PRINTED NAME Jeremy Smolich TITLE Plant Manager

AUTHORIZED SIGNATURE _____ DATE _____

STATE TAX I.D. # 5738839 FEDERAL TAX I.D. # 25-1897152

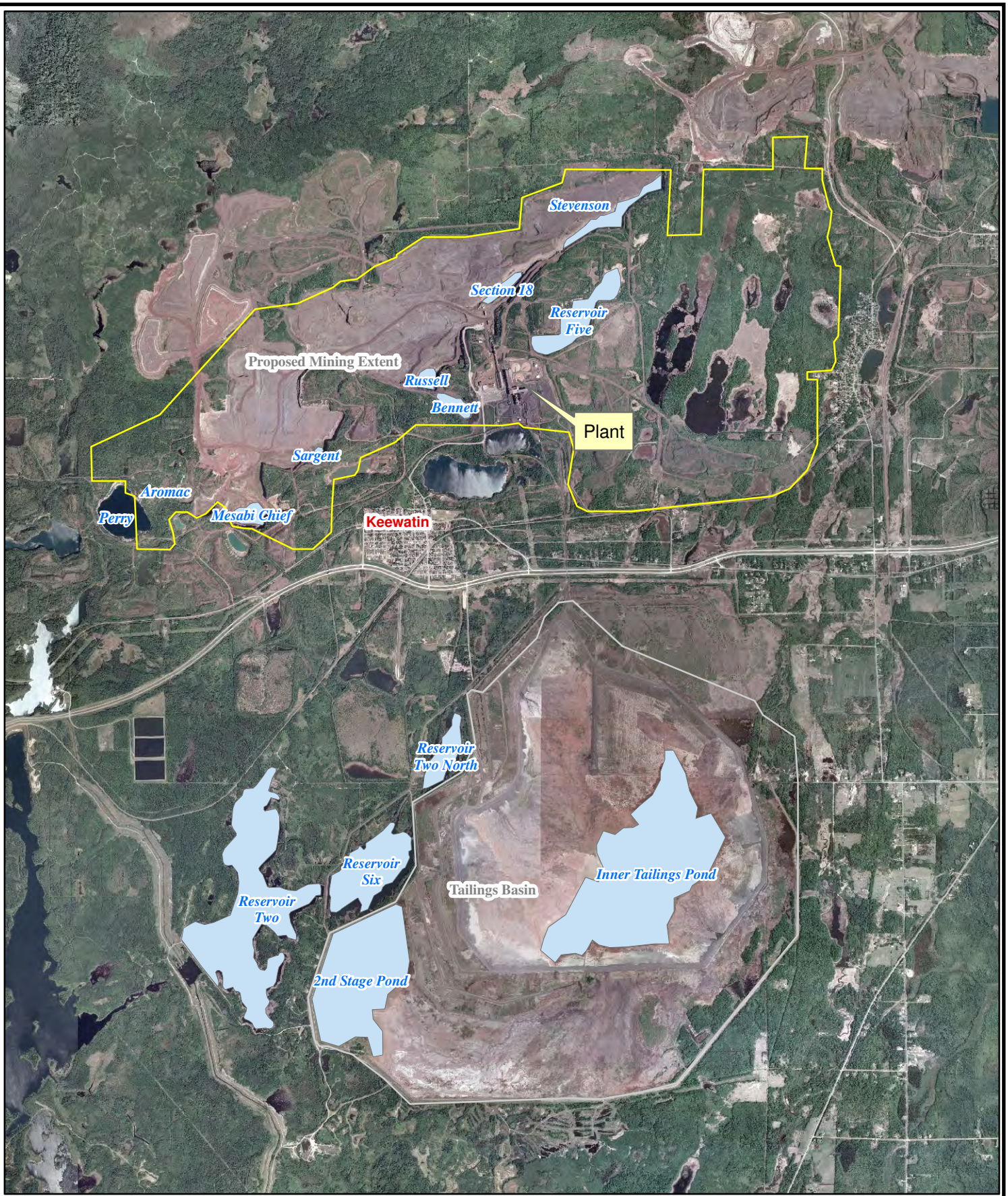
Reminder:

✓Did you enclose the Transmittal Form?
✓Did you enclose all necessary attachments?
Did you enclose the $350 app fee?

Applications submitted without an authorized signature, the required application fee and attachments, will be returned. Please make your check payable to the Minnesota Pollution Control Agency and mail to:

Minnesota Pollution Control Agency
Beckie Olson
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

APPENDIX A – FIGURES



Source: 2003 NAIP Orthophoto, MnDOT
Projection: NAD83 UTM Zone 15N

0 5,000 10,000 Feet

1:60,000
1 Inch = 5,000 Feet

N

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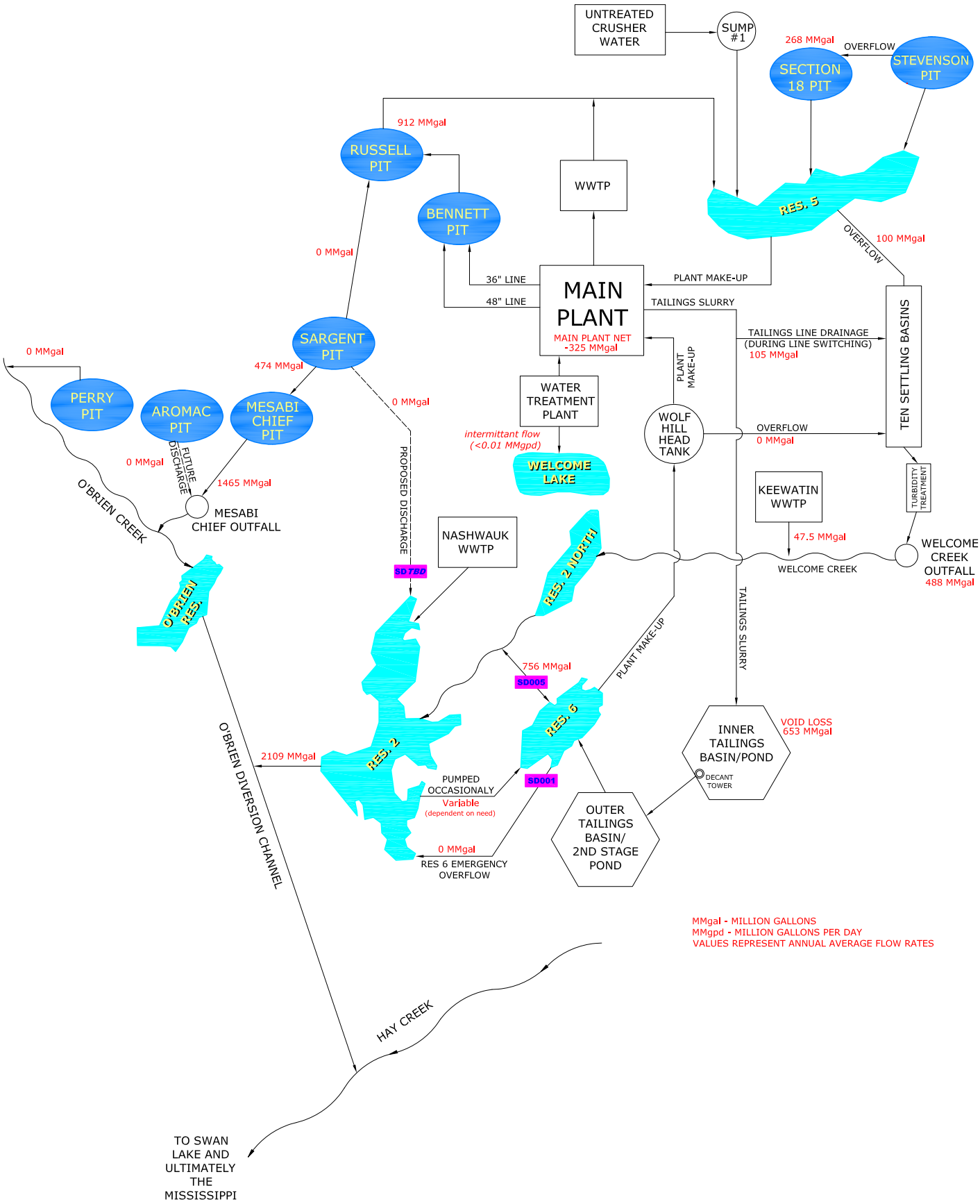
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U.S. Steel - Keetac

Feb 09

Site Location

Figure 1



version 10.02.09

LIESCH HYDROLOGISTS • ENGINEERS • ENVIRONMENTAL SCIENTISTS

6000 Gisholt Dr. Suite 203
Madison, WI 53713
(608) 223-1532

13400 15th Avenue N
Minneapolis, MN 55441
(763) 559-1423

4300 N. Miller Rd., Suite 211
Phoenix, Az 85251
(480) 421-0853

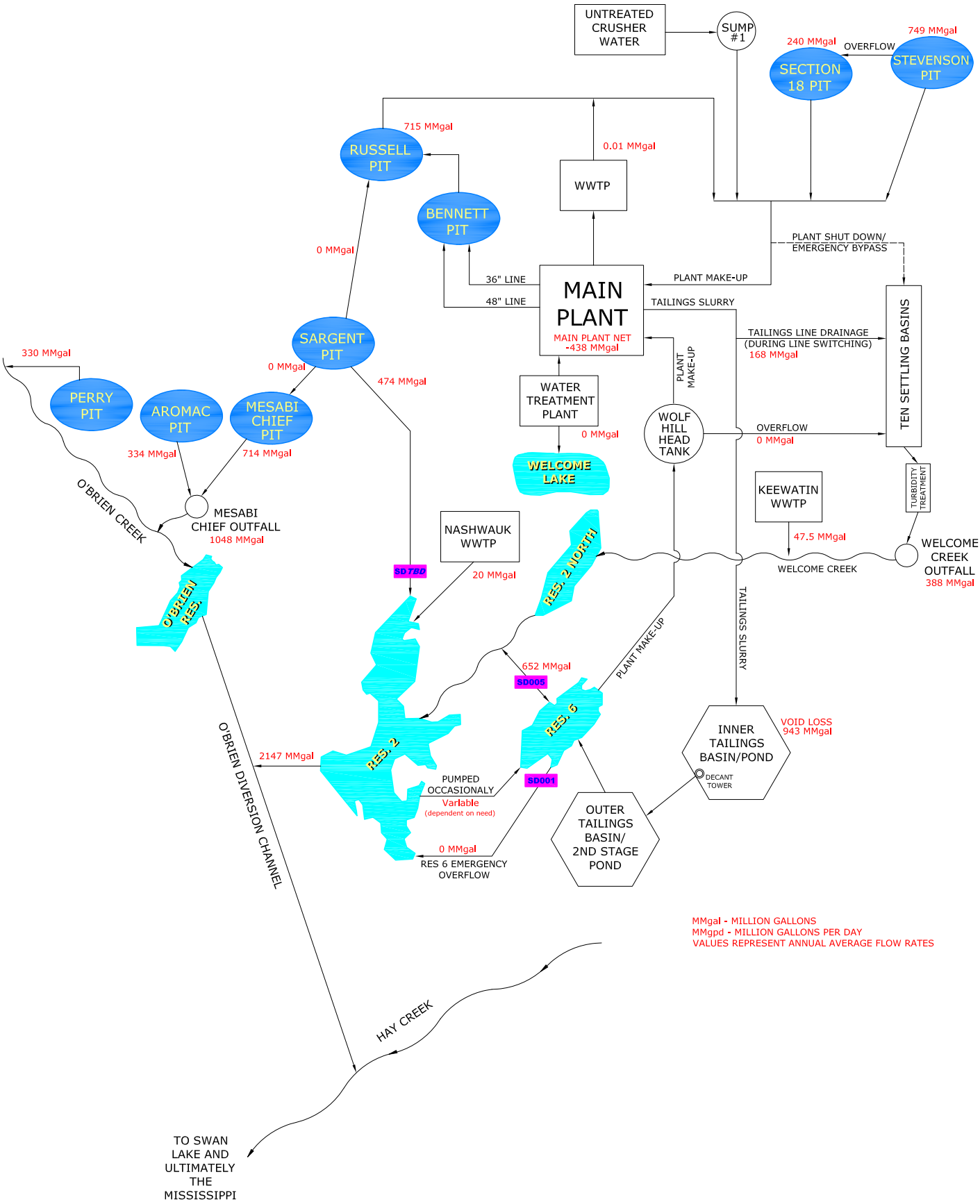
U. S. Steel - Keetac

Oct 09

Predicted Pre-Expansion Water Flow Rates Prior to Reservoir 5 Removal

FIGURE 2

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version 10.02.09

LIESCH HYDROLOGISTS • ENGINEERS • ENVIRONMENTAL SCIENTISTS

6000 Gisholt Dr. Suite 203
Madison, WI 53713
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13400 15th Avenue N
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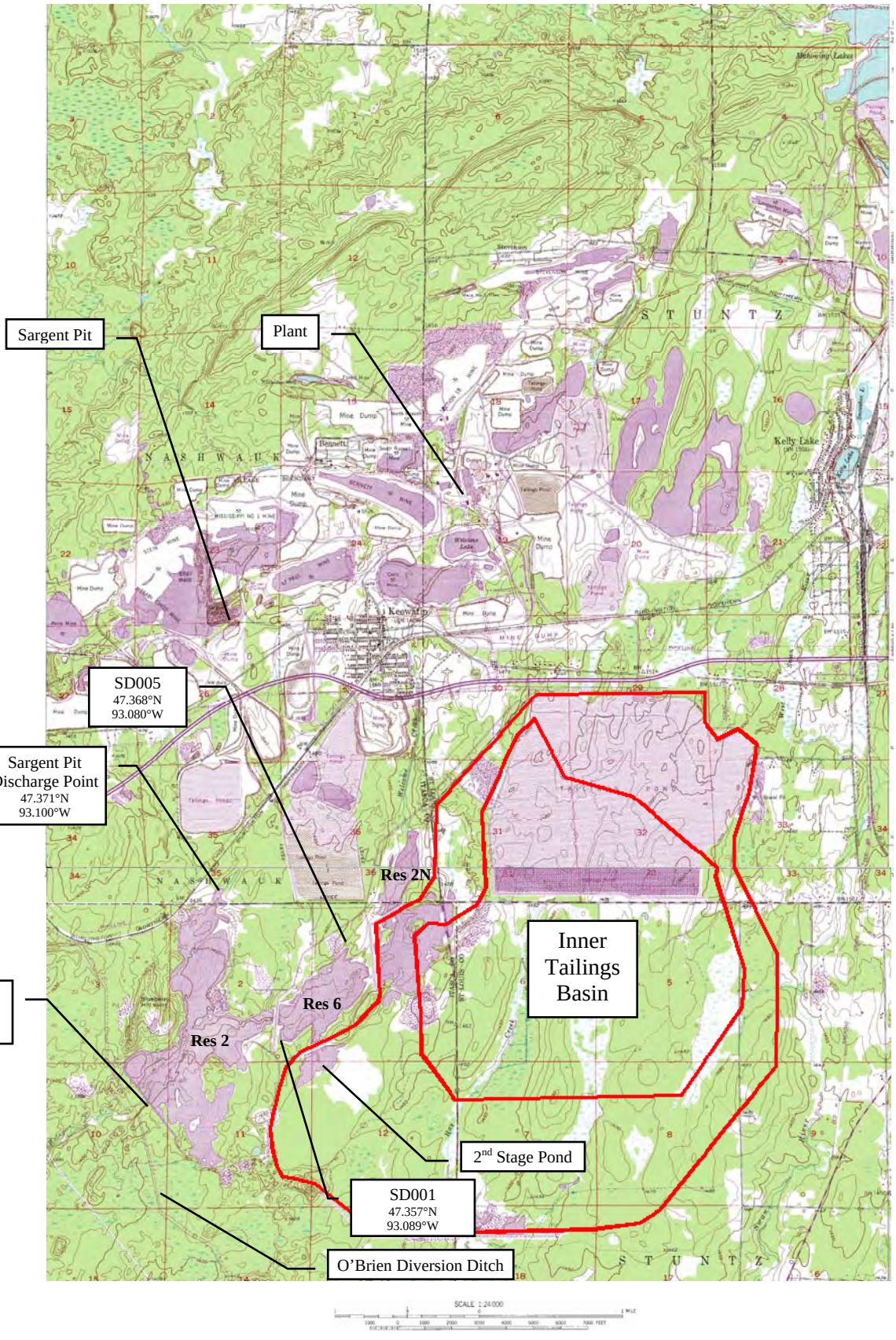
U. S. Steel - Keetac

Oct 09

Predicted Post-Expansion Water Flow Rates Following Reservoir 5 Removal

FIGURE 3

mok 10/02/09 1=1 w:\94213\CADD\FLOWSCHEMATIC WITH FLOWS NPDES.dwg



Source:USGS 7.5 minute topographic – Composite of Keewatin, MN and Silica, MN quadrangle

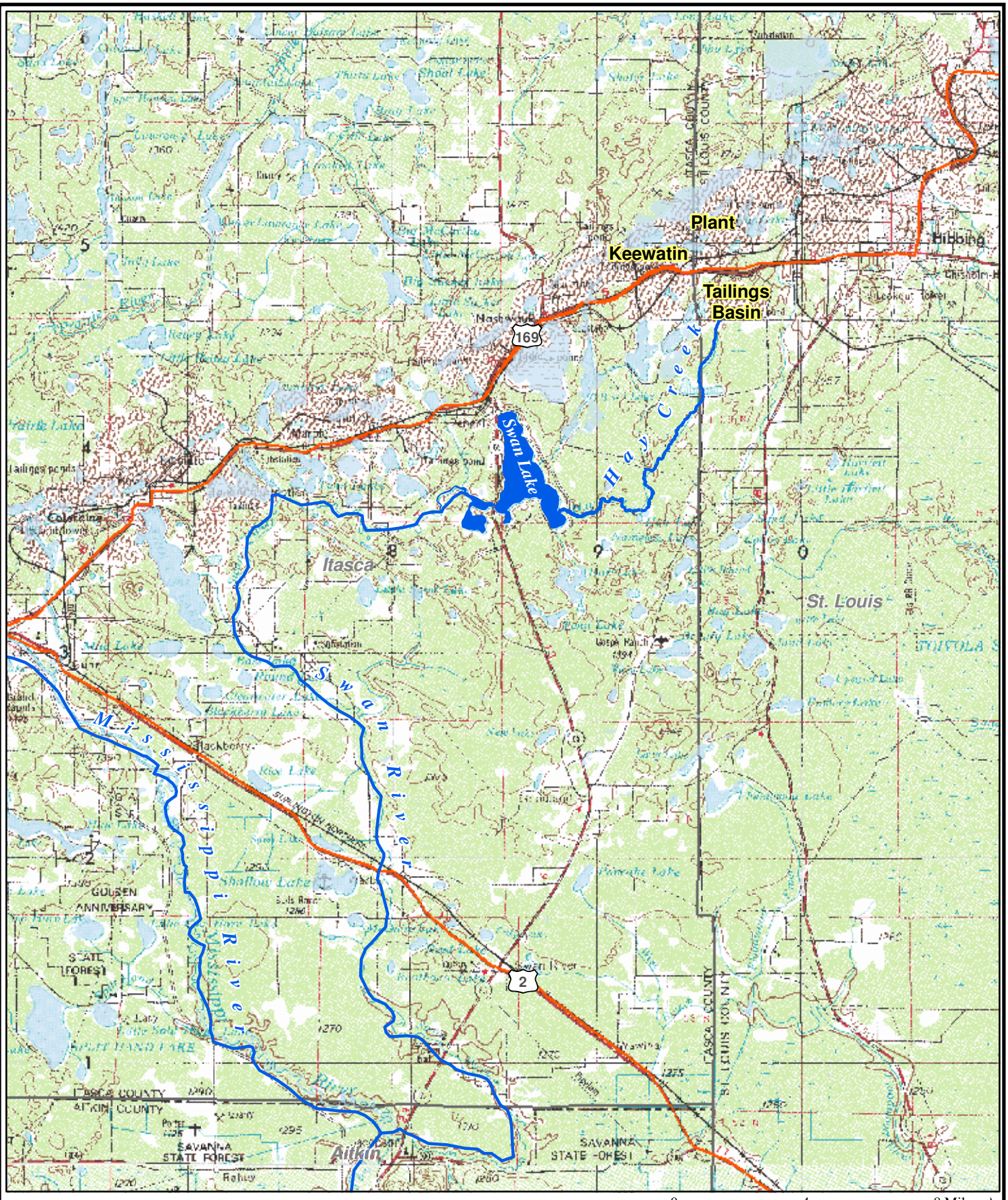
W:\ww\94213\NPDES Permit Applications\Tailings Basin\USGS Map.doc

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U. S. Steel - Keetac	**Oct 09**
USGS Topographic Map Facility Overview	**Figure 4**



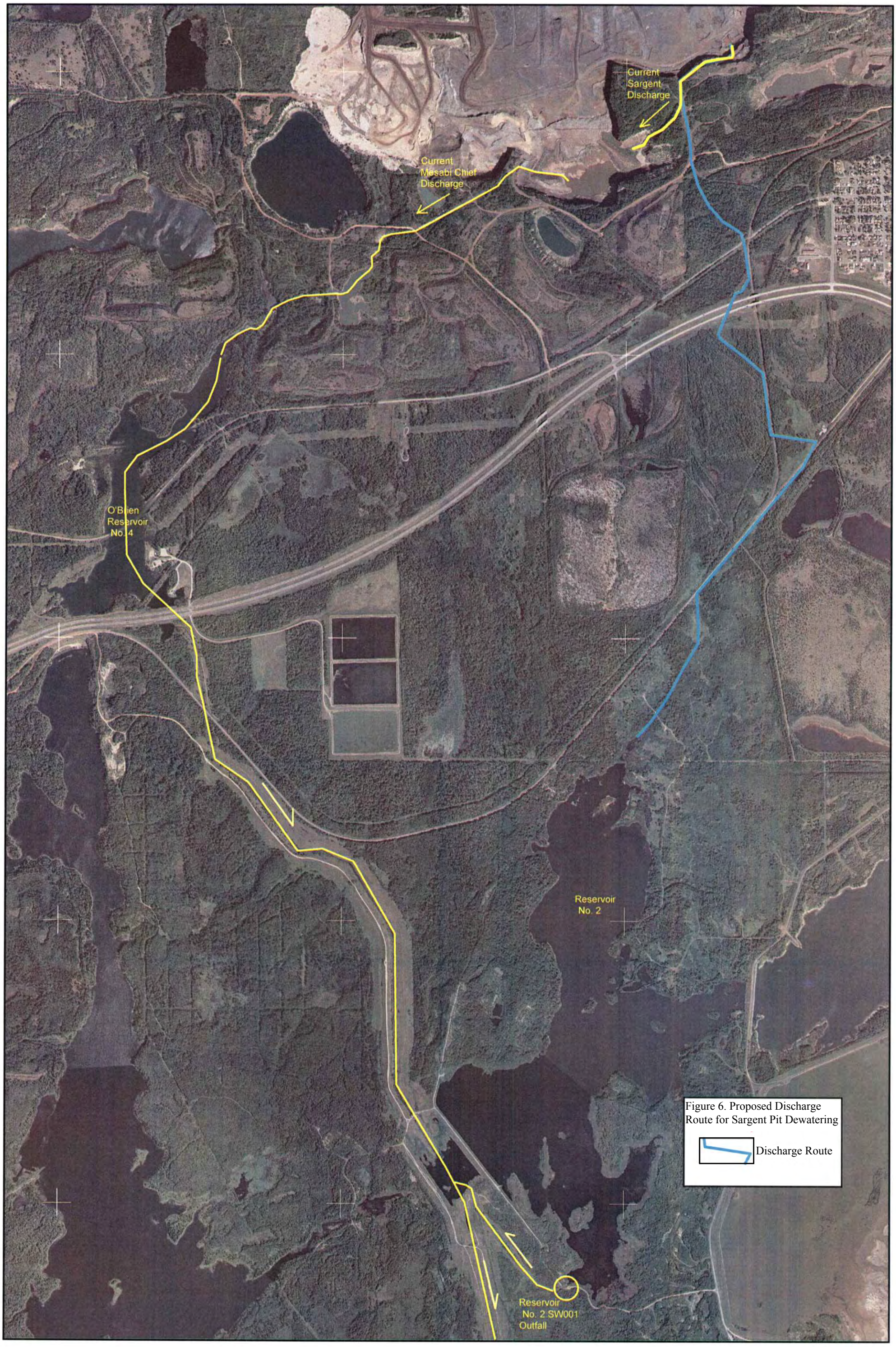
Source: Microsoft Virtual Earth Topos
Projection: NAD83 UTM Zone 15N

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U.S. Steel - Keetac	Nov 09
USGS Topographic Map Regional Overview	Figure 5


Current
Sargent
Discharge
Current
Mesabi Chief
Discharge
O'Brien
Reservoir
No. 4
Reservoir
No. 2
Reservoir
No. 2 SW001
Outfall
Figure 6. Proposed Discharge
Route for Sargent Pit Dewatering
Discharge Route

APPENDIX B – WATER QUALITY SAMPLING RESULTS

Table 1: SD001 Reservoir 6 Siphon Outfalls (Overflow) DMR Data

		Total Flow MG	Max Daily Flow mgd	Cobalt, Total (as Co) ug/L	Fluoride, Total (as F) mg/L	Iron, Dissolved (as Fe) CalMoAvg mg/L	Iron, Dissolved (as Fe) Max mg/L	Molybdenum, Total (as Mo) ug/L	Nitrite Plus Nitrate, Total (as N) mg/L	TSS CalMoAvg mg/L	TSS Max mg/L	Specific Cond. umh/cm	Strontium, Total (as Sr) ug/L	Sulfate, Total (as SO4) Max mg/L	pH Minimum s.u.	pH Maximum s.u.
2006-2009	DEC	No flow in 2006-2009														
	NOV															
	OCT															
	SEP															
	AUG															
	JUL															
	JUN															
	MAY															
	APR															
	MAR															
	FEB															
	JAN															
2005	DEC															
	NOV															
	OCT															
	SEP															
	AUG															
	JUL															
	JUN															
	MAY															
	APR															
	MAR			<1	1.4	<0.03	<0.03	47.6	0.77	<1	<1	686	66.6	68.4	8.2	8.2
	FEB															
	JAN															
2004	DEC			<1	1.1	<0.03	<0.03	33.4	0.14	8	8	637	83.3	67	8.7	8.7
	NOV															
	OCT															
	SEP			<1	1.3	0.03	0.03	35.4	0.59			561	63.9	64.9		
	AUG															
	JUL															
	JUN			<1	0.35	0.432	0.52	6.5	0.84			640	120	63.2		
	MAY															
	APR															
	MAR															
	FEB															
	JAN															
2003	DEC			<1	0.93			26.6	0.29			597	88.1	57.1		
	NOV															
	OCT															
	SEP			<1	1.3			28	5.1			625	56.6	77.6		
	AUG															
	JUL															
	JUN															
	MAY															
	APR															
	MAR															
	FEB															
	JAN															
2002	DEC			<1.0	1	<0.03	<0.03	26.2	2	5.3	5.3	542	77.5	52	8.2	8.2
	NOV															
	OCT															
	SEP			<1.0	1.2	<0.03	<0.03	32	1.5	4	4	534	60.7	62.4	8.56	8.56
	AUG															
	JUL															
	JUN			<1.0	1.7	<0.03	<0.03	47.6	2.8	<1.0	<1.0	546	73.7	63.7	8.1	8.1
	MAY															
	APR															
	MAR			<5.0	1.1	<0.03	<0.03	52	1.3	<1.0	<1.0	572	95.2	63.5	8.11	8.11
	FEB															
	JAN															
2001	DEC	No flow in 2001														
	NOV															
	OCT															
	SEP															
	AUG															
	JUL															
	JUN															
	MAY															
	APR															
	MAR															
	FEB															
	JAN															

Table 2: SD005 Reservoir 6 Weir Outfall 015 DMR Data

		Total Flow MG	Max Daily Flow mgd	Cobalt, Total (as Co) ug/L	Fluoride, Total (as F) mg/L	Iron, Dissolved (as Fe) CalMoAvg mg/L	Iron, Dissolved (as Fe) Max mg/L	Mercury, Total (as Hg) ng/L	Molybdenum, Total (as Mo) ug/L	Nitrite Plus Nitrate, Total (as N) mg/L	TSS CalMoAvg mg/L	TSS Max mg/L	Specific Cond. umh/cm	Strontium, Total (as Sr) ug/L	Sulfate, Total (as SO4) Max mg/L	Sulfate, Total (as SO4) CalMoAvg mg/L	pH Minimum s.u.	pH Maximum s.u.
2009	DEC																	
	NOV																	
	OCT																	
	SEP																	
	AUG																	
	JUL																	
	JUN				1.53			1.6		0.88								
	MAY	107.79	10.97			0.05	0.05				2	2	573			111	8.3	8.3
	APR	171.38	13.79			<0.05	<0.05				5.6	5.6	475			106	8.2	8.2
	MAR	138.2	6.77		0.67	<0.05	<0.05	0.5		1.09	1.6	1.6	596			135	8	8
	FEB	98	6.07			0.05	0.05				1	1	820			137	8.1	8.1
	JAN	6.89	0.49			0.091	0.091				1.3	1.3	845			107	7.5	7.5
2008	DEC																	
	NOV																	
	OCT																	
	SEP																	
	AUG																	
	JUL																	
	JUN	4.92	0.66		0.98	0.05	0.05	0.9		1.1	1	1	672			119	8	8
	MAY	31.2	4.92			0.05	0.05				1.6	1.6	658			122	8.4	8.4
	APR	147.49	10.62			0.05	0.05				1.6	1.6	795			115	7.9	7.9
	MAR																	
	FEB																	
	JAN																	
2007	DEC																	
	NOV																	
	OCT																	
	SEP																	
	AUG																	
	JUL																	
	JUN																	
	MAY	57.86	7.67			<0.05	<0.05				4	4	850			94.5	7.8	7.8
	APR	109.46	3.65			<0.05	<0.05				5.5	5.5	952			99.9	7.7	7.7
	MAR	16.7	0.54		1.73	<0.05	<0.05	2.2		1.47	6.4	6.4	880			109	7.6	7.6
	FEB																	
	JAN																	
2006	DEC																	
	NOV																	
	OCT																	
	SEP																	
	AUG																	
	JUL																	
	JUN				1.7			<0.2		1.5								
	MAY	38.2	5.7			<0.05	<0.05				4.8	4.8	615			87.3	8.7	8.7
	APR	54.7	7.81			0.05	0.05				3	3	463			82	7.8	7.8
	MAR																	
	FEB																	
	JAN																	
2005	DEC																	
	NOV																	
	OCT																	
	SEP																	
	AUG																	
	JUL																	
	JUN																	
	MAY																	
	APR	73.99	10.32			0.03	0.03				11.4	12	958		59.7		7.5	8.5
	MAR	18.29	7.84	<1	1.4	<0.03	<0.03		47.6	0.77	1.5	1.5	686	66.6	72.5		8.1	8.1
	FEB																	
	JAN																	
2004	DEC			<1.0	1.1	<0.03	<0.03		33.4	0.14	8	8	627	83.3	67		8.7	8.7
	NOV																	
	OCT					<0.03	<0.03				8	8	627		67		8.7	8.7
	SEP			<1	1.3	0.03	0.03		35.4	0.59			561	63.9	64.9			
	AUG																	
	JUL																	
	JUN	41.6	7.84	<1	0.35	0.432	0.52		6.5	0.84	6.23	7	640	120	63.2		8.7	8.9
	MAY	3.2	2.21															
	APR	25.18	2.95			0.29	0.52				4.5	5	536		63.2		7.1	7.6
	MAR	6.24	2.95	<1.0	1.3	<0.03	<0.03		36.2	1.2	6.7	6.7	758	86.4	87.4		8	8
	FEB																	
	JAN	0	0			<0.03	<0.03				2.4	2.4	682		71.7		8.2	8.2
2003	DEC			<1.0	0.93				26.6	0.29			597	88.1	57.1			
	NOV																	
	OCT																	
	SEP			<1	1.3				28	5.1			625	56.6	77.6			
	AUG																	
	JUL																	
	JUN	1.15	0.66	<1	1.2				31.8	2.3			627	81.8	67			
	MAY	21.04	2.3			<0.03	<0.03				1.5	2	620		67.7		8.3	8.5
	APR	66.41	4.04			<0.03	<0.03				3.9	6	627		67		8	8.4
	MAR			<1	1.2	<0.03	<0.03		34.6	2.3	2.7	2.7	622	81.5	68.7		8.2	8.2
	FEB																	
	JAN																	
2002	DEC	5.72	1.76	<1.0	1	<0.03	<0.03		26.2	2	3.3	5.6	566	77.5	56		8	8.2
	NOV	11.32	1.76			<0.03	<0.03				5.3	5.3	542		52		8.2	8.2
	OCT																	
	SEP			<1.0	1.2	<0.03	<0.03		32	1.5	4	4	534	60.7	62.4		8.56	8.45
	AUG																	
	JUL	36.55	9.54			<0.03	<0.03				1.75	2	551		85.6		8.2	8.5
	JUN	21.18	10.37	<1.0	1.7	<0.03	<0.03		47.6	2.8	<1.0	<1.0	546	73.7	63.7		8.1	8.1
	MAY	6.02	1.14			0.05	0.07				2.5	4	583		70.7		8.08	8.16
	APR	7.58	2.48			<0.03	<0.03				2.8	3.6	613		61.1		8.05	8.08
	MAR			<5.0	1.1	<0.03	<0.03		52	1.3	<1.0	<1.0	572	95.2	63.5		8.11	8.11
	FEB																	
	JAN																	
2001	DEC	9.38	0.71	<1.0	1.1	<0.03	0.03		27.9	0.71	2.27	2.8	548	69.2	56.9		7.72	7.7
	NOV	2.32	0.39			0.04	0.04				1.8	2	536		57.7		7.92	7.94
	OCT																	
	SEP																	
	AUG																	
	JUL																	
	JUN	142.33	11.27	<1.0	1.9	0.08	0.1		35.7	3.41	3.1	5.2	500	92.5	53.6		7.46	8.08
	MAY	187.23	15.51			0.048	0.06				6.48	14.4	529		61.2		7.85	8.1
	APR	676.6	28.46			0.065	0.11				5.8	9.2	664		77.4		7.86	8
	MAR	29.74	4.49	<1.0	0.97	0.03	0.03		28.5	2	1.75	2.5	589	94.2	70.8		7.41	7.69
	FEB	13.85	3.18			0.04	0.04				2.25	3.3	549		63.6		7.77	7.81
	JAN	27.02	1.1			<0.03	<0.03				1.7	2.4	531		74.4		6.48	7.87

Table 3. NPDES Permit Application Sampling Results - Metals

Metals

Sample Date	Aluminum ug/L	Antimony ug/L	Arsenic ug/L	Barium ug/L	Boron ug/L	Cadmium ug/L	Calcium mg/L	Chromium ug/L	Cobalt ug/L	Copper ug/L	Iron mg/L	Lead ug/L	Magnesium mg/L	Manganese ug/L	Mercury ng/L	Molybdenum ug/L	Nickel ug/L	Selenium ug/L	Tin ug/L	Titanium ug/L	Vanadium ug/L	Zinc ug/L
Applicable Water Quality Standard	**125**	**31**	**53**	**-**	**500**	**2.7***	**-**	**11**	**5**	**19***	**-**	**13***	**-**	**-**	**6.9**	**-**	**399***	**5**	**-**	**-**	**-**	**269***
SD-005 Res 6 Discharge																						
Sep 2004									<1							35.4						
Dec 2004									<1							33.4						
Mar 2005									<1							47.6						
Mar 2007											<0.05											
Apr 2007											<0.05											
May 2007											<0.05											
6/13/2008	29.1	<10	2.2	12.6	104	0.41	30.3	<2		<2		<1	55.3	49.3	<0.5		<2	<2	<25	<10	<10	<25
6/30/2008	<25	<10	<2	10.2	99.9	<0.2	29.1	<2		<2		<1	55.6	37.4	1		<2	2.3	<25	<10	<10	<25
8/1/2008	<25	<10	2.5	11.5	97.4	<0.2	27.6	<2		<2		<1	52.8	23	2.4		<2	<2	<25	<10	<10	<25
8/18/2008																						
AVERAGE	**< 26**	**< 10**	**< 2.23**	**11**	**< 100**	**< 0.27**	**29**	**< 2.0**	**< 1.0**	**< 2.0**	**< 0.05**	**< 1.0**	**55**	**37**	**< 1.30**	**39**	**< 2.0**	**< 2.10**	**< 25**	**< 10**	**< 10**	**< 25**
Sargent Pit																						
8/18/2008	<25	<10	4.7	35.6	<50	<0.2	61	<2	<2	<2	<0.05	<1	43.5	480	1.2	<5	<2	2.9	<25	<10	<10	<25

*Water quality standard variable depending on hardness. A hardness value of 300 mg/l was used to determine applicable standard.

Table 4. NPDES Permit Application Sampling Results - Non Metals

Non-Metals

Sample Date	Oil & Grease mg/L	BOD mg/L	Bromide mg/L	Chloride mg/L	COD mg/L	Fluoride mg/L	Nitrogen, Ammonia mg/L	Low-Level Phosphorus, Total mg/L	Solids, Filterable (TDS) mg/L	Solids, Nonfilterable (TSS) mg/L	Specific Conductance umhos	Sulfate mg/L	Turbidity NTU
Applicable Water Quality Standard	**-**	**-**	**-**	**230**	**-**	**-**	**-**	**0.03**	**700**	**-**	**1000**	*****	**25**
SD-005 Res 6 Discharge													
Mar 2005						1.4							
Jun 2006						1.7							
Mar 2007						1.7							
6/13/2008	<2	<3	<0.5	25.9	35.8		<0.1		394	2.8	914	120	2.7
6/30/2008	<2	<3	<0.5	24.4	29.2		0.42		403	1.6	720	106	1.6
8/1/2008	<2	<2.4	<1	22.9	21.5		0.19		378	2.4	714	106	1.8
8/18/2008								0.007					
9/26/2008								0.017					
10/17/2008								0.021					
Average	**< 2.0**	**< 2.8**	**< 0.67**	**24.4**	**28.8**	**1.6**	**< 0.24**	**0.015**	**392**	**2.3**	**783**	**111**	**2.0**
Sargent													
8/18/2008	<2	<2.4	<0.5	8.84	13.0	<0.1	0.19	<0.004	421	<1	660	113	0.3
9/26/2008								0.004					
10/17/2008								0.005					
Average	**< 2.0**	**< 2.4**	**< 0.50**	**8.8**	**13**	**< 0.10**	**< 0.19**	**< 0.0043**	**421**	**< 1.0**	**660**	**113**	**0.30**

* Class 4A waters include a 10 mg/l sulfate standard applicable to water used for production of wild rice. This limit is discussed in more detail in Section 6.0.

APPENDIX C – MATERIAL SAFETY DATA SHEETS (MSDS)

A summary table of estimated usages and MSDSs are included within this appendix for products utilized at Keetac that have the potential to impact discharges for which Keetac is requesting authorization under this NPDES Permit Application. The individual MSDSs follow the summary table.

The only compound not used within the taconite processing plant is the magnesium chloride solution used for dust suppressant at the facility. The remaining MSDSs included in this appendix are utilized within the processing plant. The process wastewater from the plant is discharged within the tailings slurry into the tailings basin, and therefore the tailings basin discharge has the potential to be impacted by these compounds.

U. S. Steel Keetac: Tailings Basin System NPDES Permit MSDS Review

Chemical List	Usage Estimate	Max Usage Estimate	Comment
Zetag 7130	460,000 lbs/yr	550,000 lbs/yr	flocculent added to the concentrator tailings slurry before the thickening stage
CL-2840	10,100 lbs/yr	12,120 lbs/yr	corrosion inhibitor used in closed-loop treated water system
CL-4074	9,200 lbs/yr	11,040 lbs/yr	corrosion inhibitor/descaler in vacuum pump
CL-2150	1,700 lbs/yr	2,040 lbs/yr	microbiocide used in closed-loop treated water system
Hydrated Lime	1,000 tons/yr	1,200 tons/yr	pH control in scrubber water system
P-817E	10,000 lbs/yr	12,000 lbs/yr	clarification and coagulation aid in scrubber
CL-16	16 gal/yr	19 gal/yr	water softener resin cleaner for the closed-loop water system
Diluted HCl*	16 gal/yr	19 gal/yr	used to clean pH probes
Rydlime*	240 gal/yr	288 gal/yr	used to clean lime handling systems
Super Gold	14 gal/yr	17 gal/yr	used to clean off heavy lime deposits
Magnesium Chloride Solution	4 tons/yr	4 tons/yr	dust suppression used at facility

* New chemical requesting authorization for discharge through this permit modification application.

CIBA ZETAG 7130 COAGULANT

NFPA Hazard codes:

Health: 1	Fire: 0	Reactivity: 0	Special: -

HMIS III rating

Health: 1	Flammability: 0	Physical hazard: 0	Personal protection: X

HMIS Note: * Indicates possible chronic health effects.

1. Identification of the Substance/Preparation and of the Company/Undertaking

Company Information

Company: Ciba Specialty Chemicals Corporation
2301 Wilroy Road
P.O.Box 820
Suffolk,VA 23434-0820
U.S.A.
Customer Service / Product Information: 1-800-322-3885
MSDS Request Line: 1-800-431-2360

Emergency information

Emergency 24-Hour Health/Environmental Phone: (24h) +1-800-873-1138

CHEMTREC: (800) 424-9300 (24hrs) or (703) 527-3887

Product information

Product: ZETAG 7130

Use: Coagulant.

2. Hazards Identification

Emergency overview

Signal word:	NOTICE! !
Colour:	straw yellow
Appearance:	liquid
State of matter:	liquid
Odour:	Slightly amine
Health:	Repeated or prolonged contact can cause skin irritation.
Physical/Chemical hazards:	Spills are very slippery.

Potential health effects

Primary routes of entry:

Skin, Eyes, Inhalation, Ingestion

3. Composition/Information on Ingredients

Chemical name	CAS Number	Content (Weight)	Hazardous
Poly-diallyl-dimethylammonium chloride Homopolymer	26062-79-3	33.0 - 37.0 %	Y

This material is classified as hazardous under OSHA regulations.

4. First-aid Measures

Inhalation:

Remove to fresh air, if not breathing give artificial respiration. If breathing is difficult, give oxygen and get immediate medical attention.

Skin:

If clothing is contaminated, remove and launder before reuse.
After contact with skin, wash immediately with plenty of water and soap.
Get medical attention if irritation occurs.

Eyes:

Immediately flush the eye(s) with lukewarm, gently flowing water for 15 minutes or until the chemical is removed.
Get immediate medical attention if irritation persists.

Ingestion:

Do not induce vomiting. If vomiting occurs naturally, have casualty lean forward to reduce the risk of aspiration.
Seek medical attention immediately.

5. Fire-fighting Measures

Suitable extinguishing media:

carbon dioxide, dry powder, foam, water fog

Unsuitable Extinguishing Media:

If water is used, restrict pedestrian and vehicular traffic in areas where slip hazard may exist.

Hazardous combustion products:

Carbon and nitrogen oxides., Ammonia., Hydrogen chloride.

Hazards during fire-fighting:

Standard procedure for chemical fires.
Cool fire-exposed containers with water.
Spills can cause very slippery conditions on floors.
Restrict pedestrian and vehicular traffic in areas where slip hazard may exist.

Protective equipment for fire-fighting:

Wear self-contained breathing apparatus and chemical-protective clothing.

6. Accidental Release Measures

Cleanup:

Pick up with inert absorbent material (e.g. sand, earth etc.).
Place into approved waste containers.
Wear suitable protective equipment.
Should not be released into the environment.

7. Handling and Storage

Handling

General advice:

As with all industrial chemicals, use good industrial practices when handling. Avoid eye, skin, and clothing contact. Do not inhale. Do not taste or swallow. Use only with adequate ventilation.

General advice:

Keep container tightly closed in a dry, cool and well-ventilated place.
Avoid extremes of temperature.
Temperature toleranceKeep from freezing.
Product will freeze but should recover upon warming and mixing.

> for industrial use only <

8. Exposure Controls and Personal Protection

Engineering Controls:

Work in well ventilated areas. Do not breathe vapors or mist.

Personal protective equipment

Respiratory protection:

Wear a NIOSH-certified respirator as necessary.

Eye protection:

Tightly fitting safety goggles (splash goggles) (EN 166)

Body protection:

Wear chemical resistant gloves and protective clothing.

General safety and hygiene measures:

There are no OSHA or ACGIH exposure guidelines available for component(s) in this product.
Eye wash station and safety shower should be available in immediate work area., Select additional protective equipment based upon potential for exposure.

9. Physical and Chemical Properties

Colour:	straw yellow	
Form:	liquid	
State of matter:	liquid	
Odour:	Slightly amine	
pH value:	5.5	
Evaporation rate:		Not tested
Flash point:	> 100 °C	
Self-ignition temperature:		Not tested
		Not tested
Boiling point:	> 100 °C	
Vapour pressure:		Not tested
Density:	1.1 g/cm3	
Vapour density:		Not tested
Partitioning coefficient n-octanol/water (log Pow):		Not applicable
Viscosity, dynamic:		Not tested
% Volatiles:		not determined
Solubility in water:		miscible
Solubility in other solvents:		Not tested

10. Stability and Reactivity

Stability:

Stable.

Conditions to avoid: Avoid temperature extremes, especially frost and freezing conditions.

Substances to avoid: Strong oxidizing agents., May react slowly with iron, copper, and aluminium resulting in corrosion and discoloration of product.

Possibility of Hazardous Reactions: No hazardous reactions known.

Hazardous decomposition products: No decomposition expected under normal storage conditions.

11. Toxicological Information

Acute oral toxicity:

LD50 / oral / rat: > 2,000 mg/kg
By analogy with a product of similar composition

Acute inhalation toxicity:

by inhalation:
not determined

Acute dermal toxicity:

dermal:
not determined

Skin irritation:

not determined

Eye irritation:

not determined

Skin Sensitization:

not determined

Subacute toxicity:

not determined

Chronic toxicity:

not determined

Subchronic Toxicty:

not determined

Genetic toxicity:

Not determined.

Carcinogenicity:

None of the components in this product at concentrations greater than 0.1% are listed by IARC; NTP, OSHA or ACGIH as a carcinogen.

Reproductive toxicity:

not determined

Developmental toxicity/teratogenicity:

not determined

12. Ecological Information

Toxicity to fish:

96 h/LC50: > 10 mg/l
By analogy with a product of similar composition

Toxicity to aquatic invertebrates:

48 h/EC50: > 10 mg/l
By analogy with a product of similar composition

Toxicity to aquatic plants:

Not tested

Toxicity to microorganisms:

Not tested

Biodegradation:

Not tested

13. Disposal Considerations

Waste disposal of substance:

Dispose of in accordance with national, state and local regulations.

Resource Conservation and Recovery Act (RCRA): Not a hazardous waste under RCRA (40 CFR 261).

14. Transport Information

U.S. Department of Transportation

The listed Transportation Classification does not address regulatory variations due to changes in package size, mode of shipment or other regulatory descriptors.

Road transport:

Special shipping information: Not classified as a dangerous good under transport regulations.

Air transport:

Special shipping information: Not classified as a dangerous good under transport regulations.

Inland-waterway transport:

Special shipping information: Not classified as a dangerous good under transport regulations.

15. Regulatory Information

US: Toxic Substances Control Act (TSCA):	All component(s) comprising this product are either exempt or listed on the TSCA inventory
Canada: Domestic Substances List (DSL):	All components either exempt or listed on the DSL

United States - Regulations

SARA Section 311/312 Hazard Communication Standard:

Acute Health:	Y	Fire:	N
Chronic Health:	N	Reactivity:	N
		Sudden release of pressure:	N

SARA Section 313 Toxic Chemical List:

This product does not contain any components reportable under Sec 313 (40 CFR 372).

OSHA hazard category:

This material is classified as hazardous under OSHA regulations.

Toxic Substances Control Act (TSCA) Significant New Use Rule (SNUR):

This product is not subject to a Significant New Use Rule (SNUR).

Toxic Substances Control Act (TSCA) Section 5(e) Consent Orders:

This product is not subject to a Section 5(e) Consent Order.

Toxic Substances Control Act (TSCA) Section 5(f):

This product is not subject to a Section 5(f)/6(a) rule.

Toxic Substances Control Act (TSCA) Section 12(b) Export Notification:

No components listed.

Clean Air Act - Hazardous Air Pollutants (HAP):

This product does not contain any Hazardous Air Pollutants (HAP), as defined by the U.S. Clean Air Act Section 112 (40 CFR 61).

Clean Air Act 111 - Volatile Organic Compounds (VOC):

This product does not contain any SOCMI Intermediate or Final VolatileOrganic Compounds (VOC), as defined by the U.S. Clean Air Act Section 111 (40 CFR 60.489).

Clean Air Act 602 - Ozone Depleting Substances (ODS):

This product neither contains, nor was manufactured with, a Class I or Class II ozone depleting substance (ODS), as defined by the U.S. Clean Air Act Section 602 (40 CFR 82, Subpt. A, App. A+B).

Clean Water Act - Priority Pollutants (PP):

This product does not contain any priority pollutants listed under the U.S. Clean Water Act Section 307(2)(1) Priority Pollutant List (40 CFR 401.15).

Pennsylvania Right to Know:

This product does not contain any components that are subject to the Pennsylvania Right-To-Know disclosure requirement.

California Proposition 65 - Chemicals Known to the State to Cause Cancer:

No components listed.

California Proposition 65 - Chemicals Known to the State to Cause Reproductive Toxicity:

No components listed.

International Regulations

Chemical Weapons Convention:

This product does not contain any component(s) listed under the Chemical Weapons Convention Schedule of Chemicals.

16. Other Information

Disclaimer:

The information contained herein is based upon data believed to be correct. However, no guarantee or warranty of any kind, expressed or implied, is made with respect to such data or information. The user is responsible for determining whether the product is suitable for its intended conditions of use.

END OF DATA SHEET

CHEMTREAT CL-2840

ChemTreat, Inc.

MATERIAL SAFETY DATA SHEET

Section 1. Chemical Product and Company Identification

Product Name:	**ChemTreat CL-2840**
Manufacturer's Name:	ChemTreat, Inc.
Emergency Telephone Number:	(800) 424-9300
Address (Corporate Headquarters)	4461 Cox Road, Glen Allen, VA 23060
Telephone Number for Information:	(800) 648-4579
Date of MSDS:	September 11, 2007

Section 2. Composition/Hazardous Ingredients

Component	CAS Registry #	Wt. %
Sodium nitrite	7632-00-0	30 - 60
Tolyltriazole, sodium salt	64665-57-2	0.5 – 1.5
Sodium hydroxide	1310-73-2	1 - 5

Section 3. Hazards Identification

Emergency Overview: Yellow colored liquid; mild odor; not flammable. Corrosive to eyes and skin.
Potential Health Effects:
Eyes – Will cause corrosive effects (burns or irreversible damage) to the eyes.
Skin – Will cause corrosive effects (burns or irreversible damage) to the skin.
Inhalation – Will cause corrosive effects (burns or irreversible damage) to the lungs, upper respiratory tract, and nose.
Ingestion – Will cause corrosive effects (burns or irreversible damage) to the mouth, throat, or digestive tract.
Chronic Effects/Carcinogenicity: Overexposure to sodium nitrite may produce low blood pressure, nausea, headache, weakness, and cyanosis. Persons with pre-existing diseases of the cardiovascular system or bone marrow or skin disorders or impaired pulmonary function may be more susceptible to the effects of this product.

Section 4. First Aid Measures

Inhalation: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get immediate medical attention.
Eyes: Immediately flush eyes with plenty of water for at least 15 minutes, holding eyelids apart to ensure flushing of entire eye surface. Get medical attention.

Skin: In case of contact, immediately wash with plenty of water while removing contaminated clothing. Seek medical advice. Wash and decontaminate clothing before reuse.
Ingestion: Do not induce vomiting. Call a physician or poison control center immediately. Never give anything by mouth to an unconscious person.

Section 5. Fire Fighting Measures

Flammable Properties: Not flammable
Suitable Extinguishing Media: Use extinguishing media appropriate to surrounding fire.
Fire & Explosion Hazards: Although product will not burn, high temperatures (above 900F) can result in decomposition and the release of nitrogen oxides.
Protective Equipment: If product is involved in a fire, wear full protective clothing including a positive-pressure, NIOSH-approved, self-contained breathing apparatus.

Section 6. Accidental Release Measures

Small Spill: Construct temporary dikes of dirt, sand, or any readily available inert material to prevent spreading of the material. Wearing appropriate personal protective equipment, move the leaking container to a containment area or plug the leak. Absorb on inert material, then shovel up and dispose of according to local, state, federal regulations.
Large Spill: Construct temporary dikes of dirt, sand, or any readily available inert material to prevent spreading of the product. Wearing appropriate personal protective equipment, close or cap valves and/or block or plug hole in leaking container and transfer to another container for proper disposal.

Section 7. Handling and Storage

Keep away from heat and oxidizers. Keep away from acids and reducing agents. Use only with adequate ventilation. Do not get in eyes, or on skin and clothing. Wash thoroughly after handling. Avoid breathing mists. Do not ingest. Store at ambient temperatures. Keep container securely closed when not in use. Label precautions also apply to empty container. Recondition or dispose of empty containers in accordance with government regulations. For industrial use only.

Section 8. Exposure Controls/Personal Protection

Use protective equipment in accordance with 29 CFR 1910 Subpart I. Good general ventilation should be sufficient to control airborne levels. Wear chemical splash goggles or safety glasses with full-face shield. Wear rubber gloves. Wash them after each use and replace as necessary. If conditions warrant, wear protective clothing such as boots, aprons, and coveralls to prevent skin contact. Maintain eyewash fountain and quick-drench facilities in work area.

Section 9. Physical and Chemical Properties

Appearance: Clear, yellow	Physical state: Liquid
Boiling Point: ~212°F	Solubility in Water: Complete
Evaporation Rate: 1	Specific Gravity: ~1.321
Freezing Point: <-9°F	Vapor Density: N/A

Melting Point: N/A	Vapor Pressure: <17.5
Molecular Weight: N/A	Viscosity: N/A
Odor: Mild	% VOCs: 0
pH: ~13.1	Flash Point: Not flammable

Section 10. Stability and Reactivity

Chemical Stability: Stable at normal temperatures and pressures.
Incompatibility: Cyanides, organics, ammonium salts, acids, reducing agents, and activated carbon
Hazardous Decomposition Products: Oxides of nitrogen and carbon
Hazardous Polymerization: Will not occur

Section 11. Toxicological Information

Nitrous acid, sodium salt: Oral LD50 (rats) = 85 mg/kg
Tolytriazole, sodium salt: Oral LD50 (female rats) = 640 mg/kg; Dermal LD50 (rabbits) = >2 g/kg;
TLV = 10 mg/m3 Nuisance Dust ACGIH

Section 12. Ecological Information

Fathead Minnow 96h LC50 = 76.6 mg/l; Ceriodaphnia Dubia 48h LC50 = 6.43 mg/l

Section 13. Disposal Considerations

Observe all federal, state and local regulations during disposal. In the original form, this material will have a Corrosivity hazardous waste characteristic (D002).

Section 14. Transport Information (not meant to be all inclusive)

D.O.T. Shipping Name: Corrosive liquid, n.o.s.
Technical Name: (Sodium nitrite; Sodium hydroxide)
Hazard Class 8 (Corrosive); UN1760; PG II

Section 15. Regulatory Information (*Not meant to be all inclusive – selected regulation represented)*

TSCA Status: All ingredients listed
CERCLA Reportable Quantity: Sodium hydroxide - 1,000 lbs.; Sodium nitrite - 100 lbs.
SARA Title III:
Section 302 Extremely Hazardous Substances: None
Section 313 Toxic Chemicals: Yes – Sodium nitrite
CALIFORNIA PROPOSITION 65: None known.

Section 16. Other Information

HMIS Hazard Rating:

Health: 2	Flammability: 0	Physical Hazard: 1	PPE: X (see note)

Note: PPE rating depends on circumstances of use. See Section 8 for recommended PPE.

SARA Hazard Categories - Section 311/312

Acute - Yes Chronic - No Fire - No Reactive - No Sudden Release - No

Prepared by Regulatory Affairs

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CHEMTREAT CL-4074

IHS Number: 50382

ChemTreat, Inc.

MSDS

MATERIAL SAFETY DATA SHEET

Section 1. Chemical Product and Company Identification

Product Name:	**ChemTreat CL-4074**
Manufacturer's Name:	ChemTreat, Inc.
Emergency Telephone Number:	(800) 424-9300
Address (Corporate Headquarters)	4461 Cox Road, Glen Allen, VA 23060
Telephone Number for Information:	(800) 648-4579
Date of MSDS:	April 5, 2007

Section 2. Composition/Hazardous Ingredients

Component	CAS Registry #	Wt. %
Aminotri(methylenephosphonic acid), hexapotassium salt	40588-62-3	40 - 70

Section 3. Hazards Identification

Emergency Overview: Clear light straw liquid; mild odor; Not flammable.
Potential Health Effects:
Eyes: May cause significant eye irritation.
Skin: May cause significant skin irritation.
Inhalation: May cause significant irritation to lungs, upper respiratory tract, and nose.
Ingestion: May cause significant irritation to digestive tract.
Chronic Effects/Carcinogenicity: Not listed by NTP, IARC, or OSHA. Not expected to be a reproductive toxic or a teratogen.

Section 4. First Aid Measures

Inhalation: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get immediate medical attention.
Eyes: Immediately flush eyes with plenty of water for at least 15 minutes, holding eyelids apart to ensure flushing of entire eye surface. Get medical attention.
Skin: In case of contact, immediately flush skin with plenty of water for at lest 15 minutes while removing contaminated clothing and shoes. Get medical attention immediately. Thoroughly wash or discard clothing and shoes before reuse.
Ingestion: If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Section 5. Fire Fighting Measures

Flammable Properties: Not flammable.
Suitable Extinguishing Media: Use water, carbon dioxide, dry chemical, or foam.
Fire & Explosion Hazards: Keep containers cool with water spray to minimize the potential of decomposition.
Protective Equipment: If product is involved in a fire, wear full protective clothing including a positive-pressure, NIOSH-approved, self-contained breathing apparatus.

Section 6. Accidental Release Measures

Small Spill: Construct temporary dikes of dirt, sand, or any readily available inert material to prevent spreading of the material. Wearing appropriate personal protective equipment, move the leaking container to a containment area or plug the leak. Absorb on inert material, then shovel up and dispose of according to local, state, federal regulations.
Large Spill: Construct temporary dikes of dirt, sand, or any readily available inert material to prevent spreading of the product. Wearing appropriate personal protective equipment, close or cap valves and/or block or plug hole in leaking container and transfer to another container for proper disposal.

Section 7. Handling and Storage

Keep away from heat and oxidizers. Use with adequate ventilation. Do not get in eyes, or on skin and clothing. Wash thoroughly after handling. Avoid breathing mists. Do not ingest. Store at ambient temperatures. Keep container securely closed when not in use. Label precautions also apply to empty container. Recondition or dispose of empty containers in accordance with government regulations. For industrial use only.

Section 8. Exposure Controls/Personal Protection

Use protective equipment in accordance with 29 CFR 1910 Subpart I. Good general ventilation should be sufficient to control airborne levels. Wear chemical splash goggles or safety glasses with full-face shield. Wear rubber gloves. Wash them after each use and replace as necessary. If conditions warrant, wear protective clothing such as boots, aprons, and coveralls to prevent skin contact. Maintain eyewash fountain and quick-drench facilities in work area.

Section 9. Physical and Chemical Properties

Appearance: Clear light straw
Boiling Point: ~226°F
Evaporation Rate: N/D
Freezing Point: ~9°F
Melting Point: N/A
Molecular Weight: N/A
Odor: Mild
pH: ~ 1.6
Physical state: Liquid
Solubility in Water: Miscible
Specific Gravity: ~1.336
Vapor Density: N/D
Vapor Pressure: N/D
Viscosity: N/A
% VOCs: N/D
Flash Point: Not flammable

Section 10. Stability and Reactivity

Chemical Stability: Stable at normal temperatures and pressures.
Incompatibility: Strong oxidizing agents
Hazardous Decomposition Products: Oxides of phosphorus and of carbon; acids of phosphorus.
Hazardous Polymerization: Will not occur.

Section 11. Toxicological Information

Dermal LD50 = 2000 mg/kg (rabbit); Oral LD50 = 5000 mg/kg (rat).

Section 12. Ecological Information

Ceriodaphnia Dubia: 48h LC50 = 732 mg/L
Pimephales promelas: 96h LC50 = 5,657 mg/L

Section 13. Disposal Considerations

Dispose of in accordance with local, state and federal regulations.

Section 14. Transport Information (not meant to be all inclusive)

D.O.T. Shipping Name: Corrosive liquid, acidic, organic, n.o.s.
D.O.T. Technical Name: Amino-Tri (Methylenephosphonic acid)
Hazard Class 8; UN3265; PG II; NAERG #153

Section 15. Regulatory Information (*Not meant to be all inclusive – selected regulation represented*)

TSCA Status: All ingredients listed
CERCLA Reportable Quantity: None
SARA Title III:
Section 302 Extremely Hazardous Substances: None
Section 313 Toxic Chemicals: None
CALIFORNIA PROPOSITION 65: None known.

Section 16. Other Information

HMIS Hazard Rating:
Health: 3 Flammability: 1 Physical Hazard: 1 PPE: X (see note)

Note: PPE rating depends on circumstances of use. See Section 8 for recommended PPE.

SARA Hazard Categories – Section 311/312
Acute – Yes Chronic – No Fire – No Reactive – No Sudden Release – No

Prepared by Regulatory Affairs

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CHEMTREAT CL-2150

IHS Number: 28693

MATERIAL SAFETY DATA SHEET

Section 1. Chemical Product and Company Identification

Product Name:	ChemTreat CL2150
Product Use:	Cooling Water Microbiocide and Paper Slimicide
Manufacturer's Name:	ChemTreat, Inc.
Emergency Telephone Number:	(800) 424–9300
Address (Corporate Headquarters):	4461 Cox Road Glen Allen, VA 23060
Telephone Number for Information:	(800) 648–4579
Date of MSDS:	May 29, 2008

Section 2. Hazard(s) Identification



Signal Word: **DANGER!**

Hazard Statement(s):

Causes severe skin burns and eye damage.
Causes serious eye damage.
Harmful in contact with skin.
Harmful if inhaled.
Harmful if swallowed.
Harmful to aquatic life.

Precautionary Statement(s):

Wear protective gloves/clothing and eye/face protection. Do not breathe dust/fume/gas/mist/vapors/spray. Do not eat, drink or smoke when using this product. Wash hands thoroughly after handling. Use only outdoors or in a well–ventilated area.

Section 3. Composition/Hazardous Ingredients

Component	CAS Registry #	Wt.%
5–chloro–2–methyl–4–isothiazolin–3–one	26172–55–4	1.11
2–methyl–4–isothiazolin–3–one	2682–20–4	0.39

Section 4. First Aid Measures

Inhalation:	Remove victim to fresh air and keep at rest in a position comfortable for breathing. Immediately call a poison center or doctor/physician.
Eyes:	Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center or doctor/physician.
Skin:	Immediately remove/take off all contaminated clothing. Rinse skin with water/shower. Wash contaminated clothing before re–use. Immediately call a poison center or doctor/physician.
Ingestion:	DO NOT INDUCE VOMITING. Rinse mouth. Call a POISON CENTER or doctor/physician.
Notes to Physician:	Probable mucosal damage may contraindicate the use of gastric lavage.
Additional First Aid Remarks:	Have the product container, label or MSDS with you when calling a poison control center or doctor, or when going for treatment.

Section 5. Fire Fighting Measures

Flammability of the Product:	Not flammable.
Suitable Extinguishing Media:	Use extinguishing media suitable to surrounding fire.
Specific Hazards Arising from the Chemical:	Use water spray to keep containers cool.
Protective Equipment:	If product is involved in a fire, wear full protective clothing including a positive–pressure, NIOSH approved, self–contained breathing apparatus.

Section 6. Accidental Release Measures

Personal Precautions:	Use appropriate Personal Protective Equipment (PPE).
Environmental Precautions:	This pesticide is toxic to fish and aquatic organisms. Do not discharge effluent containing this product into lakes, ponds, streams, estuaries, oceans or public waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit, and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA.

Methods for Cleaning up: Contain and recover liquid when possible. Flush spill area with water spray.

Other Statements: If RQ (Reportable Quantity) is exceeded, report to National Spill Response Office at 1-800-424-8802.

Section 7. Handling and Storage

Handling: Wear appropriate Personal Protection Equipment (PPE) when handling this product. Do not get in eyes, or on skin and clothing. Wash thoroughly after handling. Do not ingest. Avoid breathing vapors, mist or dust.

Storage: Store away from incompatible materials (see Section 10). Store at ambient temperatures. Keep container securely closed when not in use. Label precautions also apply to empty container. Recondition or dispose of empty containers in accordance with government regulations. For Industrial use only.
Store in corrosive resistant container with a resistant inliner.

Section 8. Exposure Controls/Personal Protection

Exposure Limits

Component	Source	Exposure Limits
5-chloro-2-methyl-4-isothiazolin-3-one		N/E
2-methyl-4-isothiazolin-3-one		N/E

Carcinogenicity Category

Component	Source	Code	Brief Description
5-chloro-2-methyl-4-isothiazolin-3-one			N/E
2-methyl-4-isothiazolin-3-one			N/E

Engineering Controls: Use only with adequate ventilation. The use of local ventilation is recommended to control emission near the source.

Personal Protection

Eyes: Wear chemical splash goggles or safety glasses with full-face shield. Maintain eyewash fountain in work area.

Skin: Maintain quick-drench facilities in work area.
Wear butyl rubber or neoprene gloves. Wash them after each use and replace as necessary. If conditions warrant, wear protective clothing such as boots, aprons, and coveralls to prevent skin contact.

Respiratory: If misting occurs, use NIOSH approved organic vapor/acid gas dual

cartridge respirator with a dust/mist prefilter in accordance with 29 CFR 1910.134.

Section 9. Physical and Chemical Properties

Physical State and Appearance:	Liquid, Green, Clear
Specific Gravity:	1.0290
pH:	3.6
Freezing Point:	32°F
Flash Point:	N/D
Odor:	Mild
Melting Point:	N/A
Boiling Point:	N/D
Solubility in Water:	Complete
Evaporation Rate:	<1
Vapor Density:	N/D
Molecular Weight:	N/D
Viscosity:	N/A
Flammable Limits:	N/A
Autoignition Temperature:	N/A
Density:	8.58 lb/ga
Vapor Pressure:	N/D
% VOC	0

Section 10. Stability and Reactivity

Chemical Stability: Stable at normal temperatures and pressures.

Incompatibility with Various Substances: Strong oxidizers, Strong bases

Hazardous Decomposition Products: Oxides of nitrogen, Oxides of sulfur, Oxides of carbon, Halogenated compounds

Possibility of Hazardous Reactions: None known.

Section 11. Toxicological Information

Chemical Name	Exposure	Type of Effect	Concentration	Species
ChemTreat CL2150	Oral	LD50	3810 mg/kg	Rat
	Dermal	LD50	>5000 mg/kg	Rabbit
	Inhalation	LD50	13.7 mg/l	Rat

Comments: None.

Section 12. Ecological Information

Species	Duration	Type of Effect	Test Results
Daphnia magna	48h	LC50	10.7 mg/l
Bluegill Sunfish	96h	LC50	18.6 mg/l
Ceriodaphnia dubia	48h	EC50	10.7 mg/l
Rainbow Trout	96h	LC50	12.6 mg/l
Sheepshead Minnow	96h	LC50	70.7 mg/l
Mysid Shrimp	48h	LC50	46.1 mg/l

Comments: None.

Section 13. Disposal Considerations

PESTICIDE DISPOSAL: Pesticide wastes are toxic. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal Law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance. CONTAINER DISPOSAL: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or if allowed by state and local authorities, by burning. If burned, stay out of smoke.

Section 14. Transport Information

DOT Classification

DOT Name: CORROSIVE LIQUIDS, N.O.S.
Technical Name: (5-CHLORO-2-METHYL-4-ISOTHIAZOLIN-3-ONE; 2-METHYL-4-ISOTHIAZOLIN-3-ONE)
Hazard Class: Corrosive
UN/NA#: UN1760
Packing Group: PGII

Section 15. Regulatory Information

Inventory Status

United States (TSCA): All ingredients listed.
Canada (DSL/NDSL): All ingredients listed.

Federal Regulations

SARA Title III Rules

Sections 311/312 Hazard Classes

Fire Hazard:	No
Reactive Hazard:	No
Release of Pressure:	No
Acute Health Hazard:	Yes
Chronic Health Hazard:	No

Other Sections

Component	Section 313 Toxic Chemical	Section 302 EHS TPQ	CERCLA RQ
5-chloro-2-methyl-4-isothiazolin-3-one	N/A	N/A	N/A
2-methyl-4-isothiazolin-3-one	N/A	N/A	N/A

State Regulations

California Proposition 65: None known.

Special Regulations

Component	States
5-chloro-2-methyl-4-isothiazolin-3-one	None
2-methyl-4-isothiazolin-3-one	None

International Regulations

Canada

WHMIS Classification: N/A

Controlled Product Regulations (CPR): N/A

Section 16. Other Information

HMIS Hazard Rating

Health:	3
Flammability:	0
Physical Hazard:	0
PPE:	X

Notes: The PPE rating depends on circumstances of use. See Section 8 for recommended PPE.
The Hazardous Material Information System (HMIS) is a voluntary, subjective alpha–numeric symbolic system for recommending hazard risk and personal protection equipment information. It is a subjective rating system based on the evaluator's understanding of the chemical associated risks. The end–user must determine if the code is appropriate for their use.

NSF: N/A

FDA: All ingredients in this product are authorized in 21 CFR 176.170 and 21 CFR 176.180.

KOSHER: This product is certified by the Orthodox Union as kosher pareve.

FIFRA: This product is an EPA registered biocide. 15300–24

Other: None

Abbreviations

Abbreviation	Definition
<	Less Than
>	Greater Than
ACGIH	American Conference of Governmental Industrial Hygienists
EHS	Environmental Health and Safety Dept
N/A	Not Applicable
N/D	Not Determined
N/E	Not Established
OSHA	Occupational Health and Safety Dept
PEL	Personal Exposure Limit
STEL	Short Term Exposure Limit
TLV	Threshold Limit Value
TWA	Time Weight Average
UNK	Unknown

Prepared by: Regulatory Affairs Department

Disclaimer

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HYDRATED LIME (CUTLER-MAGNER)

Cutler-Magner Company
12th Avenue West and Waterfront
P.O. Box 16807
Duluth, Minnesota 55816-0807

IHS Number: 56784

Material Safety Data Sheet

PRODUCT IDENTIFICATION	CHEMICAL ABSTRACT NO.	DATE REVISED
CALCIUM HYDROXIDE - HYDRATED LIME	**CAS No. 1305-62-0**	**08/01/2005**

Section I

MANUFACTURER		HMIS II RATING
Cutler-Magner Company Foot of Hill Avenue Superior, WI 54880	24 Hour Emergency Contact Number: (715) 392-5146 Ask for Supervisor On Call Telephone Number for Information: (800) 232-1302	Health - **3** Flammability - **0** Physical Hazard - **1** Personal Protective Equip - **E**
	Other Common Names: Hydrate, Slaked Lime Trade Name(s): Rockport, Cutler's Barn & Ag, Kelly Island	

Section II – Hazardous Ingredients / Identity Information

Specific Chemical Identity; Common Names	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (Optional)
Calcium Hydroxide - Total Calcium Hydroxide - Respirable	15 mg/m^3 5 mg/m^3	5 mg/m^3		
Crystalline Silica (Quartz)	0.1 mg/m^3	0.05 mg/m^3	OSHA Calculation	< 0.10 %

Calcium Hydroxide is not listed on the NTP, IARC, or OSHA lists of carcinogens. Cutler-Magner Company recommends using personal protection equipment when handling this product.

Section III – Physical / Chemical Characteristics

Boiling Point (Calcium Oxide)	2850 °C	Specific Gravity (H_2O = 1)	2.2-2.3
Vapor Pressure (mm Hg)	NA	Melting Point	NA
Vapor Density (Air = 1)	NA	Evaporation Rate	NA
Solubility in Water	0.185 % @ 0 ° C; 0.077 % @ 100 ° C		
Appearance and Color	White powder; faint earthy odor		

Section IV – Fire and Explosion Hazard Data

Flash Point	NA	Flammable Limits – NA
Extinguishing Method	NA	
Special Fire Fighting Procedures	NA	
Unusual Fire and Explosion Hazards	NA	

Section V – Reactivity Data

Stability	Unstable		Conditions to Avoid – NA
	Stable	X	
Incompatibility (Materials to Avoid)		Acids, Reactive Fluoridated or Brominated Compounds, Reactive Powdered Metals, Organic Acid Anhydrides, Nitro-Organic Compounds, Reactive Phosphorous Compounds, Interhalogenated Compounds	
Hazardous Decomposition or Byproducts		None	
Hazardous Polymerization	May Occur		Conditions to Avoid – NA
	Will Not Occur	X	

Section VI – Health Hazard Data

Route(s) of Entry	Inhalation? - YES	Absorption Through Skin? – YES	Ingestion (swallowing)? - YES
Health Hazards	Acute	Corrosive to skin and eyes. Causes irritation and inflammation to mucous membrane and respiratory passages.	
	Chronic		
Toxicological Information	Not listed by MSHA, OSHA, or IARC as a carcinogen, but this product may contain trace amounts of crystalline silica, which has been classified by IARC as (Group 1) carcinogenic to humans when inhaled in the form of quartz or crystobalite. ORL-RAT LD 50: 7340 mg/kg ORL-MUS LD50: 7300 mg/kg		
Signs and Symptoms of Exposure		Irritation of skin, eyes, and respiratory tract.	
Medical Conditions Generally Aggravated by Exposure		Respiratory disease, skin condition.	
Emergency and First Aid Procedures		Remove to fresh air. Wash dust with soap and water. Flush out eyes with generous amounts of water. Drink plenty of water if swallowed. See Physician.	

Section VII – Precautions for Safe Handling

Steps to Be Taken in Case Material is Released or Spilled	Normal clean-up procedures. Care should be taken to avoid causing dust to become airborne. Vacuum cleaning systems are recommended.
Waste Disposal Method	Dispose of product in accordance with Federal, State and Local regulations.
Precautions to Be Taken in Handling	Store away from water and acids.
Other Precautions	None.

Section VIII – Control Measures

Respiratory Protection - Dust filter mask is recommended as minimal protection		
Ventilation	Local Exhaust – To maintain TLV and PEL Mechanical – To maintain TLV and PEL	Special – None Other – None
Protective Gloves – Cloth or leather gloves will protect skin		
Eye Protection – Fitted goggles will reduce eye injury		
Other Protective Clothing – Long sleeve shirts and pants		
Work / Hygienic Practices – Maintain dust exposure limits below TLV and PEL. If not possible – use respiratory protection		

Section IX – Ecological Information

Ecotoxicity: Because of the high pH of this product, in high concentrations it would be expected to produce significant ecotoxicity upon exposure to aquatic organisms and aquatic systems.

Environmental Fate: This material shows no bioaccumulation effect or food chain toxicity.

Section X – Regulatory Information

EPA

RCRA Hazardous Waste Classification (40 CFR 261): Not Listed
RCRA Hazardous Waste Number (40 CFR 261.33): Not Listed
ERCLA Hazardous Substance (40 CFR 302.4): Unlisted specific per RCRA, Sec. 3001; CWA, Sec.311 (b)(4); CWA, Sec. 307(a), CAA, Sec. 112
CERCLA Reportable Quantity (RQ): Not Listed
SARA 311/312 Codes: Not Listed
SARA Toxic Chemical (40 CFR 372.65): Not Listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not Listed; Threshold Planning Quantity (TPQ): Not Listed
All chemical ingredients are listed on the USEPA TSCA Inventory List

OSHA / MSHA

Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): 5 mg/M^3 TWA-8
MSHA: Not Listed
OSHA Specifically Regulated Substance (29 CFR 1910): Not Listed

Canada

WHIMS Classification: "E" Corrosive Materials
CANADA DSL: Listed

State Regulations

Consult state and local authorities for guidance

Other

HMIS: Health Risk 3, Flammability 0, Reactivity 1, Personal Protection E
NFPA: Health Hazard 3, Fire Hazard 0, Reactivity 1
DOT: For aircraft transport only, Calcium Oxide is classified as Hazard Class 8
- Corrosive, UN 1910, Packing Group 3

The above information is believed to be correct as of the date hereof. However, no warranty of merchantability, fitness for any use, or any other warranty is expressed or is to be implied regarding the accuracy of these data, the results to be obtained from the use of the material, or the hazards connected with such use. Since the information contained herein may be applied under conditions beyond our control and with which we may be unfamiliar and since data made available subsequent to the data hereof may suggest modification of the information, we do not assume responsibility for the results of its use. This information is furnished on the condition that the person(s) receiving it shall make their own determination as to the suitability of the material for their particular purpose and on the condition that they assume the risk of use thereof.

CHEMTREAT P817E

ChemTreat, Inc.

MSDS

MATERIAL SAFETY DATA SHEET

Section 1. Chemical Product and Company Identification

Product Name:	ChemTreat P817E
Product Use:	Water Clarification/Solids Conditioning Agent
Manufacturer's Name:	ChemTreat, Inc.
Emergency Telephone Number:	(800) 424-9300
Address (Corporate Headquarters):	4461 Cox Road Glen Allen, VA 23060
Telephone Number for Information:	(800) 648-4579
Date of MSDS:	March 13, 2008

Section 2. Hazard(s) Identification



Signal Word: WARNING!

Hazard Statement(s): May be harmful in contact with skin.
May be harmful if inhaled.
May be harmful if swallowed.

Precautionary Statement(s): No significant health risks are expected from exposures under normal conditions of use.

Section 3. Composition/Hazardous Ingredients

Component	CAS Registry #	Wt.%
There are no hazardous ingredients in this product as defined in 29 CFR 1910-1200.	Proprietary	N/A

Section 4. First Aid Measures

Inhalation: Remove to fresh air and keep at rest in a position comfortable for breathing. Call a poison center or doctor/physician if you feel unwell.

Eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists, get medical advice/attention.

Skin: Wash with plenty of soap and water. Call a poison center or doctor/physician if you feel unwell.

Ingestion: DO NOT INDUCE VOMITING. Rinse mouth. Call a POISON CENTER or doctor/physician if you feel unwell.

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Notes to Physician:	N/A
Additional First Aid Remarks:	N/A

Section 5. Fire Fighting Measures

Flammability of the Product:	Not flammable.
Suitable Extinguishing Media:	Use extinguishing media suitable to surrounding fire.
Specific Hazards Arising from the Chemical:	None known.
Protective Equipment:	If product is involved in a fire, wear full protective clothing including a positive–pressure, NIOSH approved, self–contained breathing apparatus.

Section 6. Accidental Release Measures

Personal Precautions:	Use appropriate Personal Protective Equipment (PPE).
Environmental Precautions:	Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains, and sewers.
Methods for Cleaning up:	Contain and recover liquid when possible. Flush spill area with water spray.
Other Statements:	None.

Section 7. Handling and Storage

Handling:	Wear appropriate Personal Protection Equipment (PPE) when handling this product. Do not get in eyes, or on skin and clothing. Wash thoroughly after handling. Do not ingest. Avoid breathing vapors, mist or dust. Material is very slippery if spilled.
Storage:	Store away from incompatible materials (see Section 10). Store at ambient temperatures. Keep container securely closed when not in use. Label precautions also apply to empty container. Recondition or dispose of empty containers in accordance with government regulations. For Industrial use only. Keep from freezing. Do not store below 41°F. Do not store above 86°F.

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Section 8. Exposure Controls/Personal Protection

Exposure Limits

Component	Source	Exposure Limits
There are no hazardous ingredients in this product as defined in 29 CFR 1910–1200.		N/E

Carcinogenicity Category

Component	Source	Code	Brief Description
There are no hazardous ingredients in this product as defined in 29 CFR 1910–1200.			N/E

Engineering Controls: Use only with adequate ventilation. The use of local ventilation is recommended to control emission near the source.

Personal Protection

Eyes: Wear chemical splash goggles or safety glasses with full–face shield. Maintain eyewash fountain in work area.

Skin: Maintain quick–drench facilities in work area.
Wear butyl rubber or neoprene gloves. Wash them after each use and replace as necessary. If conditions warrant, wear protective clothing such as boots, aprons, and coveralls to prevent skin contact.

Respiratory: If misting occurs, use NIOSH approved organic vapor/acid gas dual cartridge respirator with a dust/mist prefilter in accordance with 29 CFR 1910.134.

Section 9. Physical and Chemical Properties

Physical State and Appearance:	Liquid Emulsion, White, Opaque
Specific Gravity:	1.0720
pH:	6.0 – 8.0
Freezing Point:	0°F
Flash Point:	N/D
Odor:	Mild
Melting Point:	N/A
Boiling Point:	N/D
Solubility in Water:	Complete
Evaporation Rate:	N/D
Vapor Density:	N/D
Molecular Weight:	N/D
Viscosity:	N/A
Flammable Limits:	N/A
Autoignition Temperature:	N/A
Density:	8.94 lb/ga

Vapor Pressure:	N/D
% VOC	N/D

Section 10. Stability and Reactivity

Chemical Stability: Stable at normal temperatures and pressures.

Incompatibility with Various Substances: Strong oxidizers

Hazardous Decomposition Products: Oxides of carbon, Oxides of nitrogen

Possibility of Hazardous Reactions: None known.

Section 11. Toxicological Information

Chemical Name	Exposure	Type of Effect	Concentration	Species
ChemTreat P817E	Oral	LD50	>5000 mg/kg	Rat

Comments: None.

Section 12. Ecological Information

Species	Duration	Type of Effect	Test Results
Fathead Minnow	96h	LC50	>1000 mg/l
Algae	72h	EC50	>1000 mg/l
Daphnia magna	48h	LC50	15 mg/l

Comments: None.

Section 13. Disposal Considerations

Dispose of in accordance with local, state and federal regulations.
Not a RCRA–regulated hazardous waste when disposed in the original product form.

Section 14. Transport Information

DOT Classification

DOT Name:	COMPOUND, INDUSTRIAL WATER TREATMENT, LIQUID
Technical Name:	N/A
Hazard Class:	Not D.O.T. Regulated.
UN/NA#:	N/A
Packing Group:	N/A

Section 15. Regulatory Information

Inventory Status

United States (TSCA):	All ingredients listed.
Canada (DSL/NDSL):	All ingredients listed.

Federal Regulations

SARA Title III Rules

Sections 311/312 Hazard Classes

Fire Hazard:	No
Reactive Hazard:	No
Release of Pressure:	No
Acute Health Hazard:	Yes
Chronic Health Hazard:	No

Other Sections

Component	Section 313 Toxic Chemical	Section 302 EHS TPQ	CERCLA RQ
There are no hazardous ingredients in this product as defined in 29 CFR 1910-1200.	N/A	N/A	N/A

State Regulations

California Proposition 65: This product contains chemical(s) known to the State of California to cause cancer and/or to cause birth defects or other reproductive harm: residual acrylamide.

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Special Regulations

Component	States
There are no hazardous ingredients in this product as defined in 29 CFR 1910-1200.	None

International Regulations

Canada

WHMIS Classification: N/A

Controlled Product Regulations (CPR): N/A

Section 16. Other Information

HMIS Hazard Rating

Health: 1
Flammability: 1
Physical Hazard: 0
PPE: X

Notes: The PPE rating depends on circumstances of use. See Section 8 for recommended PPE.
The Hazardous Material Information System (HMIS) is a voluntary, subjective alpha-numeric symbolic system for recommending hazard risk and personal protection equipment information. It is a subjective rating system based on the evaluator's understanding of the chemical associated risks. The end-user must determine if the code is appropriate for their use.

NSF: N/A

FDA: N/A

KOSHER: This product has not been evaluated for Kosher approval.

FIFRA: N/A

Other: None

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Abbreviations

Abbreviation	Definition
<	Less Than
>	Greater Than
ACGIH	American Conference of Governmental Industrial Hygienists
EHS	Environmental Health and Safety Dept
N/A	Not Applicable
N/D	Not Determined
N/E	Not Established
OSHA	Occupational Health and Safety Dept
PEL	Personal Exposure Limit
STEL	Short Term Exposure Limit
TLV	Threshold Limit Value
TWA	Time Weight Average
UNK	Unknown

Prepared by: Regulatory Affairs Department

Disclaimer

Although the information and recommendations set forth herein (hereinafter "information") are presented in good faith and believed to be correct as of the date hereof, ChemTreat, Inc. makes no representations as to the completeness or accuracy thereof. Information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for their purposes prior to use. In no event will ChemTreat, Inc. be responsible for damages of any nature whatsoever resulting from the use or reliance upon information. No representation or warranties, either expressed or implied, of merchantability, fitness for a particular purpose, or of any other nature are made hereunder with respect to information or the product to which information refers.

CHEMTREAT CL-16

ChemTreat, Inc.

MSDS

MATERIAL SAFETY DATA SHEET

Section 1. Chemical Product and Company Identification

Product Name:	**ChemTreat CL-16**
Manufacturer's Name:	ChemTreat, Inc.
Emergency Telephone Number:	(800) 424-9300
Address (Corporate Headquarters)	4461 Cox Road, Glen Allen, VA 23060
Telephone Number for Information:	(800) 648-4579
Date of MSDS:	March 19, 2007

Section 2. Composition/Hazardous Ingredients

Component	CAS Registry #	Wt. %
Citric acid	77-92-9	10 – 30
Hydroxyethylidene-1,diphosphonic acid	2809-21-4	1 - 5

Section 3. Hazards Identification

Emergency Overview: Clear colorless liquid; mild odor; not flammable.
Potential Health Effects:
Eyes – Will cause corrosive effects (burns or irreversible damage) to eyes.
Skin – Will cause corrosive effects (burns or irreversible damage) to skin.
Inhalation – Will cause corrosive effects (burns or irreversible damage) to lungs, upper respiratory tract, and nose.
Ingestion – Will cause corrosive effects (burns or irreversible damage) to mouth, throat, and digestive tract.
Chronic Effects/Carcinogenicity: No information found on significant long-term effects.

Section 4. First Aid Measures

Inhalation: Remove victim to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Get immediate medical attention.
Eyes: Hold eyes open and rinse slowly and gently with water for 15 – 20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
Skin: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15 – 20 minutes. Call a poison control center or doctor for treatment advice.
Ingestion: If swallowed, do not induce vomiting. Give victim a glass of water or milk. Call a physician or poison control center. Never give anything by mouth to an unconscious person.

Section 5. Fire Fighting Measures

Flammable Properties: Not flammable.
Suitable Extinguishing Media: Use extinguishing media appropriate to surrounding fire.
Fire & Explosion Hazards: None known
Protective Equipment: Wear full protective clothing including a positive-pressure, NIOSH-approved, self-contained breathing apparatus.

Section 6. Accidental Release Measures

Small Spill: Construct temporary dikes of dirt, sand, or any readily available inert material to prevent spreading of the material. Wearing appropriate personal protective equipment, move the leaking container to a containment area or plug the leak. Absorb on inert material, then shovel up and dispose of according to local, state, federal regulations.
Large Spill: Construct temporary dikes of dirt, sand, or any readily available inert material to prevent spreading of the product. Wearing appropriate personal protective equipment, close or cap valves and/or block or plug hole in leaking container and transfer to another container for proper disposal.

Section 7. Handling and Storage

Do not get in eyes, or on skin and clothing. Wash thoroughly after handling. Avoid breathing mists. Do not ingest. Store at ambient temperatures. Keep container securely closed when not in use. Label precautions also apply to empty container. Recondition or dispose of empty containers in accordance with government regulations. For industrial use only.

Section 8. Exposure Controls/Personal Protection

Use protective equipment in accordance with 29 CFR 1910 Subpart I. Good general ventilation should be sufficient to control airborne levels. Wear chemical splash goggles or safety glasses with full-face shield. Wear rubber gloves. Wash them after each use and replace as necessary. If conditions warrant, wear protective clothing such as boots, aprons, and coveralls to prevent skin contact. Maintain eyewash fountain and quick-drench facilities in work area.

Section 9. Physical and Chemical Properties

Appearance: Clear colorless
Boiling Point: ~ 212°F
Evaporation Rate: N/D
Freezing Point: ~ 32°F
Melting Point: N/A
Odor: Mild
pH: ~ 1.0
Physical state: Liquid
Solubility in Water: Complete
Specific Gravity: ~1.093
Vapor Density: N/D
Vapor Pressure: N/D
% VOCs: N/D

Section 10. Stability and Reactivity

Chemical Stability: Stable at normal temperatures and pressures.
Incompatibility: Bases; strong oxidizers

Hazardous Decomposition Products: Oxides of phosphorus and carbon.
Hazardous Polymerization: Will not occur.

Section 11. Toxicological Information

Citrus acid Dermal LD50 = 500 mg/kg (rabbits)
Hydroxyethylidene-1,diphosphonic acid Oral LD50 = 2400 mg/kg (rats); Dermal LD50 = 7940 mg/kg (rabbits)

Section 12. Ecological Information

Ceriodaphnia dubia 48 hour LC50 = >1000 mg/L; Fathead minnow 96 hour LC50 = >1000 mg/L

Section 13. Disposal Considerations

Dispose of in accordance with local, state and federal regulations as unlisted hazardous waste, characteristic of corrosivity D002.

Section 14. Transport Information (not meant to be all inclusive)

D.O.T. Shipping Name: Corrosive liquid, acidic, organic, n.o.s. (Citric Acid)
Hazard Class: 8 (Corrosive); UN3265; Packing Group: PG II

Section 15. Regulatory Information (*Not meant to be all inclusive - selected regulation represented*)

TSCA Status: All ingredients listed
CERCLA Reportable Quantity: None known
SARA Title III:
Section 302 Extremely Hazardous Substances: None
Section 313 Toxic Chemicals: None
CALIFORNIA PROPOSITION 65: None
KOSHER: This product is certified by the Orthodox Union as kosher pareve.
USDA: (Federally inspected meat and poultry plants) - product is approved for Category G7.

Section 16. Other Information

HMIS Hazard Rating: Health: 2 Flammability: 0 Reactivity: 1 PPE: X (see note)

NOTE: PPE rating depends on circumstances of use. See Section 8 for recommended PPE.

SARA Hazard Categories – Section 311/312
Acute – Yes Chronic – No Fire – No Reactive – No Sudden Release – No

Prepared by Regulatory Affairs

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HYDROCHLORIC ACID, DILUTE (RICCA)

Material Safety Data Sheet

Section 1: Chemical Product and Company Identification

Catalog Number:

3558, 3567.4, 3568, 3569, 3569.4, 3570, 3572, 3573, H-110, H-120, H-133, H-135, H-288, H044710, HCLBLNK, PHACID5, R3571600, SH044675, SH044680, SH044710, SHCLBLNK

Product Identity:
HYDROCHLORIC ACID, 4 - 16.9% (v/v) Aqueous Solutions; HYDROCHLORIC ACID:WATER, 6:94

Manufacturer's Name: RICCA CHEMICAL COMPANY LLC	**Emergency Contact(24 hr) -- CHEMTREC®** Domestic: 800-424-9300 International: 703-527-3887
CAGE Code: 0V553	
Address: 448 West Fork Dr Arlington, TX 76012	**Telephone Number For Information:** 817-461-5601
Date Prepared: 12/8/98	**Revision:** 14 Last Revised: 03/16/2007 Date Printed: 03/21/2007 9:37:32 am

Section 2. Composition/Information on Ingredients

Component	CAS Registry #	Concentration	ACGIH TLV	OSHA PEL
Hydrochloric Acid	7647-01-0	4-16.9	C 5 ppm C 7.5 mg/m3	C 5 ppm C 7 mg/m3
Water, Deionized	7732-18-5	Balance	Not Available Not Available	Not Available Not Available

Section 3: Hazard Identification

Emergency Overview: Mildly corrosive. Wash areas of contact with water for at least 15 minutes. Hazards increase as concentration increases.

Target Organs: eyes, skin, respiratory system.

Eye Contact: May cause irritation, redness, pain, and tearing.

Inhalation: May cause irritation.

Skin Contact: May cause irritation, redness, and pain.

Ingestion: May cause nausea, vomiting, diarrhea and cramps.

Chronic Effects/Carcinogenicity: None

IARC - Hydrochloric Acid is unclassifiable as to carcinogenicity to humans.

NTP - No.

OSHA - No.

Reproductive Information: Reproductive effects cited in 'Registry of Toxic Effects of Chemical Substances' for Hydrochloric Acid.

Teratology (Birth Defect) Information: Mutation data cited in 'Registry of Toxic Effects of Chemical Substances' for Hydrochloric Acid.

Section 4: First Aid Measures - In all cases, seek qualified evaluation.

Eye Contact: Irrigate immediately with large quantity of water for at least 15 minutes. Call a physician if irritation develops.
Inhalation: Remove to fresh air. Give artificial respiration if necessary. If breathing is difficult, give oxygen.
Skin Contact: Wash areas of contact with soap and water for at least 15 minutes. Call a physician if irritation develops.
Ingestion: Dilute with water or milk. Do not induce vomiting. Call a physician if necessary.

Section 5: Fire Fighting Measures

Flash Point: Not Available.
Method Used: Not Available.
LFL: Not Available.
UFL: Not Available.
Extinguishing Media: Use any means suitable for extinguishing surrounding fire.
Fire & Explosion Hazards: Not considered to be a fire or explosion hazard. May react with metals to release flammable Hydrogen gas.
Fire Fighting Instructions: Use normal procedures/instructions.
Fire Fighting Equipment: Use protective clothing and breathing equipment appropriate for the surrounding fire.

Section 6: Accidental Release Measures

Cover the spill with Sodium Carbonate or a soda ash-slaked lime mixture (50:50). Mix and add water to form slurry. Decant the liquid to the drain with excess water. Treat the solid residue as normal refuse. Wash site with soda ash solution. Always dispose of in accordance with local regulations.

Section 7. Handling and Storage

As with all chemicals, wash hands thoroughly after handling. Avoid contact with eyes and skin. Protect from freezing and physical damage.
Safety Storage Code: Corrosive

Section 8: Exposure Control/Personal Protection

Engineering Controls: No specific controls are needed. Normal room ventilation is adequate.
Respiratory Protection: Normal room ventilation is adequate.
Skin Protection: Chemical resistant gloves.
Eye Protection: Safety glasses or goggles.

Section 9: Physical and Chemical Properties

Appearance: Clear, colorless liquid
Odor: Odorless to slightly pungent
Solubility in Water: Inifinite
Specific Gravity: Approximately 1 - 1.03
pH: Not Available.
Boiling Point(°C): Approximately 100
Melting Point(°C): Approximately 0
Vapor Pressure: Not Applicable.

Section 10: Stability and Reactivity

Chemical Stability: Stable under normal conditions of use and storage.
Incompatibility: Most metals, Alkalis, active metals, Cyanides, Sulfides, Sulfites, Metal Oxides, Formaldehyde.
Hazardous Decomposition Products: Fumes of Hydrogen Chloride and Hydrogen in contact with metals, Chlorine gas from Oxidizers.
Hazardous Polymerization: Will not occur.

Section 11. Toxicological Information

LD50, Oral, Rabbit (Hydrochloric Acid) 900 mg/kg; Details of toxic effects not reported other than lethal dose value. LCLo, inhalation, human: 3000 ppm/5 minutes: No toxic effects noted.

Section 12. Ecological Information

Ecotoxicological Information: Hydrogen Chloride has slight acute and chronic toxicity to aquatic life.
Chemical Fate Information: Virtually 100% of Hydrogen Chloride will eventually end up in the air.

Section 13. Disposal Considerations

Cover the spill with Sodium Carbonate or a soda ash-slaked lime mixture (50:50). Mix and add water to form slurry. Decant the liquid to the drain with excess water. Treat the solid residue as normal refuse. Always dispose of in accordance with local, state and federal regulations.

Section 14. Transport Information

Part Numbers: 3558-16, 3567.4-5, 3568-1, 3568-16, 3568-30, 3568-32, 3568-5, 3569.4-16, 3569.4-32, 3570-1, 3570-16, 3570-2.5, 3570-32, 3570-5, 3572-55, H-110 4-LT, H-110 LT, H-120 20-LT, H-120 4-LT, H-120 500ML, H-120 LT, H-133 10-LT, H-133 20-LT, H-133 LT, H-135 20-LT, H-135 200-LT, H-135 4-LT, H-135 500ML, H-135 LT, H-288 20-LT, H-288 4-LT, H-288 LT, PHACID5-1CT, PHACID5-2.5, PHACID5-500, R3571600-1A, R3571600-4A, SH044710-1A, SH044710-4A, SH044710-500A, SHCLBLNK-500N

D.O.T. Shipping Name: Hydrochloric Acid Solution

D.O.T. Hazard Class: 8

U.N. / N.A. Number: UN1789

Packing Group: III

D.O.T. Label: 8



Section 15. Regulatory Information (Not meant to be all inclusive - selected regulation represented)

OSHA Status: These items meet the OSHA Hazard Communication Standard (29 CFR 1910.1200) definition of a hazardous material.
TSCA Status: All components of this solution are listed on the TSCA Inventory or are mixtures (hydrates) of items listed on the TSCA Inventory.

Sara Title III:

Section 302 Extremely Hazardous Substances: Not Applicable.
Section 311/312 Hazardous Catagories: Acute: Yes Chronic, Fire, Pressure, Reactivity: No
Section 313 Toxic Chemicals: Not Applicable.

California: None Reported.
Pennsylvania: Hydrochloric Acid is listed as an Environmental Hazard on the state's Hazardous Substances List.
RCRA Status: Not Applicable.
CERCLA Reportable Quantity: Hydrochloric Acid - 5,000 pounds.

WHMIS: E: Corrosive Material.



Section 16. Other Information

NFPA Ratings:

Health: 2	Flammability: 0	Reactivity: 0	Special Notice Key:None

HMIS Ratings:

Health: 2	Flammability: 0	Reactivity: 0	Protective Equipment:B (Protective Eyewear, Gloves)

Rev 1, 4-16-99: (Section 1) added catalog numbers 3558 and 3569.4, (Section 3) added mutation and reproductive data cited, IARC not classifiable as to carcinogenicity to humans, Oral, Rat corrected to Oral, Rabbit, (Section 15) added Florida and Pennsylvania state information.
Rev 2, 12-10-99: (Section 1) Revised emergency telephone number to CHEMTREC® 800-424-9300.
Rev 3, 2-23-2000: Reformatted from WordPerfect® to Microsoft Word®; (Section 2) revised exposure limits from mg/m3 to ppm, (Section 7) added storage code, (Section 15) added TPQ information.
Rev 4, 10-09-2001: Reformatted to electronic data format.
Rev 5, 03-13-2002: (Section 1) added catalog number 3572.
Rev 6, 09-05-2003: (Section 14) revised DOT name from Corrosive liquid, acidic, nos.
Rev 7, 09-25-2003: (Section 1) added Solutions Plus catalog number H044710.
Rev 8, 02-11-2004: (Section 1) added Solutions Plus catalog number HCLBLNK.
Rev 9, 04-19-2005: (Section 1) added catalog number 3567.4.
Rev 10, 03-01-2006: (Section 1) added Red Bird catalog number H-120.
Rev 11, 03-27-2006: (Section 1) added catalog number PHACID5.
Rev 12, 05-19-2006: (Section 1) added catalog number R3571600 and Red Bird catalog number H-110.
Rev 13, 11-17-2006: (Section 1) added Red Bird catalog number H-133.
Rev 14, 03-16-2007: (Section 1) added Red Bird catalog number H-288.

When handled properly by qualified personnel, the product described herein does not present a significant health or safety hazard. Alteration of its characteristics by concentration, evaporation, addition of other substances, or other means may present hazards not specifically addressed herein and which must be evaluated by the user. The information furnished herein is believed to be accurate and represents the best data currently available to us. No warranty, expressed or implied, is made and RICCA CHEMICAL COMPANY assumes no legal responsibility or liability whatsoever resulting from its use.

RYDLYME (APEX ENGINEERING)

MATERIAL SAFETY DATA SHEET
REVISED AUGUST 2006

APEX ENGINEERING PRODUCTS CORPORATION
1241 Shoreline Drive
Aurora, Illinois 60504
Phone: 800-451-6291 FAX: 630-820-8886

For Chemical Emergency, Spill, Leak, Fire Exposure or Accident
Call CHEMTREC Day or Night
DOMESTIC NORTH AMERICA 800-424-9300
INTERNATIONAL, CALL 703-527-3887 (collect calls accepted)

PRODUCT INFORMATION

TRADE NAMES OR SYNONYMS:	RYDLYME, RID-LIME
FORMULA:	PROPRIETARY, CONFIDENTIALITY REQUIRED
CHEMICAL FAMILY:	WATER SCALE CLEANER

HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT	TLV (p.p.m.)	PEL (p.p.m.)	APPROXIMATE %
HYDROGEN CHLORIDE, AQUEOUS	5	5	LESS THAN 10

NOTE: Laboratory tests indicate material to be **BIODEGRADABLE**. Certified to NSF/ANSI 60. NSF Registered for use in beverage, pharmaceutical, bottling, poultry, and other food processing plants. USFDA has no jurisdiction over the product, since it does not come in direct contact with food. Non-reportable under Sara Title 3: Section 311/312/313 Categorization. Not reportable under CERCLA.

PHYSICAL DATA

BOILING POINT:	213° F / 101° C.
FREEZING POINT:	0° F / -18° C
SOLUBILITY IN WATER:	MISCIBLE
SPECIFIC GRAVITY, (WATER=1):	1.045
VAPOR PRESSURE:	30 TORR.
VAPOR DENSITY, (AIR=1):	GREATER THAN 1
PERCENT VOLATILE BY VOLUME:	99.6
APPEARANCE:	DARK LIQUID
ODOR:	ROASTED ALMONDS
pH:	UNREADABLE, GENERALLY <3
EVAPORATION RATE, (WATER=1):	SLOW
PHYSICAL STATE:	LIQUID

FIRE AND EXPLOSION HAZARD DATA

FLASH POINT:	NO FLASH POINT, EXTINQUISHES FLAME
EXTINQUISHING MEDIA:	DOES NOT SUPPORT COMBUSTION
SPECIAL FIRE FIGHTING PROCEDURES:	NONE--WATER WILL CONTROL, OR CO2/DRY CHEMICALS
UNUSUAL FIRE & EXPLOSION HAZARDS:	NON-COMBUSTIBLE OR EXPLOSIVE. BREATHING APPARATUS RECOMMENDED

HMIS

HEALTH:	0
FLAMMABILITY:	0
REACTIVITY:	0
PERSONAL PROTECTION:	B

HEALTH HAZARD DATA

EFFECTS OF OVER EXPOSURE:	SHOULD NOT BE CONSIDERED HAZARDOUS WHEN USED AS DIRECTED.
EMERGENCY & FIRST AID:	IF EYE/SKIN CONTACT, COPIOUS WATER RINSE. CONSULT PHYSICIAN. NOT TO BE TAKEN INTERNALLY. IF INGESTED-DO NOT INDUCE VOMITING-DRINK MILK, EGG WHITES, ETC. AS DIRECTED BY PHYSICIAN.
NOTE:	ADVERSE EFFECTS ON HUMAN HEALTH ARE NOT EXPECTED FROM THE RYDLYME SOLUTION, BASED UPON 60+ YEARS OF USE WITHOUT REPORTED ADVERSE HEALTH INCIDENCE IN DIVERSE POPULATION GROUPS, INCLUDING EXTENSIVE USE IN THE U.S. ARMED FORCES.

REACTIVITY DATA

STABILITY:	STABLE
INCOMPATIBILITIES:	STRONG CAUSTICS
HAZARDOUS DECOMPOSITION PRODUCTS:	NONE
HAZARDOUS POLYMERIZATION:	WILL NOT OCCUR
CONDITIONS TO AVOID:	EXCESSIVE HEATING

SPILL AND DISPOSAL PROCEDURES

ACTION TO TAKE FOR SPILLS:	RINSE WITH COPIOUS AMOUNTS OF WATER TO DILUTE: SODIUM BICARBONATE MAY ALSO BE USED TO SOAK UP AND NEUTRALIZE LIQUID, IF NECESSARY.
DISPOSAL METHOD:	EXPENDED OR USED MATERIAL MAY BE DISPOSED OF DOWN SEWER WITH WATER FLUSH. MATERIAL IS **BIODEGRADABLE**-EVEN IN AS RECEIVED FORM.

SPECIAL HANDLING INFORMATION

VENTILATION:	NORMAL (MECHANICAL)
RESPIRATORY:	NONE
PROTECTIVE GLOVES:	RECOMMENDED, SUCH AS NEOPRENE GLOVES.
EYE PROTECTION:	RECOMMENDED, SUCH AS CHEMICAL GOGGLES.
OTHER PROTECTIVE EQUIPMENT:	AS RECOMMENDED BY PLANT SAFETY DEPARTMENT. TO PREVENT STAINING OF CLOTHES, WEAR AN APRON.

SPECIAL PRECAUTIONS

HANDLING AND STORING:	PRESERVE INTEGRITY OF CONTAINER.
CAN MATERIAL BE STORED OUTSIDE?	YES, MAINTAIN TEMPERATURE BETWEEN 10°-180° F.
OTHER PRECAUTIONS:	Do not circulate material for more than a six hour period without consulting the manufacturer. Most ***RYDLYME*** cleanings can be accomplished within an average of two-four hours. Please use material only as directed. If procedures are not published for your particular application, please call for assistance. Furthermore, ***RYDLYME*** is designed to be used by itself or diluted with water and water only. Do not heat. Use ***RYDLYME*** at an ambient temperature. Vent circulating solution to atmosphere. Some adverse reactions may occur with some alloys of aluminum, magnesium, and/or zinc. Please consult the manufacturer.

CAUTION: *RYDLYME* **is non-corrosive, but the application of** *RYDLYME* **may expose pre-existing under deposit corrosion (pitting, holes or similar damage) that can result in leaks in pipes, equipment or systems.**

FOR ADDITIONAL INFORMATION, PLEASE REVIEW THE RYDLYME SPECIFICATIONS OR CONTACT OUR MANUFACTURING FACILITY AT 800-451-6291.

This data is furnished independent of any sales of the product only for your investigation and independent verification. While information is believed to be correct, APEX ENGINEERING PRODUCTS CORPORATION shall in no event be responsible for any damage whatsoever, directly or indirectly, resulting from the publication or use of or reliance upon data contained herein. No warranty, either expressed or implied, of merchantability, of fitness, or of any nature with respect to the product, or to the data, is made herein. This MSDS has been reviewed by the U.S. Department of Labors' Chicago District Office.

NSF
Certified to NSF/ANSI 60

SUPER GOLD BOWL CLEANER (B. MILLER PRODUCTS)

B. Miller Products

P.O. Box 544
Hibbing, MN 55746

MSDS S-538

MATERIAL SAFETY DATA SHEET

Revision Date: 6/3/2003

MSDS No.: N-065

Emergency Phones: 218-263-8958

PLEASE NOTE: This MSDS is being provided to your company for the purpose of providing current health and safety information to your management and for your employees who work with this material. Please read the information on these sheets, and then provide this information to those people at your company whose responsibility it is to comply with FEDERAL and STATE RIGHT-TO-KNOW regulations. Also make this information available to any employee who requests it. It is your obligation to comply with these regulations.

SECTION I - PRODUCT IDENTITY

PRODUCT NAME: Super Gold Bowl Cleaner
Formula: Mixture, water, hydrochloric acid, additives
Chemical Type: Mixture, water, hydrochloric acid, additives

HMIS RATINGS

Health = 3 (Serious)	Flammability = 0 (Insignificant)
Reactivity = 0 (Minimal)	Protection = C (Safety Glasses, Gloves, Synthetic Apron)

SECTION II - HAZARDOUS INGREDIENTS

	PERCENT	TLV	CARCINOGEN (OSHA,TP,IARC)
Hydrochloric Acid CAS No. 7647-01-0)	24%	5 ppm	no

SECTION III - CHEMICAL AND PHYSICAL

Appearance: White emulsion
Odor: Acid
pH: <1
Water Solubility: Complete
Viscosity, Cp @ 25°C.: A-5 (Gardner)

Boiling Point: est. 180oF.
Melting Point: N/A
Spec. Gravity (H_2O = 1): 1.1
Vapor Pressure (mm Hg): 39
VOC Content: none (N.A.)

SECTION IV - FIRE AND EXPLOSION HAZARDS

Flash Point (Method): None

Explosion Limits: Upper: N/A
Lower: N/A

Extinguishing Media: N/A (product is non-flammable)
Special Firefighting Procedures and Hazards: : Avoid skin and eye contact, and breathing of acid vapors. Wear head and body protection and HCl respirator if exposure to liquid is likely.

SECTION V - REACTIVITY INFORMATION

Stable: ☒ Unstable: ☐

Precautions:
Incompatibility: Strong alkalis, materials not resistant to strong acids, active metals (zinc, aluminum, magnesium, etc).

Hazardous Decomposition Products: Hydrogen chloride vapors. Contact with active metals can release flammable gas

Hazardous Polymerization: Occurs: ☐ Does Not Occur: ☒

SECTION VI - HEALTH HAZARDS – PROTECTIVE MEASURES - FIRST AID

Inhalation: Breathing of vapor can cause respiratory irritation and inflammation. Breathing of mist or liquid can cause burns. Wear approved HCl vapor/mist respirator if exposure is likely. Remove to fresh air. Give artificial respiration or oxygen if needed. Get prompt medical attention.

Skin: Corrosive. Causes irritation and burns. Wear acid-resistant protective gloves, boots, and clothing. Provide convenient safety showers. Remove contaminated clothing. Flush skin thoroughly with water for 15 minutes. Get medical attention if burns persist.

Eyes: Corrosive. Causes eye damage. Wear splash proof goggles. Provide convenient eyewash stations. Flush immediately with water for 15 minutes. Get prompt medical attention.

Ingestion: Corrosive. Causes irritation and burning in mouth, esophagus, throat and stomach. Avoid swallowing. Drink lots of water or, preferably, milk. Get medical attention if effects persist. Do not induce vomiting.

Most likely routes of entry: Skin, Eyes, Inhalation, Ingestion

Other Important Medical or Precautionary Information: Overexposure to product has the following effects: Inhalation of vapors may cause pulmonary edema, collapse of circulatory system and damage to the upper respiratory system and collapse. Inhalation may cause coughing, throat burning, choking, bronchitis and difficult breathing. Ingestion is harmful and may be fatal. Ingestion may cause burns.

SECTION VII - PRECAUTIONS FOR SAFE HANDLING AND USE

Spills and Leaks: Small spills can be flushed into normal drainage or into ground with copious amounts of water, or taken up with absorbent material. Larger spills should be contained by diking or other methods and held for collection and/or reuse, or for neutralization with alkali before collection & disposal. People should use eye and skin protection & respirator.

Storage and Handling: Check daily for any leaks from containers, vessels, pumps, and piping. Have water hoses and alkali (caustic soda, lime, etc.) convenient. Only use containers and equipment designed for acid service.

Waste Disposal: If neutralized, may be disposable in sewers if local regulations permit. Otherwise, send to licensed treatment and disposal facility. As supplied, this product is a RCRA hazardous waste.

Empty Containers: Rinse well before handling and disposal.

Other Precautions: Areas of use and storage should be ventilated adequately to reduce vapors below odor level.

SECTION VIII - REGULATORY INFORMATION

Reportable for SARA Title III, S:313 (Form R): Hydrochloric Acids

The information herein has been compiled from sources believed to be reliable and is accurate to the best of our knowledge. However, B. Miller Products cannot give any guarantees regarding information from other sources, and expressly does not make any warranties, nor assumes any liability, for its use.

MAGNESIUM CHLORIDE SOLUTION (UNIVAR)

PRODUCT: MAGNESIUM CHLORIDE SOLUTION

ORDER NO: 422792
PROD NO : 769141

DUSTCOATING INC
. ERICKSON TRUAX WHSE
8933 SLATE STREET

MT IRON ,MN 55768

UNIVAR USA INC.
17425 NE UNION HILL RD , REDMOND (425)889-3400 , WA 98052

---------- EMERGENCY ASSISTANCE ----------

FOR EMERGENCY ASSISTANCE INVOLVING CHEMICALS CALL - CHEMTREC
(800)424-9300

PRODUCT NAME:	MAGNESIUM CHLORIDE SOLUTION
MSDS NUMBER:	P16583V
DATE ISSUED:	08/01/2007
SUPERSEDES:	01/26/2006
ISSUED BY:	008645

****
****

MATERIAL SAFETY DATA SHEET

SECTION 1 - CHEMICAL PRODUCT AND COMPANY INFORMATION

UNIVAR
17425 NE UNION HILL ROAD
REDMOND, WA 98052
425-889-3400

SYNONYMS:	NONE KNOWN
CAS #:	7791-18-6 7732-18-5

PRODUCT: MAGNESIUM CHLORIDE SOLUTION

ORDER NO: 422792
PROD NO : 769141

DOT HAZARD CLASS: NOT REGULATED

SECTION 2 - COMPOSITION AND INFORMATION ON INGREDIENTS

MAGNESIUM CHLORIDE HEXAHYDRATE	64% MIN.
WATER	36% MAX.

SECTION 3 - HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: CLEAR, WATER WHITE SOLUTION, WILL CAUSE LITTLE OR NO HAZARDOUS CONCERNS.

POTENTIAL HEALTH EFFECTS:
EYES & SKIN: MAY CAUSE SLIGHT IRRITATION.
INGESTION: MAY BE HARMFUL IF A LARGE QUANTITY IS SWALLOWED.

CARCINOGENICITY: NOT LISTED UNDER OSHA, IARC, OR NTP.

SECTION 4 - FIRST AID MEASURES

EYES: FLUSH IMMEDIATELY WITH PLENTY OF WATER FOR AT LEAST 10 MINUTES.
SKIN: WASH OFF WITH SOAP AND WATER.
INGESTION: DILUTE WITH SEVERAL GLASSES OF WATER.
WITH ALL OF THE ABOVE: CONSULT A PHYSICIAN IF SYMPTOMS PERSIST.

SECTION 5 - FIRE FIGHTING MEASURES

FLASH POINT: NOT FLAMMABLE

FLAMMABLE LIMITS: NOT APPLICABLE

EXTINGUISHING MEDIA; USE MEDIA THAT IS APPROPRIATE TO TEAT SURROUNDING FIRE.

SPECIAL FIRE FIGHTING PROCEDURES: USE FIRE FIGHTING PROCEDURE THAT IS APPROPRIATE TO TREAT SURROUNDING FIRE.

UNUSUAL FIRE EXPLOSION HAZARD: NONE KNOWN

AUTO IGNITION TEMPERATURE: NOT APPLICABLE

SECTION 6 - ACCIDENTAL RELEASE MEASURES

ISOLATE HAZARD AREA AND DENY ENTRY TO UNNECESSARY OR UNPROTECTED PERSONNEL. CONTAIN SPILL, COLLECT AND PLACE IN A DISPOSAL CONTAINER, AVOID RUNOFF INTO STORM SEWERS AND DITCHES WHICH LEAD TO WATERWAYS.

SECTION 7 - HANDLING AND STORAGE

PRODUCT: MAGNESIUM CHLORIDE SOLUTION

ORDER NO: 422792
PROD NO : 769141

AVOID CONTACT WITH SKIN, EYES AND CLOTHING. USE NORMAL PERSONAL HYGIENE AND HOUSEKEEPING. STORE IN COOL DRY AREA AWAY FROM OTHER INCOMPATIBLE MATERIALS.

SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION

RESPIRATORY PROTECTION: NOT APPLICABLE

VENTILATION REQUIREMENTS: NOT APPLICABLE

SKIN AND EYE PROTECTION:
USE RUBBER OR NEOPRENE GLOVES, CHEMICAL GOGGLES AND CLOTHING SUFFICIENT TO PROTECT SKIN FROM SPLASHING.

WORK, HYGIENIC PRACTICES:
AS REQUIRED TO PROTECT SKIN AND EYES FROM SPLASH, SAFETY SHOWERS AND/OR EYE WASH SHOULD BE AVAILABLE_ DO NOT LEAVE FOOD OR SMOKE IN WORK AREA. WASH THOROUGHLY AND REMOVE OR CLEAN ANY CONTAMINATED CLOTHING.

EXPOSURE LIMITS: NONE ESTABLISHED

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

BOILING POINT; NOT APPLICABLE

VAPOR PRESSURE (MM HG): NOT APPLICABLE

VAPOR DENSITY (AIR=1): NOT APPLICABLE

SPECIFIC GRAVITY (H2O=1): 1.27

BULK DENSITY: NOT APPLICABLE

PERCENT VOLATILE BY VOLUME (%): NOT APPLICABLE

MELTING POINT: NOT APPLICABLE

EVAPORATION RATE (BUTYL ACETATE-1): NOT APPLICABLE

SOLUBILITY IN WATER: NOT APPLICABLE

PH: APPROXIMATELY 7.0

SECTION 10 - STABILITY AND REACTIVITY

CHEMICAL STABILITY: STABLE UNDER NORMAL TEMPERATURES AND PRESSURES.
HAZARDOUS POLYMERIZATION: WILL NOT OCCUR UNDER NORMAL CONDITIONS.
HAZARDOUS DECOMPOSITION PRODUCTS: HYDROGEN CHLORIDE

PRODUCT: MAGNESIUM CHLORIDE SOLUTION

ORDER NO: 422792
PROD NO : 769141

KEEP AWAY FROM: OXIDIZING AGENTS AND STRONG ACID.

11- TOXICOLOGICAL INFORMATION

LD50 - ORAL-RAT 8100 MG/KG

SECTION 12 - ECOLOGICAL INFORMATION

NOT AVAILABLE

SECTION 13 - DISPOSAL CONSIDERATIONS

DISPOSE OF IN ACCORDANCE WITH ALL FEDERAL, STATE AND LOCAL REGULATIONS.

RCRA WASTE #: NOT LISTED

SECTION 14 - TRANSPORTATION INFORMATION

D.O.T. SHIPPING NAME: MAGNESIUM CHLORIDE SOLUTION - NOT REGULATED

SECTION 15 - REGULATORY INFORMATION

TSCA (TOXIC SUBSTANCE CONTROL ACT):
THIS PRODUCT IS LISTED ON THE TSCA INVENTORY.

CERCLA REPORTABLE REQUIREMENTS: (RQ) NONE

SARA TITLE III INFORMATION:
SECTION 302 EXTREMELY HAZARDOUS SUBSTANCE: UNLISTED
SECTION 313 TOXIC CHEMICALS: UNLISTED
SECTION 311/312 HAZARD CATEGORY: NOT CONSIDERED A HAZARD.

PRODUCT: MAGNESIUM CHLORIDE SOLUTION

ORDER NO: 422792
PROD NO : 769141

FOR ADDITIONAL INFORMATION

CONTACT: MSDS COORDINATOR UNIVAR USA INC.
DURING BUSINESS HOURS, PACIFIC TIME (425)889-3400

04/16/08 07:08 PRODUCT: 769141 CUST NO: 154742 ORDER NO: 422792

NOTICE

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ALL EXPRESS OR IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A

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* * * E N D O F M S D S * * *

APPENDIX D – NON-DEGRADATION REVIEW TABLES

Table 1: Allowable Discharge Volume Calculation

2000 Allowable Discharge: 1986 Permit Rules

Area	
Open Water	50,312,000 ft^2
Vegetated and Exposed	152,024,000 ft^2
Run-off	70,567,000 ft^2

Precipitation and Evaporation Factors	
1999 Precipitation	41.07 inches
2000 Precipitation	27.41 inches
Annual Evaporation	23.00 inches
Vegetated and Exposed Run-off Factor	0.81
Run-off Run-off Factor	0.64

Calculated - 1999	
Open Water - Precipitation	172,192,820 ft^3
Vegetated and Exposed - Precipitation	421,444,733 ft^3
Run-off - Precipitation	154,569,957 ft^3
Open Water - Evaporation	-96,431,333 ft^3
1999 Net Non-Process Water Input	651,776,177 ft^3
Carry-Over Factor (B6.6 MN0055948 - 1986)	346,498,560 ft^3
1999 Allowable Carry-Over	**305,277,617 ft^3**

Calculated - 2000	
Open Water - Precipitation	114,920,993 ft^3
Vegetated and Exposed - Precipitation	281,271,004 ft^3
Run-off - Precipitation	103,159,545 ft^3
Open Water - Evaporation	-96,431,333 ft^3
2000 Net Non-Process Water Input	402,920,209 ft^3
1999 Allowable Carry-Over	305,277,617 ft^3
2000 Allowable Discharge	**708,197,826 ft^3**

2000 Allowable Discharge - 1986 Permit	**5,297 MMgal**

1999 Allowable Discharge: Precipitation minus Evaporation

Area	
Open Water	50,312,000 ft^2
Vegetated and Exposed	152,024,000 ft^2
Run-off	70,567,000 ft^2

Precipitation and Evaporation Factors	
1999 Precipitation	41.07 inches
Annual Evaporation	23.00 inches

Calculated	
Total Precipitation	934,010,518 ft^3
Total Evaporation	96,431,333 ft^3
Net P-E	**837,579,184 ft^3**

1999 Allowable Discharge - Net P-E	**6,265 MMgal**

W:\ww\94213\chemistry predictions\1999 P-E Calcs.xls

Table 2. Predicted Sulfate Concentration With Expansion - Annual Average Flow

Year	Inner Tailings Pond Area (acres)	Inner Tailings Pond Volume (gal)	Total System Volume (gal)	Increased Tailings Pond Evap (gal)	Discharge from Sargent Pit into Res 2 (gal)	Res 2 Pumping into Res 6 (gal)	Void Loss (gal)	Res 6 Discharge w/out Sargent (gal)	Pellet Cooling (gal)	Misc to Welcome Creek (gal)	Tailings Basin to Groundwater (gal)	Pellet Indurator Loss (gal)	Total System "Blow-Down" (gal)	Additional Sulfate Equilibrium Conc (ppm)	Estimated System Equilibrium Conc (ppm)	Predicted Actual Conc. (ppm)	Predicted Sulfate Loading (TPY)
2005	600	1.99E+09	3.50E+09	0	0	0	652,486,154	-174,250,474	42,048,000	105,120,000	140,000,000	177,266,187	9.4E+08	141	207	66	0
2006	600	1.99E+09	3.50E+09	0	0	686,900,000	652,486,154	42,510,486	42,048,000	105,120,000	138,000,000	177,266,187	1.8E+09	72	138	96	17
2007	700	2.33E+09	3.83E+09	39479589.6	0	827,700,000	652,486,154	381,878,166	42,048,000	105,120,000	336,000,000	177,266,187	2.5E+09	53	119	107	170
2008	800	2.66E+09	4.16E+09	78959179.2	0		652,486,154	86,854,951	42,048,000	105,120,000	138,000,000	177,266,187	1.2E+09	111	177	124	45
2009	1000	2.93E+09	4.43E+09	157,918,358	0		652,486,154	1,044,033,145*	42,048,000	105,120,000	281,000,000	177,266,187	2.3E+09	58	124	124	540
2010	1300	3.39E+09	4.89E+09	276,357,127	254,000,000	254,000,000	652,486,154	776,319,212	42,048,000	105,120,000	281,000,000	177,266,187	2.3E+09	58	124	124	533
2011	1700	3.88E+09	5.38E+09	434,275,486	254,000,000	254,000,000	652,486,154	618,033,969	42,048,000	105,120,000	281,000,000	177,266,187	2.1E+09	62	128	126	456
2012	2000	3.91E+09	5.41E+09	552,714,254	298,000,000	298,000,000	942,480,000	624,919,406	67,276,800	168,192,000	281,000,000	265,899,281	2.6E+09	25	91	112	432
2013	2000	3.91E+09	5.41E+09	552,714,254	342,000,000	342,000,000	942,480,000	631,804,842	67,276,800	168,192,000	281,000,000	265,899,281	2.7E+09	25	91	104	421
2014	2000	3.91E+09	5.41E+09	552,714,254	386,000,000	386,000,000	942,480,000	638,690,279	67,276,800	168,192,000	281,000,000	265,899,281	2.7E+09	24	90	98	420
2015	2000	3.91E+09	5.41E+09	552,714,254	430,000,000	430,000,000	942,480,000	645,575,715	67,276,800	168,192,000	281,000,000	265,899,281	2.8E+09	24	90	95	425
2016	2000	3.91E+09	5.41E+09	552,714,254	474,000,000	474,000,000	942,480,000	652,461,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	93	435
2017	2000	3.91E+09	5.41E+09	552,714,254	530,200,000	530,200,000	942,480,000	613,661,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	91	435
2018	2000	3.91E+09	5.41E+09	552,714,254	586,400,000	586,400,000	942,480,000	574,861,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	90	437
2019	2000	3.91E+09	5.41E+09	552,714,254	642,600,000	642,600,000	942,480,000	536,061,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	90	441
2020	2000	3.91E+09	5.41E+09	552,714,254	698,800,000	698,800,000	942,480,000	497,261,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	89	445
2021	2000	3.91E+09	5.41E+09	552,714,254	755,000,000	755,000,000	942,480,000	458,461,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	89	450
2022	2000	3.91E+09	5.41E+09	552,714,254	727,000,000	727,000,000	942,480,000	502,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	23	89	89	455
2023	2000	3.91E+09	5.41E+09	552,714,254	699,000,000	699,000,000	942,480,000	546,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	89	460
2024	2000	3.91E+09	5.41E+09	552,714,254	671,000,000	671,000,000	942,480,000	591,061,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88	465
2025	2000	3.91E+09	5.41E+09	552,714,254	643,000,000	643,000,000	942,480,000	635,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88	471
2026	2000	3.91E+09	5.41E+09	552,714,254	615,000,000	615,000,000	942,480,000	679,461,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88	476
2027	2000	3.91E+09	5.41E+09	552,714,254	616,800,000	616,800,000	942,480,000	850,061,152	67,276,800	168,192,000	281,000,000	265,899,281	3.2E+09	21	87	88	536
2028	2000	3.91E+09	5.41E+09	552,714,254	618,600,000	618,600,000	942,480,000	1,020,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.4E+09	20	86	87	593
2029	2000	3.91E+09	5.41E+09	552,714,254	620,400,000	620,400,000	942,480,000	1,191,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.5E+09	19	85	86	648
2030	2000	3.91E+09	5.41E+09	552,714,254	622,200,000	622,200,000	942,480,000	1,361,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.7E+09	18	84	85	702
2031	2000	3.91E+09	5.41E+09	552,714,254	624,000,000	624,000,000	942,480,000	1,532,461,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	84	755
2032	2000	3.91E+09	5.41E+09	552,714,254	680,800,000	680,800,000	942,480,000	1,493,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	84	757
2033	2000	3.91E+09	5.41E+09	552,714,254	737,600,000	737,600,000	942,480,000	1,455,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	83	761
2034	2000	3.91E+09	5.41E+09	552,714,254	794,400,000	794,400,000	942,480,000	1,416,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	83	765
2035	2000	3.91E+09	5.41E+09	552,714,254	851,200,000	851,200,000	942,480,000	1,378,061,152	67,276,800	168,192,000	281,000,000	265,899,281	4.0E+09	17	83	83	771
2036	2000	3.91E+09	5.41E+09	552,714,254	908,000,000	908,000,000	942,480,000	1,339,461,152	67,276,800	168,192,000	281,000,000	265,899,281	4.0E+09	17	83	83	776

* Sargent Mine Yield was discharge to Reservoir 6 through the Russell Pit in 2009.

Pre-scrubber sulfate	66 ppm	Average AET in non-clear pool tailings area	11.96 inches
Tailings Pond Avg Depth	10.2 ft	Increased Evap when water covered	26.5 inches
Second Stage Pond Acres	319 acres	Sulfate addition from scrubber	555 tons/yr
Second Stage Pond Avg Depth	9 ft	Current avg annual flow	1502 MMgal/yr
Res 6 Acres	174 acres	Sulfate Treatment	50% (278 tons sulfate removed)
Res 6 Avg Depth	10 ft		

Table 3. Predicted Sulfate Concentration With Expansion - Annual High Flow Phase 1

Year	Inner Tailings Pond Area (acres)	Inner Tailings Pond Volume (gal)	Total System Volume (gal)	Increased Tailings Pond Evap (gal)	Discharge from Sargent Pit into Res 2 (gal)	Res 2 Pumping into Res 6 (gal)	Void Loss (gal)	Res 6 Discharge w/out Sargent (gal)	Pellet Cooling (gal)	Misc to Welcome Creek (gal)	Tailings Basin to Groundwater (gal)	Pellet Indurator Loss (gal)	Total System "Blow-Down" (gal)	Additional Sulfate Equilibrium Conc (ppm)	Estimated System Equilibrium Conc (ppm)	Predicted Actual Conc. (ppm)
2005	600	1.99E+09	3.50E+09	0	0	0	652,486,154	-174,250,474	42,048,000	105,120,000	140,000,000	177,266,187	9.4E+08	141	207	66
2006	600	1.99E+09	3.50E+09	0	0	686,900,000	652,486,154	42,510,486	42,048,000	105,120,000	138,000,000	177,266,187	1.8E+09	72	138	96
2007	700	2.33E+09	3.83E+09	39479589.6	0	827,700,000	652,486,154	381,878,166	42,048,000	105,120,000	336,000,000	177,266,187	2.5E+09	53	119	107
2008	800	2.66E+09	4.16E+09	78959179.2	0		652,486,154	86,854,951	42,048,000	105,120,000	138,000,000	177,266,187	1.2E+09	111	177	124
2009	1000	2.93E+09	4.43E+09	157,918,358	0		652,486,154	1,044,033,145*	42,048,000	105,120,000	281,000,000	177,266,187	2.3E+09	58	124	124
2010	1300	3.39E+09	4.89E+09	276,357,127	254,000,000	254,000,000	652,486,154	776,319,212	42,048,000	105,120,000	281,000,000	177,266,187	2.3E+09	58	124	124
2011	1700	3.88E+09	5.38E+09	434,275,486	254,000,000	254,000,000	652,486,154	618,033,969	42,048,000	105,120,000	281,000,000	177,266,187	2.1E+09	62	128	126
2012	2000	3.91E+09	5.41E+09	552,714,254	298,000,000	298,000,000	942,480,000	624,919,406	67,276,800	168,192,000	281,000,000	265,899,281	2.6E+09	25	91	112
2013	2000	3.91E+09	5.41E+09	552,714,254	342,000,000	342,000,000	942,480,000	631,804,842	67,276,800	168,192,000	281,000,000	265,899,281	2.7E+09	25	91	104
2014	2000	3.91E+09	5.41E+09	552,714,254	386,000,000	386,000,000	942,480,000	638,690,279	67,276,800	168,192,000	281,000,000	265,899,281	2.7E+09	24	90	98
2015	2000	3.91E+09	5.41E+09	552,714,254	430,000,000	430,000,000	942,480,000	645,575,715	67,276,800	168,192,000	281,000,000	265,899,281	2.8E+09	24	90	95
2016	2000	3.91E+09	5.41E+09	552,714,254	523,700,000	523,700,000	942,480,000	2,481,000,000	67,276,800	168,192,000	281,000,000	265,899,281	4.7E+09	14	80	86
2017	2000	3.91E+09	5.41E+09	552,714,254	530,200,000	530,200,000	942,480,000	613,661,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	87
2018	2000	3.91E+09	5.41E+09	552,714,254	586,400,000	586,400,000	942,480,000	574,861,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	88
2019	2000	3.91E+09	5.41E+09	552,714,254	642,600,000	642,600,000	942,480,000	536,061,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	88
2020	2000	3.91E+09	5.41E+09	552,714,254	698,800,000	698,800,000	942,480,000	497,261,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	89
2021	2000	3.91E+09	5.41E+09	552,714,254	755,000,000	755,000,000	942,480,000	458,461,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	89
2022	2000	3.91E+09	5.41E+09	552,714,254	727,000,000	727,000,000	942,480,000	502,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	23	89	89
2023	2000	3.91E+09	5.41E+09	552,714,254	699,000,000	699,000,000	942,480,000	546,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88
2024	2000	3.91E+09	5.41E+09	552,714,254	671,000,000	671,000,000	942,480,000	591,061,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88
2025	2000	3.91E+09	5.41E+09	552,714,254	643,000,000	643,000,000	942,480,000	635,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88
2026	2000	3.91E+09	5.41E+09	552,714,254	615,000,000	615,000,000	942,480,000	679,461,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88
2027	2000	3.91E+09	5.41E+09	552,714,254	616,800,000	616,800,000	942,480,000	850,061,152	67,276,800	168,192,000	281,000,000	265,899,281	3.2E+09	21	87	88
2028	2000	3.91E+09	5.41E+09	552,714,254	618,600,000	618,600,000	942,480,000	1,020,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.4E+09	20	86	87
2029	2000	3.91E+09	5.41E+09	552,714,254	620,400,000	620,400,000	942,480,000	1,191,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.5E+09	19	85	86
2030	2000	3.91E+09	5.41E+09	552,714,254	622,200,000	622,200,000	942,480,000	1,361,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.7E+09	18	84	85
2031	2000	3.91E+09	5.41E+09	552,714,254	624,000,000	624,000,000	942,480,000	1,532,461,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	84
2032	2000	3.91E+09	5.41E+09	552,714,254	680,800,000	680,800,000	942,480,000	1,493,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	84
2033	2000	3.91E+09	5.41E+09	552,714,254	737,600,000	737,600,000	942,480,000	1,455,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	83
2034	2000	3.91E+09	5.41E+09	552,714,254	794,400,000	794,400,000	942,480,000	1,416,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	83
2035	2000	3.91E+09	5.41E+09	552,714,254	851,200,000	851,200,000	942,480,000	1,378,061,152	67,276,800	168,192,000	281,000,000	265,899,281	4.0E+09	17	83	83
2036	2000	3.91E+09	5.41E+09	552,714,254	908,000,000	908,000,000	942,480,000	1,339,461,152	67,276,800	168,192,000	281,000,000	265,899,281	4.0E+09	17	83	83

* Sargent Mine Yield was discharge to Reservoir 6 through the Russell Pit in 2009.

Pre-scrubber sulfate	66 ppm
Tailings Pond Avg Depth	10.2 ft
Second Stage Pond Acres	319 acres
Second Stage Pond Avg Depth	9 ft
Res 6 Acres	174 acres
Res 6 Avg Depth	10 ft

Average AET in non-clear pool tailings area	11.96 inches
Increased Evap when water covered	26.5 inches
Sulfate addition from scrubber	555 tons/yr
Current avg annual flow	1502 MMgal/yr
Sulfate Treatment	50% (278 tons sulfate removed)

Table 4. Predicted Sulfate Concentration With Expansion - Annual High Flow Phase 2

Year	Inner Tailings Pond Area (acres)	Inner Tailings Pond Volume (gal)	Total System Volume (gal)	Increased Tailings Pond Evap (gal)	Discharge from Sargent Pit into Res 2 (gal)	Res 2 Pumping into Res 6 (gal)	Void Loss (gal)	Res 6 Discharge w/out Sargent (gal)	Pellet Cooling (gal)	Misc to Welcome Creek (gal)	Tailings Basin to Groundwater (gal)	Pellet Indurator Loss (gal)	Total System "Blow-Down" (gal)	Additional Sulfate Equilibrium Conc (ppm)	Estimated System Equilibrium Conc (ppm)	Predicted Actual Conc. (ppm)
2005	600	1.99E+09	3.50E+09	0	0	0	652,486,154	-174,250,474	42,048,000	105,120,000	140,000,000	177,266,187	9.4E+08	141	207	66
2006	600	1.99E+09	3.50E+09	0	0	686,900,000	652,486,154	42,510,486	42,048,000	105,120,000	138,000,000	177,266,187	1.8E+09	72	138	96
2007	700	2.33E+09	3.83E+09	39479589.6	0	827,700,000	652,486,154	381,878,166	42,048,000	105,120,000	336,000,000	177,266,187	2.5E+09	53	119	107
2008	800	2.66E+09	4.16E+09	78959179.2	0		652,486,154	86,854,951	42,048,000	105,120,000	138,000,000	177,266,187	1.2E+09	111	177	124
2009	1000	2.93E+09	4.43E+09	157,918,358	0		652,486,154	1,044,033,145*	42,048,000	105,120,000	281,000,000	177,266,187	2.3E+09	58	124	124
2010	1300	3.39E+09	4.89E+09	276,357,127	254,000,000	254,000,000	652,486,154	776,319,212	42,048,000	105,120,000	281,000,000	177,266,187	2.3E+09	58	124	124
2011	1700	3.88E+09	5.38E+09	434,275,486	254,000,000	254,000,000	652,486,154	618,033,969	42,048,000	105,120,000	281,000,000	177,266,187	2.1E+09	62	128	126
2012	2000	3.91E+09	5.41E+09	552,714,254	298,000,000	298,000,000	942,480,000	624,919,406	67,276,800	168,192,000	281,000,000	265,899,281	2.6E+09	25	91	112
2013	2000	3.91E+09	5.41E+09	552,714,254	342,000,000	342,000,000	942,480,000	631,804,842	67,276,800	168,192,000	281,000,000	265,899,281	2.7E+09	25	91	104
2014	2000	3.91E+09	5.41E+09	552,714,254	386,000,000	386,000,000	942,480,000	638,690,279	67,276,800	168,192,000	281,000,000	265,899,281	2.7E+09	24	90	98
2015	2000	3.91E+09	5.41E+09	552,714,254	430,000,000	430,000,000	942,480,000	645,575,715	67,276,800	168,192,000	281,000,000	265,899,281	2.8E+09	24	90	95
2016	2000	3.91E+09	5.41E+09	552,714,254	474,000,000	474,000,000	942,480,000	652,461,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	93
2017	2000	3.91E+09	5.41E+09	552,714,254	530,200,000	530,200,000	942,480,000	613,661,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	91
2018	2000	3.91E+09	5.41E+09	552,714,254	586,400,000	586,400,000	942,480,000	574,861,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	90
2019	2000	3.91E+09	5.41E+09	552,714,254	642,600,000	642,600,000	942,480,000	536,061,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	90
2020	2000	3.91E+09	5.41E+09	552,714,254	698,800,000	698,800,000	942,480,000	497,261,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	89
2021	2000	3.91E+09	5.41E+09	552,714,254	869,200,000	869,200,000	942,480,000	2,211,000,000	67,276,800	168,192,000	281,000,000	265,899,281	4.8E+09	14	80	84
2022	2000	3.91E+09	5.41E+09	552,714,254	727,000,000	727,000,000	942,480,000	502,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	23	89	86
2023	2000	3.91E+09	5.41E+09	552,714,254	699,000,000	699,000,000	942,480,000	546,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	87
2024	2000	3.91E+09	5.41E+09	552,714,254	671,000,000	671,000,000	942,480,000	591,061,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	87
2025	2000	3.91E+09	5.41E+09	552,714,254	643,000,000	643,000,000	942,480,000	635,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88
2026	2000	3.91E+09	5.41E+09	552,714,254	615,000,000	615,000,000	942,480,000	679,461,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88
2027	2000	3.91E+09	5.41E+09	552,714,254	616,800,000	616,800,000	942,480,000	850,061,152	67,276,800	168,192,000	281,000,000	265,899,281	3.2E+09	21	87	87
2028	2000	3.91E+09	5.41E+09	552,714,254	618,600,000	618,600,000	942,480,000	1,020,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.4E+09	20	86	87
2029	2000	3.91E+09	5.41E+09	552,714,254	620,400,000	620,400,000	942,480,000	1,191,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.5E+09	19	85	86
2030	2000	3.91E+09	5.41E+09	552,714,254	622,200,000	622,200,000	942,480,000	1,361,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.7E+09	18	84	85
2031	2000	3.91E+09	5.41E+09	552,714,254	624,000,000	624,000,000	942,480,000	1,532,461,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	84
2032	2000	3.91E+09	5.41E+09	552,714,254	680,800,000	680,800,000	942,480,000	1,493,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	83
2033	2000	3.91E+09	5.41E+09	552,714,254	737,600,000	737,600,000	942,480,000	1,455,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	83
2034	2000	3.91E+09	5.41E+09	552,714,254	794,400,000	794,400,000	942,480,000	1,416,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	83
2035	2000	3.91E+09	5.41E+09	552,714,254	851,200,000	851,200,000	942,480,000	1,378,061,152	67,276,800	168,192,000	281,000,000	265,899,281	4.0E+09	17	83	83
2036	2000	3.91E+09	5.41E+09	552,714,254	908,000,000	908,000,000	942,480,000	1,339,461,152	67,276,800	168,192,000	281,000,000	265,899,281	4.0E+09	17	83	83

* Sargent Mine Yield was discharge to Reservoir 6 through the Russell Pit in 2009.

Pre-scrubber sulfate	66 ppm
Tailings Pond Avg Depth	10.2 ft
Second Stage Pond Acres	319 acres
Second Stage Pond Avg Depth	9 ft
Res 6 Acres	174 acres
Res 6 Avg Depth	10 ft

Average AET in non-clear pool tailings area	11.96 inches
Increased Evap when water covered	26.5 inches
Sulfate addition from scrubber	555 tons/yr
Current avg annual flow	1502 MMgal/yr
Sulfate Treatment	50% (278 tons sulfate removed)

Table 5. Predicted Sulfate Concentration With Expansion - Annual High Flow Phase 3

Year	Inner Tailings Pond Area (acres)	Inner Tailings Pond Volume (gal)	Total System Volume (gal)	Increased Tailings Pond Evap (gal)	Discharge from Sargent Pit into Res 2 (gal)	Res 2 Pumping into Res 6 (gal)	Void Loss (gal)	Res 6 Discharge w/out Sargent (gal)	Pellet Cooling (gal)	Misc to Welcome Creek (gal)	Tailings Basin to Groundwater (gal)	Pellet Indurator Loss (gal)	Total System "Blow-Down" (gal)	Additional Sulfate Equilibrium Conc (ppm)	Estimated System Equilibrium Conc (ppm)	Predicted Actual Conc. (ppm)
2005	600	1.99E+09	3.50E+09	0	0	0	652,486,154	-174,250,474	42,048,000	105,120,000	140,000,000	177,266,187	9.4E+08	141	207	66
2006	600	1.99E+09	3.50E+09	0	0	686,900,000	652,486,154	42,510,486	42,048,000	105,120,000	138,000,000	177,266,187	1.8E+09	72	138	96
2007	700	2.33E+09	3.83E+09	39479589.6	0	827,700,000	652,486,154	381,878,166	42,048,000	105,120,000	336,000,000	177,266,187	2.5E+09	53	119	107
2008	800	2.66E+09	4.16E+09	78959179.2	0		652,486,154	86,854,951	42,048,000	105,120,000	138,000,000	177,266,187	1.2E+09	111	177	124
2009	1000	2.93E+09	4.43E+09	157,918,358	0		652,486,154	1,044,033,145*	42,048,000	105,120,000	281,000,000	177,266,187	2.3E+09	58	124	124
2010	1300	3.39E+09	4.89E+09	276,357,127	254,000,000	254,000,000	652,486,154	776,319,212	42,048,000	105,120,000	281,000,000	177,266,187	2.3E+09	58	124	124
2011	1700	3.88E+09	5.38E+09	434,275,486	254,000,000	254,000,000	652,486,154	618,033,969	42,048,000	105,120,000	281,000,000	177,266,187	2.1E+09	62	128	126
2012	2000	3.91E+09	5.41E+09	552,714,254	298,000,000	298,000,000	942,480,000	624,919,406	67,276,800	168,192,000	281,000,000	265,899,281	2.6E+09	25	91	112
2013	2000	3.91E+09	5.41E+09	552,714,254	342,000,000	342,000,000	942,480,000	631,804,842	67,276,800	168,192,000	281,000,000	265,899,281	2.7E+09	25	91	104
2014	2000	3.91E+09	5.41E+09	552,714,254	386,000,000	386,000,000	942,480,000	638,690,279	67,276,800	168,192,000	281,000,000	265,899,281	2.7E+09	24	90	98
2015	2000	3.91E+09	5.41E+09	552,714,254	430,000,000	430,000,000	942,480,000	645,575,715	67,276,800	168,192,000	281,000,000	265,899,281	2.8E+09	24	90	95
2016	2000	3.91E+09	5.41E+09	552,714,254	474,000,000	474,000,000	942,480,000	652,461,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	93
2017	2000	3.91E+09	5.41E+09	552,714,254	530,200,000	530,200,000	942,480,000	613,661,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	91
2018	2000	3.91E+09	5.41E+09	552,714,254	586,400,000	586,400,000	942,480,000	574,861,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	90
2019	2000	3.91E+09	5.41E+09	552,714,254	642,600,000	642,600,000	942,480,000	536,061,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	90
2020	2000	3.91E+09	5.41E+09	552,714,254	698,800,000	698,800,000	942,480,000	497,261,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	89
2021	2000	3.91E+09	5.41E+09	552,714,254	755,000,000	755,000,000	942,480,000	458,461,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	89
2022	2000	3.91E+09	5.41E+09	552,714,254	727,000,000	727,000,000	942,480,000	502,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	23	89	89
2023	2000	3.91E+09	5.41E+09	552,714,254	699,000,000	699,000,000	942,480,000	546,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	89
2024	2000	3.91E+09	5.41E+09	552,714,254	671,000,000	671,000,000	942,480,000	591,061,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88
2025	2000	3.91E+09	5.41E+09	552,714,254	643,000,000	643,000,000	942,480,000	635,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88
2026	2000	3.91E+09	5.41E+09	552,714,254	728,700,000	728,700,000	942,480,000	2,460,000,000	67,276,800	168,192,000	281,000,000	265,899,281	4.9E+09	14	80	83
2027	2000	3.91E+09	5.41E+09	552,714,254	616,800,000	616,800,000	942,480,000	850,061,152	67,276,800	168,192,000	281,000,000	265,899,281	3.2E+09	21	87	85
2028	2000	3.91E+09	5.41E+09	552,714,254	618,600,000	618,600,000	942,480,000	1,020,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.4E+09	20	86	85
2029	2000	3.91E+09	5.41E+09	552,714,254	620,400,000	620,400,000	942,480,000	1,191,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.5E+09	19	85	85
2030	2000	3.91E+09	5.41E+09	552,714,254	622,200,000	622,200,000	942,480,000	1,361,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.7E+09	18	84	84
2031	2000	3.91E+09	5.41E+09	552,714,254	624,000,000	624,000,000	942,480,000	1,532,461,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	84
2032	2000	3.91E+09	5.41E+09	552,714,254	680,800,000	680,800,000	942,480,000	1,493,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	83
2033	2000	3.91E+09	5.41E+09	552,714,254	737,600,000	737,600,000	942,480,000	1,455,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	83
2034	2000	3.91E+09	5.41E+09	552,714,254	794,400,000	794,400,000	942,480,000	1,416,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	83
2035	2000	3.91E+09	5.41E+09	552,714,254	851,200,000	851,200,000	942,480,000	1,378,061,152	67,276,800	168,192,000	281,000,000	265,899,281	4.0E+09	17	83	83
2036	2000	3.91E+09	5.41E+09	552,714,254	908,000,000	908,000,000	942,480,000	1,339,461,152	67,276,800	168,192,000	281,000,000	265,899,281	4.0E+09	17	83	83

* Sargent Mine Yield was discharge to Reservoir 6 through the Russell Pit in 2009.

Pre-scrubber sulfate	66 ppm
Tailings Pond Avg Depth	10.2 ft
Second Stage Pond Acres	319 acres
Second Stage Pond Avg Depth	9 ft
Res 6 Acres	174 acres
Res 6 Avg Depth	10 ft

Average AET in non-clear pool tailings area	11.96 inches
Increased Evap when water covered	26.5 inches
Sulfate addition from scrubber	555 tons/yr
Current avg annual flow	1502 MMgal/yr
Sulfate Treatment	50% (278 tons sulfate removed)

Table 6. Predicted Sulfate Concentration With Expansion - Annual High Flow Phase 4

Year	Inner Tailings Pond Area (acres)	Inner Tailings Pond Volume (gal)	Total System Volume (gal)	Increased Tailings Pond Evap (gal)	Discharge from Sargent Pit into Res 2 (gal)	Res 2 Pumping into Res 6 (gal)	Void Loss (gal)	Res 6 Discharge w/out Sargent (gal)	Pellet Cooling (gal)	Misc to Welcome Creek (gal)	Tailings Basin to Groundwater (gal)	Pellet Indurator Loss (gal)	Total System "Blow-Down" (gal)	Additional Sulfate Equilibrium Conc (ppm)	Estimated System Equilibrium Conc (ppm)	Predicted Actual Conc. (ppm)
2005	600	1.99E+09	3.50E+09	0	0	0	652,486,154	-174,250,474	42,048,000	105,120,000	140,000,000	177,266,187	9.4E+08	141	207	66
2006	600	1.99E+09	3.50E+09	0	0	686,900,000	652,486,154	42,510,486	42,048,000	105,120,000	138,000,000	177,266,187	1.8E+09	72	138	96
2007	700	2.33E+09	3.83E+09	39479589.6	0	827,700,000	652,486,154	381,878,166	42,048,000	105,120,000	336,000,000	177,266,187	2.5E+09	53	119	107
2008	800	2.66E+09	4.16E+09	78959179.2	0		652,486,154	86,854,951	42,048,000	105,120,000	138,000,000	177,266,187	1.2E+09	111	177	124
2009	1000	2.93E+09	4.43E+09	157,918,358	0		652,486,154	1,044,033,145*	42,048,000	105,120,000	281,000,000	177,266,187	2.3E+09	58	124	124
2010	1300	3.39E+09	4.89E+09	276,357,127	254,000,000	254,000,000	652,486,154	776,319,212	42,048,000	105,120,000	281,000,000	177,266,187	2.3E+09	58	124	124
2011	1700	3.88E+09	5.38E+09	434,275,486	254,000,000	254,000,000	652,486,154	618,033,969	42,048,000	105,120,000	281,000,000	177,266,187	2.1E+09	62	128	126
2012	2000	3.91E+09	5.41E+09	552,714,254	298,000,000	298,000,000	942,480,000	624,919,406	67,276,800	168,192,000	281,000,000	265,899,281	2.6E+09	25	91	112
2013	2000	3.91E+09	5.41E+09	552,714,254	342,000,000	342,000,000	942,480,000	631,804,842	67,276,800	168,192,000	281,000,000	265,899,281	2.7E+09	25	91	104
2014	2000	3.91E+09	5.41E+09	552,714,254	386,000,000	386,000,000	942,480,000	638,690,279	67,276,800	168,192,000	281,000,000	265,899,281	2.7E+09	24	90	98
2015	2000	3.91E+09	5.41E+09	552,714,254	430,000,000	430,000,000	942,480,000	645,575,715	67,276,800	168,192,000	281,000,000	265,899,281	2.8E+09	24	90	95
2016	2000	3.91E+09	5.41E+09	552,714,254	474,000,000	474,000,000	942,480,000	652,461,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	93
2017	2000	3.91E+09	5.41E+09	552,714,254	530,200,000	530,200,000	942,480,000	613,661,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	91
2018	2000	3.91E+09	5.41E+09	552,714,254	586,400,000	586,400,000	942,480,000	574,861,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	90
2019	2000	3.91E+09	5.41E+09	552,714,254	642,600,000	642,600,000	942,480,000	536,061,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	90
2020	2000	3.91E+09	5.41E+09	552,714,254	698,800,000	698,800,000	942,480,000	497,261,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	89
2021	2000	3.91E+09	5.41E+09	552,714,254	755,000,000	755,000,000	942,480,000	458,461,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	89
2022	2000	3.91E+09	5.41E+09	552,714,254	727,000,000	727,000,000	942,480,000	502,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	23	89	89
2023	2000	3.91E+09	5.41E+09	552,714,254	699,000,000	699,000,000	942,480,000	546,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	89
2024	2000	3.91E+09	5.41E+09	552,714,254	671,000,000	671,000,000	942,480,000	591,061,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88
2025	2000	3.91E+09	5.41E+09	552,714,254	643,000,000	643,000,000	942,480,000	635,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88
2026	2000	3.91E+09	5.41E+09	552,714,254	615,000,000	615,000,000	942,480,000	679,461,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88
2027	2000	3.91E+09	5.41E+09	552,714,254	616,800,000	616,800,000	942,480,000	850,061,152	67,276,800	168,192,000	281,000,000	265,899,281	3.2E+09	21	87	88
2028	2000	3.91E+09	5.41E+09	552,714,254	618,600,000	618,600,000	942,480,000	1,020,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.4E+09	20	86	87
2029	2000	3.91E+09	5.41E+09	552,714,254	620,400,000	620,400,000	942,480,000	1,191,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.5E+09	19	85	86
2030	2000	3.91E+09	5.41E+09	552,714,254	622,200,000	622,200,000	942,480,000	1,361,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.7E+09	18	84	85
2031	2000	3.91E+09	5.41E+09	552,714,254	740,600,000	740,600,000	942,480,000	3,327,000,000	67,276,800	168,192,000	281,000,000	265,899,281	5.8E+09	11	77	80
2032	2000	3.91E+09	5.41E+09	552,714,254	680,800,000	680,800,000	942,480,000	1,493,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	82
2033	2000	3.91E+09	5.41E+09	552,714,254	737,600,000	737,600,000	942,480,000	1,455,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	82
2034	2000	3.91E+09	5.41E+09	552,714,254	794,400,000	794,400,000	942,480,000	1,416,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	83
2035	2000	3.91E+09	5.41E+09	552,714,254	851,200,000	851,200,000	942,480,000	1,378,061,152	67,276,800	168,192,000	281,000,000	265,899,281	4.0E+09	17	83	83
2036	2000	3.91E+09	5.41E+09	552,714,254	908,000,000	908,000,000	942,480,000	1,339,461,152	67,276,800	168,192,000	281,000,000	265,899,281	4.0E+09	17	83	83

* Sargent Mine Yield was discharge to Reservoir 6 through the Russell Pit in 2009.

Pre-scrubber sulfate	66 ppm
Tailings Pond Avg Depth	10.2 ft
Second Stage Pond Acres	319 acres
Second Stage Pond Avg Depth	9 ft
Res 6 Acres	174 acres
Res 6 Avg Depth	10 ft

Average AET in non-clear pool tailings area	11.96 inches
Increased Evap when water covered	26.5 inches
Sulfate addition from scrubber	555 tons/yr
Current avg annual flow	1502 MMgal/yr
Sulfate Treatment	50% (278 tons sulfate removed)

Table 7. Predicted Sulfate Concentration With Expansion - Annual High Flow Phase 5

Year	Inner Tailings Pond Area (acres)	Inner Tailings Pond Volume (gal)	Total System Volume (gal)	Increased Tailings Pond Evap (gal)	Discharge from Sargent Pit into Res 2 (gal)	Res 2 Pumping into Res 6 (gal)	Void Loss (gal)	Res 6 Discharge w/out Sargent (gal)	Pellet Cooling (gal)	Misc to Welcome Creek (gal)	Tailings Basin to Groundwater (gal)	Pellet Indurator Loss (gal)	Total System "Blow-Down" (gal)	Additional Sulfate Equilibrium Conc (ppm)	Estimated System Equilibrium Conc (ppm)	Predicted Actual Conc. (ppm)
2005	600	1.99E+09	3.50E+09	0	0	0	652,486,154	-174,250,474	42,048,000	105,120,000	140,000,000	177,266,187	9.4E+08	141	207	66
2006	600	1.99E+09	3.50E+09	0	0	686,900,000	652,486,154	42,510,486	42,048,000	105,120,000	138,000,000	177,266,187	1.8E+09	72	138	96
2007	700	2.33E+09	3.83E+09	39479589.6	0	827,700,000	652,486,154	381,878,166	42,048,000	105,120,000	336,000,000	177,266,187	2.5E+09	53	119	107
2008	800	2.66E+09	4.16E+09	78959179.2	0		652,486,154	86,854,951	42,048,000	105,120,000	138,000,000	177,266,187	1.2E+09	111	177	124
2009	1000	2.93E+09	4.43E+09	157,918,358	0		652,486,154	1,044,033,145*	42,048,000	105,120,000	281,000,000	177,266,187	2.3E+09	58	124	124
2010	1300	3.39E+09	4.89E+09	276,357,127	254,000,000	254,000,000	652,486,154	776,319,212	42,048,000	105,120,000	281,000,000	177,266,187	2.3E+09	58	124	124
2011	1700	3.88E+09	5.38E+09	434,275,486	254,000,000	254,000,000	652,486,154	618,033,969	42,048,000	105,120,000	281,000,000	177,266,187	2.1E+09	62	128	126
2012	2000	3.91E+09	5.41E+09	552,714,254	298,000,000	298,000,000	942,480,000	624,919,406	67,276,800	168,192,000	281,000,000	265,899,281	2.6E+09	25	91	112
2013	2000	3.91E+09	5.41E+09	552,714,254	342,000,000	342,000,000	942,480,000	631,804,842	67,276,800	168,192,000	281,000,000	265,899,281	2.7E+09	25	91	104
2014	2000	3.91E+09	5.41E+09	552,714,254	386,000,000	386,000,000	942,480,000	638,690,279	67,276,800	168,192,000	281,000,000	265,899,281	2.7E+09	24	90	98
2015	2000	3.91E+09	5.41E+09	552,714,254	430,000,000	430,000,000	942,480,000	645,575,715	67,276,800	168,192,000	281,000,000	265,899,281	2.8E+09	24	90	95
2016	2000	3.91E+09	5.41E+09	552,714,254	474,000,000	474,000,000	942,480,000	652,461,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	93
2017	2000	3.91E+09	5.41E+09	552,714,254	530,200,000	530,200,000	942,480,000	613,661,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	91
2018	2000	3.91E+09	5.41E+09	552,714,254	586,400,000	586,400,000	942,480,000	574,861,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	90
2019	2000	3.91E+09	5.41E+09	552,714,254	642,600,000	642,600,000	942,480,000	536,061,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	90
2020	2000	3.91E+09	5.41E+09	552,714,254	698,800,000	698,800,000	942,480,000	497,261,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	89
2021	2000	3.91E+09	5.41E+09	552,714,254	755,000,000	755,000,000	942,480,000	458,461,152	67,276,800	168,192,000	281,000,000	265,899,281	2.9E+09	23	89	89
2022	2000	3.91E+09	5.41E+09	552,714,254	727,000,000	727,000,000	942,480,000	502,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	23	89	89
2023	2000	3.91E+09	5.41E+09	552,714,254	699,000,000	699,000,000	942,480,000	546,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	89
2024	2000	3.91E+09	5.41E+09	552,714,254	671,000,000	671,000,000	942,480,000	591,061,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88
2025	2000	3.91E+09	5.41E+09	552,714,254	643,000,000	643,000,000	942,480,000	635,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88
2026	2000	3.91E+09	5.41E+09	552,714,254	615,000,000	615,000,000	942,480,000	679,461,152	67,276,800	168,192,000	281,000,000	265,899,281	3.0E+09	22	88	88
2027	2000	3.91E+09	5.41E+09	552,714,254	616,800,000	616,800,000	942,480,000	850,061,152	67,276,800	168,192,000	281,000,000	265,899,281	3.2E+09	21	87	88
2028	2000	3.91E+09	5.41E+09	552,714,254	618,600,000	618,600,000	942,480,000	1,020,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.4E+09	20	86	87
2029	2000	3.91E+09	5.41E+09	552,714,254	620,400,000	620,400,000	942,480,000	1,191,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.5E+09	19	85	86
2030	2000	3.91E+09	5.41E+09	552,714,254	622,200,000	622,200,000	942,480,000	1,361,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.7E+09	18	84	85
2031	2000	3.91E+09	5.41E+09	552,714,254	624,000,000	624,000,000	942,480,000	1,532,461,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	84
2032	2000	3.91E+09	5.41E+09	552,714,254	680,800,000	680,800,000	942,480,000	1,493,861,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	84
2033	2000	3.91E+09	5.41E+09	552,714,254	737,600,000	737,600,000	942,480,000	1,455,261,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	83
2034	2000	3.91E+09	5.41E+09	552,714,254	794,400,000	794,400,000	942,480,000	1,416,661,152	67,276,800	168,192,000	281,000,000	265,899,281	3.9E+09	17	83	83
2035	2000	3.91E+09	5.41E+09	552,714,254	851,200,000	851,200,000	942,480,000	1,378,061,152	67,276,800	168,192,000	281,000,000	265,899,281	4.0E+09	17	83	83
2036	2000	3.91E+09	5.41E+09	552,714,254	1,027,000,000	1,027,000,000	942,480,000	3,133,000,000	67,276,800	168,192,000	281,000,000	265,899,281	5.9E+09	11	77	79

* Sargent Mine Yield was discharge to Reservoir 6 through the Russell Pit in 2009.

Pre-scrubber sulfate	66 ppm
Tailings Pond Avg Depth	10.2 ft
Second Stage Pond Acres	319 acres
Second Stage Pond Avg Depth	9 ft
Res 6 Acres	174 acres
Res 6 Avg Depth	10 ft

Average AET in non-clear pool tailings area	11.96 inches
Increased Evap when water covered	26.5 inches
Sulfate addition from scrubber	555 tons/yr
Current avg annual flow	1502 MMgal/yr
Sulfate Treatment	50% (278 tons sulfate removed)

Table 8. Reservoir 6 Discharge Loading - Annual High Flow

Year	Highest Reservoir 6 Discharge (High Precip) (MGY)	Predicted Reservoir 6 Sulfate Concentration (mg/L)	Maximum Reservoir 6 Annual Sulfate Loading (TPY)
1999-2000*	5,297	62.1	1,370
2012-2016	3,005	86	1,080
2017-2021	3,081	84	1,080
2022-2026	3,189	83	1,100
2027-2031	4,068	80	1,360
2032-2036	4,160	79	1,370

Notes:
MGY - Million gallons per year
TPY - Tons per year
* Nondegredation analysis by 1988 permit rules (conservative)

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 32

EPA, U.S. Steel's Minntac Tailings Basin Wastewater Discharge,
Functional Equivalent of a Direct Discharge Technical Assistance, July 2023.

U.S. Steel's Minntac Tailings Basin Wastewater Discharge

Functional Equivalent of a Direct Discharge Technical Assistance

Prepared by U.S. Environmental Protection Agency Region 5

July 2023

Ralph Metcalfe Federal Building

77 West Jackson Boulevard

Chicago, IL 60604

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Executive Summary

In response to a request for technical assistance from the Minnesota Pollution Control Agency (MPCA), the National Pollutant Discharge Elimination System (NPDES) permitting authority for the state of Minnesota, EPA evaluated whether seepage of pollutants from the United States Steel Corporation's (U.S. Steel's) Minntac Tailings Basin Area (tailings basin or basin) (NPDES Permit MN0057207) that reaches surface waters is the "functional equivalent" of a direct discharge. The tailings basin is part of U.S. Steel's Minntac mine, which is located in Mountain Iron, St. Louis County, Minnesota and has been in operation since approximately 1967.

The Clean Water Act (CWA), EPA's regulations, and relevant court decisions provide that an NPDES permit is necessary to authorize the discharge of pollutants from point sources to waters of the United States. The Supreme Court decision in *County of Maui v. Hawaii Wildlife Fund*, 140 S. Ct. 1462 (2020) (*Maui*) determined that a discharge of pollutants requires an NPDES permit if the discharge is the "functional equivalent" of a direct discharge.

The Supreme Court decision in *Maui* outlined a non-exhaustive list of seven factors that may be relevant in determining whether a discharge through groundwater is the "functional equivalent" of a direct discharge. The Supreme Court explained that "*time and distance will be the most important factors in most cases, but not necessarily every case*." *Id.*, 140 S. Ct. at 1477. Those factors include: 1) transit time, 2) distance traveled, 3) the nature of the material through which the pollutant travels, 4) the extent to which the pollutant is diluted or chemically changed as it travels, 5) the amount of pollutant entering the navigable waters relative to the amount of the pollutant that leaves the point source, 6) the manner by or area in which the pollutant enters the navigable waters, and 7) the degree to which the pollution (at that point) has maintained its specific identity. *Id.*, 140 S. Ct. at 1476–77. As the Supreme Court noted, the seven factors identified in its opinion were just some of the factors that may prove relevant to determining whether a discharge through groundwater is the functional equivalent of a direct discharge. For this analysis, EPA did not identify any additional factors that are relevant. The Supreme Court also noted that different considerations may be relevant in factually different cases. The Supreme Court identified time and distance as the most important factors in most cases and left flexibility in how to weigh the relevant factors. While this technical assistance evaluates each of the seven factors identified by the Supreme Court in *Maui* in order to be as helpful to the State as possible, it is not necessary to evaluate every factor to find that a discharge is the functional equivalent of a direct discharge. Where one or two factors, such as transit time and distance traveled, present evidence that a discharge is the functional equivalent of a direct discharge, analysis of other factors may not be needed. For this technical analysis, EPA evaluated each of the factors identified in *Maui* and defers the weighing of the factors to the NPDES permitting authority.

In considering the factors outlined in *Maui*, EPA's site-specific technical assistance evaluates seepage from the tailings basin to waters of the United States, and historic, background, and downstream water quality information. Based on the information available, EPA understands that the basin has been continuously discharging pollutants since approximately 1967 and will continue to do so for the foreseeable future.

EPA is providing this site-specific evaluation for consideration by MPCA in response to MPCA's request. This evaluation is based on information from a variety of publicly available documents provided by MPCA, referenced herein, and could change based on new or additional information. Under section 402(b) of the CWA, a State, such as Minnesota, that has an NPDES

program approved by EPA, has exclusive authority to administer the program. EPA can, as in this instance, provide technical assistance by providing information for the State to consider in administering its program and deciding whether in its judgment, as the exclusive permitting authority, an NPDES permit is required in a particular instance. Such technical assistance to MPCA creates no rights of third parties and is not a permitting action or otherwise a regulatory decision by EPA having any legal effect.

1. *Transit Time*

The tailings basin is located adjacent to jurisdictional surface waters. Pollutants discharge from the basin and reach jurisdictional surface waters adjacent to or in a relatively short distance from the outer edge of the perimeter dike. The perimeter dike (approximately 9.1 miles in length) is pervious and was constructed from waste material that extends below the ground surface. As wastewater travels through the material of the perimeter dike via subsurface flow, pollutants continue to leach into the subsurface water and groundwater. Thus, this report presents estimates of transit time and distance traveled from the outer edge of the perimeter dike to waters of the U.S.

EPA reviewed groundwater models, including pathline studies (which simulate pollutant pathways from the tailings basin to surface waters) that were conducted for the Sand River watershed (east) side of the basin. Transit time from the outer edge of the perimeter dike to the adjacent surface waters within the Sand River watershed (i.e., the shortest pathlines presented in the groundwater studies) is estimated to be less than 1-2 years or in some cases immediately. While pathline studies were not performed in the Dark River watershed, similar timeframes are expected because the tailings basin is similarly located adjacent to surface waters in the Dark River watershed. U.S. Steel's model used the inner edge of the tailings basin perimeter dike to calculate transit time and estimated that pollutants reach surface waters within the Sand River watershed in less than 1-2 years. Some pathways emerge immediately at the toe of the dike while other experience greater transit times through the subsurface before emerging at the surface.

2. *Distance Traveled*

The basin is surrounded by headwaters of major river systems, including wetlands. The basin was constructed on top of the headwaters of the river systems, and discharges from the basin have effectively replaced much of the rivers' headwaters sources. The distance pollutants travel from the basin through waters of the U.S. to downstream waters of the U.S., such as the Twin Lakes, has been the subject of studies carried out by U.S. Steel and others. The records show that pollutants are discharged to waters of the U.S. immediately adjacent to the basin.

3. *The Nature of the Material Through Which the Pollutant Travels*

Pollutants reach surface waters via a variety of pathways, including through the pervious perimeter dike, which is composed of coarse and fine tailings, or underneath the perimeter dike through permeable glacial till. Underlying the glacial till is a relatively impervious granitic bedrock layer that restricts vertical movement of wastewater, thus directing wastewater flow horizontally away from the basin and towards surface waters. The area around the basin to the north, east, and west is relatively flat and characterized as mainly wetlands and streams.

4. *The Extent to Which the Pollutant is Diluted or Chemically Changed as It Travels*

Monitoring data from the tailings basin and at certain locations in surface waters outside of the containment structure were compared. These data indicate that little to no dilution or chemical transformation occurs in these short pathways to surface waters. Additionally, the sulfate and chloride pollutant levels observed in all these locations are much higher than background levels.

For longer pathways to surface water, some pollutants may undergo some transformation while traveling to surface waters. Others, such as chloride, are not transformed at all.

5. *The Amount of Pollutant Entering Waters of the United States Relative to the Amount of the Pollutant That Leaves the Point Source*

EPA reviewed tailings basin wastewater quality data and compared them to water quality data collected at downstream surface water monitoring locations. EPA estimated the amount of pollutant leaving the basin using wastewater seepage rates calculated by U.S. Steel and pollutant loadings calculated at in-stream monitoring sites. EPA used information on sulfate and chloride as general indicators of the presence of a broader spectrum of pollutants.

These estimates indicate that a significant amount of sulfate and chloride that leave the basin and travel through the perimeter dike or via groundwater under the perimeter dike reach surface waters. Furthermore, due to the recirculation and reuse of water from the tailings basin in the on-going taconite processing operations, concentrations of pollutants in the tailings basin are increasing.

EPA did not find an independent measure of the amount of pollutant leaving the tailings basin, only estimates that were themselves based on amounts of basin pollutants observed in surface water. Without that independent measurement it is difficult to evaluate this factor.

6. *The Manner by or Area in Which the Pollutant Enters the Navigable Waters*

The tailings basin was constructed on top of the headwaters of the Sand River and Dark River and in an area rich with jurisdictional wetlands. Pollutants are being discharged from the basin by passing under and through the perimeter dike to surface waters. Generally, the pollutants are transported by advection and dispersion through the materials underlaying and surrounding the tailings basin, with the ultimate result being that the pollutants reach surface waters in significant amounts. The size of this point source, proximity of jurisdictional surface waters, and the abundance of those surface waters results in many potential pathways for pollutants to travel from the basin to surface waters, including discharges to surface waters adjacent to the basin. This technical analysis focuses on certain discrete seeps that emerge immediately adjacent to the basin or within a short distance from the basin. Seepage pathways are depicted in **Figure 19**, **Figure 20**, and **Figure 21**.

7. *The Degree to Which the Pollution (At That Point) Has Maintained Its Specific Identity*

Wastewater from the basin can be specifically identified at locations immediately adjacent to the basin and at downstream surface water monitoring locations. Pollutants discharged via these

short pathways maintain their specific identity and pollutants reaching downstream surface water monitoring locations, while diluted when compared to pollutant concentrations in the tailings basin, still maintain their specific identity emanating from the basin. Chloride is a pollutant that does not alter its structure as it moves from the basin to groundwater and, thereafter, to surface waters. Some of the pollutants discharged from the basin to surface waters may be partially transformed into other pollutants as they migrate through groundwater.

Discussion

EPA's technical assistance and site-specific evaluation, presented in detail in this document, indicates that the tailings basin and its components are a point source that discharges pollutants to jurisdictional surface waters in the Sand and Dark River watersheds. EPA evaluated the seven factors identified by the Supreme Court in *Maui* as applied to the tailings basin to understand whether pollutants from the basin reach surface waters via groundwater or subsurface flow in a manner that is the "functional equivalent" of a direct discharge. Our detailed review is discussed below.

1 Background and Introduction

EPA is providing this evaluation of the United States Steel Corporation's (U.S. Steel) Minntac Tailings Basin Area (tailings basin or basin) in response to a request for technical assistance from MPCA,[1] the permitting authority for the NPDES permit program in the state of Minnesota. This evaluation looks at whether discharges from the tailings basin that reach surface waters via groundwater and directly through the basin's perimeter dike are the functional equivalent of direct discharges under the Supreme Court decision in *County of Maui v. Hawaii Wildlife Fund*, 140 S. Ct. 1462 (2020) (*Maui*). MPCA provided EPA public documents including the administrative record for the 2018 permit and other information available to MPCA. EPA reviewed these materials, which numbered in the hundreds, as a part of this technical assistance. While EPA is not required to provide this technical assistance to the State pursuant to the CWA, and while MPCA is not required to rely upon it, MPCA may consider EPA's evaluation to inform its permitting decisions for the tailings basin.

The information available to EPA indicates that the tailings basin and components are point sources that discharge pollutants to waters of the United States via seeps in the basin's perimeter dike and via groundwater that flows under the basin and the perimeter dike.

EPA's evaluation of whether ongoing discharges from the tailings basin to surface waters via groundwater are the functional equivalent of direct discharges would, in EPA's technical judgement, be consistent with the Supreme Court's decision in *Maui*. In *Maui* the Supreme Court stated, "[w]hether pollutants that arrive at navigable waters after traveling through groundwater are 'from' a point source depends upon how similar to (or different from) the particular discharge is to a direct discharge." *Maui*, 140 S. Ct. at 1476. Further, the Supreme Court in *Maui* outlined a non-exhaustive list of seven factors that may be relevant in determining whether a discharge from a point source to a jurisdictional water is the "functional equivalent" of a direct discharge, depending on the circumstances of a particular case. Those factors include: 1) transit time, 2) distance traveled, 3) the nature of the material through which the pollutant travels, 4) the extent to which the pollutant is diluted or chemically changed as it travels, 5) the amount of pollutant entering the navigable waters relative to the amount of the pollutant that leaves the point source, 6) the manner by or area in which the pollutant enters the navigable waters, and 7) the degree to which the pollution (at that point) has maintained its specific identity. *Id.*, 140 S. Ct. at 1476–77.

EPA evaluated whether the discharge of pollutants from the tailings basin through groundwater and the perimeter dike to jurisdictional surface waters would, in EPA's technical judgment, support a finding by MPCA of the "functional equivalent" of a direct discharge. This is a site-specific evaluation focused on the factors identified in *Maui*.

EPA's evaluation of the tailings basin with respect to the Supreme Court's factors from *Maui* is described in **Section 3**.

[1] MPCA's request was formalized in the October 2021 Joint Evaluation Letter as "**Application of the Maui Decision.** EPA and MPCA will coordinate to apply the Supreme Court decision in the Maui matter to pollutant releases from sources, with a priority on releases from mines."

1.1 *Siting*

The tailings basin spans multiple Sections of Township 59 North, Ranges 18 and 19, Mountain Iron, St. Louis County, Minnesota. The tailings basin covers approximately 8,700 acres (13.6 square miles).[2]

Figure 1 and **Figure 2** provide maps of the facility and site location, respectively. The tailings basin was constructed in the 1960's and has been in operation as a tailings disposal site and process water reservoir for the Minntac Mine since approximately 1967. An NPDES permit was first issued for the tailings basin in 1987 for a portion of the seepage that travels directly through the dike; however, most of the seepage leaving the basin, including seepage underneath and through the dike, was never regulated by an NPDES permit. Seepage collection and return systems (SCRSs) were installed on the east and west sides of the basin and became operational June 2011 and June 2020, respectively.

The basin was constructed by depositing coarse and fine tailings onto the ground and into the wetlands and waterways of the headwaters of the Sand and Dark Rivers, with a smaller portion of the basin within the Johnson Creek watershed, which borders the basin to the north (See **Figure 3** for a site plan depicting the Sand River, Dark River, and Johnson Creek watersheds).

The tailings basin and its receiving waters in the Sand and Dark River watersheds are on the north side of the Laurentian Divide (shown in grey in **Figure 4**), a major watershed divide that separates the Great Lakes basin from the Hudson Bay basin. As shown in **Figure 4**, the Sand River connects downstream to the Pike River, Lake Vermillion, the Vermillion River and onward to Voyageurs National Park, the Boundary Waters Canoe Area Wilderness,[3] and Rainy Lake. The Dark River connects downstream to the Sturgeon River, the Little Fork River, Rainy River, and then Rainy Lake on the border with Canada. Both the Sand River and Dark River begin within a short distance of the basin. The area surrounding these rivers and the basin has expansive wetlands covering thousands of acres which abut rivers and streams that are relatively permanent tributaries, and lakes. See **Figure 5** and **Figure 6** for a depiction of these surface waters including the Sand and Dark Rivers, which are perennial, relatively permanent tributaries and the wetlands abutting those waters.

1.2 *Description of Mining Operation*

The tailings basin is part of a larger mining operation that consists of the Minntac Mine mining area, a processing plant, and the tailings basin. MPCA has issued a separate NPDES permit for the mining area (MN0052493). The principal activity at the Minntac Mine is taconite mining and processing. Taconite processing requires process water and creates process wastewater, fine slurry, and coarse refuse, which are deposited into the tailings basin.[4] Operating at full capacity, the Minntac Mine can produce 15 million long tons of taconite pellets per year.[5] The mining area and processing plant are located on the other side of the Laurentian Divide, in the Great Lakes

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[2] MPCA (2018), *Findings of Fact, Conclusions of Law, and Order*, page 1 of pdf, Background Fact #1.

[3] National Park Service (2016), Letter to MPCA regarding the Public Notice for U.S. Steel Minntac tailings basin National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit MN0057207

[4] MPCA (2018), *Findings of Fact, Conclusions of Law, and Order*, pages 2-3 of pdf, Background Fact #2.

[5] MPCA (2018), *NPDES)/SDS Permit Program Fact Sheet: US Steel Corp. – Minntac Tailings Basin Area*, Permit No. MN0057207, page 9 of pdf.

basin, and are not part of this evaluation.

1.3 *Description of Tailings Basin Operation*

Inputs to the tailings basin consist of fine tailings slurry, coarse refuse, process water from various taconite processes, sewage plant discharge, laboratory wastewater, non-process wastewater including wastewater from air pollution control devices, and runoff from adjacent areas.[6] The tailings basin's two main purposes are: 1) serve as a disposal site to contain tailings, and 2) serve as a reservoir to hold process wastewater so that some of it can be recirculated to the taconite processing plant.[7] The tailings basin is unlined and allows the seepage of pollutant-laden water into groundwater. The pollutant-laden water ultimately discharges into surface waters via pathways that run through and under the tailing basin's perimeter dike (See **Section 2.2**). It is not possible to identify and distinguish every pathway pollutants travel prior to reaching surface waters. Some pollutants may travel through groundwater only, some may travel through subsurface material only, and some may travel through both. The tailings basin has been in operation for over five decades. As the basin does continuously hold water, and is constructed from pervious materials, water is being discharged from the basin continuously.

The tailings basin is a waste treatment system, which is excluded from the definition of "waters of the United States" (See **Section 2.4**). The treatment performed within the tailings basin consists of settling to reduce concentrations of total suspended solids.

1.3.1 Inputs to the Tailings Basin

As noted above, the tailings basin receives process wastewater, fine slurry, and coarse refuse from the Minntac Mine's processing plant (See **Figure 7** for a water flow diagram of the tailings basin). The water held in the tailings basin meets the definition of "process waste water" in 40 C.F.R. § 401.11 as "*any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, by-product, or waste product*." Process wastewater within the tailings basin is either pumped back and reused in the processing plant, evaporates, evapotranspires,[8] or seeps from the basin as wastewater to surface waters beyond the perimeter dike (See **Figure 8**, which shows a mass balance model alongside the water flow of the system).

Approximately 60 million gallons per day (MGD) of process wastewater is continually circulated between the tailings basin and the processing plant (See **Figure 7** for a water flow diagram of the tailings basin). The concentration of pollutants in the basin increases with time as process

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[6] MPCA (2018), *NPDES)/SDS Permit Program Fact Sheet: US Steel Corp. – Minntac Tailings Basin Area*, Permit No. MN0057207, pages 9-10 of pdf.

[7] MWH on behalf of MPCA (2004), *Draft Minntac Water Inventory Reduction EIS,* page 68 of pdf. *"[Tailings basin] serves to store fine and coarse tails waste from taconite processing and to provide a method for recycling process water for the taconite plant processing operations."*

[8] GHD on behalf of U.S. Steel, (2021), *Hydrological Investigation Report,* page 52 of pdf. "*Evapotranspiration Rates: As described in Section 4.1.1, evapotranspiration (ET) is a significant output parameter in the Basin hydraulic balance that is difficult to measure directly. On-site ET research was initiated by DNR during the summer of 2021 in an idled Minntac fine tails cell (Cell G) in an attempt to develop a more representative ET rate for the Minntac Basin. The research equipment was removed/weatherized in November 2021 and the research is slated to be resumed in Spring 2022. Results of this research will likely increase the accuracy of the hydraulic balance*."

wastewater is withdrawn from the basin and reused in taconite processing operations.

An average of 21 million long tons of fine tailings and 14 million long tons of coarse tailings (on a dry basis) are deposited each year into the tailings basin.[9] Coarse tailings are hauled by truck and then dumped into the basin. Coarse tailings are used to construct the berms of various basin cells, channels, and launders, which channelize water movement within the basin. Fine tailings are conveyed as a slurry through a series of channels to various cells throughout the basin. This process is described in more detail in **Section 1.3.2.1**.

1.3.2 Tailings Basin Components

The tailings basin consists of inner cells (labeled A through M), an inner cell perimeter wall, outer cells with standing water in some portions (Cell 1 and Cell 2), an outer perimeter dike, and SCRSs located beyond the perimeter dike along portions of the eastern and western edges of the basin. **Figure 9** depicts the operation of the basin on December 7, 2021. **Figure 10** shows an aerial image of the perimeter dike and one of the east-side SCRS catchment basins abutting a wetland.

1.3.2.1 *Inner Cell*s

Fine tailings slurry, a mix of process wastewater and fine tailings, is pumped from the processing plant through a fine tailings discharge pipe and flows by gravity through a system of ditches and launders which leads to a spigot to inner cells.[10,11] The fine tailings slurry is approximately 50 percent solids and 50 percent water. Each inner cell is surrounded by a dike constructed from coarse tailings that provides a structure for the storage of fine tailings slurry within the cell. Fine tailings settle to the bottom of the inner cells and process wastewater is decanted via an outlet culvert to the permanent process wastewater storage areas of Cells 1 and 2. The basin operation is dynamic and operational decisions and design dictate which cells are used to settle solids. The elevation of the inner cells continually rise as fine and coarse tailings are deposited.

1.3.2.2 *Outer Cell*s

Cells 1 and 2 are reservoirs for process wastewater. Process wastewater is continually pumped from Cell 1 to the processing plant for reuse.[12] The volume of process wastewater in Cells 1 and 2 has doubled since 2012 and, as of 2021, the cells contain between 8.5 and 9 billion gallons of wastewater.[13]

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[9] MPCA (2018), *NPDES)/SDS Permit Program Fact Sheet: US Steel Corp. – Minntac Tailings Basin Area*, Permit No. MN0057207, page 10 of pdf.

[10] MPCA (2018), *NPDES)/SDS Permit Program Fact Sheet: US Steel Corp. – Minntac Tailings Basin Area*, Permit No. MN0057207, page 10 of document.

[11] MWH on behalf of MPCA (2004), *Minntac Water Inventory Reduction Draft EIS Tailings Basin Management Technical Memorandum*, page 13 of pdf. *"The fine tails slurry flows from the plant site to the intermediate cells through a gravity system of open ditches and launders (trough or flume)."*

[12] MPCA (2018), *Findings of Fact, Conclusions of Law, and Order*, page 2 of pdf, Background Fact #4.

[13] GHD on behalf of U.S. Steel (2021), *Hydrological Investigation Report*, page 42 of pdf.

1.3.2.3 *Perimeter Dike*

A perimeter dike extends along the northern, western, and eastern sides of the basin for approximately 9.1 miles. The southern side of the basin is bound by bedrock, where the Laurentian Divide exists - which is a major watershed divide separating the Great Lakes Basin from the Hudson Bay watershed (See **Figure 3** for a site plan of the basin). This perimeter dike, built on glacial till,[14] is constructed primarily of coarse and fine tailings that extend approximately 10 feet below the ground surface.[15] **Figure 11** shows a cross-section of the perimeter dike. Wastewater from the basin reaches surface waters beyond the perimeter dike and the SCRSs, where they exist, by flowing underneath or around the SCRSs.[16]

1.3.2.4 *Seepage Collection and Return System*

SCRSs were installed on portions of the east and west sides of the basin in 2010 and 2019, respectively. The 2018 NPDES Permit Fact Sheet provides a description of the east side SCRS:

"*In 2010, the permittee installed a seep collection and return system (SCRS) along roughly 1 ¾ miles of the east side of the basin including SD002. The SCRS system consists of catch basins located in each of the 13 identified seepage locations, hydraulically connected by subsurface high-density polyethylene piping to pump stations. Each of the seepage areas has been shaped and graded to promote seepage flow to the catch basins. Sheet pile cut-off walls were installed downgradient of each catch basin, connecting areas of higher elevation on either side of each discrete seepage location, to a depth of approximately 15 feet below existing ground level to ensure that surrounding wetlands are minimally impacted. The SCRS system consists of two subsystems, one collecting seepage from the northern section and the other from the southern section. Each subsystem terminates in a pump station consisting of a concrete vault containing a duplex pump system capable of returning the collected seepage back to the tailings basin.*"[17]

The west side SCRS is similar in design to the east side SCRS.[18] Both SCRSs were constructed as non-continuous segments (i.e., the system does not cover the entire extent of the perimeter dike). The SCRSs pump wastewater that surfaces immediately beyond the perimeter dike back

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[14] Glacial till is the layer above the granitic bedrock, composed primarily of fine to medium sand with some silt and rock clasts ranging from cobbles to boulders. Glacial till is often referred to as the "overburden" layer in different studies and reports of the facility.

[15] MPCA (2018), *National Pollutant Discharge Elimination System/State Disposal System Permit MN0057207: US Steel Corp. – Minntac Tailings Basin Area*, page 3 of document. "*Peat was removed from the original ground area to be occupied by the perimeter dam, and a ten foot deep key-way was dug in the glacial drift prior to spigotting fine tailings into the core portion of this area*."

[16] CRA for US Steel (2013) Estimate of Time of Travel, page 3. "*Figure 2 shows the simulated particle pathlines and travel times under current conditions (i.e., with the SC & R system sheet-pile walls in place). The simulated particle pathlines are similar to that occurring for the historical conditions, except that particles reaching the sheet-pile wall move downward from the shallow overburden into the deep overburden to pass under the sheet-pile wall, which extends through the shallow overburden only. The particles then move upwards back into the shallow overburden before discharging to the wetland area*."

[17] MPCA (2018), *NPDES)/SDS Permit Program Fact Sheet: US Steel Corp. – Minntac Tailings Basin Area*, Permit No. MN0057207, page 12 of document.

[18] HATCH on behalf of U.S. Steel Corporation (2014), *Minntac Western Seepage Collection System – Phase 2 Report*, page 5 of pdf. "*This proposed seepage collection system is similar in nature to the seepage collection and return system previously installed on the eastern perimeter of the [tailings basin].*"

into the basin; however, the SCRSs do not prevent wastewater from flowing under or around them. The SCRSs also do not treat or remove pollutants from the system, rather the SCRSs recirculate pollutants back to the basin, where they seep out again or are pumped back for reuse in the processing plant and discharged back to the tailings basin.

Topographic Map of Permitted Facility

MN0057207: U.S. Steel Minntac Tailings Basin
T59N, R18W, Sections 3-10, 14-23, and 27-30
Mt. Iron, St. Louis County, Minnesota

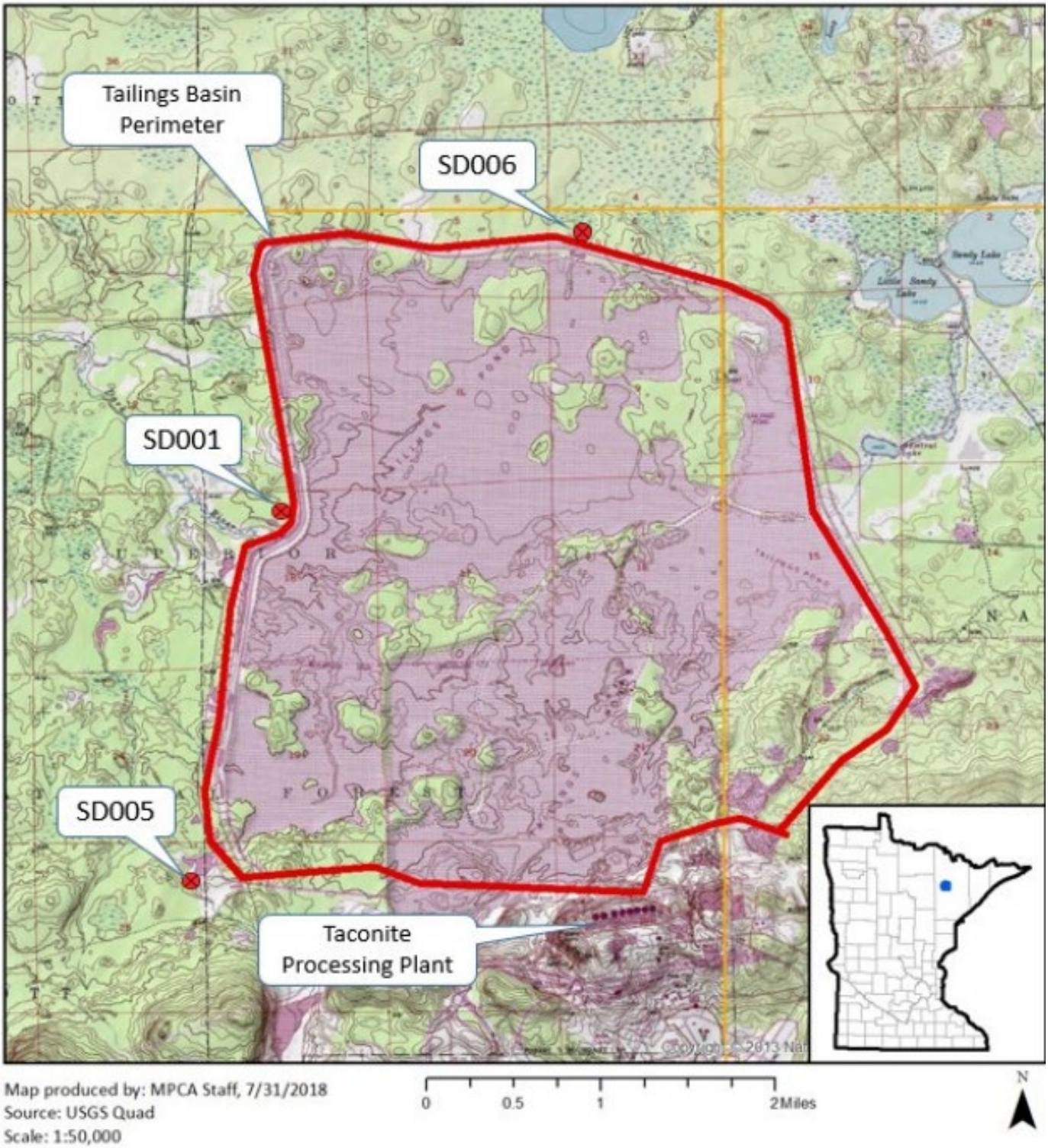


Figure 1. Map of Permitted Facility.
Taken from "NPDES/SDS Permit Program Fact Sheet for Minntac" by MPCA (2018). See page 13 of pdf. Red line represents the tailings basin area. As described by discharge monitoring report data: SD001 is "Seepage outfall 020," SD005 is "Stormwater, Non-specific Runoff," SD006 is "Seep Discharge to north wetlands." Note: SD001 has since been removed as a surface water discharge monitoring point due to the installation of the SCRS on the west side of the basin.

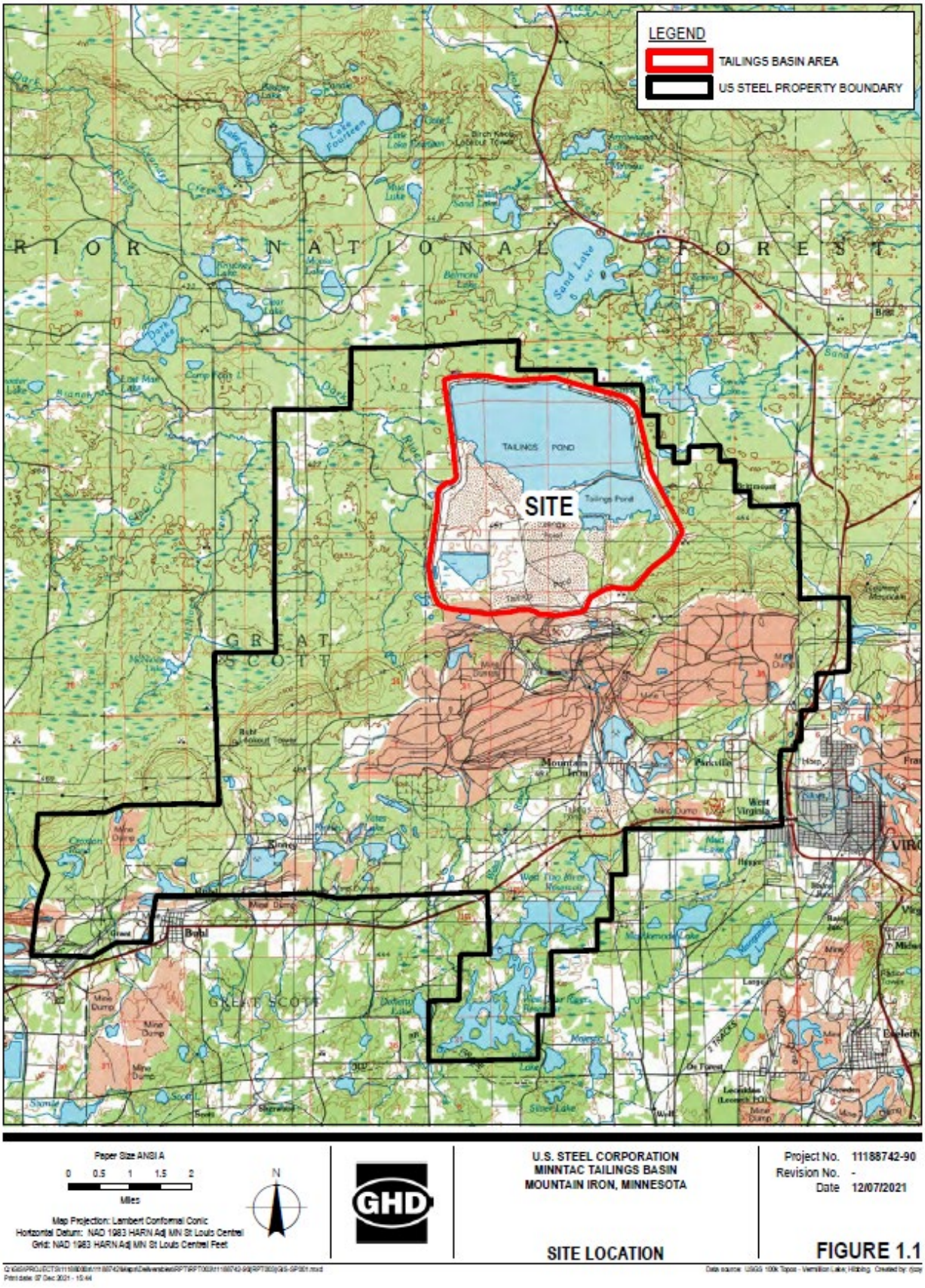


Figure 2. Site Location.
The boundary of the tailings basin area is shown in red and the property boundary in black. Taken from "Hydrological Investigation Report" by GHD on behalf of U.S. Steel (2021). See page 57 of pdf.

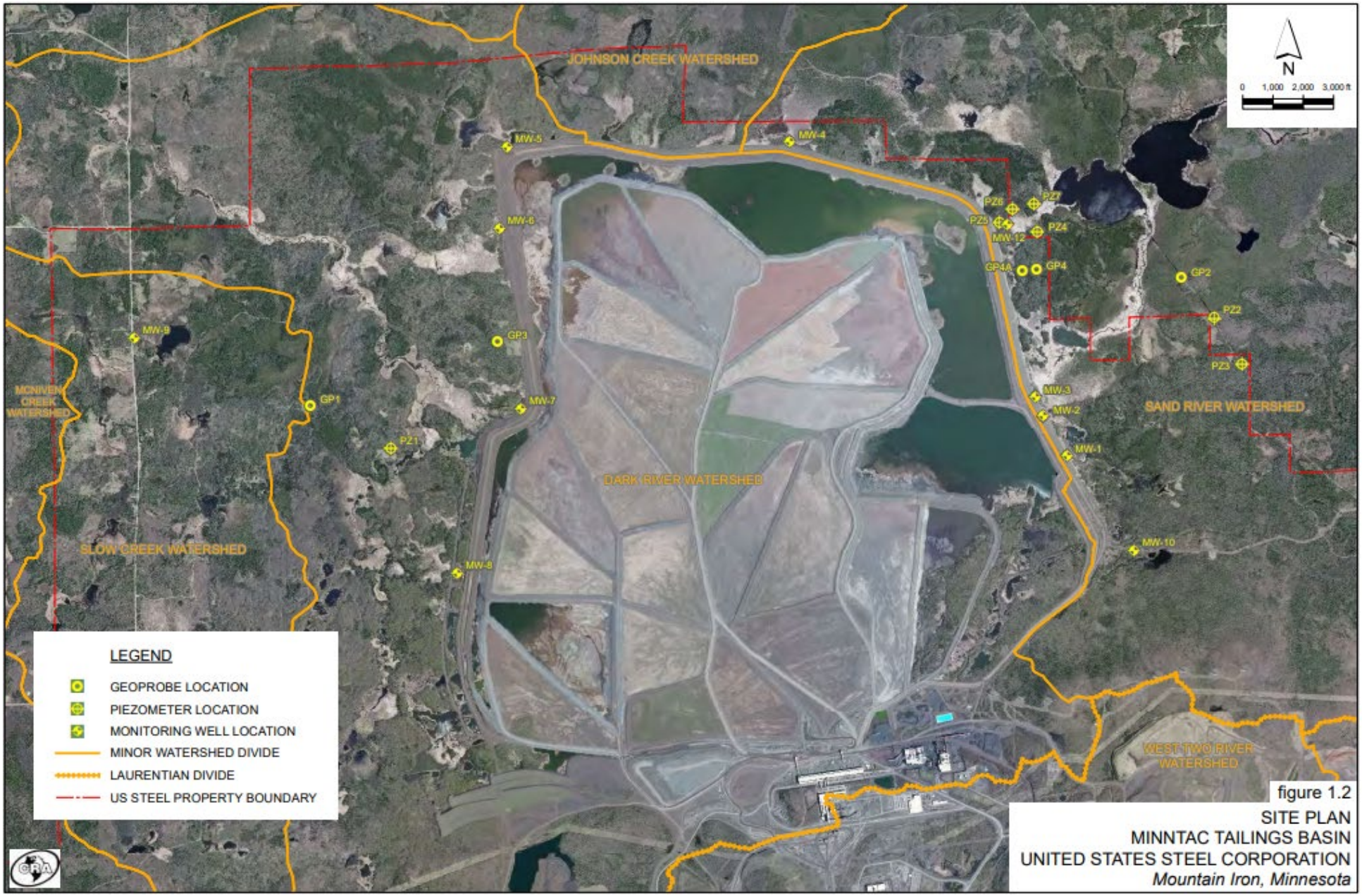


Figure 3. Site Plan.

Taken from "Groundwater Flow and Sulfate Transport Modeling Report" by CRA on behalf of U.S. Steel (2013). See page 56 of pdf.

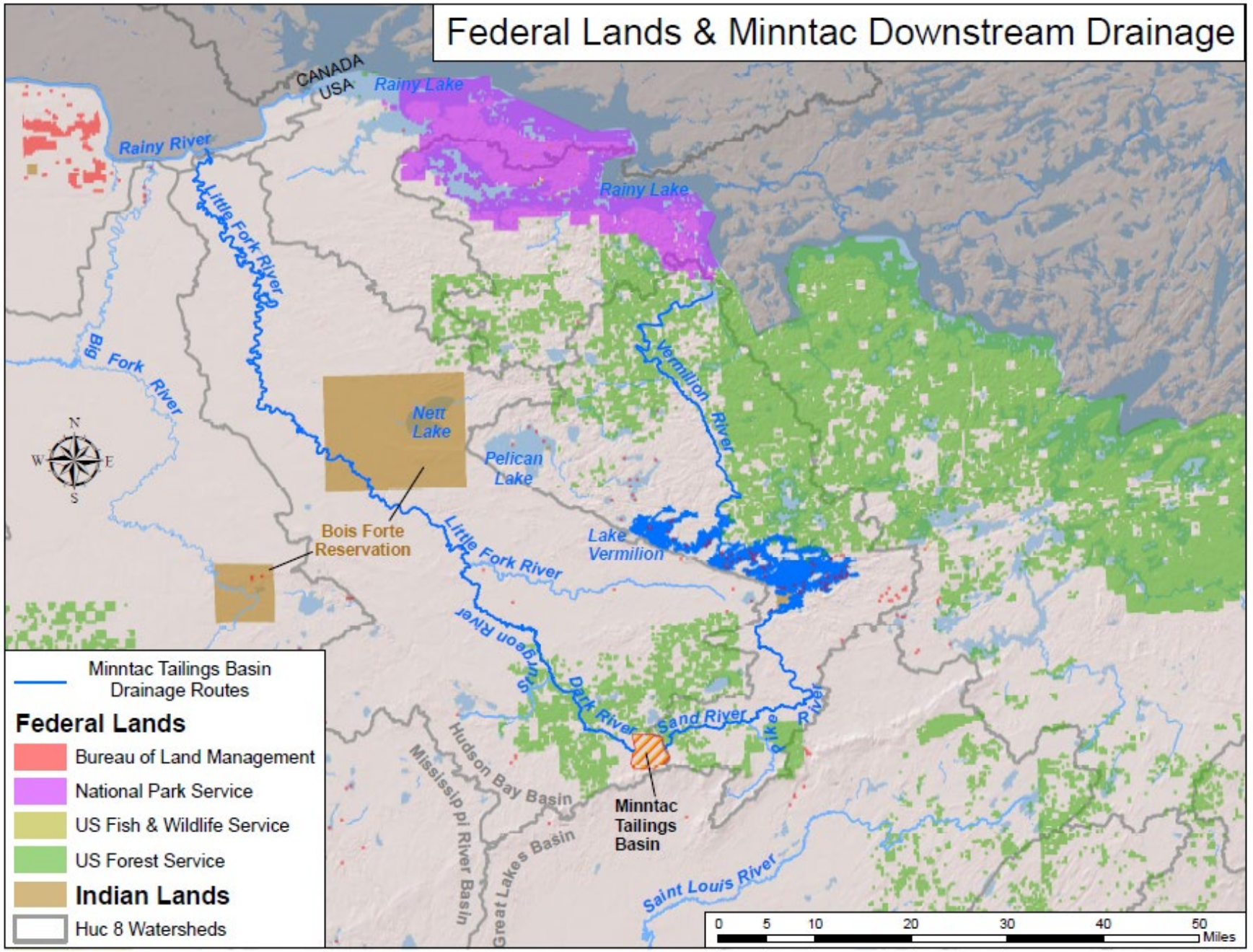


Figure 4. Minntac Tailings Basin and Drainage of Receiving Watersheds to the Border with Canada
(Also Depicting Federal Lands and Tribal Lands). Map created by U.S. EPA in 2016.

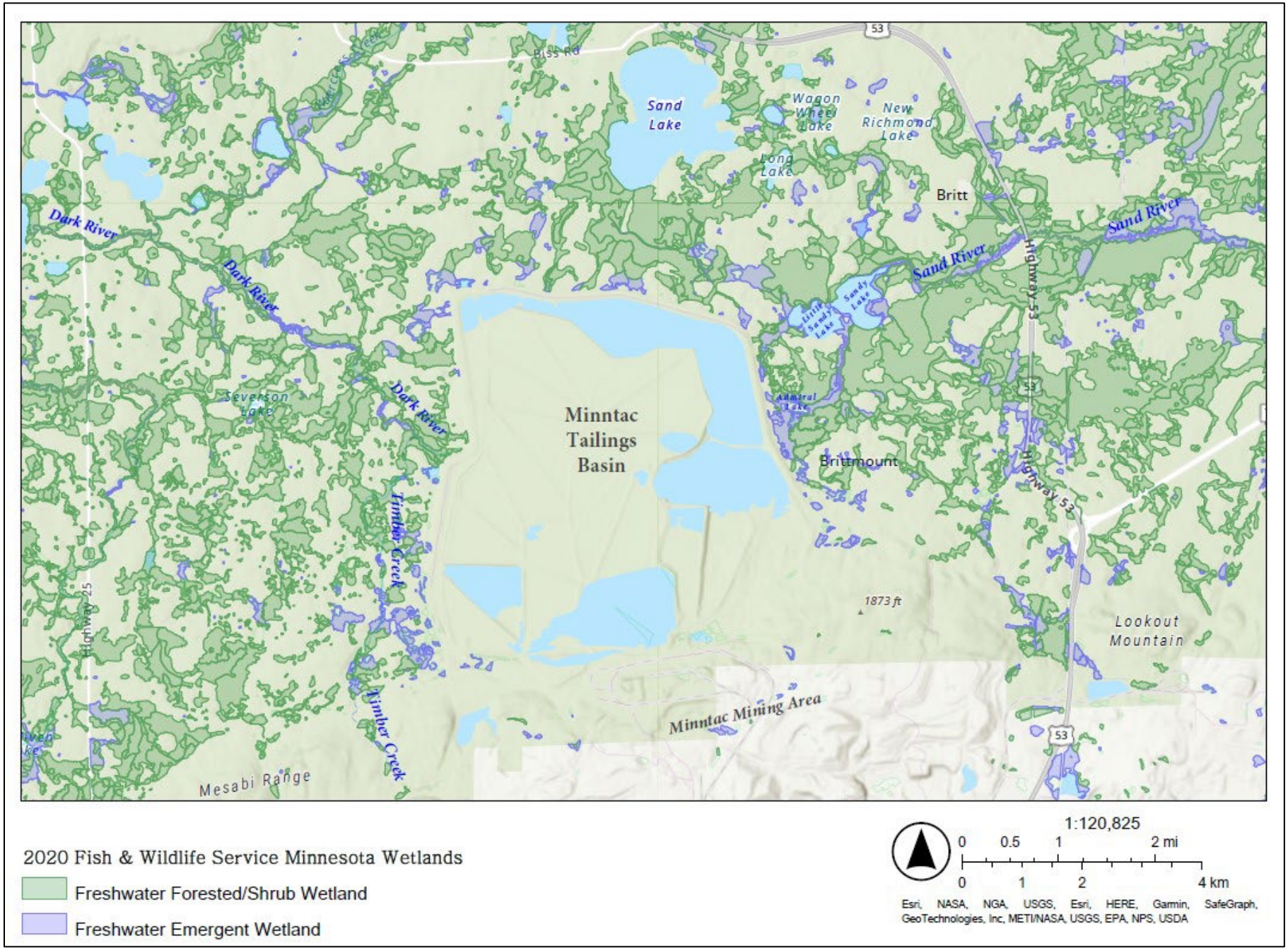


Figure 5. Wetlands Surrounding the Tailings Basin.
Data taken from the U.S. Fish and Wildlife Service National Wetlands Inventory database, last updated May 1, 2020. Map created by EPA.

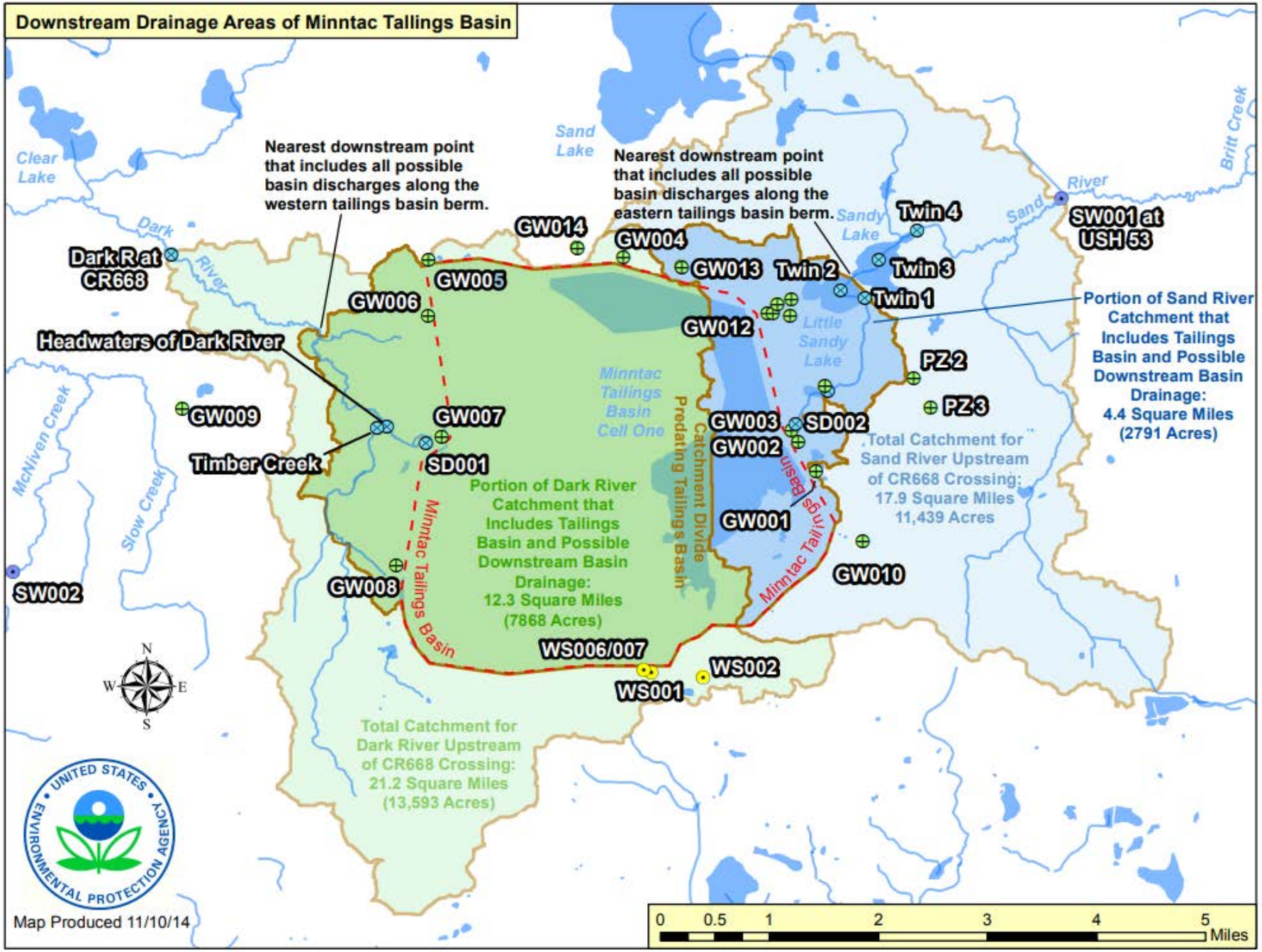


Figure 6. Downstream Drainage Areas of Minntac Tailings Basin.

Map produced by EPA on 11/10/2014. Note: station Dark R at CR668 is also known as SW003 or D-1. Station SW001 at USH 53 is also known as Station 701.

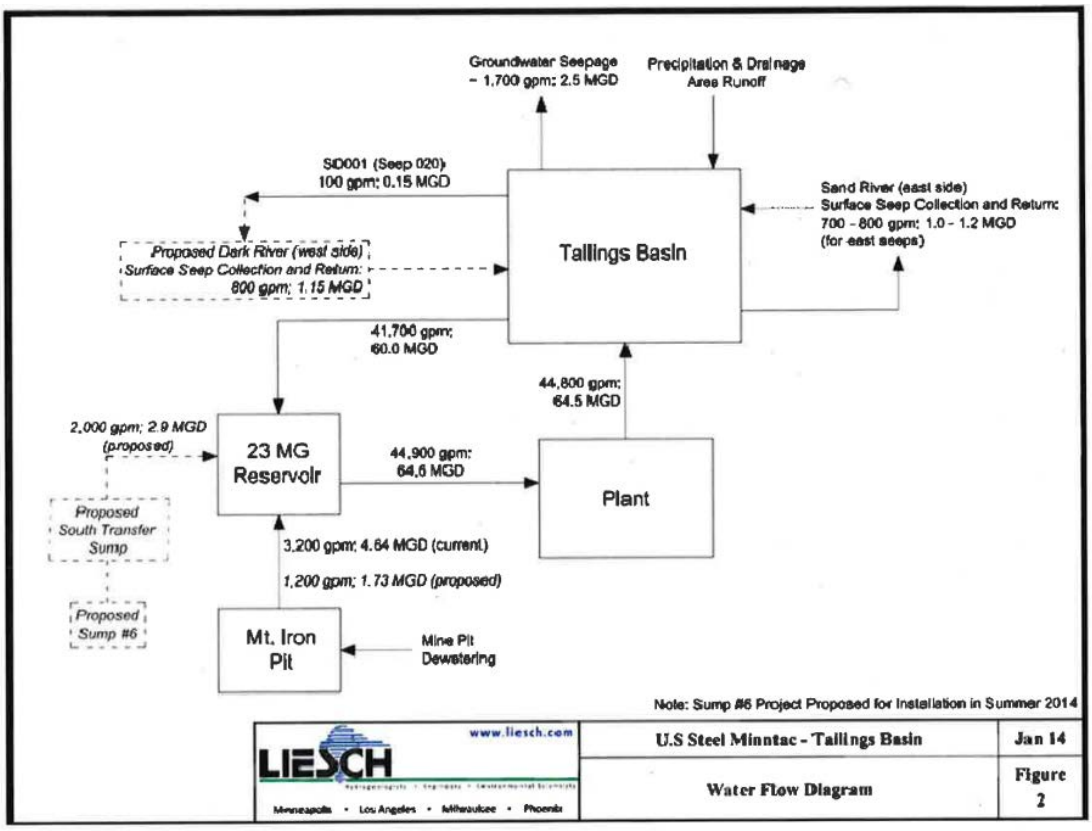


Figure 7. Water Flow Diagram of U.S. Steel Minntac – Tailings Basin.
Taken from "2018 NPDES Permit" by MPCA. See page 8 of pdf. Note: The proposed Dark River (west side) Surface Seep Collection and Return System was installed in 2019 and has been in operation since June 2020.

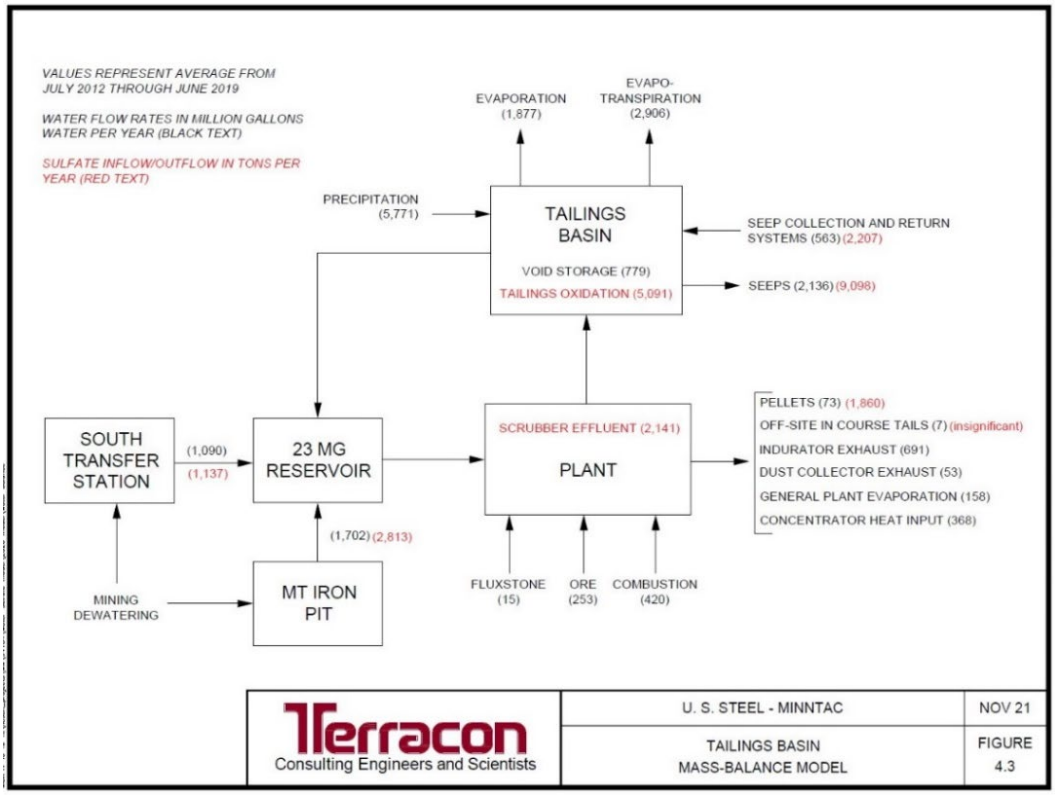


Figure 8. Tailings Basin Mass-Balance Model.
Taken from "Hydrological Investigation Report" by GHD on behalf of U.S. Steel (2021). See page 72 of pdf.

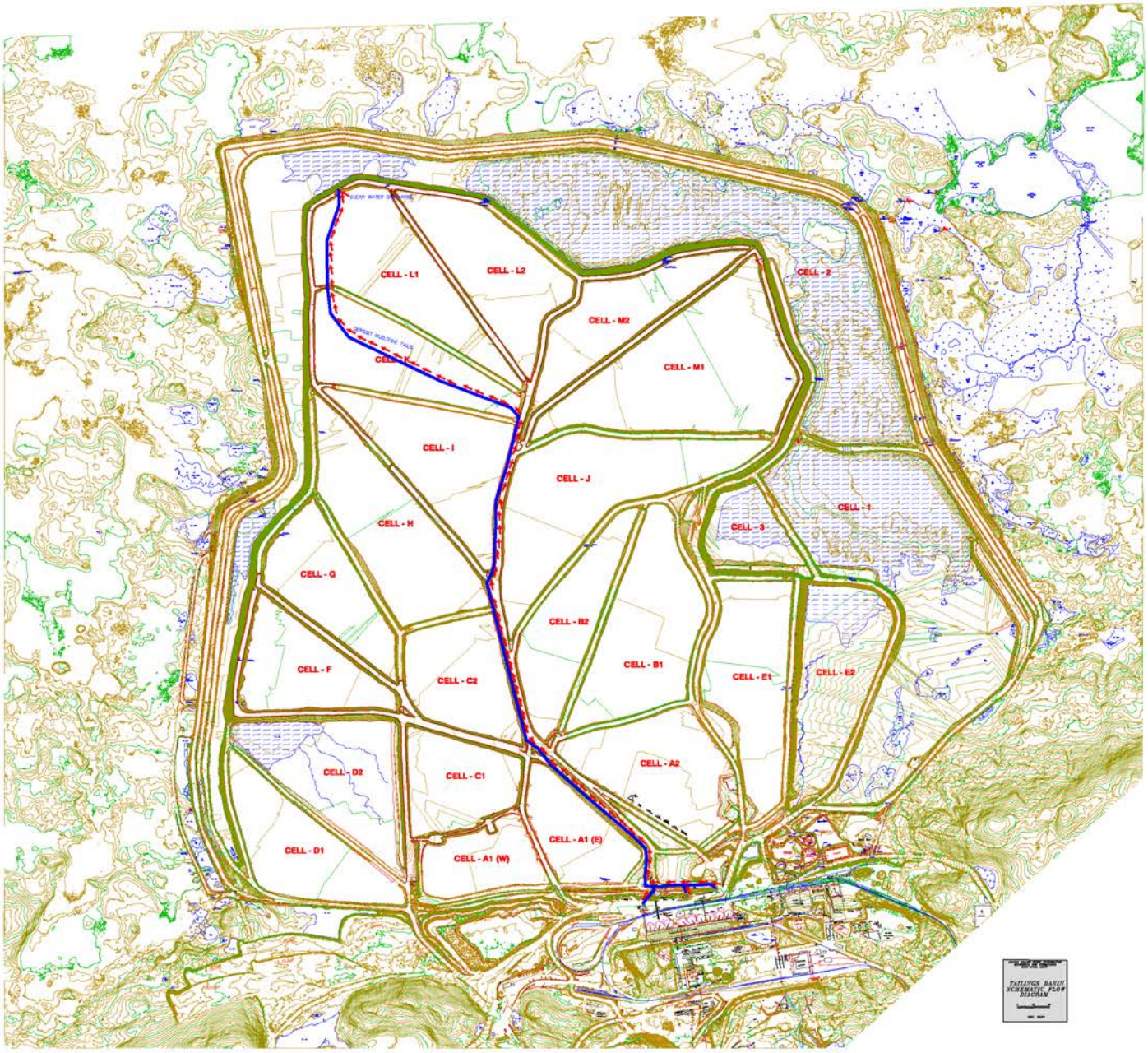
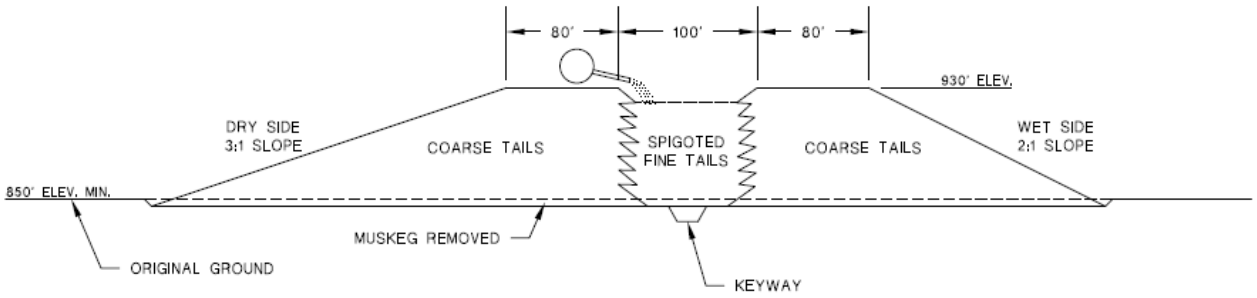


Figure 9. Tailings Basin Schematic.

Note the route of fine tailings flow, settling, and wastewater discharge to the tailings basin. This configuration changes over the course of operations. In summary, wastewater and tailings are conveyed to inner basin cells (labeled with letters and numbers). Process wastewater is drawn off and conveyed to outer cells (Cell 2 and Cell 1). Water from Cell 2 and Cell 1 flows clock-wise to a pumphouse on the southeast corner where water containing pollutants is recirculated to the processing facility. Image provided to U.S. EPA by U.S. Steel via MPCA on December 7, 2021.



Figure 10. Image of Tailings Basin Perimeter Dike.
View of the tailings basin facing south with the Minntac processing plant in the distance. Note: Sheet piling can be seen dividing the wetlands from the east side SCRS collection basin; the tailings basin standing water pool is seen on the right-hand side of this image. Taken from "Thermal imagery 2013 and 2019 for detecting Minntac east-side discharge," Technical Memorandum by Great Lakes Indian Fish & Wildlife Commission (2022). See page 3 of pdf.



TYPICAL CROSS-SECTION OF MINNTAC
BASIN DIKE CONSTRUCTION

N.T.S.

FIGURE 2-14
TYPICAL CROSS-SECTION OF MINNTAC
TAILINGS BASIN DIKE CONSTRUCTION

Figure 11. Typical Cross-Section of Minntac Basin Dike Construction.
Taken from "Draft EIS" by MWH on behalf of MPCA. See page 90 of pdf.

2 The Tailings Basin is a Point Source that Discharges Pollutants to Nearby Surface Waters

The Clean Water Act (CWA), EPA's regulations, and relevant court decisions provide that an NPDES permit is necessary to authorize the discharge of pollutants from a point source to waters of the United States. If the discharge of pollutants is through groundwater, then an NPDES permit is necessary if the discharge is the functional equivalent of a direct discharge. This chapter explains that the tailings basin is a point source and that it discharges pollutants to nearby surface waters. **Section 3** analyzes whether those discharges through groundwater that reach surface water are the functional equivalent of a direct discharge.

2.1 *Description of Point Source*

The tailings basin is a point source. *"The term 'point source' means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture." 33 U.S.C. § 1362(14); 40 C.F.R. § 122.2.*

The tailings basin is a point source because it is a "discernible, confined and discrete conveyance." The tailings basin is surrounded by a dike on the north, east, and west sides and by bedrock on the south side. The dike and bedrock form a perimeter that is intended to contain the tailings and process wastewater for the mining operations. This perimeter is clearly identifiable and the materials inside the perimeter are related to U.S. Steel's mining operations. The tailings basin is located at the headwaters of the nearby streams, making it easy to identify the source of any pollutants in the waters of the United States located directly adjacent to the perimeter dike. The tailings basin is also a circulating system that serves the mining process. The tailings basin contains fine tailings discharge pipes, ditches, launders, spigot lines, culverts, pumps, and other equipment that creates a circulating collection, settling, and drainage system that serves the mining operations (See **Section 1.3.2** for details on components of the tailings basin). When these types of circulating systems result in discharges, the escape of liquid from the system is from a point source. *U.S. v. Earth Sciences, Inc.*, 599 F.2d 368, 374 (10th Cir. 1979) ("We have no problem finding a point source here. The undisputed facts demonstrate the combination of sumps, ditches, hoses and pumps is a circulating or drainage system to serve this mining operation.") The large size of the tailings basin does not preclude it from being a "point source." *Washington Wilderness Coal v. Hecla Mining Co.*, 870 F. Supp. 983, 988 (E.D. Wash. 1994) ("[I]t is clear that the size of the pond is not relevant to determining whether or not it is a point source. As plaintiffs explain, it would be irrational to conclude that the bigger the source of pollution, the less likely it is to be a "source" under the CWA.") Any escape of liquid from the system or cells within constitutes a point source discharge.

Furthermore, the tailings basin is a point source because it is a "container." Like other types of containers, the tailings basin is intended to contain and convey water. U.S. Steel specifically constructed the tailings basin to contain process wastewater, which is evidenced by the fact that U.S. Steel reuses the process wastewater in the tailings basin for ongoing mining and processing operations. *See Cottonwood Env't Law Ctr. v. Edwards*, 2022 WL 952072, *7 (D. Mont. Mar. 30, 2022) (finding that a wastewater holding pond was a point source in part because the holding

pond was "specifically built . . . to contain effluent water"). Similarly, pollutant levels in the tailings basin can be measured directly and the pollutant load that occurs from any leak in the tailings basin may also be approximated with various modeling techniques. These characteristics are unlike non-point source pollution which flows from uncollected runoff water. *See Id*. at *8 (stating that "[c]ourts should not provide a loophole for polluters simply because the amount of pollutant being discharged proves somewhat more difficult to measure"; finding that a wastewater holding pond was a point source in part because the pollutants at issue in the case could be traced to a discrete source). For the same reasons that the tailings basin is a point source, the cells within the basin, which function in a similar manner, are also point sources.

In addition, the tailings basin is a waste treatment system, which is excluded from the definition of "waters of the United States," that discharges to a water of the United States. The area bounded by the outer edge of the perimeter dike of the tailings basin is considered a waste treatment system subject to the waste treatment system exclusion (i.e., not a water of the United States). In 2012, the U.S. Army Corps of Engineers (Corps) determined that wetlands inside the tailings basin were not jurisdictional under the CWA because "*they are part of a treatment system designed to meet the requirements of the Clean Water Act and are excluded from regulation.*"[19] The Corps' memo[20] further explained that the area bounded by the perimeter dike of the tailings basin is considered a treatment system and the waste treatment system exclusion applies to the entire tailings basin. Federal regulations provide that waste treatment systems are not waters of the United States.[21] However, discharges from a waste treatment system to a "water of the United States" require an NPDES permit.

In addition to the tailings basin and the cells within the basin being point sources, the pipes, ditches, or culverts that discharge fine tailings slurry, coarse refuse, process water from various taconite processes, sewage plant discharge, laboratory wastewater, non-process wastewater including wastewater from air pollution control devices, and runoff from adjacent areas[22] into the tailings basin from the mine processing plant areas are also point sources. In *Maui*, the Supreme Court made clear that the term "any point source" refers to such a source that need not be directly nor immediately at the end of the discharge. So long as the pollution travels "from" one such source along its path to the navigable water this requirement is satisfied. *Id*. at 1473-76. As Justice Kavanaugh further explained, the Lahaina Wastewater Reclamation Facility is itself a point source. *Id.* at 1478 (Kavanaugh, concurring). Thus, as "any discernable, confined and discrete conveyance[s]," from the Minntac processing facility to the tailings basin along its path to the navigable waters outside of the basin are also point sources under the CWA.

2.2 *Discharges from the Basin*

The tailings basin discharges pollutants to waters of the United States. As described by Darcy's Law, the discharge rate of a fluid traveling through porous medium is related to the permeability,

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[19] U.S. Army Corps of Engineers (2012), *Approved Jurisdictional Determination Form: 2012-01578-JBB, Minntac Tailings Basin (Wetland E2).*

[20] U.S. Army Corps of Engineers (2012), *Memorandum of File 2012-01578-JCB: Applicability of Waste Treatment Exclusion at the Minntac Tailings Basin*.

[21] 33 CFR 328.3(b)(1)

[22] MPCA (2018), *NPDES)/SDS Permit Program Fact Sheet: US Steel Corp. – Minntac Tailings Basin Area,* Permit No. MN0057207, pages 9-10 of pdf.

hydraulic conductivity, and the difference in pressure or "head."[23] The difference in pressure, or head, is related to the difference in water levels inside the basin and outside of the basin (i.e., transport of pollutants is driven by gravity). Process wastewater discharged from the basin enters waters of the United States adjacent to the basin. Wastewater is discharged from the tailings basin to surface waters by seeping through the perimeter dike via subsurface flow or through groundwater under the perimeter dike.

The SCRSs were designed to allow wastewater and groundwater to flow underneath and around them.[24,25,26] As a result, wastewater continues to flow underneath and around the SCRSs.[27,28] The SCRSs are designed to capture wastewater discharged from the basin and pump it back into the basin; however, the SCRSs only collect a portion of the wastewater that escapes the basin, and the pollutants are returned to the basin – not treated or removed from the process wastewater system. Calculations provided in the 2021 Hydrological Investigation Report suggest that pollutant loadings from the basin that reach downstream surface waters are not significantly affected by the operation of the SCRSs (See **Table A-5**).

The 2021 Hydrological Investigation Report states, "Given the hydraulic conditions of the Basin in relation to the surrounding areas, most of the Basin seepage that migrates past the Seep Collection and Return Systems reports to nearby surface waters within a relatively short distance from the Basin perimeter dike."[29] Rates of wastewater discharge from the tailings basin have been estimated using surface water quality data collected at downstream monitoring stations within the Sand and Dark River watersheds. U.S. Steel's consultant estimated a total seepage rate (i.e., wastewater moving under and through the perimeter dike, including seepage that is pumped back into the basin and seepage that moves downstream beyond the SCRS) at approximately 2,000 gpm (1,052 million gallons per year) to the Dark River and 2,200 gpm (1,157 million

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[23] Fitts, C. R. (2013), *Groundwater Science (2nd Editi*on), page 48.

[24] AECOM (2009), *U.S. Steel Corporation Minnesota Ore Operations – Minntac Tailing Basin Surface Seepage Collection System Design Report*, page 6 of pdf. "*The sheet pile walls will be limited to a driven depth of 15 feet (or less) so that subsurface water flows are not affected. Naturally occuring groundwater flows are present in the area and serve to regenerate the wetland. A deep cutoff wall the eliminates these subsurface flows may have a negative effect on the wetland ecology and would drive additional water to the surface in search of an outlet, requiring additional pumping volumes and energy usage to handle the increased surface seepage.*"

[25] BARR on behalf of U.S. Steel (2014), *Groundwater Sulfate Reduction Plan*, page 8 of pdf. "*Sheet pile was installed as part of the SC&R at each discrete surface seepage location to prevent dewatering of downgradient wetlands and promote additional subsurface seepage capture. The location of the sheet pile in the subject area is shown on Figure 2. Records indicate that the sheet pile was advanced to a depth of 13 – 14 feet bgs. Based upon a review of the pumping tests, groundwater flow below the approximate 400-foot length of installed sheet pile is estimated to be approximately 26 gallons per minute (gpm).*"

[26] AECOM (2009), *U.S. Steel Corporation Minnesota Ore Operations – Minntac Tailing Basin Surface Seepage Collection System Design Report*, page 6 of pdf. *"The sheet pile walls will be limited to a driven depth of 15 feet (or less) so that subsurface water flows are not affected."*

[27] MPCA (2018), *Findings of Fact, Conclusions of Law, and Order*, page 3 of pdf, Background Fact #15.

[28] GHD on behalf of U.S. Steel (2021), *Hydrological Investigation Report*, page 35 of pdf. *"Given the hydraulic conditions of the Basin in relation to the surrounding areas, most of the Basin seepage that migrates past the Seep Collection and Return Systems reports to nearby surface waters within a relatively short distance from the Basin perimeter dike."*

[29] GHD on behalf of U.S. Steel (2021), Hydrological Investigation Report, page 35 of pdf.

gallons per year) to the Sand River[30] (See **Table A-5**). The estimates were based on averaged concentrations of chloride and flow measured at downstream water quality monitoring locations.[31] While the seepage discharge flow rates referenced in the 2018 NPDES Permit Fact Sheet are from different sources and contain slightly different estimates, all reports conclude that there are process wastewater seepages from the basin that move through and under the perimeter dike and discharge to surface waters. The total amounts of sulfate and chloride reaching surface waters in the Sand River and Dark River watersheds were estimated through loading calculations based on downstream surface water monitoring data (years 2018 through 2022) (See **Section 3.5**).

Sulfate, a common component of the taconite ore,[32] is present in the facility's process wastewater. There has been more sampling of sulfate than other pollutant parameters and sulfate has been the focus of several modeling efforts. Additionally, sulfate model inputs and outputs have been estimated for the basin in the most recent 2021 Hydrological Investigation Report, suggesting that approximately 53 percent of the total sulfate entering the basin leaves via seeps (See **Figure 12)**.[33] Further, the 2021 Hydrological Investigation Report estimated that 22,612 kg/day (9,098 tons per year) of sulfate leaves the basin via seeps and is not captured by the SCRSs (See **Figure 8** and **Figure 12**).



Figure 12. Tailings Basin Sulfate Model Inputs and Outputs.
Taken from "Hydrological Investigation Report" (2021) by GHD on behalf of U.S. Steel. See page 37 of pdf. Note: TPY = tons per year.

[30] The 2021 Hydrological Investigation Report provided slightly different flow estimates. One estimate was 2,136 MGY (see Inset 4.1 of the 2021 Hydrological Investigation Report), while another estimate provided 4,200 gpm (which converted is 2,207 MGY). A range of 2,100-2,300 MGY may be more accurate.

[31] GHD on behalf of U.S. Steel (2021), *Hydrological Investigation Report*, pages 35-36 of pdf, Section 4.1.1.2.3 "Seeps."

[32] MPCA (2018), *Findings of Fact, Conclusions of Law, and Order*, page 4 of pdf, Permit History Fact #23. "*U.S. Steel contributes sulfate to the Tailings Basin from a variety of sources, including sulfate that forms as the result of chemical reactions which occur during processing and disposal of the mined ore, sulfate that accumulates in the wastewater stream from the 'wet scrubber' air pollution control equipment that U.S. Steel operates to control air emissions, and sulfate that is present in 'make-up' water used by U.S. Steel in processing the ore*."

[33] Calculations of percentages based on input and output estimates in 2021 HI Report by U.S. Steel Consultants. Sulfate seep (9,098 tons per year [TPY]) divided by total input (17,064 TPY – i.e., adding inputs from scrubbers, 2,141 TPY; Mt. Iron Make-Up, 2,813 TPY; STS Make-up 1,137 TPY; Tailings Oxidation, 5,091 TPY; and SCRS Pump Back, 5,882 TPY). Thus, seepage leaving equals 53% of the input sulfate.

The 2021 Hydrological Investigation Report presents fate and transport conceptual site models that identify the various sources of sulfate and the transformational processes occurring both inside and outside the tailings basin that result from the use of process makeup water, ore processing and waste gas scrubbing, and the deposition of fine and coarse tailings into the tailings basin. **Figure 13** and **Figure 14**, taken from the 2021 Hydrological Investigation Report, are conceptual models of the fate and transport of sulfate from the eastern and western sides of the tailings basin, respectively.

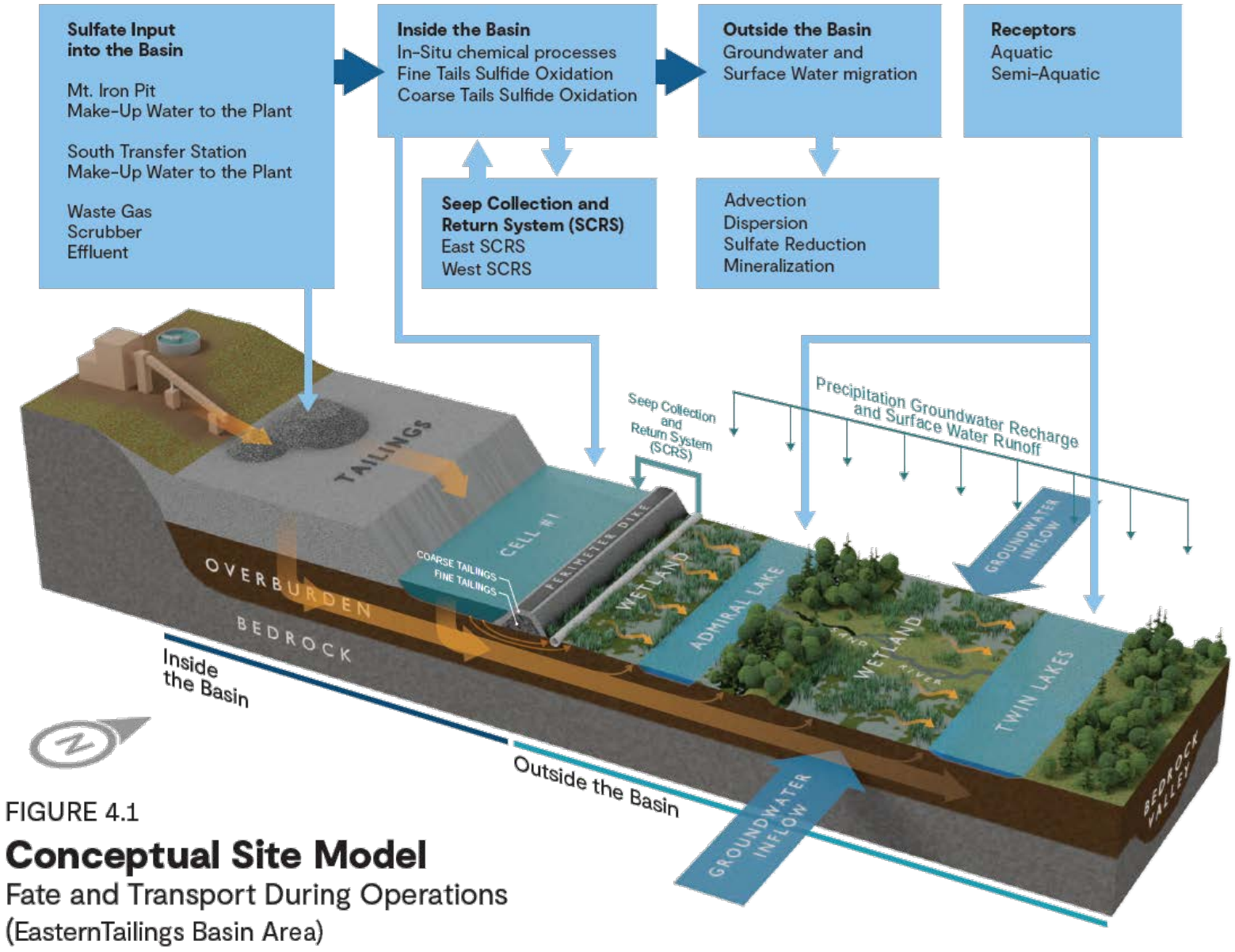


FIGURE 4.1

Conceptual Site Model

Fate and Transport During Operations

(EasternTailings Basin Area)

Figure 13. Eastern Tailings Basin Area Conceptual Site Model – Fate and Transport During Operations.
Taken from "Hydrological Investigation Report" (2021) by GHD on behalf of U.S. Steel. See page 70 of pdf.

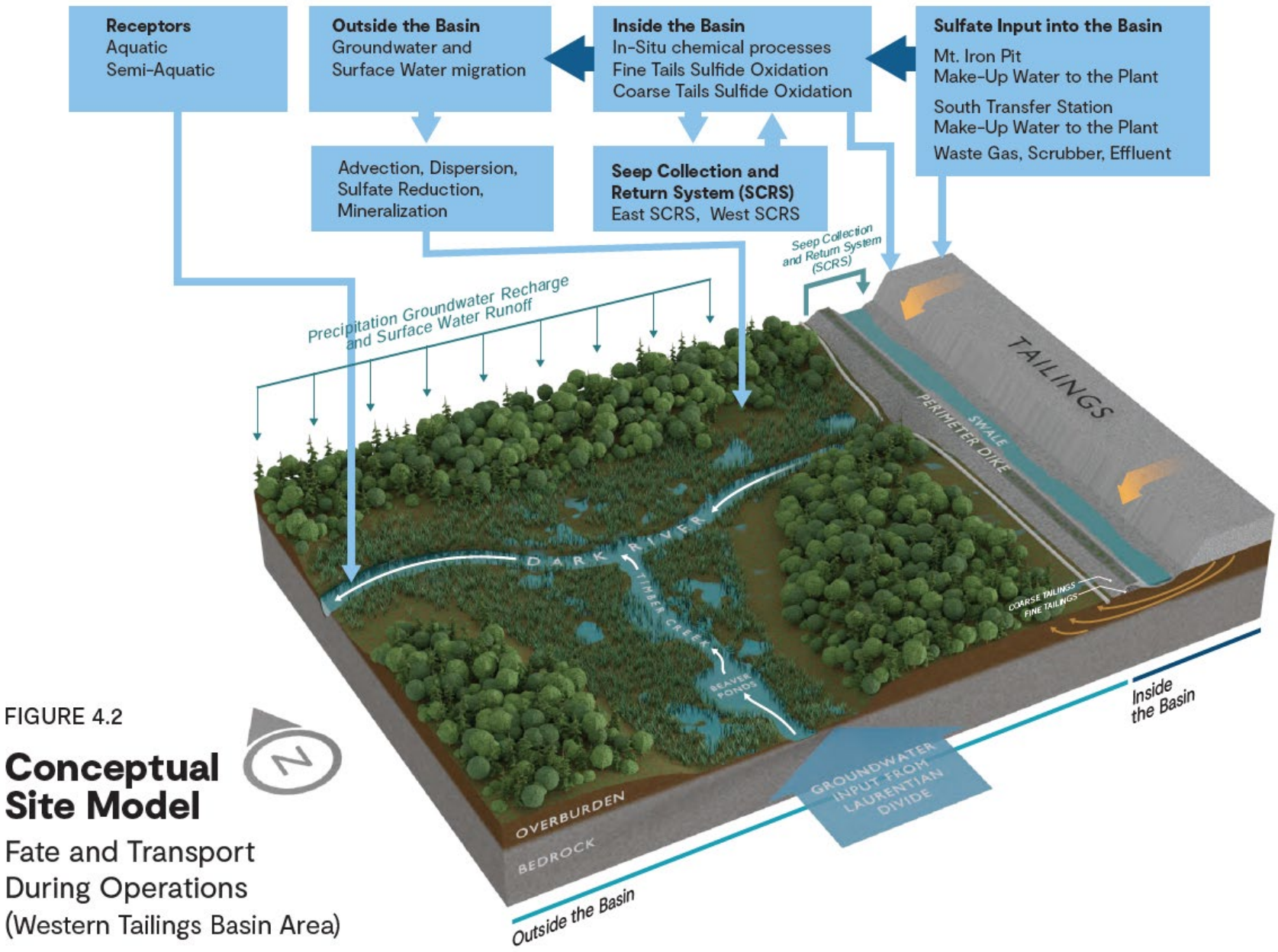


Figure 14. Western Tailings Basin Area Conceptual Site Model – Fate and Transport During Operations.
Taken from "Hydrological Investigation Report" (2021) by GHD on behalf of U.S. Steel. See page 71 of pdf.

2.3 *Discharge of a Pollutant*

2.3.1 Tailings Basin Wastewater Characterization

U.S. Steel identified the following pollutant parameters as present in its discharge in its 2014 NPDES permit application: chemical oxygen demand, total organic carbon, bromide, color, fluoride, nitrate-nitrite, total phosphorus, sulfate, total barium, total cobalt, total ion, total magnesium, total molybdenum, total manganese, total tin, total arsenic, total copper, total mercury, total nickel, total selenium, total thallium, and total zinc.[34] This evaluation focuses on sulfate and chloride because of the robust data which includes sampling, modeling, and studies which also focused on these pollutant parameters. EPA expects that the other pollutants in the wastewater are discharged through the same pathways. EPA would expect these pollutant parameters to be evaluated in an NPDES permitting context which is beyond the scope of this evaluation.

2.3.2 Surface Water Quality

Wastewater discharged from the tailings basin reaches surface waters. U.S. Steel acknowledges that wastewater from the tailings basin seeps under the perimeter dike and travels to surface waters via groundwater pathways.[35,36,37,38] Data collected at the downstream surface water quality monitoring stations show elevated levels of sulfate and chloride compared to pre-facility and background levels (See **Table 1**, **Table 2**, and **Table A-1**).

As shown in **Figure 15** and **Figure 16**, sulfate and chloride concentrations decrease at locations farther away from the basin, which indicates that the basin is a source of pollutants to the receiving water. Furthermore, there are no other sources contributing pollutants to the

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[34] U.S. Steel (2014), *EPA Application Form 1 and 2C, NPDES Permitting Program, Permit No: MN0057207.*

[35] CRA on behalf of U.S. Steel (2013), *Groundwater Flow and Sulfate Transport Model Report*, page 20 of pdf. "*Groundwater primarily discharges to the wetlands and ultimately to the lakes and Sand River*."

[36] CRA on behalf of U.S. Steel (2009), *Groundwater Investigation and Modeling Report,* page 18 of pdf. "*Sulfate-enriched surface seeps flow away from the basin as surface water, which allows for them to travel significant distances within a relatively short time frame. As the surface water moves away from the Minntac Tailings Basin, it also infiltrates into the shallow groundwater system. The effect of this process would be the extension of the sulfate-enriched groundwater plume and may explain the elevated sulfate levels observed at PZ1 and GP4A.*"

[37] GHD on behalf of U.S. Steel (2019), *Hydrological Investigation Work Plan Interim Requirements Status Report NPDES Permit MN005720,* page 6 of pdf. "*GHD reviewed LiDAR contour data, stream flow lines and aerial imagery to divide auto-catchments into areas likely receiving Tailings Basin surface water and groundwater inputs and areas unlikely to receive Tailings Basin surface water and groundwater. Surface water discharge from the Tailings Basin is assumed to be via flow paths from the perimeter of the Tailings Basin through wetlands, seeps, flowages and unnamed tributaries to Timber Creek, Dark River, and Sand River. Groundwater discharge from the Tailings Basin is assumed to extend radially from the perimeter dike to the point where groundwater flows daylight and are intercepted by surface water features such as streams, lakes, ponds or wetlands. Groundwater flow paths were determined from review of hydraulic data, monitoring well and piezometer data, soil borings, and surficial geology*."

[38] GHD on behalf of U.S. Steel (2021), *Hydrological Investigation Report,* page 53 of pdf. "*Surface water sampling and analysis has demonstrated that the surface water bodies that are impacted by discharge from the Basin include Timber Creek (although there is no evidence of impacts to water features on the west side of Timber Creek), the Dark River and wetlands near the Basin perimeter dike that make up the Dark River floodplain, and the Sand River and wetland 'tributaries' to the Sand River adjacent to the perimeter dike.*"

downstream surface water quality monitoring stations discussed in this evaluation.[39,40] Sulfate levels measured in the receiving waters have been increasing throughout the timeframe within which the basin has been operating (See **Figure 17** for graphs of sulfate concentrations within the Sand River and Dark River watersheds, respectively).

[39] MWH on behalf of MPCA, (2004). *Minntac Water Inventory Reduction EIS Surface Water Hydrology and Quality Technical Memorandum*, page 44 of pdf. *"There are at least three other sources of permitted discharge to nearby surface waters [in the Sand River watershed]: [1)] Ispat-Inland Minorca Tailings Basin - NPDES permit MN0055964, [2)] Tower POTW - NPDES permit MN0056618, [3)] Soudan State Park (Department of Natural Resources) - NPDES permit MN0060151. Both the Tower POTW and Soudan State Park, discharge to the East Two Rivers, which in turn discharges to Pike Bay of Lake Vermilion, downstream of monitoring stations discussed here. The Ispat-Inland Minorca Tailings Basin discharges intermittently to Wouri Creek, which in turn discharges to the Sandy River upstream of station S-1."* Wouri Creek connects with the Sand River downstream of Station SW001. Thus, Wouri Creek connects into the Sand River downstream of all monitoring stations discussed here. As such, current data associated with stations SW001, SW005, SW007 are not impacted by the Ispat-Inland Minorca Tailings Basin. Additionally, since the East Two Rivers discharges to Lake Vermilion, current data at stations SW001, SW005, SW007 are not impacted by the Tower POTW or Soudan State Park.

[40] MWH on behalf of MPCA, (2004). *Minntac Water Inventory Reduction EIS Surface Water Hydrology and Quality Technical Memorandum*, page 41 of pdf. *"There is at least one other source of permitted discharge to nearby surface waters in the Dark River watershed and that is the Hibbing Taconite Tailings Basin. This permittee (NPDES permit MN0049760) discharges to the Shannon River (west of the Minntac Tailings Basin), which in turn discharges to the Sturgeon River."* While Hibbing discharge exists, its discharge does not contribute pollutants to any of the monitoring stations discussed in this report.

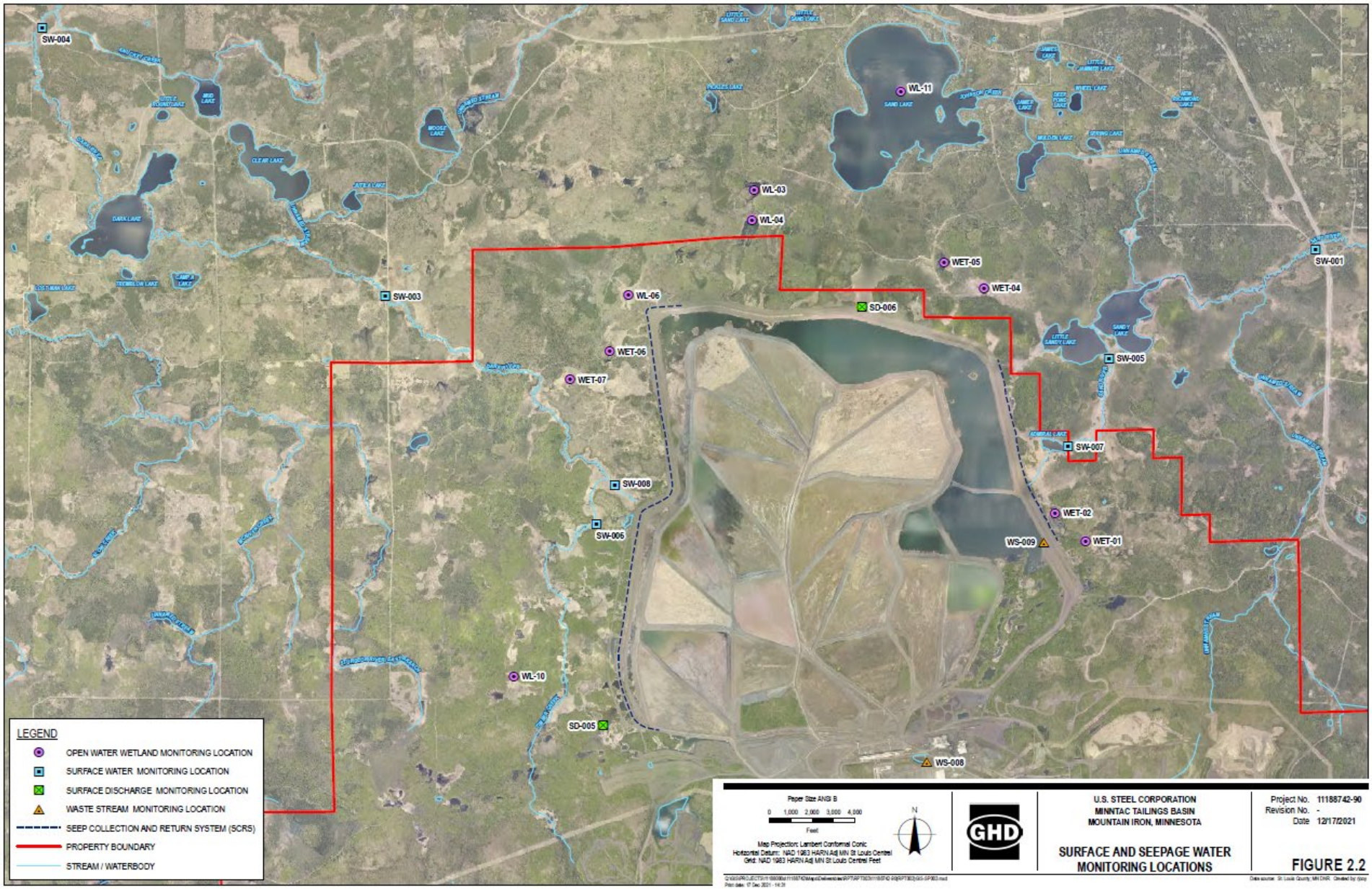


Figure 15. Surface and Seepage Water Monitoring Locations.
Taken from "Hydrological Investigation Report" (2021) by GHD on behalf of U.S. Steel. See page 55 of pdf.

Table 1. Sand River Surface Water Quality Data

Pollutant Parameters	**Current Conditions** (Data from December 2018 to April 2022, U.S. Steel Minntac DMR)				**Available Background**[3] (Data from May 2003 to November 2003, MPCA)		**Historic Conditions** (Data from 1958-1962, USGS)
	SD006 (Adjacent to perimeter dike of basin.) Number of samples = 139 Min – Max (Mean)	SW007 (Approximately 400 meters to perimeter dike of basin.) Number of samples = 39 Min – Max (Mean)	SW005 (Approximately 2,500 meters to perimeter dike of basin.) Number of samples = 41 Min – Max (Mean)	SW001 (i.e., Station 701) (Approximately 5 miles/8 kilometers downstream of basin) Number of samples = 41 Min – Max (Mean)	Britt Creek Number of samples = 7 Min-Max	Unnamed Creek at HW 170 Number of samples = 7 Min-Max	SW001 (i.e., Station 701) (Approximately 5 miles/8 kilometers downstream of basin's current location) Number of samples = 21 Min – Max (Mean)
Sulfate, Total (as SO4) (mg/L)	787-998[2] (891)	167-873 (650)	100-894 (525)	9.3-537 (200)	1-1.8	2.6-5.4	1.8-26 (8.5)
Chloride, Total (mg/L)	91.1-122 (105)	26.7-139 (101)	14.2-141 (83)	16.1-90.2 (45.6)	2.2-3.4	1.4-5.6	0.1-1 (0.25)
Hardness, Calcium & Magnesium, Calculated (as CaCO3) (mg/L)	1,390-1,710 (1,518)	283-1,290 (956)	161-1,260 (785)	161-779 (366)	12.8-50	14.8-72	13-54 (29.6)
Total Dissolved Solids (TDS) (mg/L)	1670-2,080 (1,938)	362-1,830 (1359)	241-1,970 (1,124)	102-1,110 (558)	---	---	---
Specific Conductance (umhos/cm)	867-2,817 (2,369)	765-2,535 (1908)	367-2,534 (1,551)	393-1,625 (781)	---	---	37-119 (63.6)

Notes:

1. This technical assistance focuses on the two pollutant parameters of sulfate and chloride as general indicators of the presence of process wastewater pollutants.
2. Discharge Monitoring Report (DMR) data from December 2018 to April 2022 was provided by MPCA to U.S. EPA on July 8, 2022. Above are summaries of instantaneous measurements. The dataset for Sulfate, Chloride, Hardness, TDS, and Specific Conductance can be found in **Table A-1**. The facility also regularly monitored for pH, bicarbonates (HCO3), and temperature; however, those pollutant parameters are not shown in this assessment.
3. For SD 006, ten samples taken from December 2018 to September 2019 reported units of "degrees C" for sulfate. EPA is considering this as a data entry error and included those values in the statistical summary calculations for sulfate in units of mg/L.
4. Britt Creek and the unnamed creek at Highway 170 had 7 samples taken from May 2003 to November 2003 which were considered background conditions for the 2004 EIS. Background data for stream surface water quality was collected as part of the Surface Water Hydrology and Quality Technical Memorandum for the 2004 Water Inventory Reduction EIS. MPCA confirmed in a May 11, 2022 email that they do not have any more recent data for those streams considered representative of background conditions. MPCA also confirmed in a May 12, 2022 email that they have had difficulty identifying a stream that is appropriately representative of background conditions for the Dark or Sand Rivers. Locations for Britt Creek and unnamed creek at Highway 170 can be found in the 2004 Water Inventory Reduction EIS, Surface Water Hydrology, and Quality Technical Memorandum.

Table 2. Dark River Surface Water Quality Data

Pollutant Parameters	Current Conditions (Data from December 2018-April 2022, U.S. Steel Minntac DMR)					Background Conditions (Data from May 2003 to November 2003)		Historic Conditions (Data from 1955-1961, pre-facility)
	SD001[2] (Adjacent to basin) Number of samples = 59 Min–Max (Mean)	SW006 (Approximately 600 meters to basin) Number of samples = 42 Min–Max (Mean)	SW008[3] (Approximately 1,200 meters to basin) Number of samples = 27 Min–Max (Mean)	SW003 (D-1) (Approximately 8 kilometers to basin) Number of samples = 42 Min–Max (Mean)	SW004 (Approximately 11 kilometers to basin.) Number of samples = 42 Min–Max (Mean)	Knuckey Creek[4] Number of samples = 7 Min-Max	Leander Creek[4] Number of samples = 7 Min-Max	Station D-2 (Approximately 15 miles/24 kilometers downstream of basin's current location) Number of samples = 8 Min-Max (Mean)
Sulfate (mg/L)	954-1150 (1028.4)	80.3-646 (363.4)	264-713 (498.9)	150-853 (516)	76-420 (218.1)	<1-2.2	<1-1.2	6.5-12 (8.2)
Chloride (mg/L)	119-146 (130.5)	4-36.3 (21.1)	26.8-90 (54.6)	16.2-90.6 (54.8)	9.7-43.1 (24.9)	1.7-2	4-7.7	0.3-0.7 (0.44)
Hardness, Calcium & Magnesium, Calculated (as CaCO3) (mg/L)	1450-1,880 (1615)	178-1,300 (758)	446-1,160 (890)	272-1,500 (919)	196-758 (409)	36.2-50	32-54	22-37 (31)
Total Dissolved Solids (TDS) (mg/L)	1940-2,450 (2218)	226-1,530 (897)	652-1,660 (1168)	372-1,990 (1187)	255-940 (511)	---	---	60-104 (79)
Specific Conductance (umhos/cm)	2,498-2,958 (2693)	363-2,150 (1282)	938-2,049 (1571)	568-2,488 (1609)	364-1,429 (218)	---	79-96	55-78 (68)

Notes:

1. This technical assistance focuses on the two pollutant parameters of sulfate and chloride as general indicators of the presence of process wastewater pollutants.
2. Discharge Monitoring Report (DMR) data from December 2018 to April 2022 was provided by MPCA to U.S. EPA on July 8, 2022. Above are summaries of instantaneous measurements. The dataset for Sulfate, Chloride, Hardness, TDS, and Specific Conductance can be found in **Table A-1**. The facility also regularly monitored for pH, bicarbonates (HCO3) and temperature; however, those pollutant parameters are not shown in this assessment.
3. SD001 was monitored until March 2020.
4. SW008 monitored monthly from April-November due to monitoring site access. Four samples between December 2018 and March 2019 were reported as "detect" with concentration values of zero for all the pollutant parameters; EPA is making the assumption that no samples were taken during December 2018-March 2019 and, thus, removed those zero values from the summarized data calculations.
5. Knuckey and Leander Creek had 7 samples taken from May 2003 to November 2003 which were considered background conditions for the 2004 EIS. Background data for stream surface water quality was collected as part of the Surface Water Hydrology and Quality Technical Memorandum for the 2004 Water Inventory Reduction EIS. MPCA confirmed in a May 11, 2022 email that they do not have any more recent data for those streams considered representative of background conditions. MPCA also confirmed in a May 12, 2022 email, that they have had difficulty identifying a stream that is appropriately representative of background conditions for the Dark or Sand Rivers. Locations for Knuckey Creek and Leander Creek can be found in the 2004 Water Inventory Reduction EIS, Surface Water Hydrology and Quality Technical Memorandum.

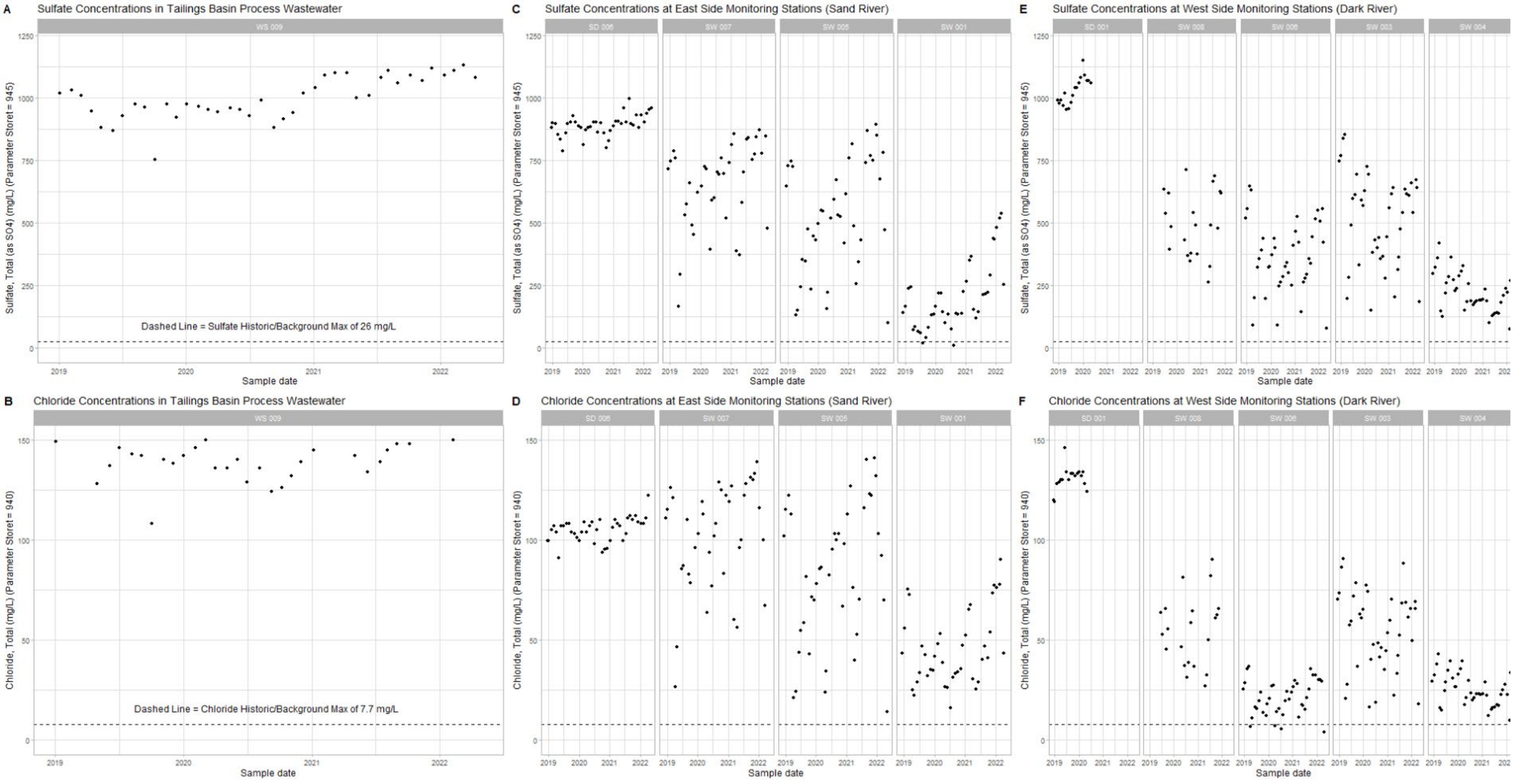


Figure 16. Sulfate and Chloride Concentrations Between December 2018 and April 2022.

Charts A-B show sulfate and chloride concentrations at the tailings basin. Charts C and D (Sand River) and E and F (Dark River) show monitoring stations within each watershed by order of distance from the tailings basin (left =closest and right is furthest from basin). Additional notes on data are included in Table 1 and Table 2. The full data set is included in Table A-1. EPA created charts from DMR Data using R-Project and RStudio.

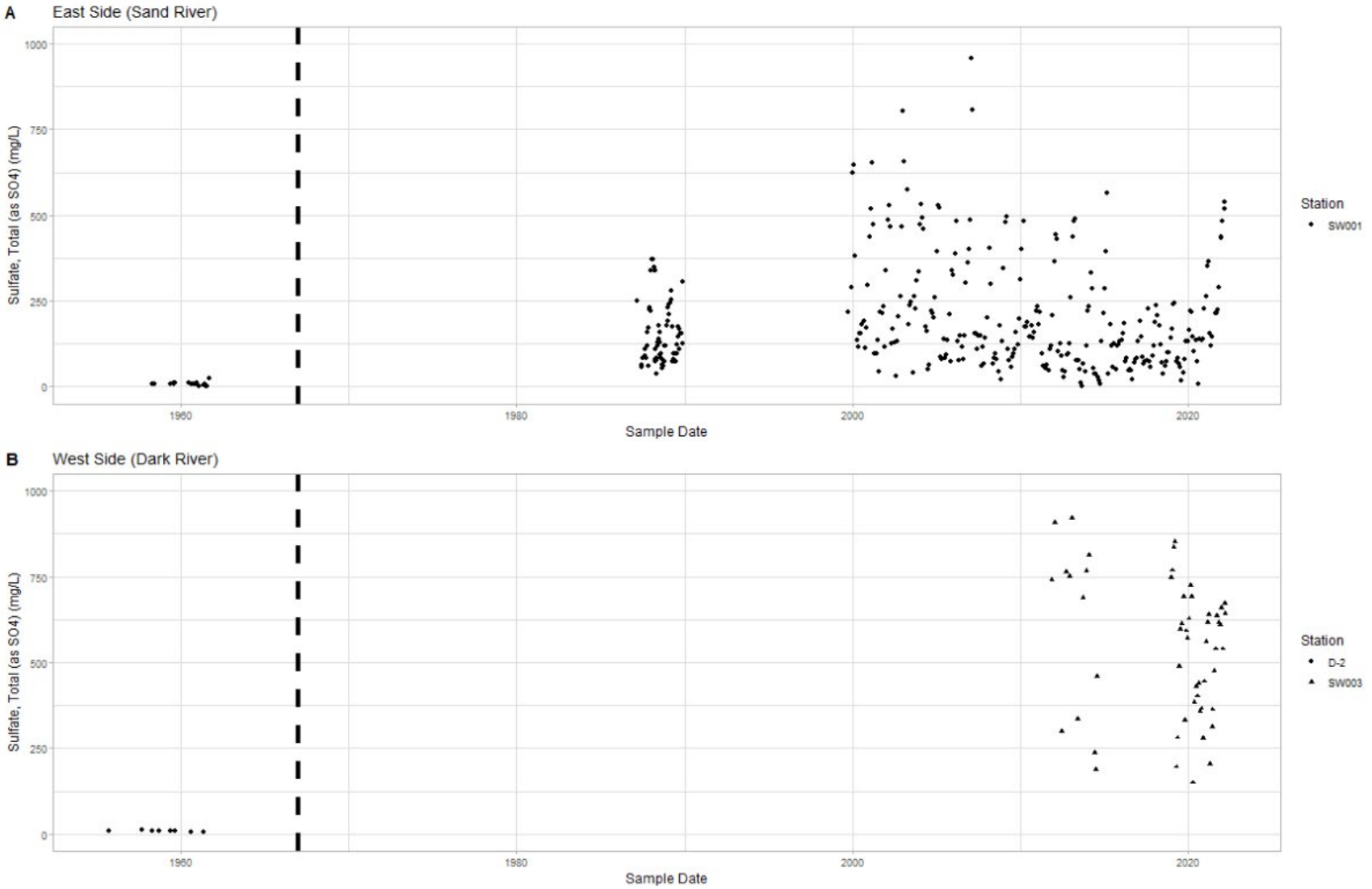


Figure 17. Sulfate Concentrations Over Time.

Chart A shows the east side of the basin (Sand River watershed). SW001 is approximately 5 miles downstream from the basin. Chart B shows the west side of the basin (Dark River watershed) at SW003 and D-2. SW003 and D-2 are within the Dark River watershed. SW003 is approximately 4.5 miles downstream of the basin and D-2 is approximately 15 miles downstream of the basin. Vertical dash lines indicate approximate initiation of tailings basin operation. EPA created charts using R-Project and RStudio from DMR Data and other sources provided by the State. Historic data are located in the Appendix.

2.4 *Waters of the United States*

EPA reviewed documents in the record including CWA section 404 permit applications from U.S. Steel,[41,42] United States Army Corps of Engineers' (Corps) permits,[43,44] and the administrative record for those decisions[45,46] to identify waters of the U.S. Those records identify the rivers, lakes, and wetlands surrounding the basin as waters of the U.S. As part of the 2021 Hydrological Investigation study, U.S. Steel submitted an interim status report,[47] which includes a summary of surface waters inclusive of waters of the U.S. and waters of the State[48] within a two-mile radius of the basin impacted or potentially impacted by the discharge from the basin (See **Figure 6**, which depicts the downstream drainage areas of the basin and **Figure 18**, which identifies surface waters surrounding the basin).[49] While the definition of waters of the State is broader than that for waters of the U.S., the waters identified as waters of the State by U.S. Steel (**Figure 18**) include the waters that were identified and permitted for impacts under CWA section 404 by the Corps.

The Sand River on the east side of the basin is a relatively permanent tributary that flows into the Pike River, a traditionally navigable water. On this side of the basin, the waters of the U.S. which receive discharges from the basin include: 1) the Sand River beginning near the toe of the dike and flowing to Admiral Lake; 2) Admiral Lake which is a relatively permanent water that connects downstream to the Pike River; 3) the Sand River flowing from Admiral Lake to the Twin Lakes (Little Sandy Lake and Sandy Lake); 4) Little Sandy Lake and Sandy Lake which

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[41] Permit Application for Water/Wetland Projects. United States Steel Corporation, Minnesota Ore Operations – Minntac Western Tailings Basin Seepage Collection System.

[42] Wetland Replacement Plan, Minntac Tailings Basin Surface Seepage Collection Project, with CWA section 404 permit application for 2009-02600-TWP attached. U.S. Steel. December 2009

[43] Permit and Letter. USACE, Regulatory File No. 2014-01247-TJH. April 26, 2019

[44] Permit and Letter. USACE Regulatory File No. 2009-02600-TWP June 9, 2009

[45] Memorandum to File 2012-01578-JCB

[46] Memorandum for Record. Department of the Army Environmental Assessment and Statement of Findings for Permit Application MVP-2014-01247-TJH

[47] GHD on behalf of U.S. Steel (2019), *Hydrological Investigation Work Plan Interim Requirements Status Report NPDES Permit MN005720.*

[48] In 1974, Minnesota received authority to administer the NPDES program from the Environmental Protection Agency. In the administration of the NPDES program, the Minnesota Statute Chapter 115 Water Pollution Control Sanitary Districts applies the following definition with respect to pollution of waters of the state: *"Waters of the state" means all streams, lakes, ponds, marshes, watercourses, waterways, wells, springs, reservoirs, aquifers, irrigation systems, drainage systems and all other bodies or accumulations of water, surface or underground, natural or artificial, public or private, which are contained within, flow through, or border upon the state or any portion thereof (Minn. Stat. Ann. § 115.01(22)).*

[49] GHD on behalf of U.S. Steel (2021), *Hydrological Investigation Report*, page 8 of pdf. *"The Interim Status Report noted that the Basin area is located on two major watersheds north of the Laurentian Continental Divide. Within these two major watersheds there are 131 minor sub-catchments watersheds that include 128 wetlands, 3 lakes (Admiral, Little Sandy, and Sandy) and 3 streams (Timber Creek, Dark River, and Sand River), encompassing 3,804 acres. Because the Basin acts as a groundwater recharge source, some surface water or wetland locations near the perimeter dike can receive groundwater due to strong upward vertical hydraulic gradients created by the elevated hydraulic head present inside the Basin."*

are relatively permanent waters that connect downstream to the Pike River; and 5) relatively permanent open water and adjacent wetlands with continuous surface connections to the Sand River and its unnamed tributaries.[50]

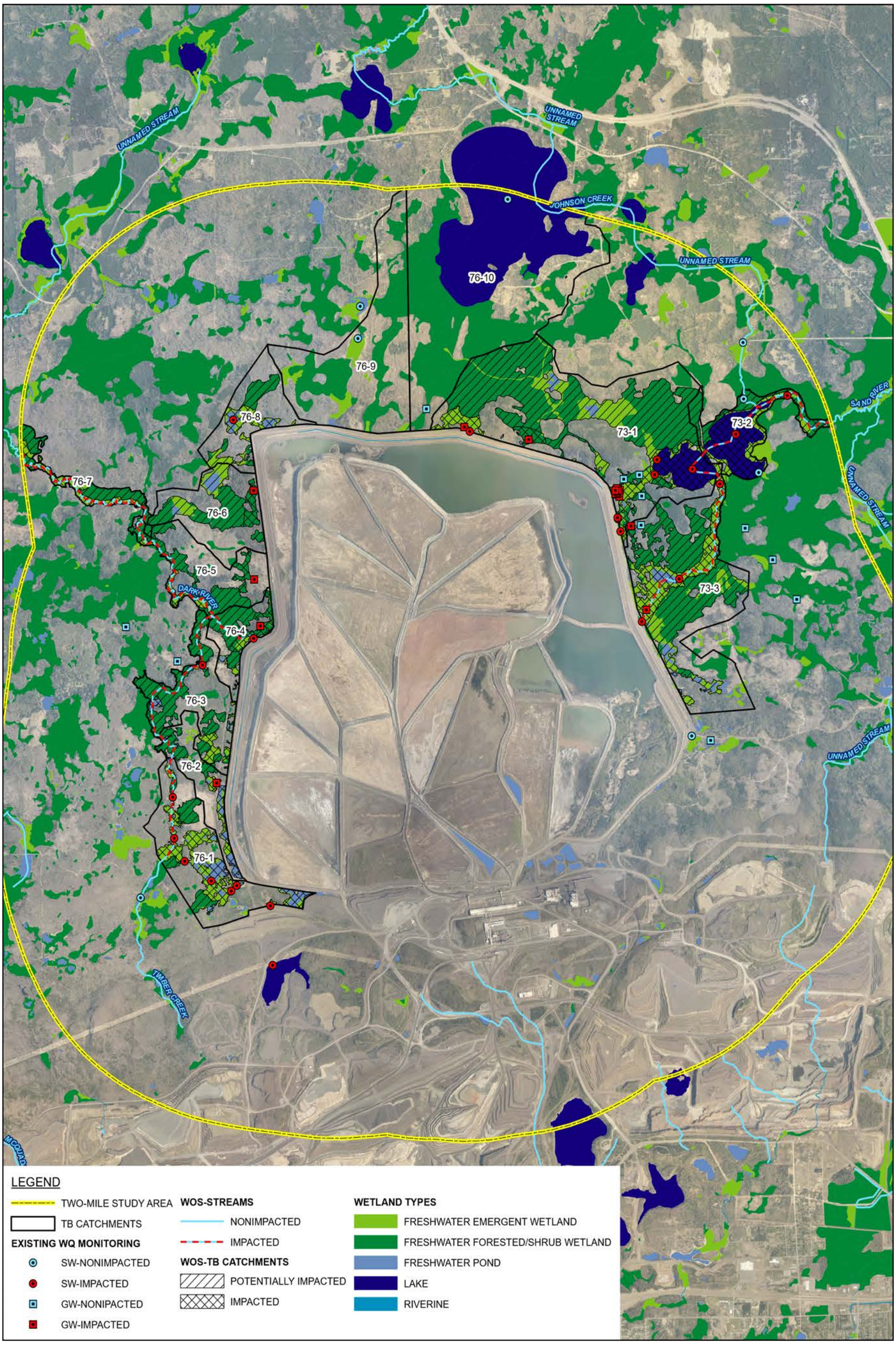
The Dark River is a relatively permanent tributary of the Sturgeon River which flows into the Little Fork River which is navigable-in-fact throughout. Along the Dark River (west) side of the basin, waters of the U.S. which receive discharges from the basin include: 1) the Dark River emerging near the toe of the perimeter dike; 2) Timber Creek, a relatively permanent tributary to the Dark River, which runs north along and parallel to the west side of the tailings basin; and 3) relatively permanent ponds and adjacent wetlands with continuous surface connections to the Dark River and to relatively permanent tributaries thereof. These wetlands span the length of the west side of the perimeter dike and are located immediately next to the perimeter dike and/or outside of the SCRS.

The Johnson Creek watershed to the northwest includes the following surface water features: 1) freshwater ponds, freshwater emergent wetlands, and freshwater forested/shrub wetlands, and 2) Sand Lake. It is unclear at this time whether surface water features within the Johnson Creek watershed are receiving discharges from the basin.

So, while EPA did not evaluate the extent and precise location of all of the waters of the U.S., the review of the permit records as noted above for the East Side SCRS (Permit No. 2009-02600-TWP) and the West Side SCRS (Permit No. MVP-2014-01247-TJH)[51] from the Corps and other documents indicate that the basin discharges to waters of the U.S. Further, as described in **Section 2.3**, pollutants from the tailings basin have been detected at water monitoring locations in waters of the U.S.

[50] U.S. Army Corps of Engineers permit files - Permits No. 2009-02600-TWP and MVP-2014-01247-TJH

[51] U.S. Army Corps of Engineers (2019), *Standard Permit with attachments*, see page 18 of document.



Source: St. Louis County; USFWS National Wetlands Inventory; MN DNR

Figure 18. Identified Waters of the State Classifications.
Taken from "Hydrological Investigation Work Plan Interim Requirements Status Report" by GHD on behalf of U.S. Steel (2019). Page 15 of pdf.

3 Technical Analysis of certain factors that may be relevant to a functional equivalent determination

While transit time and distance traveled will be the most important factors in most cases, and in many cases the only factors that need be considered, multiple other factors may also provide evidence to support the functional equivalent determination where time and distance are not dispositive. For this technical analysis, EPA analyzed each of the factors laid out by the Court and did not identify any additional factors that are relevant. The Supreme Court identified time and distance as the most important factors in most cases and left flexibility in how to weigh the relevant factors. While this technical assistance evaluates each of the seven factors identified by the Supreme Court in *Maui* in order to be as helpful to the State as possible, it is not necessary to evaluate every factor to find that a discharge is the functional equivalent of a direct discharge. Where one or two factors, such as transit time and distance traveled, present evidence that a discharge is the functional equivalent of a direct discharge, analysis of other factors may not be needed. For this technical analysis, EPA defers the weighing of the factors to the NPDES permitting authority. The following is EPA's evaluation of the publicly-available documents relevant to the Minntac tailings basin for each of the Supreme Court factors: (1) transit time, (2) distance traveled, (3) the nature of the material through which the pollutant travels, (4) the extent to which the pollutant is diluted or chemically changed as it travels, (5) the amount of pollutant entering the navigable waters relative to the amount of the pollutant that leaves the point source, (6) the manner by or area in which the pollutant enters the navigable waters, and (7) the degree to which the pollution (at that point) has maintained its specific identity. *Maui*, 140 S. Ct. at 1476–77.

Pollutant discharge pathways described in this section are limited to what has been modeled by various stakeholders. These pathways have not been confirmed with tracer studies.

3.1 *Transit Time*

The time a pollutant takes to reach surface waters depends on the path traveled by the pollutant. Some seepage from the tailings basin reaches surface waters adjacent to the outer edge of the perimeter dike.[52] An example of this is the seepage along the northern perimeter near SD006. In this instance, EPA considers time and distance traveled to be as short as from the outer edge of the basin to the wetlands immediately adjacent to the basin having the shortest amount of time for discharge to occur which is immediately. In instances where pollutants are traveling longer distances in the subsurface, the timeframes are longer, with many pathways taking less than 1-2 years. The specific pathways taken by molecules of wastewater to reach surface waters has been modeled for the Sand River watershed.[53,54]

U.S. Steel's model utilized the inner edge of the tailings basin perimeter dike as the start of the pathline, and transit time estimates for discharges reaching surface waters within the Sand River watershed predicted a minimum transit time of 1 year. As described below, the Great Lakes

[52] MPCA (2018), *Minntac NPDES Permit Fact Sheet*, page 11 of pdf. "*Emergent groundwater seepage at the toe of the basin dam flows into the Dark River and Sand River*"

[53] CRA on behalf of U.S. Steel (2013), *Estimate of Time of Travel between the Tailings Basin and the Twin Lakes.*

[54] Great Lakes Indian Fish and Wildlife Commission (2017), *Water Flow Pathlines from Minntac Basin East and Northeast Berm.*

Indian Fish and Wildlife Commission (GLIFWC), which also considered the start of pollutant pathlines to be at the inner edge of the perimeter dike, showed that some of the transit times to surface waters are relatively short, with many being "1 to 5 years in duration." GLIFWC estimated transit times from the inside of the tailings basin to surface waters at a minimum of 1 year, with most of the pathways emerging into surface waters in less than 25 years.

Retardation, the apparent slowing of contaminants because of adsorption onto the aquifer solids, does not affect sulfate[55] and chloride.[56] Thus, sulfate and chloride would be expected to have the same transit time as groundwater. Other pollutants were not evaluated.

3.1.1 Sand River Watershed

In response to a requirement from MPCA to estimate the transit time between the tailings basin and the Twin Lakes, U.S. Steel's consultant, CRA, simulated transit time for a specific portion of the Sand River Watershed under current (2013) conditions (i.e., with the SCRS sheet pile walls in place). CRA describes the model,[57] as shown in **Figure 19**, as follows:

"[Figure 19] *shows the simulated particle pathlines and travel times under current conditions (i.e., with the SC & R system sheet-pile walls in place). The simulated particle pathlines are similar to that occurring for the historical conditions, except that particles reaching the sheet-pile wall move downward from the shallow overburden [glacial till] into the deep overburden to pass under the sheet-pile wall, which extends through the shallow overburden [glacial till] only. The particles then move upwards back into the shallow overburden [glacial till] before discharging to the wetland area. Particles reach the location of the SC & R system in approximately 8 to 14 years, as occurs under historical conditions. Particles reaching the wetland area do so in approximately 10 to 25 years, and these particles reach piezometer nest PZ-12S/I/D in approximately 9 to 24 years. The sheet-pile wall moderately increases the travel time to piezometer nest PZ-12S/I/D and the wetland area compared to that occurring under historical conditions."*

The GLIFWC presented findings in a 2017 particle tracking assessment that utilized the same MODFLOW model as the 2013 CRA study but expanded the scope to include the entire eastern side of the basin.[58] **Figure 20** and **Figure 21** detail the pathline simulations presented in the GLIFWC report. GLIWFC estimated transit times for the same pathways as CRA's study (as

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[55] CRA on behalf of U.S. Steel (2013), *Groundwater Flow and Sulfate Transport Model Report*, page 47 of pdf. "In the subsurface, sulfate is not subject to sorption to soil particles and therefore travels at the same speed as groundwater. Thus, sorption is not represented for sulfate and a retardation factor of 1.0 is applied."

[56] Fitts, C. R. (2013), *Groundwater Science (2nd Edition).* Elsevier, page 539.

[57] CRA on behalf of U.S. Steel (2013), *Estimate of Time of Travel between the Tailings Basin and the Twin Lakes*

[58] Great Lakes Indian Fish and Wildlife Commission (2017), *Water Flow Pathlines from Minntac Basin East and Northeast Berm. "…we conducted additional particle tracking using the CRA MODFLOW model (T65Fut) that was supplied to the MPCA on a CD as Appendix C to the 2013a report. Using CRA's model output files, we began by duplicating the particle tracking presented in their [Figure 2] of the 2013b report. We then increased the number of particles released to include the entire north and eastern berm that was modeled by CRA in their 2013a MODFLOW model report. Our pathline analysis uses CRA's MODFLOW model output files and MODPATH. The only difference from CRA's work is that our analysis uses more released particles and, therefore, shows a more complete picture of the path that water takes from the basin to the toe of the berm and surrounding surface water features (our [Figure 18])."*

shown circled in **Figure 20**). Estimated flow paths include pathways directly through the dike and via groundwater under the dike. The GLIWFC study also modeled flows via groundwater reaching the SCRS system in approximately 10 years and the monitoring station PZ12 (located roughly 1,000 feet from the interior of the dike) in approximately 20 years. Additionally, in GLIFWC's expanded model, GLIFWC showed that some of the transit times to surface waters are relatively short, with many being "1 to 5 years in duration." Paths to surface water features (wetlands, pools, and channels) emerge at the toe of the basin berm and at locations close to the berm. Most of these flow paths are found within what is characterized as the shallow glacial till zone.[59] Also, the study suggests that most of the pathlines emerge into surface waters in less than 25 years. The study also identifies flow paths at the northern edge of the perimeter dike with less than 5 years of transit time before emerging into the wetlands near the toe of the basin.

3.1.2 Dark River Watershed

Analyses of transit time from the basin to surface waters within the Dark River watershed are not readily available. However, the nature of materials through which wastewater moves, including the berm and glacial till, are similar on both sides of the tailings basin. Therefore, due to similar subsurface conditions between the Sand River and Dark River watersheds (See **Section 3.3**), a similar range of transit times can be expected for discharges that pass under and through the perimeter dike and reach surface waters within the Dark River watershed.

[59] Glacial till zone is the layer above the granitic bedrock, often referred to as the "overburden" layer in the 2013 CRA report on behalf of U.S. Steel. In this report, the term "shallow" appears to refer to the areas where the glacial till ranges from approximately 0-50 ft. deep. The term "deep" appears to refer to the areas where the glacial till is more than 50 ft. deep.

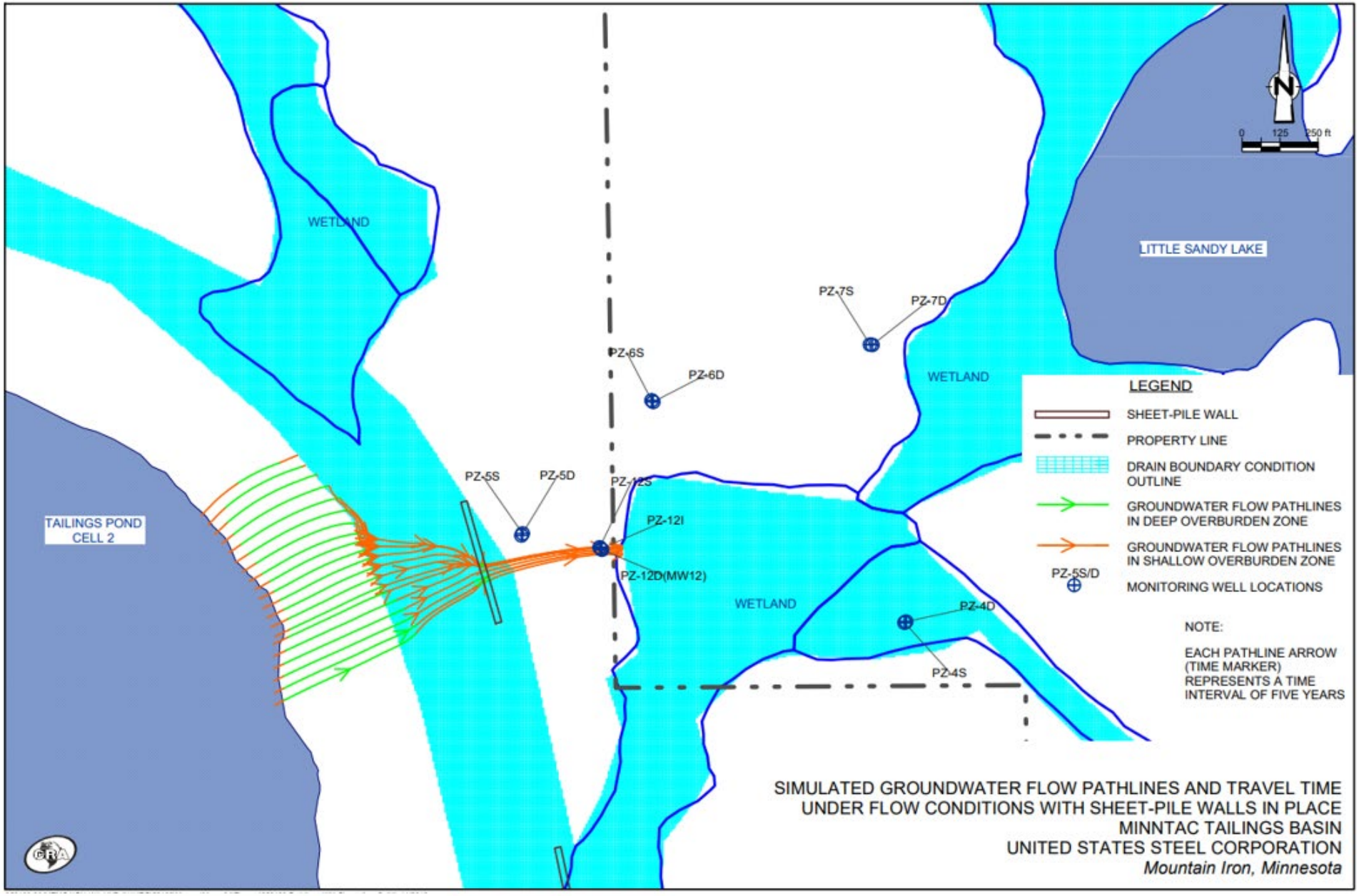


Figure 19. Simulated Groundwater Flow Pathlines and Travel Time Under Flow Conditions With Sheet Pile Walls in Place.
Taken from "Estimate of Time of Travel between the Tailings Basin and the Twin Lakes." by CRA on behalf of U.S. Steel (2013). See Page 5 of pdf. Modified by EPA to remove figure label.

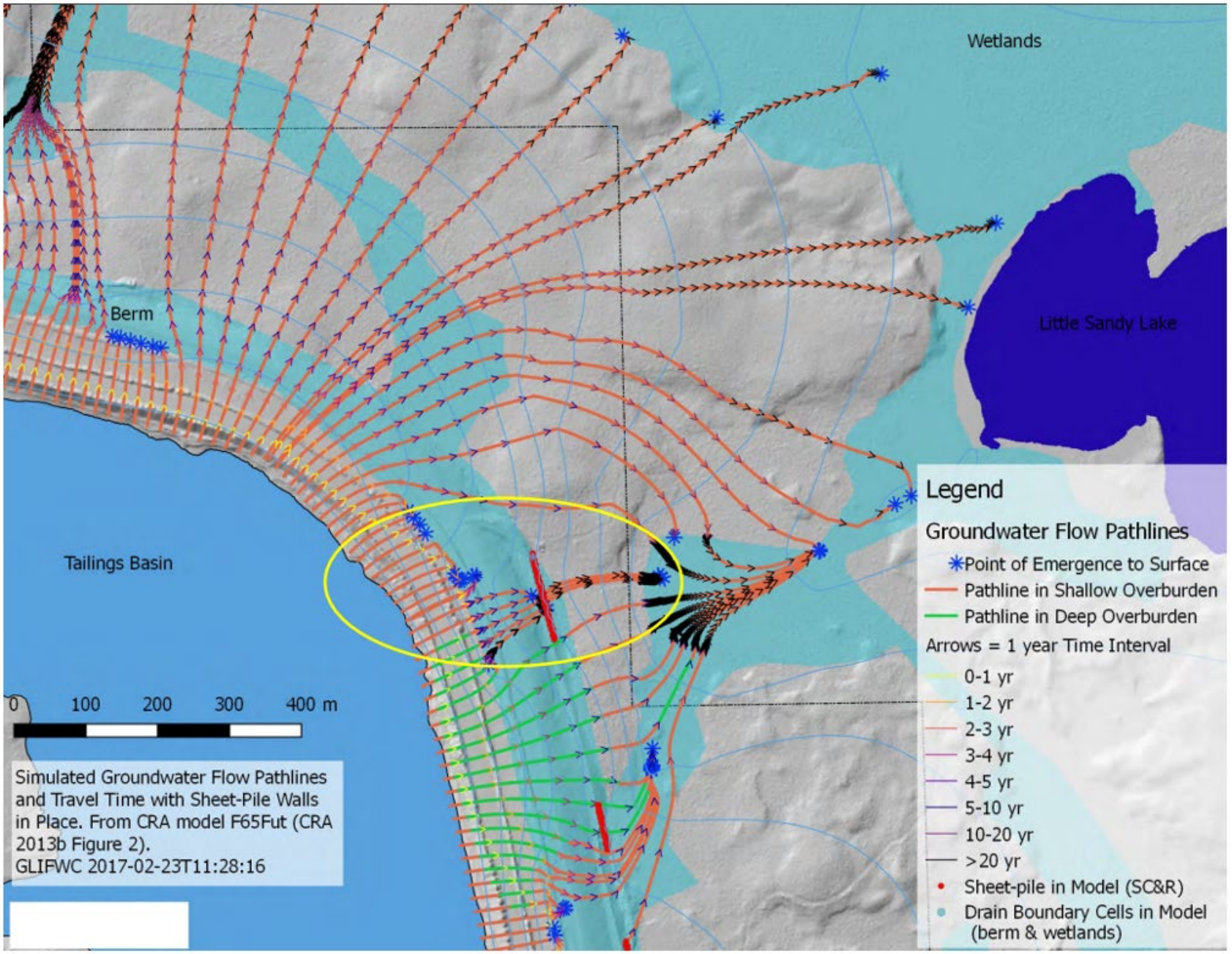


Figure 20. Simulated Groundwater Flow Pathlines and Travel Time With Sheet Pile Walls in Place.
From CRA model F65Fut. Taken from "Water Flow Pathlines from Minntac Basin East and Northeast Berm" by Great Lakes Indian Fish and Wildlife Commission (2017). See page 6 of pdf. Modified by EPA to remove figure label.

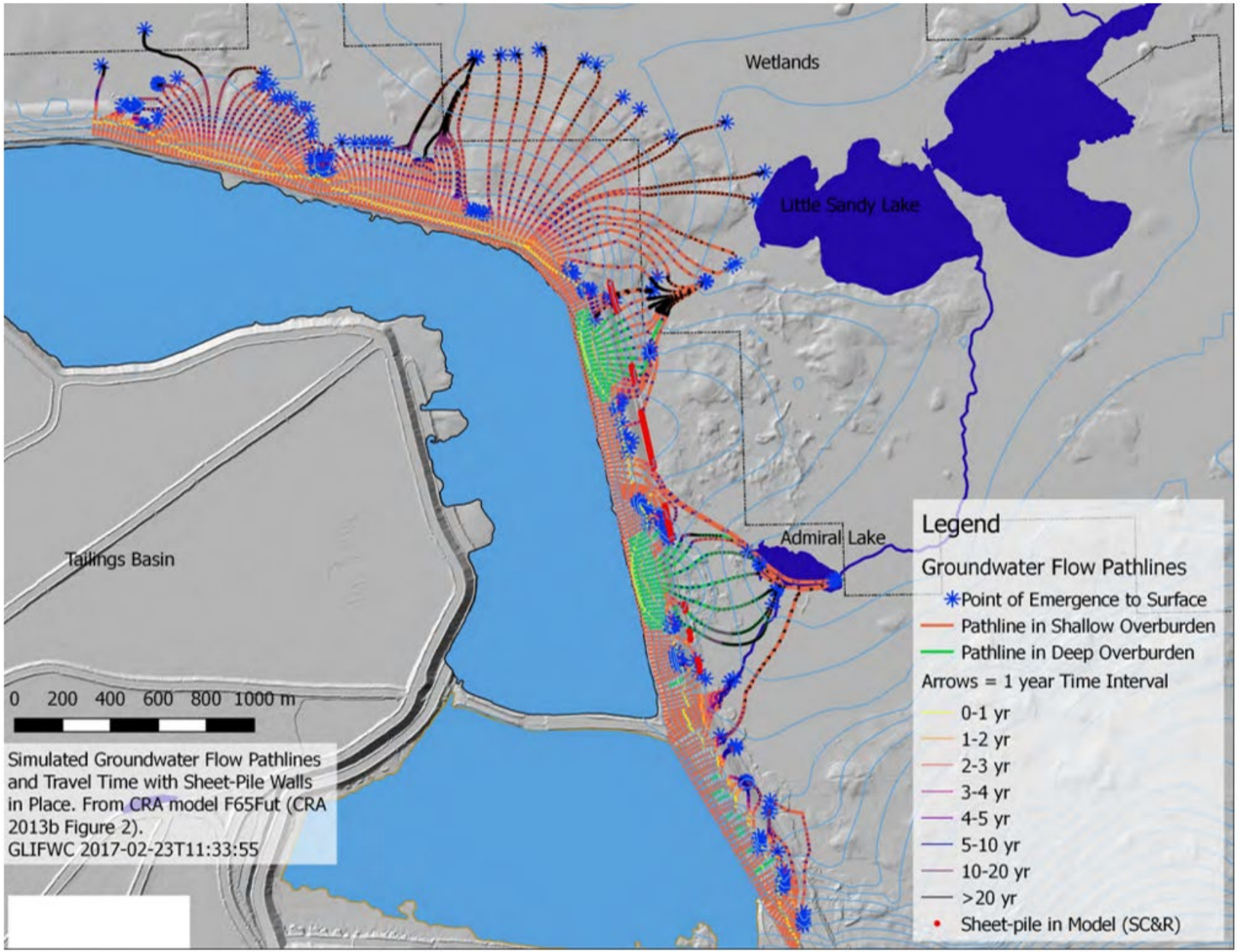


Figure 21. Simulated Groundwater Flow Pathlines and Travel Time With Sheet Pile Walls in Place (full extent).
From CRA model F65Fut. Taken from "Water Flow Pathlines from Minntac Basin East and Northeast Berm" by Great Lakes Fish and Wildlife Commission (2017). See page 7 of pdf. Modified by EPA to remove figure label.

3.2 *Distance Traveled*

Similar to what was discussed in Section 3.1, the distance traveled depends on the pathway traveled by the pollutant. EPA considers the outside of the perimeter dike to be a starting point for pollutant pathways, and as there are wetlands immediately adjacent to the basin in some areas, the shortest distance that can be traveled by pollutants to surface waters is zero feet, or an immediate release.

Other pathways are described in the 2021 Hydrological Investigation Report by U.S. Steel's contractor, GHD. In this report GHD characterized the distance traveled to surface waters: "*[g]iven the hydraulic conditions of the Basin in relation to the surrounding areas, most of the Basin seepage that migrates past the Seep Collection and Return System reports to nearby surface waters within a relatively short distance from the Basin perimeter dike*."[60] Other studies discussed below provide numeric estimates of 100 feet to 3,300 feet of distance traveled, depending on the surface water of interest in each study.

Also, thermal studies (discussed below) suggest that seepage enters surface waters within 100 meters (330 feet) of the perimeter dike. Additionally, a 2017 EPA inspection report (also discussed below) indicates elevated sulfate and chloride levels within and immediately outside of the SCRS, where they are located. Some wastewater emerges in surface waters at the toe of the dike (adjacent to the basin).[61] See **Figure 11** for a cross section of the dike. Other pathways exist that represent longer distances traveled to surface waters.

3.2.1 *Sand River Watershed*

The approximate distance traveled by pollutants that move through the subsurface to surface waters is as little as zero feet where seeps emerge immediately along the outer edge of the perimeter dike into wetlands at the toe of the perimeter dike. Other discharges occur in the large wetland complex that covers over 2,000 acres that abut unnamed tributaries, lakes and the Sand River. See **Section 2.4** and for a description of siting and waters of the U.S.

3.2.1.1 Estimating Distance Traveled Utilizing Pathline Studies

The CRA and GLIFWC studies estimated both transit time and distance travelled for the eastern side of the tailings basin. The 2013 CRA study showed that discharges through groundwater along the study path from inside the perimeter dike emerge to the wetland boundary condition within 1,000 feet (305 meters) of the perimeter dike (See **Figure 19**, which depicts pathline and travel time simulations from the east and northeast berms of the basin).

The 2017 GLIFWC report, which utilized the model from the 2013 CRA study, expanded the scope to include the length of the east side of the basin under conditions with sheet pile walls in place (from the SCRS system). The model estimated multiple pathways resulting in a range of distances traveled for pollutants from the basin to reach surface waters. To the south and north of the SCRS system, pollutants pass through and under the perimeter dike to surface waters via pathways that include subsurface flows emerging into wetlands, which are adjacent to or within

[60] GHD on behalf of U.S. Steel (2021), *Hydrological Investigation Report*, page 35 of pdf.

[61] MPCA (2018), *Minntac NPDES Permit Fact Sheet.* pages 11 of pdf. "*Emergent groundwater seepage at the toe of the basin dam flows into the Dark River and Sand River*"

approximately 330 feet (100 meters) of the perimeter dike and through the "shallow" glacial till zone that travel up to a modeled 3,300 feet (1,000 meters) from the perimeter dike.[62] (See **Figure 20** and **Figure 21**, which show the general location of discharge pathways). The 2017 GLIFWC model estimated that 51 percent of flow paths emerge within 330 feet (100 meters) of the toe of the berm and 87 percent of the flow paths emerge within 1,650 feet (500 meters) from the toe of the tailings basin berm. The pathline studies suggest the vast majority of flow paths in the Sand River watershed reach surface waters within 3,300 feet (1,000 meters).

3.2.1.2 Thermal Studies

In 2022, GLIFWC compared a 2013 thermal and visible light imagery study by Fond du Lac Band and 2019 imagery provided by U.S. Steel in their 2021 Hydrological Investigation Report.[63] Referencing the 2013 study, GLIFWC mentions identifying "*14 areas of open water with thermal anomalies within 100 [meters] of the basin berm toe and outside the SCRS,*" as shown in **Figure 22**. **Figure 10** provides an aerial image of the east side of the basin for visual reference of the proximity of wetlands to the SCRS.

As required under Section 5.29.32(a) of the 2018 NPDES Permit,[64] the 2021 Hydrological Investigation Report included an analysis of thermal imaging around the perimeter dike to identify significant surface and subsurface flow paths coming from the basin.[65] The results are presented in **Figure 23** and in Appendix E of the 2021 Hydrological Investigation Report. In addition to seepage emerging along the length of the east side SCRS, the thermal study is consistent with the 2017 GLIFWC model, which shows seepage emerging in the wetlands to the north and south of the east side SCRS. Disagreements exist as to whether thermal anomalies from the 2019 thermal study appear immediately outside of the east side SCRS (and outside of the associated sheet piling).[66,67]

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[62] The term "shallow glacial till zone" is referred to as the "shallow overburden" in the 2013 CRA report on behalf of U.S. Steel. The term "shallow" glacial till zone appears to refer to the areas where the glacial till ranges from 0-50 ft deep. "Deep" glacial till zone appears to refer to the areas where the glacial till is more than 50 ft deep.

[63] Great Lakes Indian Fish & Wildlife Commission (2022), *Technical Memorandum – Thermal imagery 2013 and 2019 for detecting Minntac east-side discharge.* "*In 2013 the Fond du Lac Band contracted with A.W. Research Laboratories to do an overflight of the entire Minntac tailings basin berm. During the flight on March 26 multi-band imagery was captured. This included visible light imagery and infrared (IR) imagery. The IR imagery was used to identify locations of higher temperature near the toe of the tailings basin berm. Because most water was ice-covered and the ground snow-covered, the visible light imagery could be used to identify areas of open water*."

[64] MPCA *(2018*), *National Pollutant Discharge Elimination System/State Disposal System Permit MN0057207: US Steel Corp. – Minntac Tailings Basin Area,* page 22 of document.

[65] GHD on behalf of U.S. Steel (2021), *Hydrological Investigation Report*, page 14 of pdf.

[66] GHD on behalf of U.S. Steel (2021), *Hydrological Investigation Report*, page 23 of pdf. "*Although a few thermal anomalies were noted on the eastern portion of the perimeter dike, all of the anomalies were within the confines of the east-side SCRS, indicating the existing east-side SCRS is effectively controlling the discharge of surface and shallow subsurface seepage along the eastern perimeter dike*."

[67] Great Lakes Indian Fish & Wildlife Commission (2022), *Technical Memorandum – Thermal imagery 2013 and 2019 for detecting Minntac east-side discharge*, page 2 of pdf. "*USS's consultant identified 4 thermal anomalies as seeps in this same area (USS 2021 Figure 3.4), all of which the consultant crudely mapped as outside of the SCRS. USS provided imagery for 3 of these anomalies. All three of these anomalies were also seen in the 2013 FdL imagery. Of the three, when we accurately aligned them with the location of the SCRS in qGIS, two (9E & 9F) were*

3.2.2 Dark River Watershed

On the west side, some wastewater emerges near the perimeter dike and SCRS. In 2016, U.S. Steel's consultant, Barr Engineering Company, prepared a wetland monitoring plan for wetlands that may be impacted by the west side SCRS.[68] The report, which includes satellite images of the west side of the basin overlaid by seep locations and wetland delineations (delineations were also presented in US Steel's CWA section 404 permit application to construct the SCRS[69]), indicates seepage and wetlands at the toe of the dike and within a short distance from the berm. For instance, **Figure 24** shows an aerial image of the central portion of the west side perimeter dike abutting wetlands. Specific flow paths have not been studied post-SCRS installation in 2019. However, it is reasonable to assume that water continues to flow beyond the SCRS system and emerge in surface water features due to 1) the SCRS design allowing subsurface flows, 2) the west side SCRS being similar in design to the east side SCRS (i.e., allowing subsurface flows), and 3) estimates of seepage that reach surface water locations downstream (post-SCRS) not showing a decreasing trend at this time (See **Table A-5**).

outside (to the east) of the SCRS (Figure 2). Discharge 9E and 9F are near the location of the historical channel of the Sand River, which is visible in 1940's imagery. In addition to georeferencing the USS imagery, we noted that in the USS imagery the consultant used red arrows to indicate the locations of thermal anomalies. Thermal images for anomalies 9E and 9F had arrows identifying anomalies outside the SCRS. The thermal and visible imagery collected in 2013, which shows 14 areas of open water and elevated water temperature outside the east-side SCRS in March, confirms and supplements the thermal imagery in the 2021 USS report identifying basin discharges outside the SCRS."

[68] BARR Engineering Company on behalf of U.S. Steel (2016), *Wetland Monitoring plan – U.S. Steel Minntac West Tailings Basin Seepage Collection Project.*

[69] Permit Application for Water/Wetland Projects – United States Steel Corporation, Minnesota Ore Operations – Minntac. Western Tailings Basin Seepage Collection System. April 4, 2014

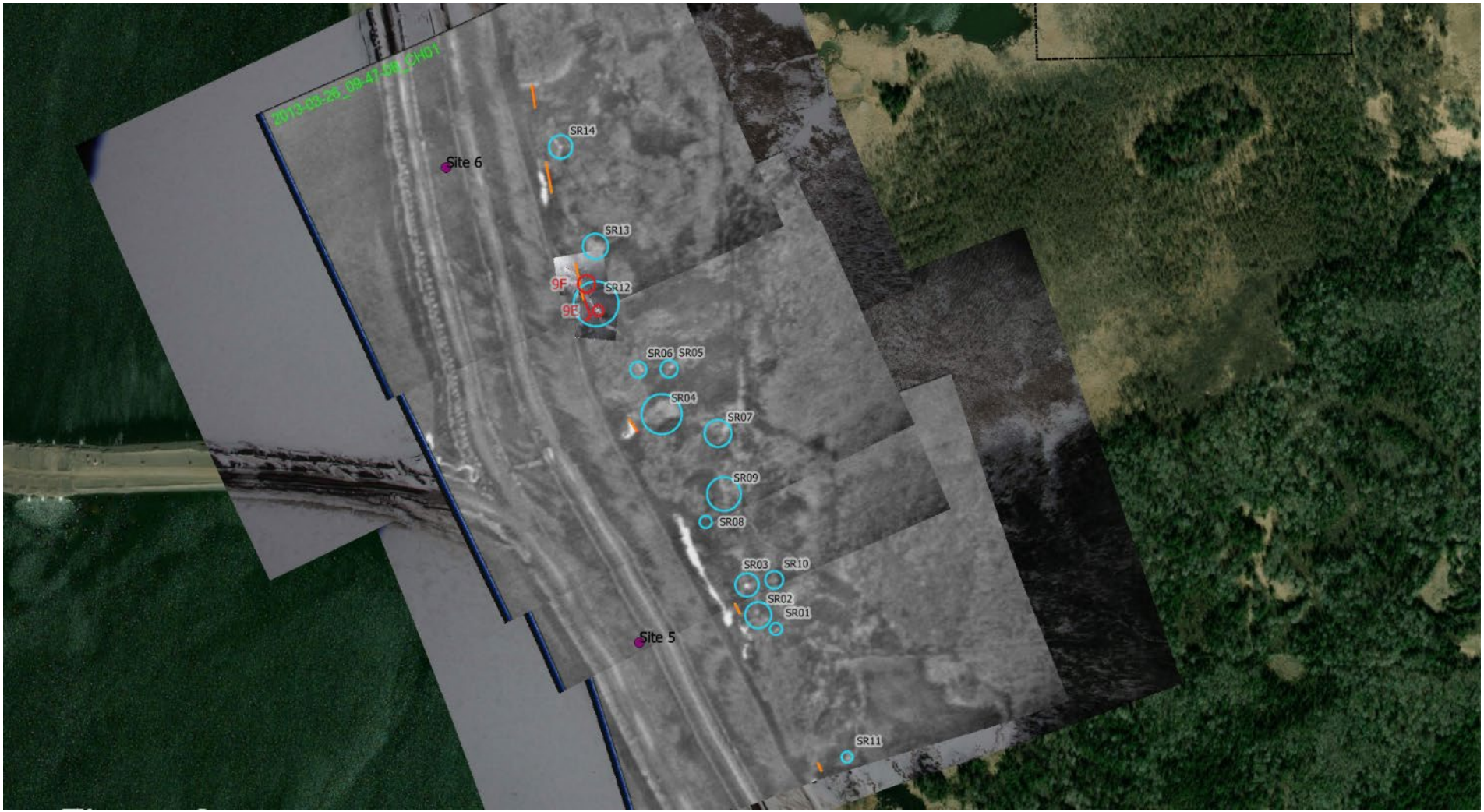


Figure 22. Image of East Side of Tailings Basin With Overlapping Infrared Images.
From "Thermal imagery 2013 and 2019 for detecting Minntac east-side discharge", Technical Memorandum by Great Lakes Indian Fish & Wildlife Commission (2022). See page 3 of pdf.

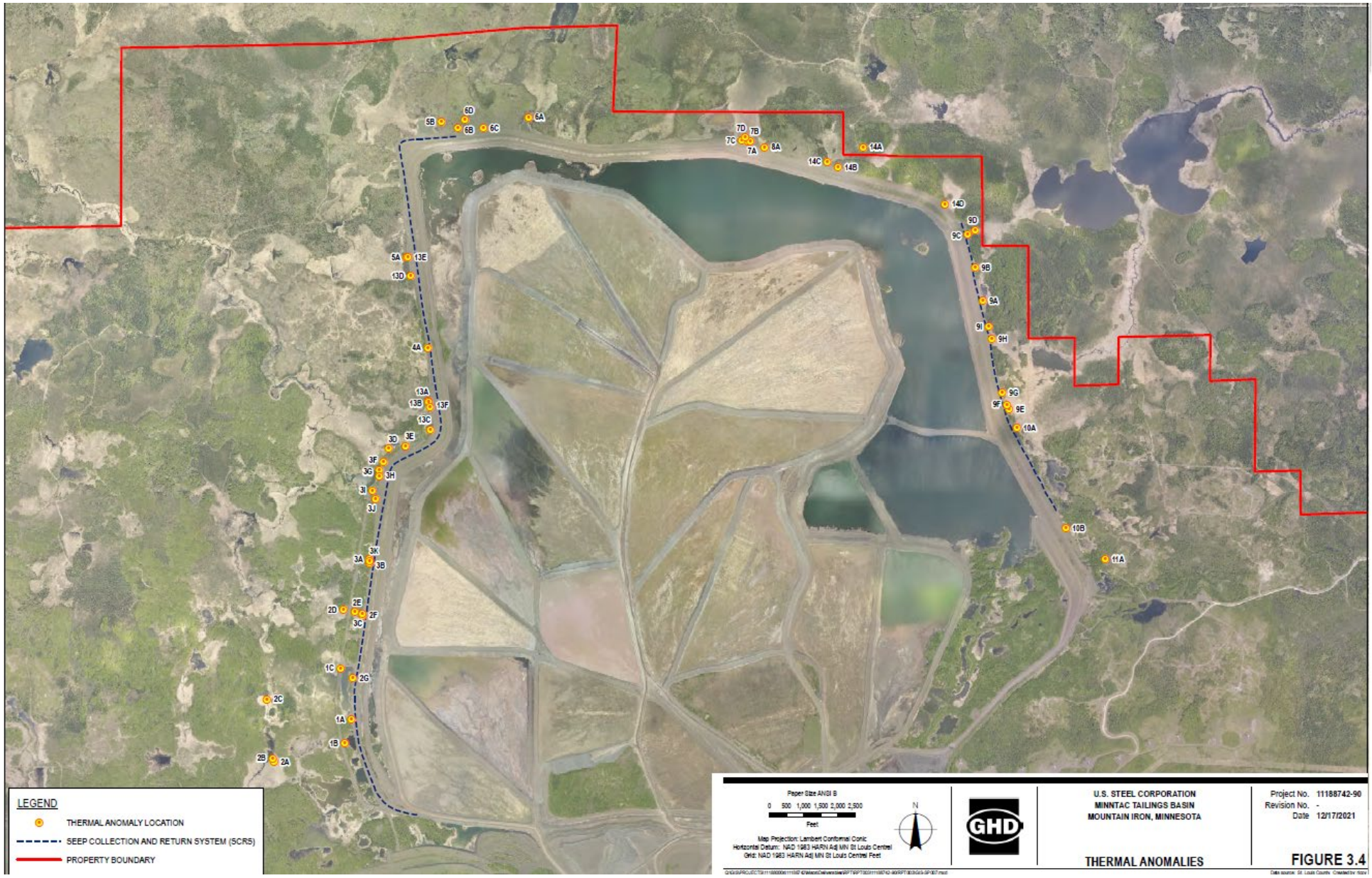


Figure 23. Thermal Anomalies.

Taken from "Hydrological Investigation Report" performed by GHD on behalf of U.S. Steel (2021). Page 58 of pdf. Note: SCRS was not installed on the West Side at time of study.

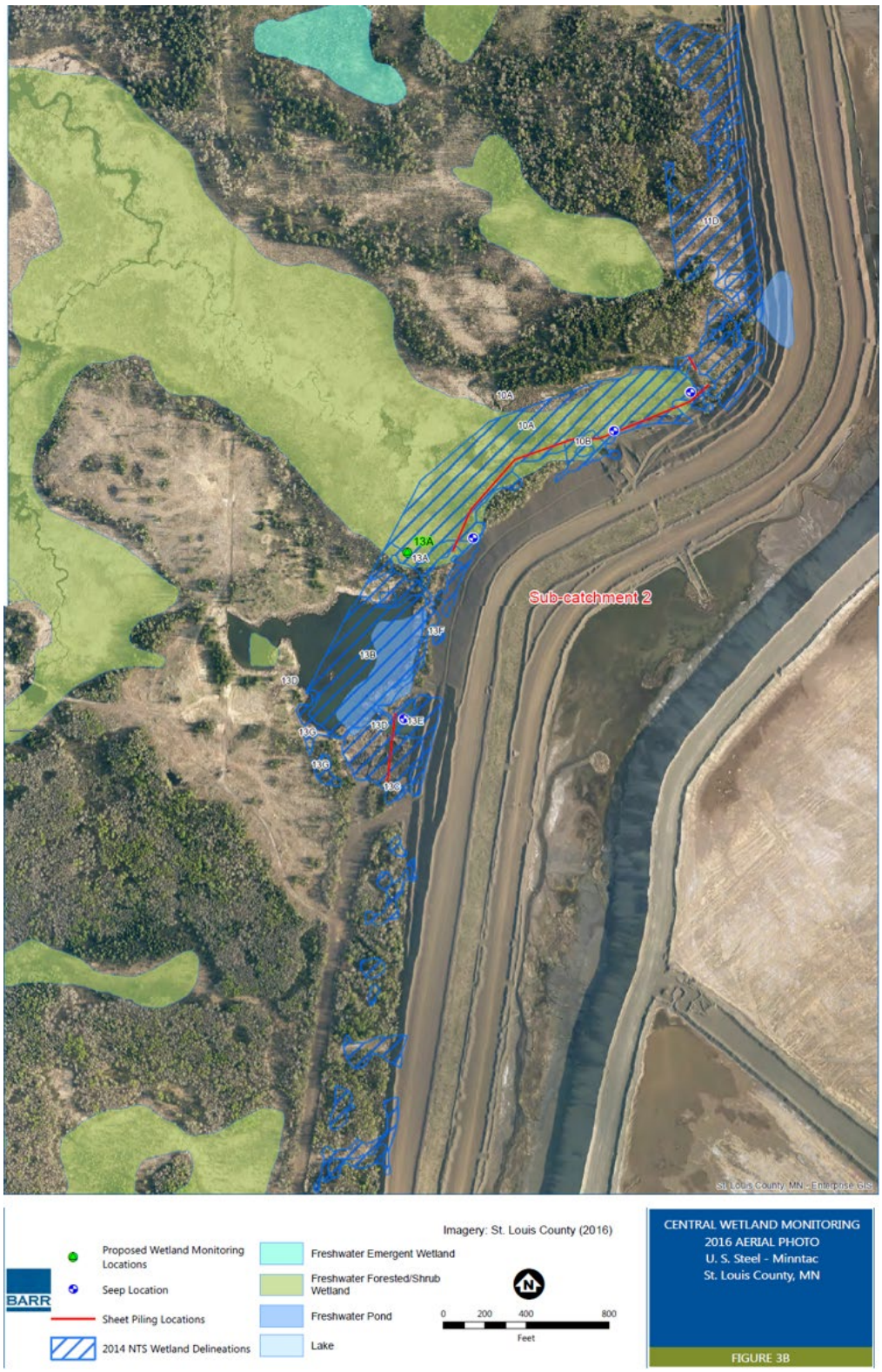


Figure 24. Central Wetland Monitoring 2016 Aerial Photo.

Taken from "Wetland Monitoring Plan – U.S. Steel Minntac West Tailings Basin Seepage Collection Project" - BARR Engineering on behalf of U.S. Steel (2016). [70]. Page 18 of pdf. The wetlands delineation shown here is taken from the 2014 CWA section 404 permit application for construction of the SCRS (see the legend referring to "2014 NTS Wetland Delineations"). Note the presence of wetlands located between the SCRS and the basin perimeter dike.

[70] Permit Application for Water/Wetland Projects – United States Steel Corporation, Minnesota Ore Operations – Minntac. Western Tailings Basin Seepage Collection System. April 4, 2014

3.3 *The Nature of the Material Through Which the Pollutant Travels*

The tailings basin is underlain by unconsolidated glacial till consisting primarily of fine to medium sand with some silt and rock clasts ranging from cobbles to boulders. Pollutants travel through a variety of pathways to reach surface waters such as the basin perimeter dike, composed of coarse and fine tailings, or through the permeable glacial till. Furthermore, while there are pollutants that may be impacted as the discharge moves with groundwater through the subsurface material, there are pollutants (e.g., chloride) that will not be affected.

In localized sites, areas consisting of peat are found underneath the basin and above the glacial till layer. Underneath the glacial till is the bedrock made up of the igneous rock granite, which can be considered a hydraulic barrier due to its low permeability. This granitic bedrock contains overlaying weathered zones within which fractures exist; however, the thickness of these weathered zones remains unknown.[71] The nature of materials along the pollutant transport path can be examined by reviewing subsurface geologic cross-sections and soil borings. A geologic cross section from east to west for a portion along the north side of the basin, as interpreted by NTS (2015), is shown in **Figure 25**, **Figure 26**, and **Figure 27**. The cross-section suggests the presence of sand, silt and occasional gravel underlying the tailings basin. Geologic cross-sections are not available for the entire perimeter of the basin.

Soil borings are located around the perimeter of the basin in the Sand and Dark River watersheds. In the Sand River, subsurface monitoring sites include monitoring wells (MW-1, MW-2, MW-3, MW-4, MW-10, MW-12, MW-17D), soil borings (SB-01-19, SB-02-19, SB-03-19, SB-04-19, SB-05-19), geoprobes (GP-2, GP-3, GP-4, GP-4A), and piezometers (PZ-2, PZ-3, PZ-4, PZ-5, PZ-6, PZ-7). In the Dark River watershed, subsurface monitoring sites include monitoring wells (MW-5, MW-6, MW-7, MW-8), geoprobes (GP-1, GP-3), and piezometers (PZ-1) (See **Figure 28** for a map of monitoring well and soil boring locations). The boring log information concurs with the predominant presence of sands, silt, clay, gravel, and localized areas where a peat layer overlays the glacial till, as interpreted by GHD on behalf of U.S. Steel.[72]

A 2013 study by CRA on behalf of U.S. Steel provided a three-dimensional groundwater flow model of the east side of the basin based on the interpretation of the observed geological and hydrogeological conditions available at the basin and in the surrounding area. The study indicates a bedrock depression beginning at the basin and continuing underneath the Sand River. The study provided model layers that indicate the projected spatial hydraulic conductivities. **Figure 29**, **Figure 30**, and **Figure 31** describe the spatial hydraulic conductivities in the model layers representative of the glacial till.[73] **Table A-6** describes hydraulic conductivity values and soil descriptions at individual monitoring sites (notably higher conductivity values were found at stations PZ-4D, PZ-6D and PZ-7D). The higher hydraulic conductivity values generally indicate

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[71] CRA on behalf of U.S. Steel (2013), *Groundwater Flow and Sulfate Transport Modeling Report*, page 8 and 10..

[72] GHD on behalf of U.S. Steel (2021), *Hydrological Investigation Report*, page 18 of pdf.

[73] CRA on behalf of U.S. Steel (2013), *Groundwater Flow and Transport Modeling Report*, page 24 of pdf. "*The top elevation for Model Layer 2 (or the bottom elevation of Model Layer 1) was assigned equal to the ground surface elevation beyond the Tailings Basin pools and perimeter dike area. Beneath the perimeter dike and Tailings Basin pools, the top elevation of Model Layer 2 was assigned to the ground surface elevation estimated to have existed prior to the presence of the Tailings Basin pools and perimeter dike. The top of bedrock was used for the bottom elevation of the Model Layer 3. The model layer elevation for the bottom of Model Layer 2 was approximately the middle of the saturated overburden thickness*."

dominant flow paths.

From the bottom of the basin, the contaminated wastewater mixes with groundwater in the uppermost, unconfined glacial till aquifer and travels towards the Sand and Dark River watersheds. Glacial till is porous in nature and allows groundwater to flow through it.

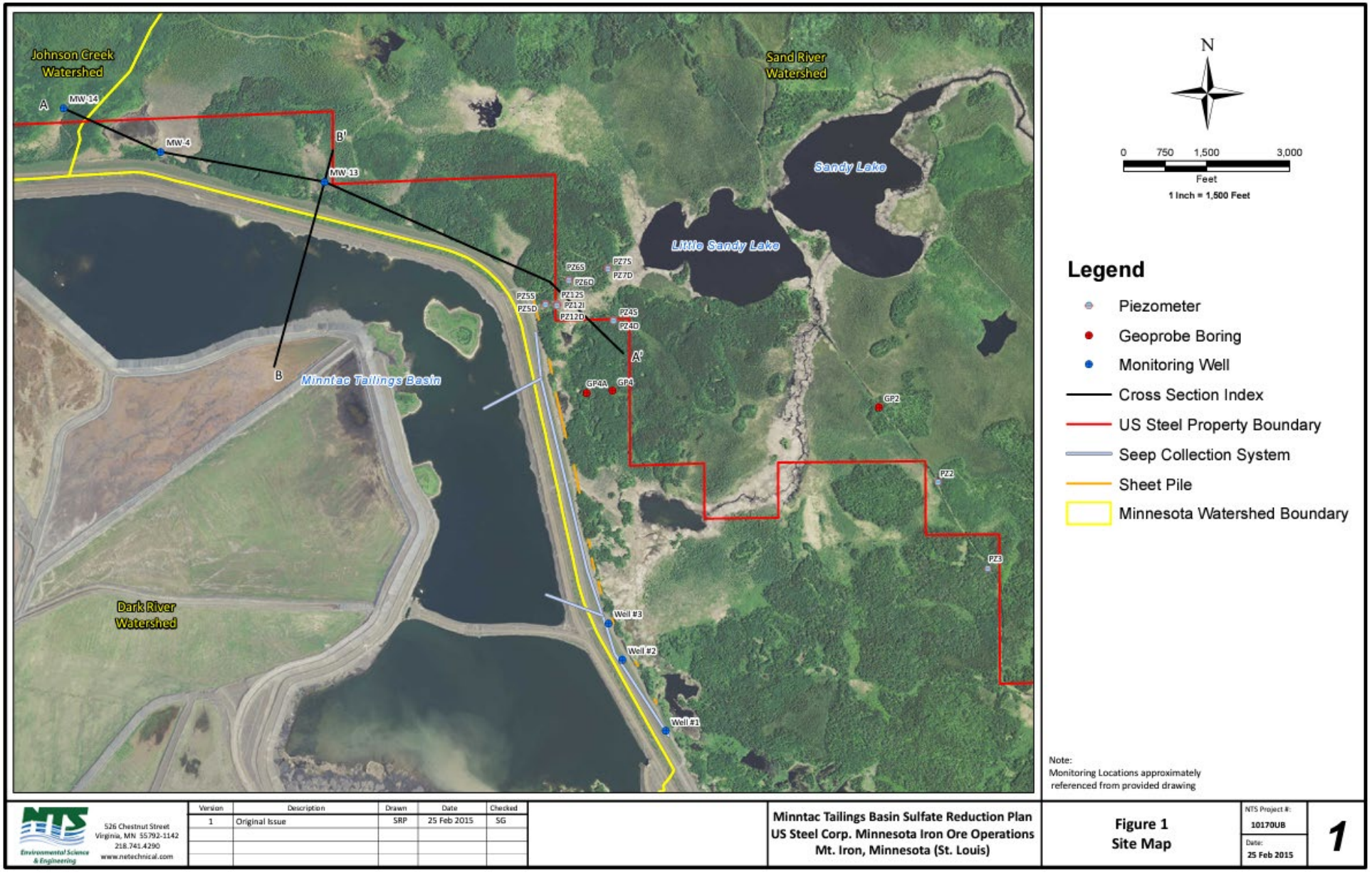


Figure 25. Site Map.
Taken from "Groundwater Sulfate Reduction Plan – Addendum #1, Minntac Tailings Basin – North Side" Northeast Technical Services, Inc. on behalf of U.S. Steel (2015).

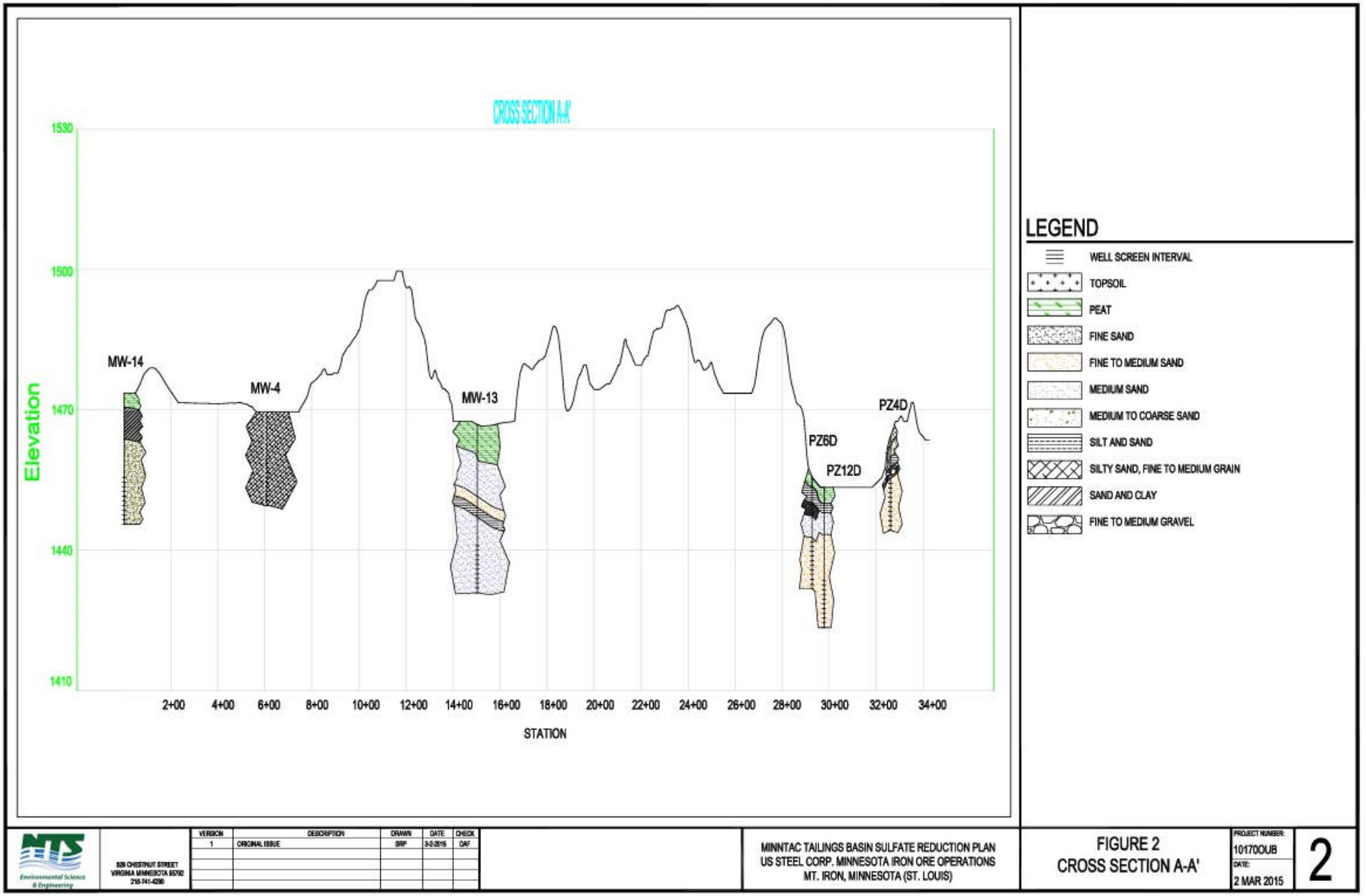


Figure 26. Cross Section A-A'.
Taken from "Groundwater Sulfate Reduction Plan – Addendum #1, Minntac Tailings Basin – North Side" Northeast Technical Services, Inc. on behalf of U.S. Steel (2015).

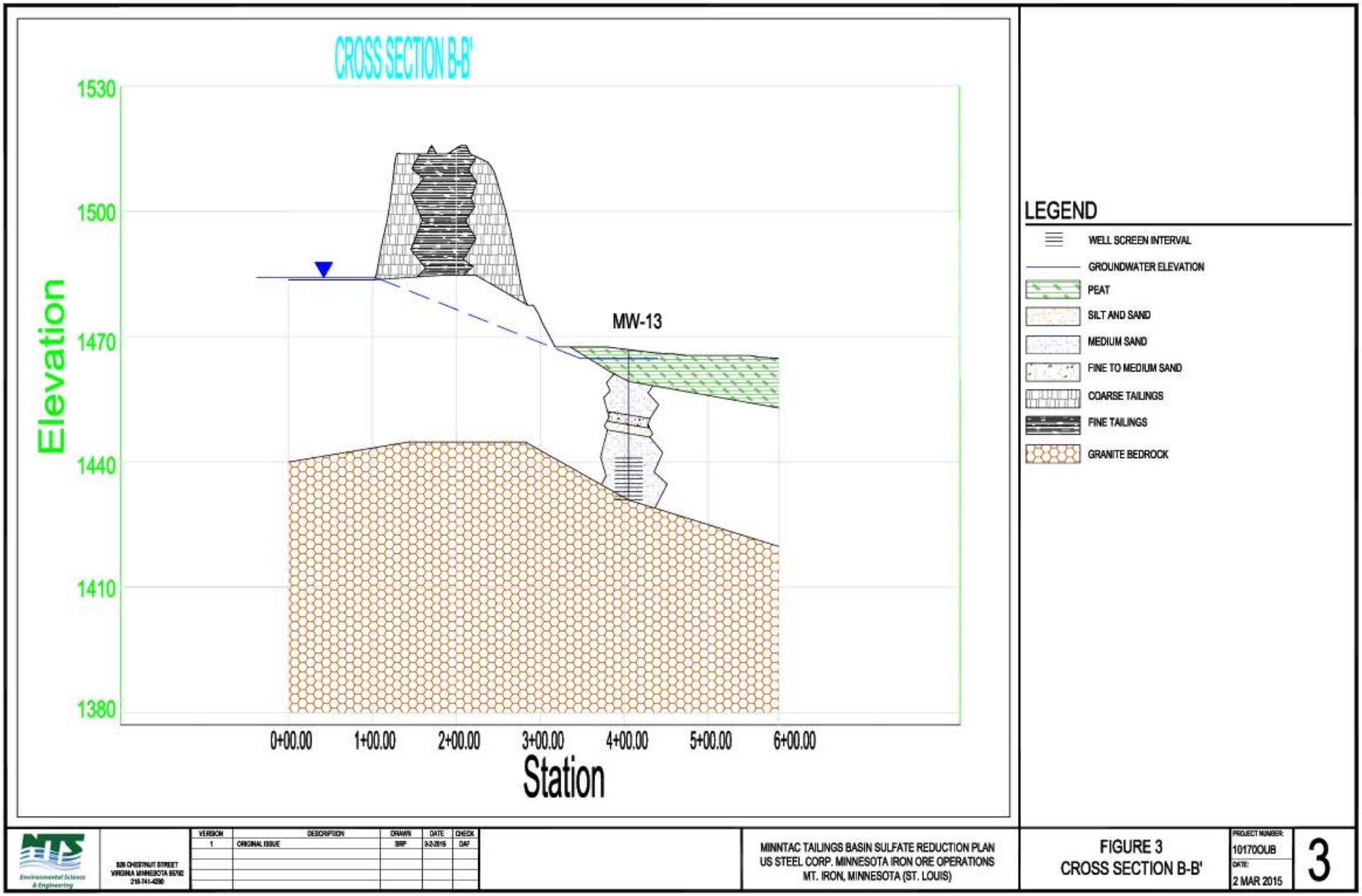


Figure 27. Cross Section B-B'.

Taken from "Groundwater Sulfate Reduction Plan – Addendum #1, Minntac Tailings Basin – North Side" Northeast Technical Services, Inc. on behalf of U.S. Steel (2015).

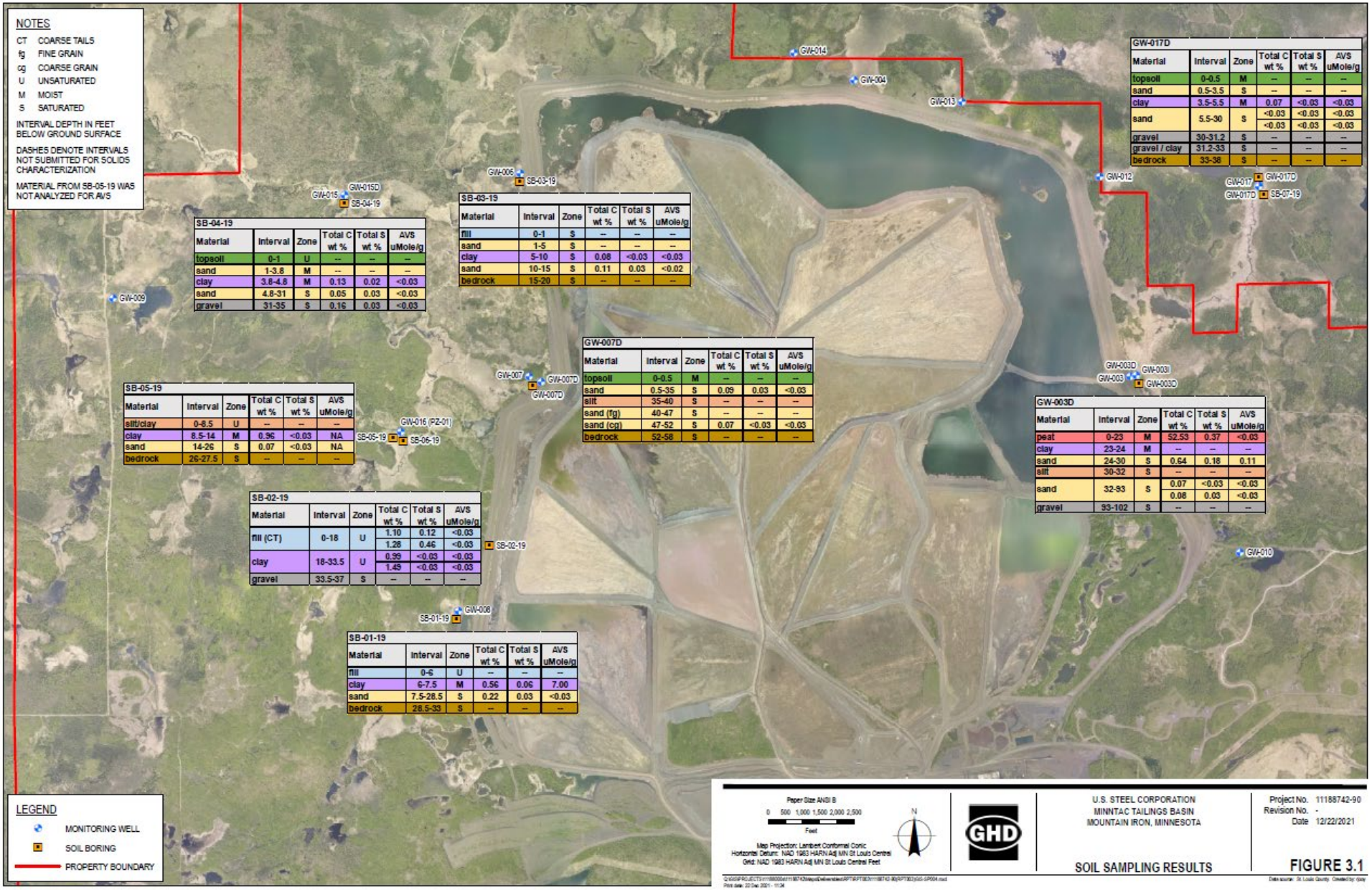


Figure 28. Soil Sampling Results.
Taken from "Hydrological Investigation Report" performed by GHD on behalf of U.S. Steel (2021).

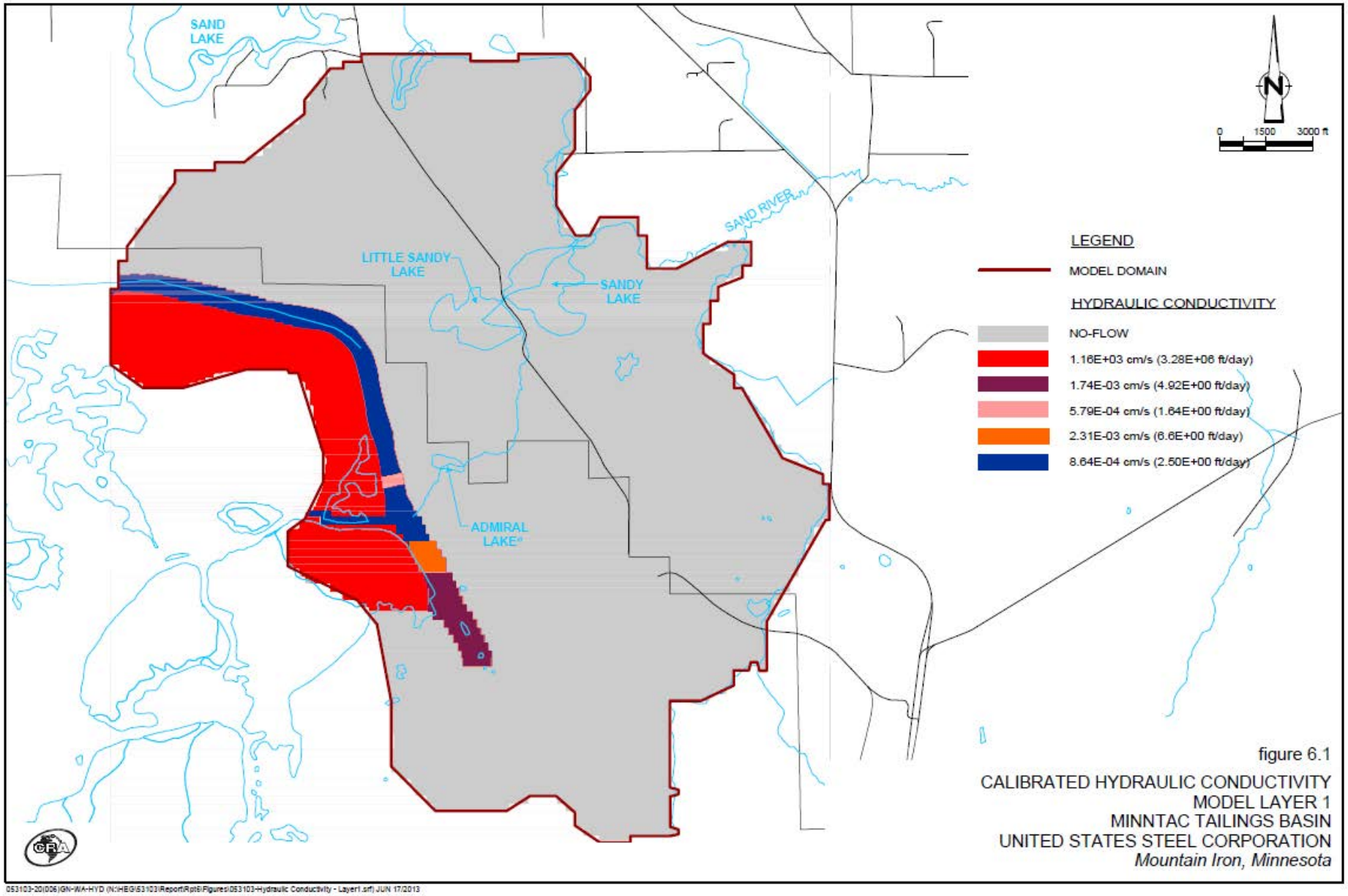


Figure 29. Calibrated Hydraulic Conductivity – Model Layer 1.

Taken from "Groundwater Flow and Sulfate Transport Modeling Report" by CRA on behalf of U.S. Steel. See page 70 of pdf. "Ground surface elevations throughout the model domain were generated using a combination of USGS Digital Elevation Model (DEM) data and survey data associated with the Site boreholes. The current ground surface elevations along the perimeter dike were used to represent the presence of the dike. Over the Tailings Basin pools and perimeter dike area, the top elevation of Model Layer 1 was assigned equal to the groundwater surface elevation. Beyond this area, the top elevation of Model Layer 1 was assigned to a uniform 1-ft distance above ground surface."

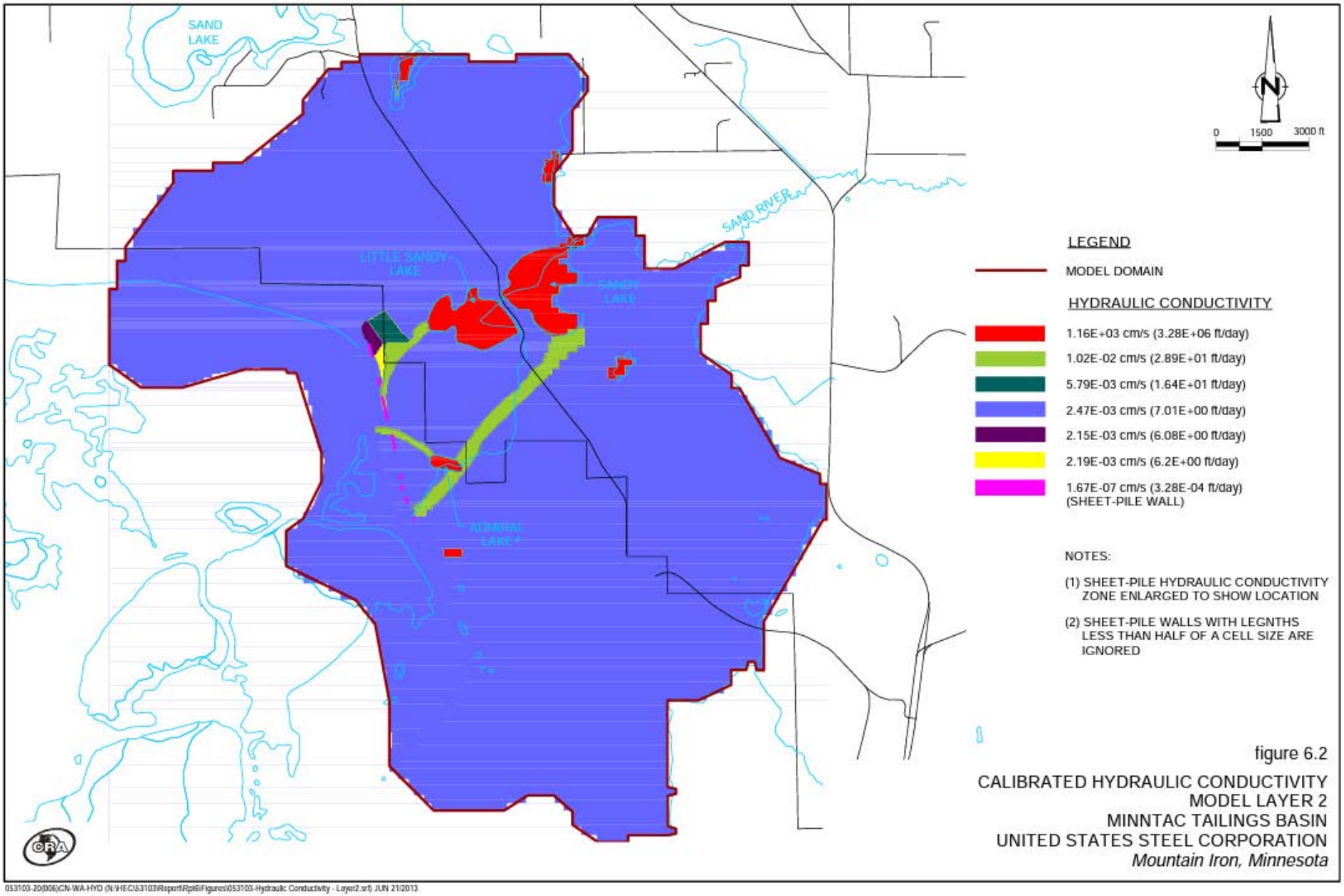


Figure 30. Calibrated Hydraulic Conductivity – Model Layer 2.

Taken from "Groundwater Flow and Sulfate Transport Modeling Report" by CRA on behalf of U.S. Steel. See page 70 of pdf. "The top elevation for Model Layer 2 (or the bottom elevation of Model Layer 1) was assigned equal to the ground surface elevation beyond the Tailings Basin pools and perimeter dike area. Beneath the perimeter dike and Tailings Basin pools, the top elevation of Model Layer 2 was assigned to the ground surface elevation estimated to have existed prior to the presence of the Tailings Basin pools and perimeter dike. The top of bedrock was used for the bottom elevation of the Model Layer 3. The model layer elevation for the bottom of Model Layer 2 was approximately the middle of the saturated overburden thickness."

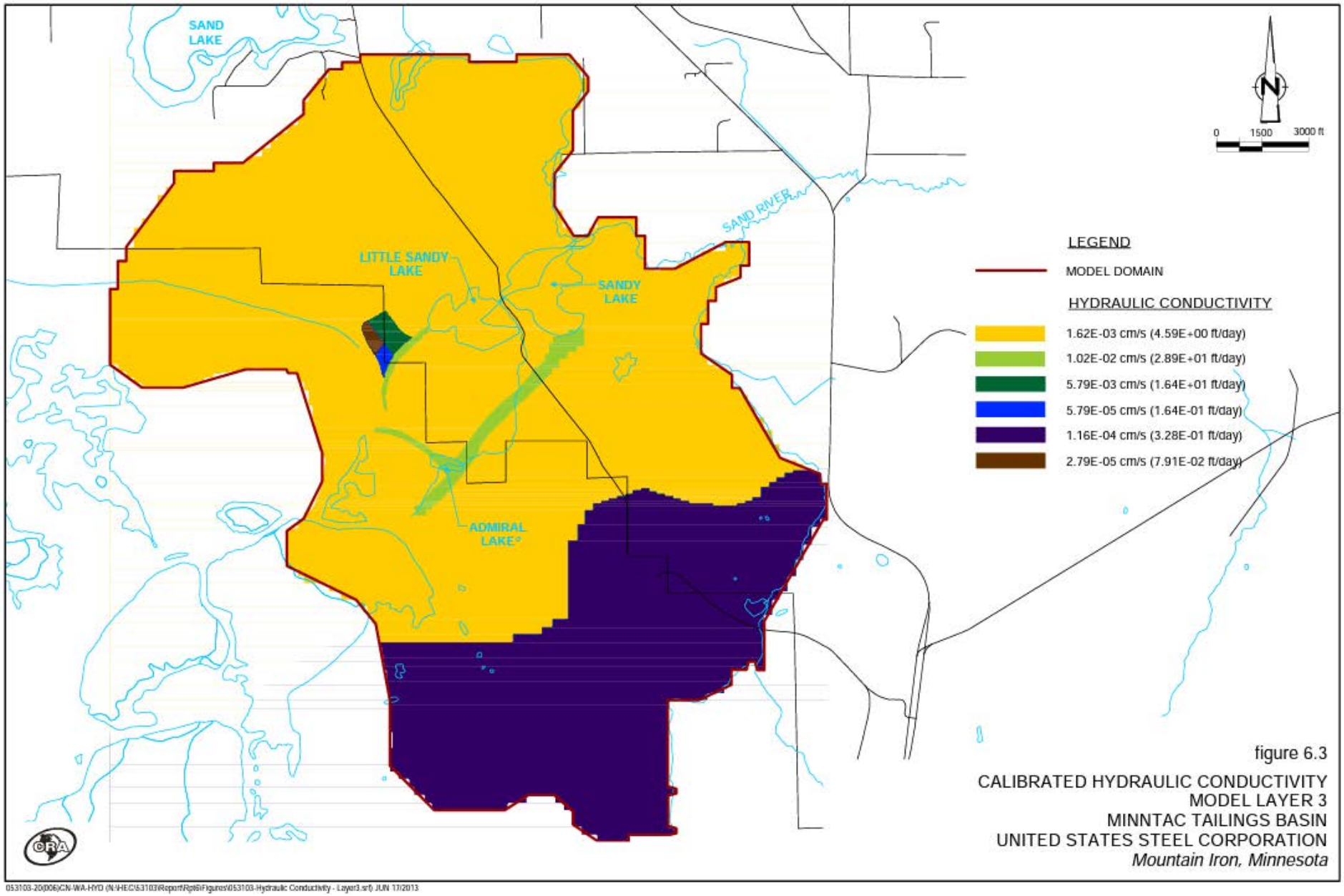


Figure 31. Calibrated Hydraulic Conductivity – Model Layer 3.

Taken from "Groundwater Flow and Sulfate Transport Modeling Report" by CRA on behalf of U.S. Steel. See page 71 of pdf. "The top elevation for Model Layer 2 (or the bottom elevation of Model Layer 1) was assigned equal to the ground surface elevation beyond the Tailings Basin pools and perimeter dike area. Beneath the perimeter dike and Tailings Basin pools, the top elevation of Model Layer 2 was assigned to the ground surface elevation estimated to have existed prior to the presence of the Tailings Basin pools and perimeter dike. The top of bedrock was used for the bottom elevation of the Model Layer 3. The model layer elevation for the bottom of Model Layer 2 was approximately the middle of the saturated overburden thickness."

3.4 *The Extent to Which the Pollutant is Diluted or Chemically Changed as It Travels*

Recent process water monitoring data collected from the tailings basin is presented in **Table A-1**, and data for sulfate and chloride are summarized below (See **Table 3**). U.S. Steel is required to monitor Station WS009 per its NPDES/SDS permit issued by the MPCA. The permit requires that "Samples for Station WS009 shall be taken at: a location in Basin Cell 1 that is representative of the overall composition of the process wastewater that is stored in the basin and recirculated through the taconite processing plant." Therefore, data collected and reported under WS009 are representative of tailings basin water quality. The data generated at two surface discharge points monitored between 2018-2022 (SD001 in the Dark River and SD006 in the Sand River) provide recent direct discharge quality information (See **Table 1** and **Table 2** for water quality data for the surface water discharge points).

Monitoring data from the tailings basin were compared to monitoring data from wetlands just inside and outside of the SCRS. Basin wastewater monitoring data were compared to data from downstream surface water stations to understand the extent to which the pollutants are diluted or chemically changed as they travel. As the distance from the basin to where surface water monitoring is occuring increases, there are greater observed effects of dilution due to: 1) dilution with precipitation; 2) dilution with ambient groundwater and surface water; 3) addition of pollutants to the basin water while it moves through and is in contact with tailings; and 4) processes that occur when wastewater contacts organic matter in glacial till and peat.[74] Only dilution provided by groundwater is considered as part of the functional equivalent evaluation, but it can be difficult to isolate the source of dilution when looking farther downstream. Notably, the farther downstream the monitoring stations are from the basin, the more influence there is by surface water dilution on the downstream surface water sampling monitoring stations.

These data indicated that there is relatively little dilution or chemical transformation happening between the basin and these surface water sampling points located just outside the basin.

The following section explains results from an EPA inspection report that provided data on water quality within the east side SCRS and in the adjacent wetlands (outside of the east side SCRS).

3.4.1 Inspection Report

In 2017, U.S. EPA conducted an NPDES compliance inspection at the Minntac tailings basin.[75] Samples were collected during the inspection, and the results are presented in the inspection report. EPA collected water quality data on both sides of the east side SCRS, including sampling inside the sheet pile (i.e., inside the "catch basin") and outside the sheet pile (i.e., in the wetlands that are immediately adjacent). Sampling results for sulfate and chloride are provided **Table 5** (see **Table A-4** for full results) and sampling locations are depicted in **Figure 32**, **Figure 33**, and **Figure 34**.

Results from the monitoring located at the east side SCRS indicate that the sulfate level in the

[74] Kelly et al (2016), *Geochemical Tracer Based (GTB) Sulfate Balance Models for Active Tailing Basins on Minnesota's Iron Range (III) Well waters, seeps, and downstream surface waters.*

[75] U.S. EPA (2018), *U.S. Steel Corporation – Minntac Tailings Basin Facility NPDES Compliance Sampling Inspection Report.*

wetlands outside of the sheet pile (S09) was within 5 percent of the level inside of the SCRS (S10), and that the wetlands outside of the sheet pile (S09) had higher chloride levels (See **Figure 33** for sampling locations). Additionally, results from samples taken on the east side SCRS in wetlands outside of the sheet pile locations (S11 and S13) were within 1 percent of sulfate level and within 2 percent of the chloride level inside the SCRS (S12) (See **Figure 34** for sampling locations). Specifically, sulfate measured outside of the SCRS was 71-79% of the concentration measured inside the tailings basin, and chloride measured outside of the SCRS was 78-86% of the concentration measured inside the tailings basin.

Data were also collected from a background location (S08) for the same pollutant parameters. The results show impacted areas had more than 190 times greater sulfate levels and had more than 70 times greater chloride levels than background conditions (See **Table 5**).

When compared, the data from the tailings basin, surface discharge sampling points SD001 and SD006, and the data presented in the inspection report show that sulfate and chloride levels sampled in surface waters just outside of the SCRS are similar to levels inside the SCRS, indicating that there is little to no dilution or chemical transformation occurring in these short pathways to surface waters. Additionally, the sulfate and chloride pollutant levels observed in all these locations are much higher than background levels.

These monitoring results indicate that sulfate and chloride, which are parameters representative of other pollutants in the wastewater being discharged from the basin, are not chemically changed or significantly diluted between the tailings basin and where they emerge inside the SCRS and just outside of the SCRS.

Table 3. Tailings Basin Process Wastewater Data (December 2018-April 2022)

Pollutant Parameters (units of measurement)	Tailings Basin Process Wastewater Pollutant Characterization (WS009) Min-Max (Average)
Total Sulfate (as SO_4) (mg/L)	752-1,120 (994)
Total Chloride (mg/L)	108-158 (142)
Bicarbonates (mg/L)	345-435 (385)
Hardness (mg/L)	1,250-1,560 (1,356)
pH (S.U.)	7.2-8.6 (8.2)
Total Dissolved Solids (mg/L)	1,490-2,210 (1,976)
Specific Conductance (umhos/cm)	2,060-2,755 (2,510)

Notes:

1. This technical assistance focuses on the two pollutant parameters of sulfate and chloride as general indicators of the presence of process wastewater pollutants.
2. Monitoring Data was provided by MPCA to U.S. EPA on July 8, 2022. The dataset for total chloride, hardness, TDS, specific conductance, and total sulfate can be found in **Table A-1**.

Table 4. Tailings Basin Process Wastewater Sulfate and Chloride Pollutant Concentrations Compared to Surface Water Sampling Points Adjacent to the Basin (December 2018-April 2022)

Pollutant Parameters (units of measurement)	Tailings Basin Process Wastewater Pollutant Characterization (WS009) Min-Max (Average)	SD006 (Adjacent to perimeter dike of basin.) Number of samples = 139 Min – Max (Mean)	SD001 (Adjacent to the basin) Number of samples = 59 Min–Max (Mean)
Total Sulfate (as SO_4) (mg/L)	752-1,120 (994)	787-998[2] (891)	954-1150 (1028.4)
Total Chloride (mg/L)	108-158 (142)	91.1-122 (105)	119-146 (130.5)

Table 5. Sulfate and Chloride Monitoring Results in Wetlands and SCRS Catch Basins. September 12-13, 2017 EPA Inspection.

Pollutant Parameters (units)	S08 **Background Conditions**[2] (Sampled wetland at foot of berm)	S09 **Wetland** (Sampled wetland immediately outside of sheet pile at SCRS Catch Basin-12)	S10 **Catch Basin** (Sampled seepage collected in SCRS Catch Basin-12)	S11 **Wetland** (Sampled wetland immediately outside of sheet pile at SCRS Catch Basin-5)	S12 **Catch Basin** (Sampled seepage collected in SCRS Catch Basin-5, near inlet)	S13 **Wetland** (Sampled wetland immediately outside of north end of sheet pile at SCRS Catch Basin-5)
Sulfate as SO4 (mg/L)	3.61	702	720	773	780	781
Chloride (mg/L)	1.28	122	91.2	114	114	110

Notes:
1. See **Figure 33**, **Figure 34** for sampling locations.
2. U.S. Steel confirmed the S08 location as "background area" (See page 9 of Inspection Report)

3.4.2 Geochemical Transformation

For other longer pathways (and/or as the discharge flows from inside the tailings basin to the outer edge of the basin), a portion of the sulfate discharged may be involved in geochemical transformations as it travels through groundwater from the basin to surface waters. The 2021 Hydrological Investigation Report explains that, generally, a chemical process known as sulfate reduction occurs as the pollutant travels underground in the presence of naturally occuring organic carbon and sulfate reducing bacteria, which can transform some of the sulfate into sulfide. In the presence of dissolved iron, the iron bonds with the sulfide to produce iron sulfide, which then precipitates out as a mineral, thus removing sulfide.[76]

The chemical reduction of sulfate is dependent on organic carbon reactivity and groundwater velocities.[63] According to Kelly et al. (2016), when sulfate encounters naturally occurring organic carbon in the glacial till below the perimeter dike, it can be reduced to sulfide and precipitate in the presence of dissolved iron as iron sulfide minerals are formed.

The 2016 study by the University of Minnesota (which implemented reactive transport models for six cross sections across the perimeter dike of the tailings basin) confirmed sulfate reduction

[76] GHD on behalf of U.S. Steel (2021), *Hydrological Investigation Report.*

and established that the extent to which sulfate chemically changes is dependent on certain factors, stating "*[h]ow much sulfate reduction occurs depends on organic carbon degradation rates and on groundwater velocities. However, in nearly all cross sections, the majority of sulfate leaves via out-flux at the down-gradient end rather than is reduced*." The study also suggested that groundwater velocity may have a significant control on sulfate reduction as increased transit times (i.e., slower velocity) through the subsurface provides more time for chemical processes and sulfate reduction.[63]

Given the size of the basin and multiple pathways pollutants travel in groundwater and beyond the basin, the exact amount of sulfate reduction that occurs as the pollutant travels is unknown; however, sulfate reduction appears to primarily occur when the pollutant travels through peat materials. This pattern was observed in a series of studies by the Minnesota Department of Natural Resources in 2016, which used geochemical tracer-based methods to quantify the impact of dilution, sulfide oxidation, and microbial sulfate reduction on surrounding surface waters and groundwaters. Also, according to the 2021 Hydrological Investigation Report, the extent to which sulfate is reduced within the subsurface appears to be closely associated with the peat units surrounding the basin. These areas where sulfate reduction is likely to occur are identified based on 1) confirmation of the presence of acid volatile sulfide (AVS)[77] in solids, 2) demonstration of equilibria between water chemistry and iron sulfide phases, and 3) documented subsurface geologic types that are known to be amenable to sulfate reduction (i.e., are commonly anoxic with a source of organic carbon).[78] The 2021 Hydrological Investigation Report further describes the fate and transport of sulfate inside and outside the basin.[79, 80]

Chloride is not involved in geochemical transformations and is considered to be conserved as it is discharged out of the basin and travels to surface waters unchanged.[81] There are other pollutants present in the discharge (See **Section 2.3**), but EPA did not evaluate the extent to which other pollutants may chemically change.

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[77] GHD on behalf of U.S. Steel, Hydrological Investigation Report (2021), page 13 of pdf. AVS is defined as follows: "*AVS is an operationally defined constituent that includes some quantity of several iron sulfide phases likely to precipitate in anoxic sediments*," .

[78] A site-specific rate for sulfate attenuation model was developed in the *2021 Hydrological Investigation Report*.

[79] GHD on behalf of U.S. Steel (2021), *Hydrological Investigation Report*, page 41 of pdf.

[80] MPCA (2018), *Findings of Fact, Conclusions of Law, and Order*, pages 4-5 of pdf, Permit History Fact #24. "*U.S. Steel recirculates water that accumulates in the Tailings Basin for use in processing the ore, which causes sulfate, hardness, bicarbonate, and chloride concentrations to build up in the water. In addition, the deposited tailings themselves generate pollutants, including sulfate, when exposed to precipitation*."

[81] Ng et al. (2016), *Development of a Reactive Sulfate Transport Model for a Minnesota Taconite Tailings Basin (Minntac).* Department of Earth Sciences, University of Minnesota, page 6 of pdf.



Figure 32. Sampling Locations in Township 59N, Range 18W, Section 23.
Taken from "NPDES Compliance Sampling Inspection Report" by U.S. EPA. See page 29 of pdf. Image modified by EPA to remove prior figure label and description.



Figure 33. Sampling Locations in Township 59N, Range 18W, Section 10.
Taken from "NPDES Compliance Sampling Inspection Report" by U.S. EPA. See page 27 of pdf. Image modified by EPA to remove figure label and description.



Figure 34. Sampling Locations in Township 59N, Range 18W, Section 15.
Taken from "NPDES Compliance Sampling Inspection Report" by U.S. EPA. See page 28 of pdf. Sample results for S11, S12, and S13 are located in Image modified by EPA to remove prior figure label and description.

3.5 *The Amount of Pollutant Entering the Navigable Waters Relative to the Amount of the Pollutant That Leaves the Point Source*

U.S. Steel's contractor, GHD, in the 2021 Hydrological Investigation Report, estimated that 22,612 kg/day (9,098 tons per year) of sulfate leaves the basin via seeps (See **Figure 8** and **Figure 12**). This estimate was derived using a mass balance approach modeling sulfate inputs and outputs to the tailings basin as well as downstream surface water data.

As explained in **Section 3.2**, most of the wastewater traveling through groundwater is believed to enter surface water within 1,000 meters of the basin. Further, the 2021 Hydrological Investigation Report states, "[g]iven the hydraulic conditions of the Basin in relation to the surrounding areas, most of the Basin seepage that migrates past the SCRSs reports to nearby surface waters within a relatively short distance from the Basin perimeter dike."

The total amounts of sulfate and chloride reaching surface waters in the Sand River and Dark River watersheds were estimated through loading calculations based on downstream surface water monitoring data (years 2018 through 2022). The sulfate and chloride loading rates at stations (SW001 or "Station 701" on the Sand River and SW003 or "D-1" on the Dark River) were calculated using measured values of flow and concentration. These stations are located downstream of where most of the surficial discharge from the tailings basin flows, as seen in **Figure 6**. Evidence suggests pollutants are stored within wetlands during low flow conditions and released downstream in medium and high flow events.[82] Thus, daily load fluctuations are observed in the data and may be due to precipitation/run-off events. Averaged values may be more representative of the discharge as it reaches receiving waters.[83] The average sulfate and chloride loading rates calculated were 4,221 kg/day sulfate and 1,058 kg/day chloride in the Sand River watershed at SW001; and 9,550 kg/day sulfate and 993 kg/day chloride in the Dark River watershed at SW003 (See **Table 6** for loading calculations in the Sand River and **Table 7** for the Dark River).

Background loading values averaged 264 kg/day sulfate and 4.4 kg/day chloride in the Sand River (SW001) and 904 kg/day sulfate and 20.4 kg/day chloride in the Dark River at Station D-2 (See **Table 6** for loading calculations for the Sand River and **Table 7** for the Dark River).

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[82] BARR Engineering Co. on behalf of U.S. Steel Minnesota Ore Operations - Minntac (2010), *Memorandum: Tailings Basin Seepage Estimation Method*, page 2 of pdf. "*A general phenomenon observed at the 701 and the D-1 monitoring locations was that high stream flows led to increased delivery of sulfate mass when compared to lower flow conditions (the concentration of sulfate in the streams at these points would not go down during high flows). If tailings basin seep waters were delivered at a constant rate, sulfate levels should have declined at 701 and D-1 at high stream flow rates and increased during lower flows. To explain this observation, it was hypothesized that seepage from the tailings basin (other than seepage from 020 and 030) is stored during low flow conditions and released during medium and high flow events. Wetlands or subsurface soils were hypothesized to be the storage media.*"

[83] GHD on behalf of U.S. Steel (2021), *Hydrological Investigation Report*, pages 30-31 of pdf. "*The field measurements and chloride concentrations used in the seep estimate are included in Table 4.1. It should be noted that seepage flow rates do not fluctuate per the line-by-line Table 4.1 calculations. These line-by-line measurements fluctuate significantly due to local precipitation/run-off events but the average is expected to represent seepage rates from the Basin. Basin seepage flowrates are much more stable/steady than the individual calculations suggest. It is expected that seepage flow rates gradually increase and decrease modestly in response to Basin clear pool elevation changes. The model incorporates an adjustment based on clear pool elevation to account for this change in head pressure on seeps.*"

Due to recirculation and reuse of water from the tailings basin in ongoing taconite processing, concentrations and loadings of pollutants, including sulfate, have increased over time within the tailings basin pond. MPCA acknowledged the continual increase in pollutant concentrations due to recirculation of process wastewater.[84] In 2015, U.S. Steel began importing water with lower sulfate concentrations to potentially mitigate the increased concentrations of sulfate in the tailings basin.[85] The 2018 NPDES Minntac Tailings Basin Permit[86] authorizes U.S. Steel to look for other sources of intake water for the purpose of dilution and to allow new water sources to be used without modification to the permit under certain conditions. The volume of process wastewater within the tailings basin outer cells has increased from 2012 to 2021.[87] The 2018 Fact Sheet summarizes annual mass calculations where net sulfate increases ranged from 81,094 lbs/year to 402,639 lbs/year from 2011 to 2017.[88]

The total amounts of sulfate and chloride reaching receiving waters within the Sand River and Dark River watersheds as a result of wastewater leaking from the tailings basin at rates discussed in this section are significant. However, EPA did not find an independent measure of the amount of pollutant leaving the tailings basin, only estimates that were themselves based on amounts of basin pollutants observed in surface water. Without that independent measurement it is difficult to quantify the amount of pollutant reaching surface waters compared to the amount that is discharged from the tailings basin. However, we are able to find that a significant portion of the discharge does reach surface waters.

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[84] MPCA (2018), *Findings of Fact, Conclusions of Law, and Order*, pages 4-5 of pdf, Permit History Fact #24. "*U.S. Steel recirculates water that accumulates in the Tailings Basin for use in processing the ore, which causes sulfate, hardness, bicarbonate, and chloride concentrations to build up in the water. In addition, the deposited tailings themselves generate pollutants, including sulfate, when exposed to precipitation.*"

[85] MPCA (2018), *Findings of Fact, Conclusions of Law, and Order*, page 19 of pdf. "*The operation currently imports approximately 4.64 MGD of water from the Mt. Iron pit at the mining area to make up for losses that occur during taconite processing and recirculation of the water through the tailings basin ponds. Under Part 7.ppp of the June 9, 2011, SOC, the MPCA identified the use of alternate make up water with a lower sulfate concentration than Mt. Iron pit water as a means to mitigate the increased loading of sulfate to the basin water and required a study to evaluate alternative water sources. To fulfill this requirement, the permittee identified Sump 6 at the mining area as a suitable source, a pipeline was constructed, and the permittee began to utilize a minimum of 2000 gpm (monthly average) of Sump 6 water on January 26, 2015.*"

[86] MPCA (2018), *National Pollutant Discharge Elimination System/State Disposal System Permit MN0057207 – Minntac Tailings Basin Area.*

[87] GHD on behalf of U.S. Steel (2021), *Hydrological Investigation Report*, page 42 of pdf.

[88] MPCA (2018), *NPDES)/SDS Permit Program Fact Sheet: US Steel Corp. – Minntac Tailings Basin Area*, Permit No. MN0057207, page 23-24 of pdf.

Table 6. Calculated Pollutant Load in the Sand River Watershed.

Pollutant Parameter	Loading calculations using 2018-2022 DMR data from downstream Station SW001 (i.e., Station 701) (Approximately 5 miles/8 kilometers downstream of basin)		Pre-basin data from SW001 (i.e., Station 701) (Approximately 5 miles/8 kilometers downstream of basin's current location)	
	Concentration (mg/L) Min-Max (Average)	Calculated Load (kg/day)[1] Min-Max (Average)	Concentration (mg/L) Min-Max (Average)	Calculated Load (kg/day)[1] Min-Max (Average)
Sulfate	9.3-537 (200)	20.9[5]-20,363 (4221)	1.8-26 (8.5)	2.6-1507.4 (263.6)
Chloride	16.1-90.2 (45.6)	36.6[5]-5,407 (1058)	0-1 (0.125)	0-25.9 (4.4)

Notes:

1. See **Table A-1** for 2018-2022 DMR data.
2. Loads based on field measurements were calculated by using reported concentration and corresponding flow values collected during the same monitoring events by using the following equation:

$$Reported\ Concentration\ in\ \frac{mg}{L} * reported\ flow\ in\ \frac{cubic\ feet}{sec} * \left(\frac{60\ sec}{min}\right) * \left(\frac{60 min}{hr}\right) * \left(\frac{24 hr}{day}\right) * \left(\frac{28.3168\ liters}{cubic\ feet}\right) * \left(\frac{1\ kg}{10^6 mg}\right) = Pollutant\ Load\ in\ kg/day$$

3. SW001 is the only surface water monitoring station in the Sand River watershed where flow is monitored. Thus, SW001 was assessed for loading values.

Table 7. Calculated Pollutant Load in the Dark River Watershed

Pollutant Parameters	Loading calculations using 2018-2022 DMR data from downstream Station SW003 (Approximately 5 miles/8 kilometers downstream of tailings basin)		Pre-basin Data from Station D-2[3] (Approximately 15 miles/24 kilometers downstream of basin's current location)	
	Concentration (mg/L) Min-Max (Average)	Calculated Load(kg/d)[1] Min-Max (Average)	Concentration (mg/L) Min-Max (Average)	Calculated Load (kg/d)[1] Min-Max (Average)
Sulfate	150-853 (515.7)	1,321-27,333 (9550)	6.5-12 (8.2)	513.7-2,017 (904.1)
Chloride	16.2-90.6 (45.6)	167-2,901 (993)	0-0.7 (0.3)	0-42.8 (20.6)

Notes:

1. See **Table A-1** for 2018-2022 DMR data.
2. Loads based on field measurements were calculated by using reported concentration and corresponding flow values collected during the same monitoring events by using the following equation:

$$Reported\ Concentration\ in\ \frac{mg}{L} * reported\ flow\ in\ \frac{cubic\ feet}{sec} * \left(\frac{60\ sec}{min}\right) * \left(\frac{60 min}{hr}\right) * \left(\frac{24 hr}{day}\right) * \left(\frac{28.3168\ liters}{cubic\ feet}\right) * \left(\frac{1\ kg}{10^6 mg}\right) = Pollutant\ Load\ in\ kg/day$$

3. SW003 is the only surface water monitoring station in the Dark River watershed where flow is consistently monitored. Thus, SW003 was assessed for loading values.
4. Pre-facility monitoring in the Dark River watershed was done at Station D-2.

3.6 *The Manner by or Area in Which the Pollutant Enters the Navigable Waters*

As explained in **Section 1.1**, the 8,700-acre tailings basin was constructed on top of the headwaters of the Sand River and Dark River and in an area rich with jurisdictional wetlands. Wastewater from the tailings basin seeps through and under the perimeter dike. The predominant direction of groundwater flow and pollutant (e.g., sulfate and chloride) transport is from the tailings basin east to the Sand River watershed and from the tailings basin west to the Dark River watershed (See **Figure 35** for a map of groundwater elevation contours).

Wastewater takes different pathways to reach surface water features. As explained in **Section 3.3**, there have been several studies of groundwater discharge pathways over the years, which depict and model a variety of pollutant pathways from the tailings basin. The general locations of these pathways are modeled for the Sand River watershed in **Figure 19**, **Figure 20**, and **Figure 21**. As depicted in the simulated groundwater flow pathlines in these figures, the pollutants emerge in surface waters via distinct plumes. **Section 3.3** details the nature of the materials through which a pollutant travels, including spatial hydraulic conductivity values as documented by U.S. Steel contractor, CRA.[89] **Figure 29**, **Figure 30**, and **Figure 31** describe the spatial hydraulic conductivities in the model layers representative of the glacial till.[73] The higher hydraulic conductivity values generally indicate dominant flow paths.

Pollutants enter surface waters in the Sand and Dark River watersheds via a contaminate plume after traveling with groundwater through the soil or rock medium (glacial till). This process is primarily through advection (the transport of a substance or quantity by bulk motion of a fluid[90]) and dispersion (the spreading of the contaminant plume from highly concentrated areas to less concentrated areas[91]). Pollutants reach surface waters from the tailings basin via advection and dispersion, with the ultimate result being that the pollutants reach surface waters in significant amounts. The size of this point source, proximity of jurisdictional surface waters, and the abundance of those surface waters results in many potential pathways for pollutants to travel from the basin to surface waters.

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[89] CRA on behalf of U.S. Steel (2013), *Groundwater Flow and Transport Modeling Report.*

[90] Fitts, C. R. (2013), *Groundwater Science (2nd Edition).* Elsevier, page 527.

[91] CRA on behalf of U.S. Steel (2012), *Revised Conceptual Groundwater Model Report*, page 18 of pdf. "*Dispersion results from two basic processes, molecular diffusion and mechanical mixing. Molecular diffusion is a process where solutes move from zones of higher concentration to zones of lower concentration. The driving force of this movement is kinetic activity at the molecular level. Mechanical dispersion is derived from the variability (heterogeneity) of the microscopic velocities in groundwater which act to spread or mix a solute in an aquifer. The primary aquifer characteristics that cause this mixing are variable frictional forces in pore channels, variations in pore channel geometry, and pore channel branching. Dispersion/spreading of solutes during groundwater flow results in dilution of solute pulses and attenuation of concentration peaks*."

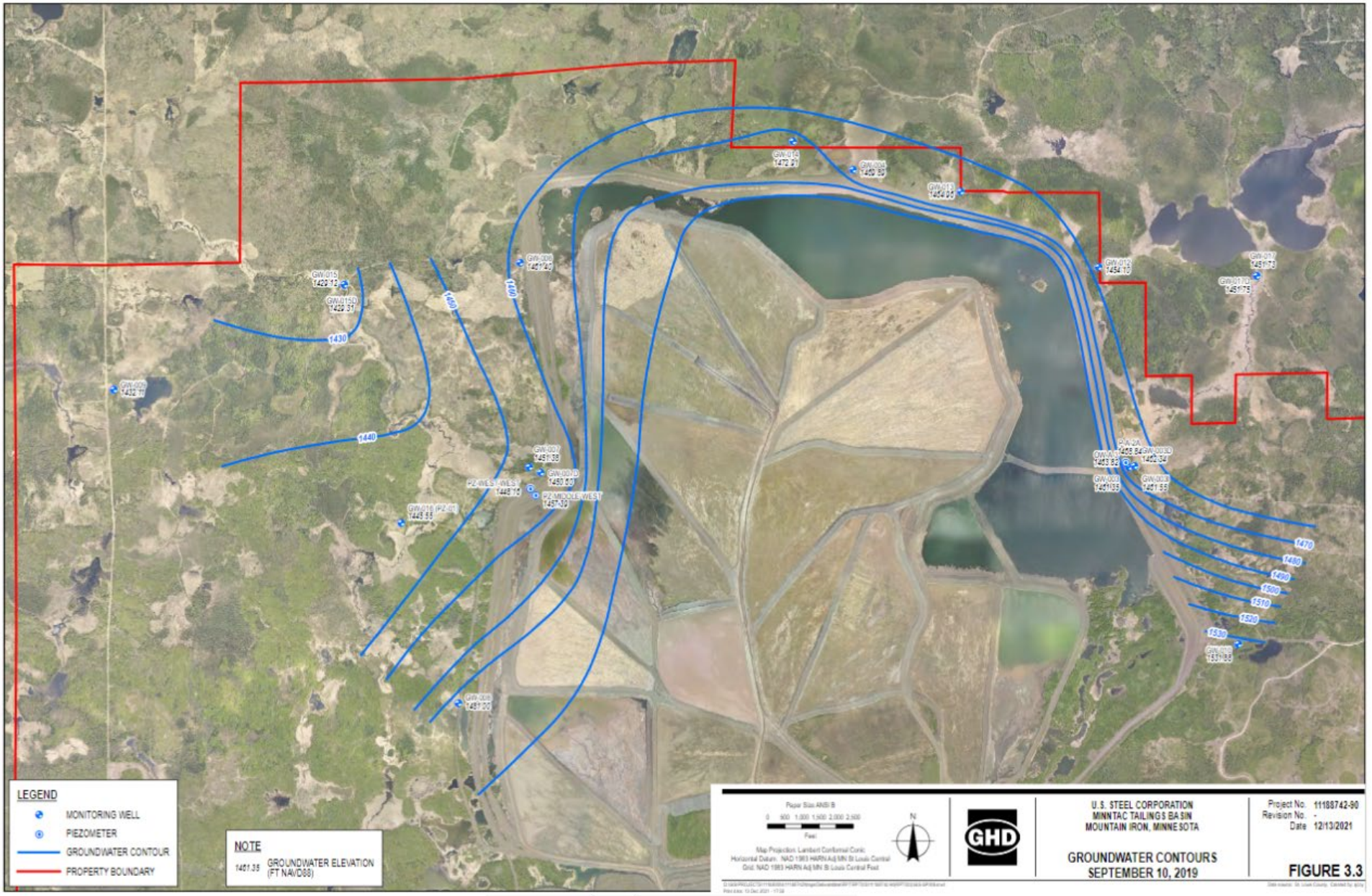


Figure 35. Groundwater Contours on September 10, 2019.
Taken from "Hydrological Investigation Report" performed by GHD on behalf of U.S. Steel (2021).

3.7 The Degree to Which the Pollution (At that point) Has Maintained Its Specific Identity

Sulfate and chloride from the basin are observed at downstream surface water monitoring locations in the Sand and Dark River watersheds (See **Table 1** and **Table 2**). Other pollutants have been identified in the discharge and receiving waters (See **Section 2.3**), but their fate and transport are not evaluated here. Further, a 2017 EPA inspection report described sulfate and chloride levels outside of the east side SCRS (i.e., in the adjacent wetlands) as being similar to levels inside the east side SCRS (See **Section 3.4**). These findings suggest that discharges from the basin have maintained their identity inside and outside of the basin and the SCRSs, and that pollutant concentrations in the discharge are much higher than background levels.

As wastewater seeps from the tailings basin, its geochemical signature may be affected by factors including 1) dilution by groundwater, 2) oxidation and rinsing of sulfide minerals present in the materials used to construct the basin (i.e., coarse and fine tailings), and 3) processes that occur when wastewater contacts buried organic matter in glacial till and peat.[92] While sulfate may undergo chemical transformation as it travels through groundwater beyond the basin, as explained in **Section 3.4.2**, there is still a significant amount of sulfate that leaves the basin and enters surface waters as discussed in **Section 3.5**. Like sulfate, a significant amount of chloride leaves the basin and enters surface waters; however, chloride is a conservative pollutant and does not chemically change as it travels through groundwater.

[92] Kelly et al. (2016), *Geochemical Tracer Based (GTB) Sulfate Balance Models for Active Tailing Basins on Minnesota's Iron Range (III) Well waters, seeps, and downstream surface waters.*

4 Discussion

While transit time and distance traveled will be the most important factors in most cases, and in many cases the only factors that need be considered, multiple other factors may also provide evidence to support the functional equivalent determination where time and distance are not dispositive. In this case, EPA considered the Supreme Court's seven factors as they relate to the Minntac tailings basin and information from a variety of publicly available documents which are referenced herein. The outcome of EPA's evaluation could change based on new or additional information. As noted above, EPA is providing this technical assistance to MPCA at their request and as part of EPA's longstanding practice of offering technical assistance to authorized states. EPA's technical assistance is not required by the CWA and creates no rights of third parties, nor does it constitute a permitting action or decision.

The observations and available data suggest that the tailings basin is discharging pollutants, including (but not limited to) sulfate and chloride, through groundwater and through the perimeter dike to surface waters. EPA did not identify any other significant sources of pollutants to the receiving water monitoring station data reviewed here. The effect on surface waters due to the discharge from the Minntac tailings basin via groundwater and subsurface flow under and through the perimeter dike is similar to the effect that would be expected if the discharges were direct to surface waters.

Transit time – Pollutants reach surface waters after a range of timeframes dependent on the location from which they leave the basin and the surface water body they are discharged into. Various studies have been conducted over the operational period of the tailings basin, resulting in a variety of estimates. The shortest estimate of transit time involves the consideration of wastewater traveling through the perimeter dike where it continues to accumulate pollutants and then is discharged into surface waters directly adjacent to the basin resulting in an immediate discharge when measuring from the outer edge of the tailings basin.

Distance traveled – Pollutants discharged from the tailings reach surface waters via a variety of pathways and corresponding distances. The shortest distance would be the distance from the outer edge of the tailings basin to adjacent surface waters, which would be immediately adjacent to the basin. Some studies reviewed in this evaluation concluded that longer distances are traveled by pollutants, for example those pollutants that travel from inside the dike, under the dike and into more distant downstream surface waters. Those estimates are as low as 3,300 feet (1,000 meters) traveled for pollutants discharged from the tailings basin to reach nearby surface waters.

The nature of the material through which the pollutants travel – Pollutants travel through porous media consisting of glacial till consisting of sands, silt, clay, and gravel. There are also localized areas where a peat layer overlays the glacial till. Pollutants flow with groundwater through this glacial till and to surface waters. The porous media through which the pollutants travel is not a hydraulic barrier to the transport of pollutants via groundwater from the point source to surface waters. **Section 3.3** considers the available data specific to the nature of the material through which the pollutant travels. Evaluation of the nature of the material through which the pollutant travels informs the evaluation of the other factors.

The extent to which the pollutant is diluted or chemically changed as it travels - Sulfate and chloride levels outside of the perimeter dike or SCRS are similar to levels inside the SCRS, are comparable to levels in the basin, and are much higher than background levels. This suggests that these pollutants are not diluted or changed as they travel these short pathways. Sulfate may be chemically changed as it travels in other longer pathways to reach surface waters.

The amount of pollutant entering the navigable waters relative to the amount of the pollutant that leaves the point source – EPA reviewed a robust record documenting pollutant discharge via groundwater to surface waters based on information collected over many years. EPA did not find an independent measure of the amount of pollutant leaving the tailings basin, only estimates that were themselves based on amounts of basin pollutants observed in surface water. Without that independent measurement it is difficult to evaluate this factor. However, EPA does observe that basin pollutants are present in basin receiving waters at levels significantly higher than is observed in background locations and in data collected in the same receiving water locations before the basin was constructed. Due to the nature of the materials under the basin, porous media overlain on relatively impermeable bedrock, and the abundance of surface waters that are connected to groundwater, it is reasonable to find that most of the pollutant leaving the basin would enter surface waters within a short distance of the basin.

The manner by or area in which the pollutant enters navigable waters – The 8,700-acre tailings basin was constructed on top of the headwaters of the Sand and Dark Rivers and in an area rich with jurisdictional wetlands. Pollutants are being discharged from the basin by passing under and through the perimeter dike via groundwater to surface waters. Pollutants from the tailings basin are found throughout downstream waters on the east and west side of the basin. Generally, the pollutants are transported with groundwater by advection and dispersion through the materials underlaying and surrounding the tailings basin and emerge in the nearby surface waters. The size of this point source, its close proximity to jurisdictional surface waters, and the abundance of those surface waters result in many potential pathways for pollutants to travel from the basin to surface waters.

The degree to which the pollution (at that point) has maintained its specific identity Information considered in this evaluation shows that several pollutants present in the basin are also present in surface waters surrounding the basin, and that those pollutants are clearly traceable to the basin. EPA did not evaluate every pollutant parameter being discharged from the basin. Most studies of the basin focus on a short list of pollutants. Some pollutants are known to be conserved as they are transported with groundwater to surface water while others may undergo some transformation. In general, the pollutant parameters that have been observed in the basin have been found in surrounding surface waters where monitoring was conducted. Pollutants found in receiving waters are clearly traceable to the basin, and some, including chloride and sulfate generally retain their specific identity while traveling through groundwater.

In *Maui*, the Supreme Court stated that of the factors listed, "[t]ime and distance will be the most important factors in most cases, but not necessarily every case." *Id*., 140 S. Ct. at 1477. Although the Supreme Court declined to define the exact outer parameters for time and distance, it expressed doubt that a point source pollutant discharge ending 50 miles from a navigable water and with a groundwater transit time of "many" years that first mixes with "much other

material[s]" would qualify as a functional equivalent discharge under the Clean Water Act. *Id*., 140 S. Ct. at 1477. As to those "many years" and distance, the Court concluded that Congress did not intend to extend the "point source-permitting requirement" to a 100-year migration of pollutants through 250 miles of groundwater to a river. *Id*., 140 S. Ct. at 1471.

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Appendix A

Table A-1. Discharge Monitoring Reporting Data from 2018-2022.
Table created by EPA using data submitted by U.S. Steel to MPCA.

Subject Item Designation	Subject Item Desc	Watershed	Source	Sample date	Sulfate, Total (as SO4) (mg/L)	Chloride, Total (mg/L)	Hardness, Calcium & Magnesium, Calculated (as CaCO3) (mg/L)	Solids, Total Dissolved (TDS) (mg/L)	Specific Conductance (umhos/cm)	Flow, Stream, Instantaneous (cfs)
SD 001	Seepage outfall 020	Dark River	Minntac DMR	12/19/2018	990	120	1530	1940	2667	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	1/2/2019	978	119	1520	1960	2618	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	2/6/2019	991	128	1580	2060	2584	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	3/6/2019	970	129	1520	2180	2500	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	4/3/2019	1020	130	1510	2150	2661	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	5/1/2019	954	130	1450	2060	2579	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	6/5/2019	957	146	1510	2130	2615	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	7/3/2019	982	134	1530	2200	2548	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	8/7/2019	1010	130	1530	2150	2704	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	9/4/2019	1040	133	1520	2240	2634	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	10/3/2019	1040	133	1650	2230	2633	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	11/6/2019	1060	132	1660	2350	2498	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	12/6/2019	1080	133	1690	2360	2945	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	1/3/2020	1150	134	1800	2450	2946	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	2/5/2020	1090	132	1880	2420	2704	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	3/4/2020	1070	134	1770	2390	2871	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	4/1/2020	1070	128	1710	2360	2815	
SD 001	Seepage outfall 020	Dark River	Minntac DMR	5/6/2020	1060	124	1710	2290	2958	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	12/19/2018	882	99.7	1650	1960	2454	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	1/2/2019	899	99.7	1620	1870	1364	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	2/6/2019	897	105	1710	1980	867	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	3/6/2019	854	107	1540	1920	1815	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	4/3/2019	835	104	1500	1960	1448	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	5/1/2019	787	91.1	1510	2010	2528	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	6/5/2019	861	107	1640	1930	2413	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	7/3/2019	898	107	1660	2050	2316	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	8/7/2019	905	108	1590	1970	1954	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	9/4/2019	928	108	1510	2020	2611	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	10/3/2019	902	104	1610	1940	2161	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	11/6/2019	887	103	1500	1870	2546	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	12/6/2019	882	101	1470	1910	2539	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	1/3/2020	814	99.4	1590	1990	1678	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	2/5/2020	873	104	1630	1990	2425	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	3/4/2020	881	109	1510	1970	2534	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	4/1/2020	885	104	1410	1940	2425	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	5/6/2020	905	107	1460	1950	2587	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	6/3/2020	903	109	1530	2000	2511	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	7/1/2020	862	98.1	1540	2010	2575	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	8/5/2020	899	105	1610	1980	2597	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	9/9/2020	861	110	1530	1940	2583	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	10/7/2020	799	93.5	1510	1910	2817	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	11/4/2020	829	95.1	1520	1950	2531	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	12/2/2020	870	95.7	1520	1930	2542	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	1/6/2021	887	99.5	1410	1960	2540	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	2/3/2021	906	106	1390	1900	2529	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	3/3/2021	907	110	1450	2000		
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	4/7/2021	896	108	1400	2060	2618	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	5/5/2021	961	107	1530	2080	2504	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	6/9/2021	905	99.6	1500	2070	2553	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	7/15/2021	998	103	1530	2000	2576	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	8/4/2021	898	111	1450	1930	2552	

Subject Item Designation	Subject Item Desc	Watershed	Source	Sample date	Sulfate, Total (as SO4) (mg/L)	Chloride, Total (mg/L)	Hardness, Calcium & Magnesium, Calculated (as CaCO3) (mg/L)	Solids, Total Dissolved (TDS) (mg/L)	Specific Conductance (umhos/cm)	Flow, Stream, Instantaneous (cfs)
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	9/1/2021	892	112	1510	1870	2567	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	10/6/2021	931	110	1430	1670	2545	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	11/10/2021	883	112	1430	1730	2530	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	12/8/2021	932	109	1520	1800	2421	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	1/12/2022	904	108	1430	1870	2515	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	2/9/2022	937	108	1400	2030	2658	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	3/9/2022	952	111	1450	1830	2491	
SD 006	Seep Discharge to north wetlands	Sand River	Minntac DMR	4/11/2022	961	122	1530	1700	2563	
SW 001	Sandy River Station 701	Sand River	Minntac DMR	12/7/2018	141	43.3	304	364	636	13.2
SW 001	Sandy River Station 701	Sand River	Minntac DMR	1/4/2019	167	55.7	366	416	778	9.18
SW 001	Sandy River Station 701	Sand River	Minntac DMR	2/11/2019	239	75.5	501	670	1102	7
SW 001	Sandy River Station 701	Sand River	Minntac DMR	3/8/2019	245	72.6	576	712	1193	9.5
SW 001	Sandy River Station 701	Sand River	Minntac DMR	4/8/2019	72.1	25.1	161	234	413	49.6
SW 001	Sandy River Station 701	Sand River	Minntac DMR	5/1/2019	83.8	22.4	163	256	393	43.6
SW 001	Sandy River Station 701	Sand River	Minntac DMR	6/7/2019	66.4	28.8	185	250	411	16.9
SW 001	Sandy River Station 701	Sand River	Minntac DMR	7/1/2019	58.9	33.6	201	236	457	10.106
SW 001	Sandy River Station 701	Sand River	Minntac DMR	8/5/2019	18.8	46.7	228	324	522	3.329
SW 001	Sandy River Station 701	Sand River	Minntac DMR	9/6/2019	41.6	42.4	195	278	450	2.372
SW 001	Sandy River Station 701	Sand River	Minntac DMR	10/8/2019	81.3	32	201	276	446.8	39.164
SW 001	Sandy River Station 701	Sand River	Minntac DMR	11/12/2019	133	35.2	283	380	616.5	10.602
SW 001	Sandy River Station 701	Sand River	Minntac DMR	12/13/2019	134	34.9	288	412	663	9.752
SW 001	Sandy River Station 701	Sand River	Minntac DMR	1/3/2020	166	41.9	338	458	636	12.684
SW 001	Sandy River Station 701	Sand River	Minntac DMR	2/10/2020	220	47.9	401	322	828	5.288
SW 001	Sandy River Station 701	Sand River	Minntac DMR	3/6/2020	219	53.1	446	608	906.5	7.372
SW 001	Sandy River Station 701	Sand River	Minntac DMR	4/3/2020	145	38.5	265	102	417	57.391
SW 001	Sandy River Station 701	Sand River	Minntac DMR	5/1/2020	102	26.7	175	644	432	21.4835
SW 001	Sandy River Station 701	Sand River	Minntac DMR	6/5/2020	135	26.3	250	334	545	10.019
SW 001	Sandy River Station 701	Sand River	Minntac DMR	7/10/2020	74.6	16.1	203	290	598	0.925
SW 001	Sandy River Station 701	Sand River	Minntac DMR	8/7/2020	9.3	31.3	190	256	425	0.9185
SW 001	Sandy River Station 701	Sand River	Minntac DMR	9/4/2020	138	33.1	287	384	630.2	6.0185
SW 001	Sandy River Station 701	Sand River	Minntac DMR	10/2/2020	136	34	297	402	634	2.4405
SW 001	Sandy River Station 701	Sand River	Minntac DMR	11/10/2020	138	35.5	266	394	574	17.696
SW 001	Sandy River Station 701	Sand River	Minntac DMR	12/4/2020	226	47.3	414	569	882	4.363
SW 001	Sandy River Station 701	Sand River	Minntac DMR	1/8/2021	265	52.3	514	673	882.5	3.146
SW 001	Sandy River Station 701	Sand River	Minntac DMR	2/16/2021	352	65.1	632	875	1276	1.69711
SW 001	Sandy River Station 701	Sand River	Minntac DMR	3/5/2021	365	67.4	598	855	1257	2.98
SW 001	Sandy River Station 701	Sand River	Minntac DMR	4/6/2021	155	30.6	273	413	585	24.57175
SW 001	Sandy River Station 701	Sand River	Minntac DMR	5/7/2021	121	25.2	203	311	472	9.4795
SW 001	Sandy River Station 701	Sand River	Minntac DMR	6/4/2021	145	29	271	402	517	8.277
SW 001	Sandy River Station 701	Sand River	Minntac DMR	7/29/2021	214	40.1	338	600	796	2.523
SW 001	Sandy River Station 701	Sand River	Minntac DMR	8/25/2021	215	46.9	381	588	862	1.1585
SW 001	Sandy River Station 701	Sand River	Minntac DMR	9/29/2021	224	40.8	334	535	770	3.93625
SW 001	Sandy River Station 701	Sand River	Minntac DMR	10/26/2021	291	53.7	474	624	978	0.381
SW 001	Sandy River Station 701	Sand River	Minntac DMR	11/30/2021	437	73.4	597	884	1297	4.44
SW 001	Sandy River Station 701	Sand River	Minntac DMR	12/14/2021	434	77.2	624	944	1336	2.702
SW 001	Sandy River Station 701	Sand River	Minntac DMR	1/10/2022	482	76.1	693	1000	1417	6.67
SW 001	Sandy River Station 701	Sand River	Minntac DMR	2/21/2022	520	77.7	736	1100	1539	3.603
SW 001	Sandy River Station 701	Sand River	Minntac DMR	3/4/2022	537	90.2	779	1110	1625	3.481
SW 001	Sandy River Station 701	Sand River	Minntac DMR	4/11/2022	253	43.3	385	538	817.5	23.879
SW 003	Dark River at CR668	Dark River	Minntac DMR	12/7/2018	747	70.1	1300	1560	2106	10.8
SW 003	Dark River at CR668	Dark River	Minntac DMR	1/4/2019	769	73.2	1410	1610	2283	7.52

Subject Item Designation	Subject Item Desc	Watershed	Source	Sample date	Sulfate, Total (as SO4) (mg/L)	Chloride, Total (mg/L)	Hardness, Calcium & Magnesium, Calculated (as CaCO3) (mg/L)	Solids, Total Dissolved (TDS) (mg/L)	Specific Conductance (umhos/cm)	Flow, Stream, Instantaneous (cfs)
SW 003	Dark River at CR668	Dark River	Minntac DMR	2/11/2019	837	86.1	1450	1990	2483	9.8
SW 003	Dark River at CR668	Dark River	Minntac DMR	3/8/2019	853	90.6	1500	1880	2488	9.8
SW 003	Dark River at CR668	Dark River	Minntac DMR	4/8/2019	196	20.8	372	506	771	57
SW 003	Dark River at CR668	Dark River	Minntac DMR	5/1/2019	281	27.8	492	678	978	25.8
SW 003	Dark River at CR668	Dark River	Minntac DMR	6/7/2019	490	57.3	935	1180	1605	10
SW 003	Dark River at CR668	Dark River	Minntac DMR	7/1/2019	597	59.3	1010	1240	1769	15.879
SW 003	Dark River at CR668	Dark River	Minntac DMR	8/5/2019	613	72	1150	1490	1987	4.97325
SW 003	Dark River at CR668	Dark River	Minntac DMR	9/6/2019	693	78.5	1180	1540	1992	2.763
SW 003	Dark River at CR668	Dark River	Minntac DMR	10/8/2019	332	36.8	618	758	1107	4.51975
SW 003	Dark River at CR668	Dark River	Minntac DMR	11/12/2019	592	62.8	1050	1300	1851	7.891
SW 003	Dark River at CR668	Dark River	Minntac DMR	12/2/2019	570	60.8	982	1250	1741	10.246
SW 003	Dark River at CR668	Dark River	Minntac DMR	1/3/2020	628	65.2	1080	1350	1756	10.433
SW 003	Dark River at CR668	Dark River	Minntac DMR	2/10/2020	725	77.4	1200	1600	2025	6.562
SW 003	Dark River at CR668	Dark River	Minntac DMR	3/6/2020	693	74	1230	1590	2028	8.66
SW 003	Dark River at CR668	Dark River	Minntac DMR	4/3/2020	150	16.2	272	372	568	51.02925
SW 003	Dark River at CR668	Dark River	Minntac DMR	5/1/2020	383	40.2	622	792	1183	12.40475
SW 003	Dark River at CR668	Dark River	Minntac DMR	6/5/2020	431	47.7	851	1070	1470	2.3765
SW 003	Dark River at CR668	Dark River	Minntac DMR	7/10/2020	402	18.6	796	1030	1417	9.857
SW 003	Dark River at CR668	Dark River	Minntac DMR	8/7/2020	441	48.4	864	1110	1557	1.427
SW 003	Dark River at CR668	Dark River	Minntac DMR	9/4/2020	358	41.5	745	922	1348	6.984
SW 003	Dark River at CR668	Dark River	Minntac DMR	10/2/2020	366	46	786	984	1366	4.42075
SW 003	Dark River at CR668	Dark River	Minntac DMR	11/10/2020	280	35.1	573	718	1041	19.3485
SW 003	Dark River at CR668	Dark River	Minntac DMR	12/4/2020	445	44.4	842	1060	1481	4.64
SW 003	Dark River at CR668	Dark River	Minntac DMR	1/8/2021	561	53.4	1090	1320	1833	3.702
SW 003	Dark River at CR668	Dark River	Minntac DMR	2/12/2021	616	59.9	1170	1460	1971	2.292
SW 003	Dark River at CR668	Dark River	Minntac DMR	3/5/2021	640	70.3	1100	1520	2031	3.519
SW 003	Dark River at CR668	Dark River	Minntac DMR	4/6/2021	205	22.2	388	496	729	12.02975
SW 003	Dark River at CR668	Dark River	Minntac DMR	5/26/2021	312	33.1	578	790	1093	6.101
SW 003	Dark River at CR668	Dark River	Minntac DMR	6/4/2021	363	42	644	896	1087	4.5025
SW 003	Dark River at CR668	Dark River	Minntac DMR	7/2/2021	476	52.4	796		1571	1.6585
SW 003	Dark River at CR668	Dark River	Minntac DMR	7/16/2021				1240		
SW 003	Dark River at CR668	Dark River	Minntac DMR	8/6/2021	540	68.3	918	1280	1582	0.996
SW 003	Dark River at CR668	Dark River	Minntac DMR	9/3/2021	635	88.4	1160	1490	1897	0.9105
SW 003	Dark River at CR668	Dark River	Minntac DMR	10/8/2021	616	68.8	989	1280	1753	6.1425
SW 003	Dark River at CR668	Dark River	Minntac DMR	11/9/2021	610	61.3	913	1260	1690	2.5685
SW 003	Dark River at CR668	Dark River	Minntac DMR	12/14/2021	659	65.4	1100	1450	1916	3.554
SW 003	Dark River at CR668	Dark River	Minntac DMR	1/10/2022	540	49.6	931	1230	1708	3.121
SW 003	Dark River at CR668	Dark River	Minntac DMR	2/21/2022	672	65.4	1150	1430	2049	3.733
SW 003	Dark River at CR668	Dark River	Minntac DMR	3/4/2022	642	69.1	1120	1490	2011	3.925
SW 003	Dark River at CR668	Dark River	Minntac DMR	4/11/2022	185	17.8	319	450	658.6	26.3915
SW 004	Dark River at CH65	Dark River	Minntac DMR	12/7/2018	298	29.3	508	638	943	
SW 004	Dark River at CH65	Dark River	Minntac DMR	1/4/2019	324	32.4	573	568	1076	
SW 004	Dark River at CH65	Dark River	Minntac DMR	2/11/2019	361	38	659	876	1278	
SW 004	Dark River at CH65	Dark River	Minntac DMR	3/8/2019	420	43.1	758	940	1429	
SW 004	Dark River at CH65	Dark River	Minntac DMR	4/8/2019	148	15.8	284	358	603	
SW 004	Dark River at CH65	Dark River	Minntac DMR	5/1/2019	127	14.9	234	362	509	
SW 004	Dark River at CH65	Dark River	Minntac DMR	6/14/2019	219	24.5	411	524	808	
SW 004	Dark River at CH65	Dark River	Minntac DMR	7/1/2019	261	29	465	550	905.8	
SW 004	Dark River at CH65	Dark River	Minntac DMR	8/5/2019	286	34.6	556	702	1070	
SW 004	Dark River at CH65	Dark River	Minntac DMR	9/6/2019	363	39.5	648	860	1190	
SW 004	Dark River at CH65	Dark River	Minntac DMR	10/8/2019	272	31	492	624	925	

Subject Item Designation	Subject Item Desc	Watershed	Source	Sample date	Sulfate, Total (as SO4) (mg/L)	Chloride, Total (mg/L)	Hardness, Calcium & Magnesium, Calculated (as CaCO3) (mg/L)	Solids, Total Dissolved (TDS) (mg/L)	Specific Conductance (umhos/cm)	Flow, Stream, Instantaneous (cfs)
SW 004	Dark River at CH65	Dark River	Minntac DMR	11/12/2019	228	26.4	423	526	364.4	
SW 004	Dark River at CH65	Dark River	Minntac DMR	12/2/2019	237	26.6	444	534	837	
SW 004	Dark River at CH65	Dark River	Minntac DMR	1/3/2020	288	32.8	510	668	899	
SW 004	Dark River at CH65	Dark River	Minntac DMR	2/10/2020	307	35.4	537	366	977	
SW 004	Dark River at CH65	Dark River	Minntac DMR	3/6/2020	328	39.3	629	790	1119	
SW 004	Dark River at CH65	Dark River	Minntac DMR	4/3/2020	152	17.6	268	384	573	
SW 004	Dark River at CH65	Dark River	Minntac DMR	5/1/2020	184	21.1	311	406	648.7	
SW 004	Dark River at CH65	Dark River	Minntac DMR	6/5/2020	258	29.7	483	594	915	
SW 004	Dark River at CH65	Dark River	Minntac DMR	7/10/2020	187	23.3	366	502	754	
SW 004	Dark River at CH65	Dark River	Minntac DMR	8/7/2020	173	19.9	341	424	678	
SW 004	Dark River at CH65	Dark River	Minntac DMR	9/4/2020	183	21.1	351	442	714	
SW 004	Dark River at CH65	Dark River	Minntac DMR	10/2/2020	189	22.9	396	500	757	
SW 004	Dark River at CH65	Dark River	Minntac DMR	11/10/2020	190	23.1	378	448	702	
SW 004	Dark River at CH65	Dark River	Minntac DMR	12/4/2020	192	22.7	391	492	750	
SW 004	Dark River at CH65	Dark River	Minntac DMR	1/8/2021	195	23.1	392	472	765.3	
SW 004	Dark River at CH65	Dark River	Minntac DMR	2/12/2021	234	28.9	498	579	788	
SW 004	Dark River at CH65	Dark River	Minntac DMR	3/5/2021	189	22.4	341	445	793.4	
SW 004	Dark River at CH65	Dark River	Minntac DMR	4/6/2021	102	12.2	217	280	418	
SW 004	Dark River at CH65	Dark River	Minntac DMR	5/26/2021	128	15.1	255	346	510	
SW 004	Dark River at CH65	Dark River	Minntac DMR	6/4/2021	132	15.8	269	358	480.6	
SW 004	Dark River at CH65	Dark River	Minntac DMR	7/2/2021	139	16.4	291		512	
SW 004	Dark River at CH65	Dark River	Minntac DMR	7/16/2021				314		
SW 004	Dark River at CH65	Dark River	Minntac DMR	8/6/2021	141	17.4	272	370	600	
SW 004	Dark River at CH65	Dark River	Minntac DMR	9/3/2021	139	17.1	278	350	557.7	
SW 004	Dark River at CH65	Dark River	Minntac DMR	10/8/2021	182	22.7	333	480	736	
SW 004	Dark River at CH65	Dark River	Minntac DMR	11/9/2021	210	25.1	368	478	761	
SW 004	Dark River at CH65	Dark River	Minntac DMR	12/14/2021	237	27.7	422	572	853.3	
SW 004	Dark River at CH65	Dark River	Minntac DMR	1/10/2022	221	22.6	371	522	773	
SW 004	Dark River at CH65	Dark River	Minntac DMR	2/21/2022	75.5	9.7	196	255	843	
SW 004	Dark River at CH65	Dark River	Minntac DMR	3/4/2022	270	33.7	507	658	862	
SW 004	Dark River at CH65	Dark River	Minntac DMR	4/11/2022	172	19	323	414	632.5	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	12/13/2018	648	102	991	1330	1863	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	1/4/2019	728	115	1080	1450	2005	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	2/11/2019	747	122	1170	1610	2200	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	3/8/2019	725	113	1120	1600	2153	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	4/8/2019	131	20.9	213	316	524	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	5/1/2019	152	24.3	238	374	549	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	6/7/2019	243	43.6	425	588	872	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	7/1/2019	353	54.8	538	736	1115	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	8/5/2019	347	58.5	615	874	1240	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	9/6/2019	475	81.4	779	968	1506	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	10/8/2019	235	43.1	401	538	834	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	11/12/2019	446	71.3	691	978	1440	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	12/11/2019	431	69.9	679	956	1363	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	1/3/2020	498	78.1	760	1050	1415	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	2/10/2020	552	85.3	791	1150	1622	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	3/6/2020	547	86.1	909	1240	1703	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	4/15/2020	157	23.9	233	344	545	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	5/1/2020	222	34.5	319	458	726	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	6/5/2020	520	82.5	788	1090	1535	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	7/10/2020	593	95.1	882	1330	1777	

Subject Item Designation	Subject Item Desc	Watershed	Source	Sample date	Sulfate, Total (as SO4) (mg/L)	Chloride, Total (mg/L)	Hardness, Calcium & Magnesium, Calculated (as CaCO3) (mg/L)	Solids, Total Dissolved (TDS) (mg/L)	Specific Conductance (umhos/cm)	Flow, Stream, Instantaneous (cfs)
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	8/7/2020	672	103	996	1390	1909	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	9/4/2020	533	100	872	1230	1740	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	10/2/2020	527	103	911	1310	1722	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	11/17/2020	420	66.9	630	896	1261	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	12/4/2020	617	97.9	932	1330	1792	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	1/8/2021	759	113	1100	1690	2010	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	2/16/2021	815	127	1260	1730	2130	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	3/15/2021	489	76.3	744	1100	1498	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	4/6/2021	256	39.7	404	543	819	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	5/7/2021	344	52.7	493	733	1054	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	6/4/2021	432	70.4	630	1010	1215	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	7/29/2021	741	116	1060	1560	2063	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	8/25/2021	870	140	1160	1970	2359	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	9/29/2021	769	123	1040	1570	2000	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	10/26/2021	750	122	1080	1200	2018	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	11/30/2021	894	141	1150	1770	2349	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	12/14/2021	851	132	1200	1700	2306	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	1/17/2022	674	103	963	1470	2039	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	2/25/2022	781	92	1060	1700	2534	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	3/21/2022	471	69.7	722	972	1434	
SW 005	Little Sandy Lake Inlet	Sand River	Minntac DMR	4/27/2022	99.9	14.2	161	241	366.7	
SW 006	Timber Creek	Dark River	Minntac DMR	12/13/2018	520	25.5	1090	1220	1769	
SW 006	Timber Creek	Dark River	Minntac DMR	1/4/2019	557	28.5	1160	1240	1847	
SW 006	Timber Creek	Dark River	Minntac DMR	2/11/2019	646	35.4	1300	1530	2150	
SW 006	Timber Creek	Dark River	Minntac DMR	3/8/2019	633	36.6	1280	1480	2125	
SW 006	Timber Creek	Dark River	Minntac DMR	4/8/2019	92.6	6.5	226	278	463	
SW 006	Timber Creek	Dark River	Minntac DMR	5/1/2019	200	11.1	416	550	779	
SW 006	Timber Creek	Dark River	Minntac DMR	6/14/2019	322	16.3	716	810	1239	
SW 006	Timber Creek	Dark River	Minntac DMR	7/5/2019	356	15.7	755	866	1283	
SW 006	Timber Creek	Dark River	Minntac DMR	8/16/2019	390	19.4	853	852	1442	
SW 006	Timber Creek	Dark River	Minntac DMR	9/9/2019	439	23.7	894	1060	788	
SW 006	Timber Creek	Dark River	Minntac DMR	10/15/2019	197	13.7	445	532	739	
SW 006	Timber Creek	Dark River	Minntac DMR	11/25/2019	322	11.9	706	806	1278	
SW 006	Timber Creek	Dark River	Minntac DMR	12/13/2019	327	18.1	711	890	1317	
SW 006	Timber Creek	Dark River	Minntac DMR	1/14/2020	372	20.6	833	1010	1441	
SW 006	Timber Creek	Dark River	Minntac DMR	2/24/2020	437	27	935	1120	1573	
SW 006	Timber Creek	Dark River	Minntac DMR	3/10/2020	402	27.3	841	1050	1473	
SW 006	Timber Creek	Dark River	Minntac DMR	4/6/2020	92.7	7	196	250	390	
SW 006	Timber Creek	Dark River	Minntac DMR	5/4/2020	247	14.1	494	596	904	
SW 006	Timber Creek	Dark River	Minntac DMR	6/5/2020	264	15.7	654	708	1075	
SW 006	Timber Creek	Dark River	Minntac DMR	7/10/2020	284	5.4	685	836	1204	
SW 006	Timber Creek	Dark River	Minntac DMR	8/7/2020	326	12.6	779	898	1330	
SW 006	Timber Creek	Dark River	Minntac DMR	9/8/2020	342	19.6	748	874	1297	
SW 006	Timber Creek	Dark River	Minntac DMR	10/2/2020	301	24	726	836	1207	
SW 006	Timber Creek	Dark River	Minntac DMR	11/10/2020	250	20.1	523	602	883	
SW 006	Timber Creek	Dark River	Minntac DMR	12/11/2020	409	23.9	789	1020	1291	
SW 006	Timber Creek	Dark River	Minntac DMR	1/14/2021	465	26.6	946	1170	1620	
SW 006	Timber Creek	Dark River	Minntac DMR	2/8/2021	526	29.6	1090	978	1809	
SW 006	Timber Creek	Dark River	Minntac DMR	3/9/2021	422	28.1	835	1090	1446	
SW 006	Timber Creek	Dark River	Minntac DMR	4/6/2021	143	11.4	306	363	571	
SW 006	Timber Creek	Dark River	Minntac DMR	5/21/2021	264	17.4	529	708	1007	

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SW 006	Timber Creek	Dark River	Minntac DMR	6/7/2021	279	17.2	609	740	1134	
SW 006	Timber Creek	Dark River	Minntac DMR	7/2/2021	294	15.2	724		1180	
SW 006	Timber Creek	Dark River	Minntac DMR	7/16/2021				896		
SW 006	Timber Creek	Dark River	Minntac DMR	8/6/2021	358	21	742	964	1314	
SW 006	Timber Creek	Dark River	Minntac DMR	9/3/2021	339	25.5	793	932	1370	
SW 006	Timber Creek	Dark River	Minntac DMR	10/1/2021	444	35.6	857	1070	1446	
SW 006	Timber Creek	Dark River	Minntac DMR	11/9/2021	517	32.5	797	1070	1445	
SW 006	Timber Creek	Dark River	Minntac DMR	12/14/2021	550	32.5	983	1200	1665	
SW 006	Timber Creek	Dark River	Minntac DMR	1/28/2022	507	30	1000	1190	1717	
SW 006	Timber Creek	Dark River	Minntac DMR	2/25/2022	558	30	1110	1310	1760	
SW 006	Timber Creek	Dark River	Minntac DMR	3/18/2022	423	29.4	823	968	1417	
SW 006	Timber Creek	Dark River	Minntac DMR	4/27/2022	80.3	4	178	226	362.9	
SW 007	Admiral Lake	Sand River	Minntac DMR	12/13/2018	717	111	1100	1470	2019	
SW 007	Admiral Lake	Sand River	Minntac DMR	1/4/2019	746	115	1150	1490	2342	
SW 007	Admiral Lake	Sand River	Minntac DMR	2/11/2019	788	126	1210	1670	2231	
SW 007	Admiral Lake	Sand River	Minntac DMR	3/8/2019	760	121	1200	1630	2246	
SW 007	Admiral Lake	Sand River	Minntac DMR	4/8/2019	167	26.7	283	362	765	
SW 007	Admiral Lake	Sand River	Minntac DMR	5/1/2019	295	46.3	454	690	1179	
SW 007	Admiral Lake	Sand River	Minntac DMR	6/25/2019	533	85.6	815	1130	1581	
SW 007	Admiral Lake	Sand River	Minntac DMR	7/17/2019	575	87.1	876	1160	1706	
SW 007	Admiral Lake	Sand River	Minntac DMR	8/28/2019	660	110	1010	1470	1946	
SW 007	Admiral Lake	Sand River	Minntac DMR	9/18/2019	492	82.8	808	1090	1578	
SW 007	Admiral Lake	Sand River	Minntac DMR	10/9/2019	455	78.6	776	1000	1490	
SW 007	Admiral Lake	Sand River	Minntac DMR	12/2/2019	621	95.9	895	1300	1765	
SW 007	Admiral Lake	Sand River	Minntac DMR	1/14/2020	648	103	1020	1520	1989	
SW 007	Admiral Lake	Sand River	Minntac DMR	2/24/2020	724	119	1120	1590	2175	
SW 007	Admiral Lake	Sand River	Minntac DMR	3/10/2020	716	113	1000	1390	1982	
SW 007	Admiral Lake	Sand River	Minntac DMR	4/28/2020	394	63.7	583	876	1193	
SW 007	Admiral Lake	Sand River	Minntac DMR	5/22/2020	590	93.6	785	1230	1596	
SW 007	Admiral Lake	Sand River	Minntac DMR	6/15/2020	601	76.9	851	1270	1697	
SW 007	Admiral Lake	Sand River	Minntac DMR	7/22/2020	703	102	1020	1440	1932	
SW 007	Admiral Lake	Sand River	Minntac DMR	8/10/2020	695	108	1090	1580	2025	
SW 007	Admiral Lake	Sand River	Minntac DMR	9/14/2020	759	129	1170	1680	2142	
SW 007	Admiral Lake	Sand River	Minntac DMR	10/12/2020	696	125	1050	1510	2001	
SW 007	Admiral Lake	Sand River	Minntac DMR	11/6/2020	518	83	803	1180	1765	
SW 007	Admiral Lake	Sand River	Minntac DMR	12/11/2020	740	122	1080	1630	2147	
SW 007	Admiral Lake	Sand River	Minntac DMR	1/14/2021	812	119	1140	1670	2197	
SW 007	Admiral Lake	Sand River	Minntac DMR	2/8/2021	856	127	1190	1750	2340	
SW 007	Admiral Lake	Sand River	Minntac DMR	3/9/2021	387	60.3	588	880	1835	
SW 007	Admiral Lake	Sand River	Minntac DMR	4/23/2021	373	56.1	566	840	1194	
SW 007	Admiral Lake	Sand River	Minntac DMR	5/21/2021	581	96.1	842	1320	1714	
SW 007	Admiral Lake	Sand River	Minntac DMR	6/7/2021	705	100	941	1420	1897	
SW 007	Admiral Lake	Sand River	Minntac DMR	7/13/2021	834	122	1170	1740	2173	
SW 007	Admiral Lake	Sand River	Minntac DMR	8/6/2021	842	128	1140	1830	2295	
SW 007	Admiral Lake	Sand River	Minntac DMR	9/24/2021	752	131	912	1680	2140	
SW 007	Admiral Lake	Sand River	Minntac DMR	10/22/2021	774	130	1140	1200	2128	
SW 007	Admiral Lake	Sand River	Minntac DMR	11/10/2021	843	133	1290	1330	2201	
SW 007	Admiral Lake	Sand River	Minntac DMR	12/14/2021	873	139	1250	1700	2366	
SW 007	Admiral Lake	Sand River	Minntac DMR	1/11/2022	779	116	1120	1630	2170	
SW 007	Admiral Lake	Sand River	Minntac DMR	2/25/2022	848	100	1130	1700	2535	
SW 007	Admiral Lake	Sand River	Minntac DMR	3/21/2022	479	67.1	697	956	1742	

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SW 008	Dark River near Basin	Dark River	Minntac DMR	6/25/2019	636	63.7	1140	1460	1898	
SW 008	Dark River near Basin	Dark River	Minntac DMR	7/17/2019	538	52.6	921	1170	1648	
SW 008	Dark River near Basin	Dark River	Minntac DMR	8/28/2019	619	65.7	1050	1400	1865	
SW 008	Dark River near Basin	Dark River	Minntac DMR	9/18/2019	393	45.1	721	900	1342	
SW 008	Dark River near Basin	Dark River	Minntac DMR	10/9/2019	486	55.6	866	1100	1576	
SW 008	Dark River near Basin	Dark River	Minntac DMR	4/28/2020	432	46.6	768	1000	1368	
SW 008	Dark River near Basin	Dark River	Minntac DMR	5/22/2020	713	81.2	1140	1590	2002	
SW 008	Dark River near Basin	Dark River	Minntac DMR	6/15/2020	368	37.2	652	856	1218	
SW 008	Dark River near Basin	Dark River	Minntac DMR	7/22/2020	349	31.1	682	906	1246	
SW 008	Dark River near Basin	Dark River	Minntac DMR	8/10/2020	378	38.6	779	978	1327	
SW 008	Dark River near Basin	Dark River	Minntac DMR	9/14/2020	540	58.5	1000	1290	1711	
SW 008	Dark River near Basin	Dark River	Minntac DMR	10/12/2020	490	64.4	881	1180	1620	
SW 008	Dark River near Basin	Dark River	Minntac DMR	11/6/2020	376	36.6	756	982	1383	
SW 008	Dark River near Basin	Dark River	Minntac DMR	4/23/2021	264	26.8	446	652	938	
SW 008	Dark River near Basin	Dark River	Minntac DMR	5/21/2021	326	32.2	611	816	1176	
SW 008	Dark River near Basin	Dark River	Minntac DMR	6/7/2021	490	50	818	1120	1430	
SW 008	Dark River near Basin	Dark River	Minntac DMR	7/13/2021	667	82	1120	1560	2005	
SW 008	Dark River near Basin	Dark River	Minntac DMR	8/6/2021	687	90	1120	1660	2049	
SW 008	Dark River near Basin	Dark River	Minntac DMR	9/24/2021	478	60.8	1090	1220	1600	
SW 008	Dark River near Basin	Dark River	Minntac DMR	10/22/2021	626	62.3	967	1320	1773	
SW 008	Dark River near Basin	Dark River	Minntac DMR	11/10/2021	620	65.7	1160	1370	1809	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	1/2/2019	1020	149	1370	1980	2487	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	2/6/2019	1030	154	1560	1980	2495	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	3/6/2019	1010	152	1380	2080	2597	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	4/3/2019	947	155	1400	2040	2449	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	5/1/2019	881	128	1330	1770	2261	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	6/5/2019	870	137	1360	1850	2344	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	7/3/2019	930	146	1340	2020	2457	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	8/7/2019	975	143	1310	1960	2456	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	9/4/2019	962	142	1324	1980	2420	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	10/3/2019	752	108	1350	1490	2386	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	11/6/2019	975	140	1300	1910	2462	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	12/4/2019	923	138	1290	1860	2452	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	1/2/2020	975	142	1320	1930	2442	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	2/5/2020	965	146	1250	2010	2495	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	3/4/2020	954	150	1270	1980	2566	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	4/1/2020	944	136	1250	2000	2412	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	5/6/2020	961	136	1320	1950	2060	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	6/3/2020	954	140	1330	1980	2375	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	7/1/2020	927	129	1370	1970	2432	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	8/5/2020	990	136	1390	1970	2375	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	9/9/2020	881	124	1330	1960	2755	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	10/7/2020	917	126	1350	1970	2755	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	11/4/2020	940	132	1360	2010	2485	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	12/2/2020	1020	139	1330	2030	2532	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	1/6/2021	1040	145	1250	2050	2645	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	2/3/2021	1090	153	1440	2080	2581	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	3/3/2021	1100	155	1480	2210	2576	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	4/7/2021	1100	158	1400	2170	2609	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	5/5/2021	1000	142	1330	2130	2472	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	6/9/2021	1010	134	1320	2070	2500	

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WS 009	Basin Water	Tailings Basin Water	Minntac DMR	7/15/2021	1080	139	1360	2000		
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	8/4/2021	1110	145	1440	2100	2571	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	9/1/2021	1060	148	1390	1900	2593	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	10/6/2021	1090	148	1260	1770	2614	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	11/10/2021	1070	155	1310	1930	2647	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	12/8/2021	1120	158	1530	1930	2672	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	1/6/2022					2673	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	1/12/2022	1090	152	1410	1900		
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	2/9/2022	1110	150	1440	2170	2733	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	3/9/2022	1130	157	1410	1900	2694	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	4/6/2022			1410		2655	
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	4/11/2022	1080	159		2000		
WS 009	Basin Water	Tailings Basin Water	Minntac DMR	4/30/2022						

Background/Pre-Facility	Data Source	Date Range	Sulfate, Total (as SO4) (mg/L)	Chloride, Total (mg/L)	Hardness, Calcium & Magnesium, Calculated (as CaCO3) (mg/L)	Solids, Total Dissolved (TDS) (mg/L)	Specific Conductance (umhos/cm)
Background Max	2004 EIS	May 2003- Nov 2003	5.4	7.7	72		96
Pre-Facility Historic Max	USGS	1955-1962	26	1	54	104	119

Note:
123 Shaded cells indicate values that exceed the highest background or historic value.

Table A-2. Historic Water Quality Data – 1955-1979.

MWH on behalf of MPCA, from "Minntac Water Inventory Reduction EIS – Surface Water Hydrology and Quality Technical Memorandum" (2004), pages 163-165 of pdf.

			General Inorganics																													Metals/Mettaloids						
Station	Watershed	Date Sampled	Acid Neutral Potential (mg/L as CaCO3)	Bicarbonate, total (mg/L)	Calcium, dissolved (mg/L)	Carbonate, total (mg/L	Chloride, dissolved (mg/L)	CO2, total (mg/L)	Conductivity (usiemens/cm)	Discharge (CFS)	Fluoride, dissolved (mg/L)	Hardness, total (mg/L as CaCO3)	Iron, dissolved (ug/L)	Iron, total (ug/L)	Nitrate as N, dissolved (mg/L)	Nitrate, dissolved (ug/L)	Nitrate, total (mg/L)	Nitrite + nitrate, dissolved (mg/L)	Non-Carbonate Hardness (mg/L as CaCO3)	pH	Phosphorous, total (mg/L)	Potassium, dissolved (mg/L)	Silica, dissolved (mg/L)	Sodium (% of major cations)	Sodium + Potassium, dissolved (mg/l as Na	Sodium adsorption ratio	Sodium, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Temp (C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Boron, dissolved (ug/L)	Boron, total rec (ug/L)	Magnesium, dissolved (mg/L)	Manganese, dissolved (ug/L)	Manganese, total (ug/L)	Manganese, total rec (ug/L)
701	Sandy/Pike River	04/26/58	13	16	3.6	0	0.5	10	43	12	0.2	17			0.8	3.5	0.8		4	6.4		0.8	3.5	15		0.2	1.5	7.5				50		1.9			
701	Sandy/Pike River	05/21/58	14	17	5.1	0	1	6.8	47	11	0.1	19			0.3	1.3	0.3		5	6.6		0.6	2.2	16		0.2	1.7	7.8						1.5			
701	Sandy/Pike River	06/25/58	11	14	5	0	0.2	11	38	22	0.1	19			0.5	2.2	0.5		8	6.3		0.2	3	14		0.1	1.4	9.5						1.6			
701	Sandy/Pike River	08/04/59	11	13	3.7	0	0.1	26	37		0.2	17	780	1	4.4	1		6	5.9		0.1	1.6	15		0.1	1.4	8.3						1.9		0	
701	Sandy/Pike River	08/04/59	20	24	6	0	0.1		51	3.1	0.2	26		1.6	7.1	1.6		6			0.2	7.6	11		0.1	1.5	9.5						2.7			
701	Sandy/Pike River	08/26/59	16	20	6.4	0	0.1	13	57	18	0.3	26		0.8	3.5	0.8		10	6.4		0.4	11	10		0.1	1.4	10						2.4			
701	Sandy/Pike River	09/04/59	11	14	5.5	0	0	22	41	313	0.2	22	1400	3.8	17	3.8		11	6		0.4	9.4	14		0.2	1.7	12						2		0	
701	Sandy/Pike River	07/06/60		16	4.9	0	0.1		43	8.6	0	20	520		2			7	6.1		0.6	5.4			0.2	1.9	11						1.9			
701	Sandy/Pike River	07/28/60							41	27																											
701	Sandy/Pike River	08/10/60		18	5.2	0	0.1		44		0.1	23	1100		1.9			8	6.5		0.6	10			0.1	1.4	9.3						2.4		0	
701	Sandy/Pike River	09/30/60		35	11	0	0		70		0.1	32	1900		1.5			3	6.5		1	12			0.2	2	7.8				10		1.1			
701	Sandy/Pike River	10/29/60	21	25	6.3	0	0	10	67	4.4	0.1	26	1500	1.5	6.6	1.5		5	6.6		1	11	14		0.2	2	9.3				30	30	2.5			
701	Sandy/Pike River	11/16/60	20	24	7.3	0	0	9.6	59	8.9	0.1	24	1700	1.3	5.8	1.3		4	6.6		1.4	11	14		0.2	2	7.3				50	50	1.4			
701	Sandy/Pike River	12/22/60	49	60	18	0	0.2	7.6	119	0.85	0.1	54	1900	0.9	4	0.9		5	7.1		1.2	24	11		0.2	3.2	10				120	120	2.2			
701	Sandy/Pike River	01/23/61	55	67	16	0	0	17	118	0.37	0.1	54	1500	1.2	5.3	1.2		0	6.8		1.8	22	10		0.2	2.8	5.5				20	20	3.4			
701	Sandy/Pike River	02/11/61											1300																								
701	Sandy/Pike River	02/21/61	52	64	15	0	0	13	114	0.54	0.1	50		0.9	4	0.9		0	6.9		2.3	21	11		0.2	3.1	2				10	10	3.1			
701	Sandy/Pike River	05/11/61	7	8	3.2	0	0.1	8.1	37	43	0.1	13	370	1.1	4.9	1.1		6	6.2		1.5	3.6	16		0.2	1.3	6				70	70	1.2		50	
701	Sandy/Pike River	05/23/61							39	61																											
701	Sandy/Pike River	06/21/61	25	30	7.9	0	0	9.6	62	5	0.2	28	2200	1.1	4.9	1.1		3	6.7		0.8	5.6	16		0.2	2.6	7.3				70	70	2			
701	Sandy/Pike River	07/17/61	43	52	11	0	0	6.6	93	1.3	0.3	41	1700	0.6	2.7	0.6		0	7.1		1.1	11	12		0.2	2.7	1.8				20	20	3.3			
701	Sandy/Pike River	08/14/61	48	58	13	0	0	4.7	103	0.38	0.2	45	590	0.6	2.7	0.6		0	7.3		1.2	8.5	14		0.2	3.4	2.8				20	20	3.1			
701	Sandy/Pike River	09/13/61	11	13	9.2	0	0	4.2	76	23	0.4	35	1300	1.8	8	1.8		24	6.7		1	11	14		0.2	2.7	26				20	20	2.9			
S-2	Sandy/Pike River	09/25/57											1500																								
S-2	Sandy/Pike River	04/18/58		20	7		0.8		56		0.1	24	690			1.5		8	6.6		0.9	7.1	15		0.2	2	11						1.6			
S-2	Sandy/Pike River	10/01/58		26	7.4		0.8		65		0.2	31	960			0.5		10	6.1		0	8	11		0.1	1.7	11						3.1			
S-2	Sandy/Pike River	06/03/59		18	5.4		0.5		47		0.2	22	730			0.8		7	6.1		0.2	3.1	14		0.1	1.6	10						2.1			
S-2	Sandy/Pike River	09/03/59		17	6.3		0.1		57		0.4	28	1300			0.8		14	6.1		0.4	9.9	11		0.1	1.6	16						3			
S-2	Sandy/Pike River	08/09/60		26	7.8	0	0		60		0.2	30				1.3		9	6.6		0.5	11			0.1	1.8	11						2.6			
S-2	Sandy/Pike River	05/11/61		15	7.2	0	0		53		0.1	21	370			1.2		9	6.4		0.8	4.6			0.2	1.6	13					80	0.7		20	
S-2	Sandy/Pike River	05/23/62		14	5.7	0	0.7		51		0.2	22	580			0.6		11	6.3		0.5	2.8			0.1	1.6	11					50	1.9			0
S-2	Sandy/Pike River	09/26/62		38	9.2	0	1		84		0.2	41	1500			2.3		10	6.8		1.6	10			0.2	2.3	11					60	4.4			10
S-2	Sandy/Pike River	04/17/63											520																						0		
ST-1	Dark/Sturgeon River	09/28/55	43	52	12	0	0.2	6.6	96	77		45		1.2	5.3			2	7.1			12	15	3.7	0.2		8.8				10		3.6			
ST-1	Dark/Sturgeon River	09/27/57	41	50	14	0	0.4	16	101	82	0.2	48	1100	2.1	9.3	2.1		7	6.7		1.3	11	9		0.1	2.3	14				60		3.2			
ST-1	Dark/Sturgeon River	04/18/58	35	43	12	0	1	5.5	84	75	0.1	40	610	1.1	4.9	1.1		5	7.1		1.1	6.9	11		0.2	2.4	7.3				50		2.4		120	
ST-1	Dark/Sturgeon River	07/20/58	34	42	12	0	0.6	13	85	60	0.2	44		2.1	9.3	2.1		10	6.7		0.7	7.1	9		0.1	2	14						3.4			
ST-1	Dark/Sturgeon River	08/17/58	42	51	14	0	0.2	13	94	27	0.2	46		0.9	4	0.9		4	6.8		0.8	6.2	12		0.2	3	11						2.7			
ST-1	Dark/Sturgeon River	09/26/58	35	43	11	0	0.4	8.7	85	28	0.2	41		0.6	2.7			6	6.9		1.2	10	12		0.2	2.6	7.3						3.3			

Station	Watershed	Date Sampled	General Inorganics																												Metals/Mettaloids					
			Acid Neutral Potential (mg/L as CaCO3)	Bicarbonate, total (mg/L)	Calcium, dissolved (mg/L)	Carbonate, total (mg/L	Chloride, dissolved (mg/L)	CO2, total (mg/L)	Conductivity (usiemens/cm)	Discharge (CFS)	Fluoride, dissolved (mg/L)	Hardness, total (mg/L as CaCO3)	Iron, dissolved (ug/L)	Iron, total (ug/L)	Nitrate as N, dissolved (mg/L)	Nitrate, dissolved (ug/L)	Nitrate, total (mg/L)	Nitrite + nitrate, dissolved (mg/L)	Non-Carbonate Hardness (mg/L as CaCO3)	pH	Phosphorous, total (mg/L)	Potassium, dissolved (mg/L)	Silica, dissolved (mg/L)	Sodium (% of major cations)	Sodium + Potassium, dissolved (mg/l as Na	Sodium adsorption ratio	Sodium, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Temp (C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Boron, dissolved (ug/L)	Boron, total rec (ug/L)	Magnesium, dissolved (mg/L)	Manganese, dissolved (ug/L)	Manganese, total (ug/L)	Manganese, total rec (ug/L)
ST-1	Dark/Sturgeon River	10/02/58	37	45	13	0	0.2	23	89	62	0.2	45		790	1.9	8.4	1.9		8	6.5		1.2	9.3	10		0.1	2.3	14						3.1		0	
ST-1	Dark/Sturgeon River	10/24/58							89	47																											
ST-1	Dark/Sturgeon River	11/22/58	30	36	10	0	0.1	11	84	179	0.2	38			1.5	6.6	1.5		8	6.7		1.2	11	11		0.2	2.3	9.5						3.2			
ST-1	Dark/Sturgeon River	12/19/58	39	48	13	0	0.1	2.4	108	26	0.2	49			7.3	32	7.3		10	7.5		1.5	12	12		0.2	3.1	9.8						4			
ST-1	Dark/Sturgeon River	01/22/59	57	69	16	0	0.3	8.8	122	18	0.1	58			0.5	2.2	0.5		1	7.1		1.5	13	10		0.2	3.1	7						4.4			
ST-1	Dark/Sturgeon River	02/22/59	68	83	18	0	0.4	42	154	11	0.1	72			0.8	3.5			4	6.5		1.7	17	10		0.2	3.7	20						6.6			
ST-1	Dark/Sturgeon River	02/25/59		83	18		0.4		154		0.1	72					0.8		4	6.5		1.7	17	10		0.2	3.7	20						6.6			
ST-1	Dark/Sturgeon River	03/26/59	69	84	19	0	1.7	5.4	150	19	0.1	68			0.8	3.5	0.8		0	7.4		1.6	16	11		0.2	4	3						5			
ST-1	Dark/Sturgeon River	04/29/59	32	39	9.2	0	0	7.9	78	93	0.1	35			0.9	4	0.9		3	6.9		1	6.9	10		0.1	1.9	8						2.9			
ST-1	Dark/Sturgeon River	05/27/59	25	31	8	0	0	12	65	313	0.2	31			1.8	8	1.8		6	6.6		0.8	5.3	10		0.1	1.6	9.5						2.7			
ST-1	Dark/Sturgeon River	06/04/59	29	35	9	0	0.1	11	77	186	0.2	34		520	1.2	5.3	1.2		5	6.7		0.7	6.9	11		0.1	1.9	8.3						2.8		0	
ST-1	Dark/Sturgeon River	08/02/59	41	50	13	0	0.1	8	88	43	0.3	46			1	4.4	1		5	7		0.6	7.8	9		0.1	2.1	7.3						3.3			
ST-1	Dark/Sturgeon River	08/27/59	39	48	12	0	0.1	31	96	93	0.2	44			2.6	12	2.6		5	6.4		1	10	11		0.2	2.5	5.8						3.4			
ST-1	Dark/Sturgeon River	09/05/59	30	37	11	0	0	9.4	72	274	0.3	38		740	2.3	10	2.3		8	6.8		0.6	9	9		0.1	1.7	9.5						2.6		0	
ST-1	Dark/Sturgeon River	07/06/60		41	10	0	0.7		77	61	0.1	37				0.3	0.3		3	6.7		1	5			0.1	2.1	11						2.9			
ST-1	Dark/Sturgeon River	07/27/60							71	113																											
ST-1	Dark/Sturgeon River	08/10/60		37	10	0	0		70	83	0.2	37		460		0.9	0.9		7	6.8		1	8.8			0.1	1.8	8.8						2.9		0	
ST-1	Dark/Sturgeon River	09/20/60		60	14	0	0		104	22	0.2	48		780		0.5	0.5		0	7		1.2	9.1			0.2	2.7	6.5						3.2		0	
ST-1	Dark/Sturgeon River	10/19/60		70	16	0	0		126	20	0.1	56		690		0.3	0.3		0	7.4		1.6	10			0.2	3.1	5.3				30	30	3.9			
ST-1	Dark/Sturgeon River	11/16/60		59	14	0	0		106	39	0.1	49		800		0.6	0.6		1	7.5		1.2	12			0.2	2.6	7.3				60	60	3.4			
ST-1	Dark/Sturgeon River	02/28/61		82	18	0	0.2		142	14	0.1	66		890		0.8	0.8		0	7.4		1.1	15			0.2	3.3	4				30	30	5.1			
ST-1	Dark/Sturgeon River	04/12/61		47	10	0	0.5		91	47	0.1	39		670		0.8	0.8		0	7.1		2	7.3			0.2	2.2	3.5				20	20	3.4		70	
ST-1	Dark/Sturgeon River	05/11/61		28	7.7	0	0.5		63	243	0.2	28		360		1.5	1.5		5	6.6		1.2	5.4			0.1	1.8	5.8				60	60	2.1		50	
ST-1	Dark/Sturgeon River	05/17/61		20		0	0		54	940		22							6	6.7					0.8	0.1	0.8	7									
ST-1	Dark/Sturgeon River	06/12/61		45	12	0	0		86	86	0.2	42		360		1.4	1.4		5	6.6		0.9	4.8			0.1	1.9	4.8				50	50	2.9			
ST-1	Dark/Sturgeon River	07/12/61		76	20	0	0		134	14	0.2	64		340		0.8	0.8		2	7.8		1.2	5.3			0.1	2.5	5				30	30	3.4			
ST-1	Dark/Sturgeon River	08/10/61		63	14	0	0		114	14	0.2	51		220		0.3	0.3		0	7.3		1.2	6.1			0.2	3.1	6				40	40	3.9			
ST-1	Dark/Sturgeon River	09/16/61		46	14	0	0.3		97	104	0.2	45		510		0.8	0.8		7	6.9		1.4	8.8			0.2	2.5	14				20	20	2.4			
ST-1	Dark/Sturgeon River	10/03/61		41		0	0.2		86	54		38		570					4	6.9					1.1	0.1	1.1	6.3									
ST-1	Dark/Sturgeon River	10/31/61		43	14	0	0		91	74	0.2	41		570		0.9	0.9		6	7.2		0.8	8.6			0.2	2.3	12				60	60	1.5		0	
ST-1	Dark/Sturgeon River	11/28/61		55	14	0	0		110	36	0.2	50		790		0.9	0.9		5	6.9		1.6	10			0.2	2.7	12				50	50	3.7			
ST-1	Dark/Sturgeon River	01/03/62		67	15	0	0.2		129	19		57							2	6.8					4	0.2	4	10						4.8			
ST-1	Dark/Sturgeon River	02/07/62		72		0	0.2		126	17		58							0	7.1					3.6	0.2	3.6	6.3									
ST-1	Dark/Sturgeon River	03/14/62		78		0	0		137	14		64							0	7.2					2.7	0.1	2.7	5.8									
ST-1	Dark/Sturgeon River	04/16/62		41	9.9	0	0.5		96	89	0.1	40		560		1.7	1.7		6	6.7		2.1	9.6			0.2	2.2	9.5				40	40	3.7			
ST-1	Dark/Sturgeon River	05/12/62							66	393																											
ST-1	Dark/Sturgeon River	05/24/62		24	7	0	1.1		58	770	0.1	27		410		0.4	0.4		7	6.4		0.6	5.2			0.2	1.8	9.3				40	40	2.3		0	
ST-1	Dark/Sturgeon River	06/11/62		33		0	0		69	317		33							6	7					1.2	0.1	1.2	8.3									
ST-1	Dark/Sturgeon River	07/10/62		34		0	0.1		65	243		34							6	6.9					0.3	0	0.3	6.5									

Station	Watershed	Date Sampled	General Inorganics																													Metals/Mettaloids					
			Acid Neutral Potential (mg/L as CaCO3)	Bicarbonate, total (mg/L)	Calcium, dissolved (mg/L)	Carbonate, total (mg/L	Chloride, dissolved (mg/L)	CO2, total (mg/L)	Conductivity (usiemens/cm)	Discharge (CFS)	Fluoride, dissolved (mg/L)	Hardness, total (mg/L as CaCO3)	Iron, dissolved (ug/L)	Iron, total (ug/L)	Nitrate as N, dissolved (mg/L)	Nitrate, dissolved (ug/L)	Nitrate, total (mg/L)	Nitrite + nitrate, dissolved (mg/L)	Non-Carbonate Hardness (mg/L as CaCO3)	pH	Phosphorous, total (mg/L)	Potassium, dissolved (mg/L)	Silica, dissolved (mg/L)	Sodium (% of major cations)	Sodium + Potassium, dissolved (mg/l as Na	Sodium adsorption ratio	Sodium, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Temp (C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Boron, dissolved (ug/L)	Boron, total rec (ug/L)	Magnesium, dissolved (mg/L)	Manganese, dissolved (ug/L)	Manganese, total (ug/L)	Manganese, total rec (ug/L)
ST-1	Dark/Sturgeon River	09/27/82		42		0	0.2		78	72		40							6	6.8					0.6	0	0.6	6.3									
ST-1	Dark/Sturgeon River	10/10/82		45	11	0	0		83	55	0.2	40		860		0.8			3	6.9		1.3	9			0.1	2	6.8				40		3.1			
ST-1	Dark/Sturgeon River	12/04/82		53	13	0	0		97	61	0.1	44		1100		1.2			1	7.3		1	11			0.2	2.4	5.8				30		2.8			
ST-1	Dark/Sturgeon River	02/11/83		78	19	0	0.8		136	9.1	0.2	66		930		1			2	7.3		1.4	18			0.2	3.1	7.2				20		4.5			
ST-1	Dark/Sturgeon River	04/18/83		28	7.6	0	0.1		65	348	0.2	28		390		1			5	6.6		1.3	6.4			0.1	1.7	9				70		2.3		20	
ST-1	Dark/Sturgeon River	05/15/83		33		0	1.2		70	193		32							5	7					2.4	0.2		8.2									
ST-1	Dark/Sturgeon River	07/16/83		52	13	0	1.4		92	68	0.2	45		1100		0.6			2	7		0.9	8.2			0.2	2.4	6.8				30		3.1			
ST-1	Dark/Sturgeon River	10/18/72	36	44	10	0	1.9	2.8	81	117	0.3	39	1200					0.07	3	7.4	0.05	1.1	11	9		0.1	1.9	6.9	2			110		3.4	40		
ST-1	Dark/Sturgeon River	04/21/79																											2.5		44						
D-2	Dark/Sturgeon River	09/27/55		38	7.4	0	0.4		74	28		36	810				1.5		5	6.9			11			0.2	2.1	7.5		76		20		4.3			
D-2	Dark/Sturgeon River	09/26/57		38	9.3	0	0.3		77.4	25	0.2	36	1500				1.8		5	6.5		1.1	11			0.2	2.1	12		86		70		3.1			
D-2	Dark/Sturgeon River	04/18/58		41	10	0	0.7		78	24	0.1	37	980				1.1		3	7.2		1.3	10	11		0.2	2.2	9.3		77		60		2.9	21		
D-2	Dark/Sturgeon River	10/02/58		34	8.6	0	0.5		70	28	0.2	34	950				1.5		6	6.2		0.4	8.9	12		0.2	2.1	7.3		83				3.1	0		
D-2	Dark/Sturgeon River	06/04/59		27	6.6	0	0.3		57	53	0.2	26	510				0.9		4	6.5		0.6	5.1	13		0.2	1.8	7.8		72				2.3	0		
D-2	Dark/Sturgeon River	09/05/59		26	6.9	0	0		55	95	0.2	28	830				2.4		7	6.7		0.6	8.3	11		0.1	1.6	8.5		104				2.6	0		
D-2	Dark/Sturgeon River	08/10/60		30	7.6	0	0		61	39	0.2	29	670			0.4	0.4		4	6.6		0.6	6			0.2	1.9	6.5		76				2.4	0		0
D-2	Dark/Sturgeon River	05/11/61		23	4.6	0	0		68	76	0.1	22	370				0.9		3	6.7		1.3	5.6			0.1	1.5	6.5		60		50	50	2.6	0		0
D-2	Dark/Sturgeon River	10/18/72		56	13	0	3.7	2.8	128	22	0.3	57	930					0.12	11	7.5	0.05	1.8	13	12		0.2	3.7	14	2			100		6	50		

Notes:
1. USGS Swater Quality Data downloaded from the following website: http://nwis.waterdata.usgs.gov/mn/nwis/sw

Table A-3. Historic Sulfate Data.

MWH on behalf of MPCA, taken from "Minntac Water Inventory Reduction EIS – Surface Water Hydrology and Quality Technical Memorandum" (2004), pages 168-170 of pdf.

Dark River Watershed				Sandy/Pike Rivers Watershed			
020		D2		030		701	
Date	Sulfate[1]	Date	Sulfate[1]	Date	Sulfate[1]	Date	Sulfate[1]
10/22/84	400	08/18/87	57	10/22/84	290	03/04/87	250
05/21/85	490	09/22/87	68	05/21/85	410	06/05/87	63
08/27/85	490	10/06/87	110	08/27/85	420	06/18/87	57
11/08/85	370	11/12/87	100	11/08/85	280	07/16/87	84
08/19/87	430	12/02/87	121	08/19/87	605	08/18/87	110
11/04/87	330	01/07/88	140	11/04/87	280	08/19/87	90
11/18/87	430	02/03/88	130	11/18/87	470	09/22/87	83
12/02/87	370	03/02/88	92	12/02/87	370	10/06/87	160
01/14/88	325	04/07/88	86	01/14/88	355	10/22/87	120
02/17/88	370	05/05/88	95	02/17/88	390	11/12/87	173
03/23/88	350	06/02/88	98	03/23/88	360	11/18/87	60
04/06/88	360	07/04/88	12	04/06/88	370	12/02/87	225
04/20/88	290	08/10/88	110	04/20/88	380	12/10/87	230
05/03/88	405	09/07/88	54	05/03/88	390	12/17/87	220
05/18/88	425	10/05/88	45	05/18/88	410	12/22/87	340
06/02/88	365	11/02/88	60	06/02/88	385	01/15/88	370
06/15/88	360	12/02/88	80	06/15/88	380	01/21/88	370
07/14/88	390	01/11/89	65	07/14/88	360	02/17/88	370
08/11/88	410	02/10/89	76	08/11/88	335	03/02/88	350
08/24/88	430	04/20/99	92.1	08/24/88	400	03/10/88	340
09/07/88	460	05/19/99	139	09/07/88	430	03/16/88	340
09/21/88	455	06/17/99	113	09/21/88	410	03/30/88	340
10/05/88	370	07/22/99	79	10/05/88	500	04/07/88	110
10/19/88	590	08/24/99	112	10/19/88	430	04/14/88	75
11/02/88	610	09/20/99	130	11/02/88	370	04/15/88	80
11/17/88	370	10/21/99	128	11/17/88	370	04/22/88	84
12/02/88	675	12/27/99	161	12/02/88	370	05/05/88	76
12/13/88	705	02/18/00	221	12/13/88	400	05/12/88	37
01/11/89	720	05/08/03	136	01/11/89	365	05/26/88	120
01/25/89	580	06/05/03	187	01/25/89	360	06/02/88	130
02/15/89	620	07/09/03	136	02/15/89	330	06/09/88	140
02/22/89	480	08/07/03	131	02/22/89	350	06/15/88	140
03/10/89	520	09/04/03	143	03/10/89	380	06/23/88	180
03/22/89	540	10/02/03	159	03/22/89	380	06/29/88	140
04/05/89	590	11/05/03	169	04/05/89	380	07/04/88	130
04/19/89	660	--	--	04/19/89	480	07/07/88	160
05/03/89	680	--	--	05/03/89	440	07/21/88	94
05/17/89	740	--	--	05/17/89	500	07/27/88	85
05/31/89	760	--	--	05/31/89	480	08/11/88	98
06/15/89	765	--	--	06/15/89	475	08/24/88	65
07/12/89	760	--	--	07/12/89	470	08/30/88	63
07/26/89	750	--	--	07/26/89	410	09/07/88	55
08/09/89	780	--	--	08/09/89	440	09/21/88	60
08/23/89	830	--	--	08/23/89	480	10/05/88	77
10/04/89	825	--	--	10/04/89	450	10/19/88	73
10/18/89	820	--	--	10/18/89	440	11/02/88	120
11/14/89	860	--	--	11/14/89	435	11/17/88	120
11/29/89	875	--	--	11/29/89	425	12/14/88	180
01/31/90	790	--	--	01/31/90	418	12/27/88	--
02/28/90	793	--	--	02/28/90	395	12/28/88	190
03/31/90	781	--	--	03/31/90	475	01/12/89	230
04/30/90	738	--	--	04/30/90	420	01/25/89	210
05/31/90	719	--	--	05/31/90	420	02/10/89	240
06/30/90	763	--	--	06/30/90	520	02/22/89	245
07/31/90	780	--	--	07/31/90	480	03/08/89	280

Dark River Watershed				Sandy/Pike Rivers Watershed			
020		D2		030		701	
Date	Sulfate[1]	Date	Sulfate[1]	Date	Sulfate[1]	Date	Sulfate[1]
08/31/90	811	--	--	08/31/90	468	03/22/89	255
09/30/90	880	--	--	09/30/90	435	04/06/89	175
10/31/90	884	--	--	10/31/90	--	04/19/89	74
12/31/90	735	--	--	12/31/90	415	05/03/89	75
01/31/91	784	--	--	01/31/91	407	05/17/89	95
02/28/91	801	--	--	02/28/91	415	05/31/89	79
03/31/91	788	--	--	03/31/91	410	06/15/89	75
04/30/91	681	--	--	04/30/91	417.5	06/28/89	95
05/31/91	729	--	--	05/31/91	444	07/12/89	98
06/30/91	808	--	--	06/30/91	435	07/26/89	123
07/31/91	775	--	--	07/31/91	435	08/09/89	145
08/31/91	895	--	--	08/31/91	465	08/23/89	175
09/30/91	925	--	--	09/30/91	485	09/06/89	110
10/31/91	725	--	--	10/31/91	460	09/20/89	168
12/31/91	775	--	--	12/31/91	450	10/04/89	155
01/31/92	550	--	--	01/31/92	465	10/18/89	155
02/29/92	812	--	--	02/29/92	450	11/14/89	127
03/31/92	950	--	--	03/31/92	440	11/29/89	305
04/30/92	725	--	--	04/30/92	450	04/19/99	113
05/31/92	730	--	--	05/31/92	450	05/19/99	129
06/30/92	725	--	--	06/30/92	460	06/17/99	187
07/31/92	725	--	--	07/31/92	420	07/22/99	58.6
08/31/92	--	--	--	08/31/92	712	08/24/99	78
09/30/92	712	--	--	09/30/92	440	09/20/99	122
10/31/92	662	--	--	10/31/92	410	10/21/99	163
11/30/92	662	--	--	11/30/92	640	12/27/99	550
12/31/92	550	--	--	12/31/92	440	02/18/00	713
01/31/93	650	--	--	01/31/93	440	05/08/03	172
02/28/93	650	--	--	02/28/93	430	06/05/03	227
03/31/93	600	--	--	03/31/93	420	07/09/03	247
04/30/93	660	--	--	04/30/93	150	08/07/03	31.9
05/31/93	650	--	--	05/31/93	440	09/04/03	259
06/30/93	675	--	--	06/30/93	455	10/02/03	210
07/31/93	590	--	--	07/31/93	420	11/05/03	304
08/31/93	670	--	--	08/31/93	490	--	--
09/30/93	825	--	--	09/30/93	540	--	--
10/31/93	750	--	--	10/31/93	535	--	--
11/30/93	800	--	--	11/30/93	520	--	--
12/31/93	685	--	--	12/31/93	470	--	--
03/31/94	640	--	--	03/31/94	530	--	--
04/30/94	650	--	--	04/30/94	505	--	--
05/31/94	650	--	--	05/31/94	530	--	--
06/30/94	760	--	--	06/30/94	512	--	--
07/31/94	580	--	--	07/31/94	552	--	--
08/31/94	633	--	--	08/31/94	546	--	--
09/30/94	780	--	--	09/30/94	580	--	--
10/31/94	697	--	--	10/31/94	593	--	--
11/30/94	676	--	--	11/30/94	523	--	--
12/31/94	820	--	--	12/31/94	578	--	--
01/31/95	700	--	--	01/31/95	562	--	--
02/28/95	785	--	--	02/28/95	570	--	--
03/31/95	725	--	--	03/31/95	590	--	--
04/30/95	725	--	--	04/30/95	545	--	--
08/31/95	749	--	--	08/31/95	542	--	--
09/30/95	772	--	--	09/30/95	545	--	--

Dark River Watershed				Sandy/Pike Rivers Watershed			
020		D2		030		701	
Date	Sulfate[1]	Date	Sulfate[1]	Date	Sulfate[1]	Date	Sulfate[1]
11/30/95	835	--	--	11/30/95	364	--	--
12/31/95	850	--	--	12/31/95	675	--	--
01/31/96	825	--	--	01/31/96	562	--	--
02/29/96	765	--	--	02/29/96	590	--	--
04/30/96	790	--	--	04/30/96	600	--	--
05/31/96	860	--	--	05/31/96	740	--	--
06/30/96	830	--	--	06/30/96	555	--	--
07/31/96	887	--	--	07/31/96	645	--	--
08/31/96	816	--	--	08/31/96	641	--	--
09/30/96	845	--	--	09/30/96	611	--	--
10/31/96	832	--	--	10/31/96	611	--	--
11/30/96	750	--	--	11/30/96	580	--	--
12/31/96	802	--	--	12/31/96	580	--	--
01/31/97	765	--	--	01/31/97	580	--	--
02/28/97	810	--	--	02/28/97	585	--	--
03/31/97	775	--	--	03/31/97	600	--	--
04/30/97	711	--	--	04/30/97	550	--	--
05/31/97	858	--	--	05/31/97	667	--	--
06/30/97	845	--	--	06/30/97	619	--	--
07/31/97	765	--	--	07/31/97	583	--	--
08/31/97	682	--	--	08/31/97	583	--	--
09/30/97	712	--	--	09/30/97	712	--	--
10/31/97	667	--	--	10/31/97	530	--	--
11/30/97	710	--	--	11/30/97	560	--	--
12/31/97	672	--	--	12/31/97	516	--	--
01/31/98	765	--	--	01/31/98	573	--	--
04/20/99	824	--	--	04/20/99	728	--	--
04/28/99	--	--	--	04/28/99	697	--	--
05/20/99	842	--	--	05/20/99	633	--	--
06/18/99	860	--	--	06/18/99	704	--	--
07/22/99	987	--	--	07/22/99	806	--	--
08/24/99	948	--	--	08/24/99	742	--	--
09/21/99	812	--	--	09/21/99	709	--	--
10/21/99	834	--	--	10/21/99	712	--	--
01/24/00	822	--	--	01/24/00	716	--	--
02/16/00	703	--	--	02/16/00	637	--	--
05/08/03	898	--	--	05/08/03	761	--	--
06/05/03	1050	--	--	06/05/03	885	--	--
07/09/03	999	--	--	07/09/03	877	--	--
08/07/03	983	--	--	08/07/03	876	--	--
09/04/03	900	--	--	09/04/03	824	--	--
10/02/03	898	--	--	10/02/03	772	--	--
11/05/03	995	--	--	11/05/03	796	--	--

Notes:

1. Total sulfate in mg/L

-- = not analyzed

Data duplicated from Table C.1

Table A-4. Water Quality and Field Measurement Results in Wetlands and SCRS Catch Basins from September 12-13, 2017 EPA Inspection.

Pollutant Parameters (units)	S08 (Sampled wetland at foot of berm) -Background Conditions[2]	S09 (Sampled wetland immediately outside of sheet pile at SCRS Catch Basin-12)	S10 (Sampled seepage collected in SCRS Catch Basin-12)	S11 (Sampled wetland immediately outside of sheet pile at SCRS Catch Basin-5)	S12 (Sampled seepage collected in SCRS Catch Basin-5, near inlet)	S13 (Sampled wetland immediately outside of north end of sheet pile at SCRS Catch Basin-5)	CB11 out (Field measurement at wetland location immediately outside of sheet pile at SCRS Catch Basin-11)	CB11 in (Field measurements of seepage collected in SCRS Catch Basin-11, immediately inside of sheet pile)	CB 12 in (Field measurements of seepage collected in SCRS Catch Basin-12, 20 feet southeast of inlet)
Specific Conductance (uS/cm)	134	2,163	2,509	2,399	2,316	2,348	877	2,518	2,387
pH (S.U.)	7.19	7.24	7.08	7.83	7.13	7.51	7.71	8.16	7.23
Dissolved Oxygen (mg/L)	7.11	No reading	3.64	12.53	1.47	6.62	9.64	7.79	7.54
Temperature (deg. C)	19.11	17.47	19.17	17.91	11.19	17.54	20.1	26.06	21.8
Hardness (mg/L)	60	1,210	1,330	1,290	1,260	1,250	---	---	---
Chloride (mg/L)	1.28	122	91.2	114	114	110	---	---	---
Sulfate as SO4 (mg/L)	3.61	702	720	773	780	781	---	---	---
TDS (mg/L)	104 J[1]	1,780 J[1]	1,970 J[1]	1,930	1,890	1,900	---	---	---

Notes:

1. See **Figure 32**, **Figure 33**, **Figure 34** for sampling locations
2. J – The identification of the analyte is acceptable; the reported value is an estimate.
3. U.S. Steel confirmed the S08 location as “background area” (See page 9 of Inspection Report)
4. Stations CB 11 and CB 12 monitored only for specific conductance, pH, dissolved oxygen, temperature.

Table A-5. Minntac Tailings Basin Seepage Estimates.
Taken from "Hydrological Investigation Report" performed by GHD on behalf of U.S. Steel (2021). Pages 97-100.

DARK RIVER - Station D-1

Sampling Date	D-1 Flow (gpm)	D-1 Chloride (mg/L)	West Side Seep Chloride (020) (ppm)	Seeps Pumped Back (gpm)	Calculated Basin Seep Flow - West (gpm)
01/24/14	1,827	81.3	115	0	1,271
05/23/14	9,923	21.4	134	0	1,292
06/20/14	10,794	17.4	141	0	1,012
07/18/14	4,107	44.4	134	0	1,261
08/18/14	5,000	43.8	132	0	1,542
09/11/14	1,867	58.3	127	0	818
10/17/14	4,811	55.5	113	0	2,265
11/17/14	1,921	80.1	113	0	1,338
12/08/14	2,096	91.0	118	0	1,595
01/12/15	1,530	98.9	116	0	1,290
02/06/15	2,789	98	119	0	2,272
03/09/15	707	96.7	118	0	576
04/03/15	6,329	53.9	127	0	2,545
05/08/15	4,755	72.8	145	0	2,319
06/05/15	7,098	46.6	138	0	2,236
07/10/15	2,321	72	140	0	1,158
08/07/15	2,430	98.4	133	0	1,771
09/04/15	6,646	83.3	135	0	4,024
10/07/15	3,504	85.4	127	0	2,306
11/06/15	7,363	63	126	0	3,532
02/05/16	4,245	79.2	120	0	2,733
03/04/16	3,633	70.7	117	0	2,131
04/08/16	9,884	5.2	115	0	56
05/05/16	7,458	31.4	114	0	1,826
06/03/16	5,684	37.4	106	0	1,838
07/01/16	6,136	27.5	106	0	1,386
08/01/16	2,765	41.7	103	0	1,040
09/09/16	8,135	37.6	118	0	2,372
10/07/16	4,904	46.7	112	0	1,932
11/04/16	3,403	52.8	116	0	1,476
12/02/16	13,670	28.1	114	0	2,937
01/06/17	5,710	57.2	113	0	2,760
02/10/17	5,015	63.2	116	0	2,648
03/03/17	7,380	38.8	114	0	2,304
04/07/17	10,561	16.5	113	0	1,167
05/05/17	14,854	16.9	111	0	1,723
06/02/17	5,980	31.4	99	0	1,695
07/07/17	3,733	28.7	103	0	915
08/04/17	2,459	59.8	103	0	1,379
09/01/17	4,862	34	103	0	1,453
10/06/17	11,245	23.7	104	0	2,153
11/03/17	5,589	44.3	104	0	2,223
12/08/17	5,023	53.3	110	0	2,326
01/19/18	3,010	65.9	105	0	1,835
02/13/18	2,790	75.3	105	0	1,962
03/09/18	3,817	72.9	126	0	2,150
04/06/18	4,438	66	113	0	2,513
05/04/18	11,155	22.1	110	0	1,861
06/01/18	9,412	34.7	103	0	2,895
07/06/18	13,447	21.6	95	0	2,528
08/08/18	2,087	58.1	104	0	1,120
09/07/18	2,932	70.8	104	0	1,947

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10/05/18	6,858	59.2	109	0	3,574
11/02/18	5,096	45.6	109	0	1,998
12/07/18	4,840	70.1	123	0	2,680
01/04/19	3,377	73.2	120	0	2,013
02/11/19	4,378	86.1	123	0	3,009
03/08/19	4,391	90.6	129	0	3,033
04/08/19	25,559	20.8	133	0	3,227
5/3/2019	11,579	27.8	134	0	2,073
6/7/2019	4,492	57.3	143	0	1,712
7/1/2019	7,126	59.3	143	0	2,819
8/5/2019	2,232	72	143	0	1,088
9/6/2019	1,240	78.5	126	0	755
11/12/2019	3,541	62.8	132	0	1,615
12/2/2019	4,598	60.8	132	0	2,025
01/03/20	4,667	65.2	130	0	2,265
02/10/20	2,944	77.4	129	0	1,718
03/06/20	3,889	74	134	0	2,087
04/03/20	22,917	16.2	138	0	2,003
05/01/20	5,565	40.2	138	0	1,491
06/05/20	1,067	47.7	122	1,500	1,892
06/19/20	2,297	31.5	122	1,500	2,027
07/10/20	4,424	18.6	122	1,500	2,028
07/27/20	2,885	9.6	122	1,500	1,624
08/07/20	640	48.4	122	1,500	1,739
08/21/20	2,174	25.7	122	1,500	1,891
09/04/20	3,134	41.5	122	1,500	2,486
09/18/20	1,356	51.3	122	1,500	2,040
10/02/20	1,984	46	122	1,500	2,200
11/10/20	8,684	35.1	122	1,500	3,757
12/04/20	2,082	44.4	122	1,500	2,206
01/08/21	1,661	53.4	122	1,500	2,191
02/12/21	1,029	59.9	122	1,500	1,985
02/16/21	730	67.5	122	1,500	1,891
02/19/21	736	69.3	122	1,500	1,906
03/05/21	1,579	70.3	122	1,500	2,384
04/06/21	5,399	22.2	122	1,500	2,310
05/26/21	2,738	33.1	122	1,500	2,165
06/04/21	2,021	42	122	1,500	2,144
07/02/21	744	52.4	122	1,500	1,803
08/06/21	447	68.3	122	1,500	1,743
				average estimated flow to west =	1,992

Outfall 020 (aka SD001) has been eliminated after westside SCRS operations began. Therefore, an average of Outfall 020 chloride concentrations from 2012-2020 is used after 5/28/2020.

SAND RIVER - Station 701

Sampling Date	701 Flow (gpm)	701 Chloride (mg/L)	Basin Return Water Chloride (ppm)	Seeps Pumped Back (gpm)	Calculated Basin Seep Flow - East (gpm)
08/06/14	3,451	19.3	176	769	916
09/03/14	247	26.9	176	764	786
11/05/14	4,694	30	176	766	1,272
04/01/15	1,364	42.2	176	657	905
05/06/15	4,605	41.6	144	693	1,720
06/03/15	9,748	31	145	723	2,100
07/01/15	9,084	25.3	148	710	1,580
08/05/15	1,979	26.8	148	698	909
09/09/15	6,710	31.4	141	745	1,741
10/02/15	6,219	35.6	141	742	1,868
11/06/15	8,976	44.1	140	714	2,955
12/04/15	9,318	39.9	139	723	2,749
01/08/16	6,779	42.9	135	572	2,270
03/04/16	4,138	62.2	144	484	2,054
04/08/16	18,087	24.4	144	388	2,053
05/04/16	12,091	20.4	125	640	1,512
06/03/16	9,039	23.1	139	737	1,510
07/01/16	12,706	25.5	123	752	2,268
08/01/16	8,025	19.1	123	588	1,080
09/09/16	12,068	19.9	128	479	1,271
10/07/16	10,596	32.5	125	837	2,745
11/04/16	6,265	35.9	125	971	2,279
12/02/16	15,331	39.2	131	907	4,391
01/06/17	5,619	44.5	135	575	2,055
02/10/17	4,084	57.2	136	468	1,949
03/03/17	11,117	40.3	136	533	3,048
04/07/17	26,560	20.4	136	524	2,263
05/05/17	25,142	22.2	120	530	2,840
06/02/17	8,945	19.4	124	1,167	1,736
07/07/17	6,391	24	126	1,162	1,822
08/04/17	1,750	65.8	122	1,214	2,068
09/01/17	7,652	29	128	1,278	2,380
10/06/17	30,272	29.5	128	1,301	5,791
11/03/17	9,541	30.6	139	1,302	2,679
12/08/17	6,123	42.1	138	1,279	2,735
01/19/18	2,851	58.2	138	1,272	2,310
02/13/18	2,327	68.8	138	1,253	2,296
03/09/18	3,694	73.1	171	1,246	2,659
04/06/18	7,818	71.8	155	1,257	4,529
05/04/18	27,346	25.1	154	1,242	3,722
06/01/18	13,401	29.9	154	1,224	2,895
07/06/18	24,765	26	136	1,224	3,963
08/03/18	4,035	24.5	136	1,215	1,613
09/07/18	1,696	28.8	141	1,225	1,442
10/05/18	6,912	32.9	145	1,253	2,331
11/02/18	8,693	32.2	143	1,245	2,568
12/07/18	5,957	43.3	144	1,122	2,526
01/04/19	4,118	55.7	146	1,120	2,454
02/11/19	3,151	75.5	150	1,086	2,535
03/08/19	4,253	72.6	165	1,042	2,722
04/08/19	22,279	25.1	155	1,063	3,063
05/03/19	19,577	22.4	120	1,062	2,898
06/07/19	7,598	28.8	131	964	2,017

07/01/19	4,536	33.6	131	999	1,810
08/05/19	1,494	46.7	134	1,134	1,558
09/06/19	1,065	42.4	144	1,134	1,377
10/08/19	17,577	32	142	1,134	3,811
11/12/19	4,758	35.2	141	1,134	1,978
12/11/19	4,377	34.9	142	1,134	1,896
1/3/2020	5,693	41.9	143	1,134	2,423
2/10/2020	2,373	47.9	143	1,134	1,781
3/6/2020	3,309	53.1	151	1,134	2,109
4/3/2020	25,757	38.5	149	1,134	6,081
5/1/2020	9,642	26.7	149	1,134	2,152
6/5/2020	4,497	26.3	136	1,134	1,644
7/10/2020	415	16.1	138	1,134	1,147
8/7/2020	412	31.3	142	1,134	1,195
9/4/2020	2,701	33.1	142	1,134	1,568
10/2/2020	1,095	34	141	1,134	1,319
11/17/2020	7,942	35.5	148	1,134	2,488
12/4/2020	1,958	47.3	154	1,134	1,617
1/8/2021	1,391	52.3	148	1,134	1,545
2/16/2021	1,179	65.1	149	1,134	1,589
2/19/2021	966	71.5	149	1,134	1,552
3/5/2021	1,337	67.4	153	1,134	1,660
4/6/2021	11,028	30.6	153	1,134	2,573
5/7/2021	4,254	25.2	142	1,134	1,556
6/4/2021	3,715	29	135	1,134	1,639
7/29/2021	1,132	40.1	133	1,134	1,394
8/25/2021	520	46.9	140	1,134	1,275
				average estimated flow to east =	2,195

Dark River background chloride removed from downstream concentration (mg/L) =	4.6
Sand River background chloride removed from downstream concentration (mg/L) =	12.3
Total estimated tailings basin seep flow reporting downstream (gpm) =	4,187
Estimated seep flow not reporting at D-1/701 (gpm) =	0
Total Estimated Tailings Basin Seep Flow Rate (gpm) =	**4,187**

Table A-6. Summary of Estimated Hydraulic Conductivity Values and Soil Descriptions of Slug and Pumping Tests in the Minntac Tailings Basin.
Taken from "Groundwater Flow and Sulfate Transport Modeling Report" by CRA on behalf of U.S. Steel. See page 80 of pdf.

Well ID	Hydraulic Conductivity [1]			Soil Descriptions
	(ft/min)	(ft/day)	(cm/s)	
Slug Tests (by CRA)				
PZ-4S	1.02E-02	14.67	5.17E-03	Medium to coarse grained sand (SP/SM)
PZ-4D	1.13E-02	16.34	5.76E-03	Fine to coarse grained sand (SP/SM)
PZ-5S	3.28E-03	4.72	1.66E-03	Fine to coarse grained sand (SP)
PZ-5D	7.52E-04	1.08	3.82E-04	Fine to coarse grained sand (SP) with some silt
PZ-6S	1.84E-04	0.27	9.37E-05	Fine to coarse grained sand (SP/SM)
PZ-6D	1.68E-02	24.17	8.53E-03	Medium grained sand (SP) with silt and gravel
PZ-7S	1.15E-03	1.66	5.85E-04	Fine grained sand (SM)
PZ-7D	3.16E-02	45.48	1.60E-02	Medium to coarse grained sand (SW)
MW-12S	1.28E-03	1.85	2.14E-03	Interbedded peat and fine sand
MW-12I	1.09E-03	1.58	1.82E-03	Medium grained sand (SP) with trace fine gravel/clay
MW-12D	1.78E-03	2.56	2.97E-03	Medium grained sand (SP) with trace fine gravel/clay
Slug Tests (by STS)				
B-B-2/P-B-2	1.68E-04	0.24	8.53E-05	Granite Bedrock
OW-A-1	3.12E-04	0.45	1.58E-04	Coarse Tails (SP)
OW-A-2	7.80E-05	0.11	3.96E-05	Fine Tails (ML to CL)
P-A-2A	4.86E-05	0.07	2.47E-05	Till - Fine to medium sand (SP)
OW-A-3	2.04E-03	2.94	1.04E-03	Coarse Tails (SP)
OW-A-4	8.40E-04	1.21	4.27E-04	Coarse Tails (SP)
OW-B-1	3.48E-03	5.01	1.77E-03	Coarse Tails (SP)
OW-B-2	7.20E-05	0.10	3.66E-05	Fine Tails (ML to CL)
P-B-2A	9.00E-04	1.30	4.57E-04	Till- Silty fine to coarse sand, trace clay, some gravel
OW-B-3	1.68E-03	2.42	8.53E-04	Coarse Tails (SP)
OW-C-2	8.40E-04	1.21	4.27E-04	Coarse Tails (SP)
MW-1	2.94E-03	4.23	1.49E-03	Till-Fine to coarse sand (SP)
MW-2	3.90E-03	5.62	1.98E-03	Till-Fine to medium sand (SP)
MW-3	2.76E-03	3.97	1.40E-03	Till-fibrous peat and fine to medium sand (Pt and SP)
Pumping Tests (by CRA)				
MW-12S	2.53E-03	3.65	1.29E-03	Interbedded peat and fine sand
MW-12I	6.70E-04	0.96	3.40E-04	Medium grained sand (SP) with trace fine gravel/clay
MW-12D	1.36E-03	1.96	6.92E-04	Medium grained sand (SP) with trace fine gravel/clay
PZ-6S	2.20E-02	31.68	1.12E-02	Fine to coarse grained sand (SP/SM)
PZ-6D	1.62E-02	23.35	8.24E-03	Medium grained sand (SP) with silt and gravel

Note:

(1) The hydraulic conductivity values presented are the geometric means of the values estimated for individual wells.

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EXHIBIT 33

Discharge Monitoring Reports, Bulk Exports for Keetac Permit MN0031879,
Mercury in scrubber blowdown after treatment, 2018-2024.

MPCA Online Discharge Monitoring Reports (Bulk Export of Data from 2018-2024)

U.S. Steel Corp - Keetac Permit MN0031879

Mercury in Waste Stream

Facility	Preferred Id	Permit Action	Station	Station Description	Avg Wet Weather Flow Rate	Year of Mon End Date	Month of Mon End Date	Mon End Date	Parameter	Limit	Rpt Value	Units	Limit Type	No Discharge Flag
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2018	March	03/31/2018	Mercury, Total (as Hg)		1910	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2018	June	06/30/2018	Mercury, Total (as Hg)		4190	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2018	September	09/30/2018	Mercury, Total (as Hg)		393	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2018	December	12/31/2018	Mercury, Total (as Hg)		1480	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2019	March	03/31/2019	Mercury, Total (as Hg)		241	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2019	June	06/30/2019	Mercury, Total (as Hg)		411	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2019	September	09/30/2019	Mercury, Total (as Hg)		580	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2019	December	12/31/2019	Mercury, Total (as Hg)		408	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2020	March	03/31/2020	Mercury, Total (as Hg)		347	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2020	June	06/30/2020	Mercury, Total (as Hg)			ng/L	SingleVal	Y
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2020	September	09/30/2020	Mercury, Total (as Hg)			ng/L	SingleVal	Y
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2020	December	12/31/2020	Mercury, Total (as Hg)		583	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2021	March	03/31/2021	Mercury, Total (as Hg)		634	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2021	June	06/30/2021	Mercury, Total (as Hg)		4980	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2021	September	09/30/2021	Mercury, Total (as Hg)		343	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2021	December	12/31/2021	Mercury, Total (as Hg)		400	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2022	March	03/31/2022	Mercury, Total (as Hg)		558	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2022	June	06/30/2022	Mercury, Total (as Hg)		739	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2022	September	09/30/2022	Mercury, Total (as Hg)		290	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2022	December	12/31/2022	Mercury, Total (as Hg)		144	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2023	March	03/31/2023	Mercury, Total (as Hg)		38.5	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2023	June	06/30/2023	Mercury, Total (as Hg)		66	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2023	September	09/30/2023	Mercury, Total (as Hg)		138	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2023	December	12/31/2023	Mercury, Total (as Hg)		118	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2024	March	03/31/2024	Mercury, Total (as Hg)		76	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2024	June	06/30/2024	Mercury, Total (as Hg)		199	ng/L	SingleVal	N
United State	MN0031879	IND2012000	WS 012	Scrubber blowdown after treatment		2024	September	09/30/2024	Mercury, Total (as Hg)		996	ng/L	SingleVal	N
											810.5	AVERAGE		

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 34

Myrbo A, Swain EB, Johnson NW, Engstrom DR, Pastor J, Dewey B, Monson P, Brenner J, Dykhuizen Shore M, Peters EB (2017) Increase in nutrients, mercury, and methylmercury as a consequence of elevated sulfate reduction to sulfide in experimental wetland mesocosms. *J. Geophysical Research: Biogeosciences* 10.1002: 2769-85.

AGU PUBLICATIONS

JGR

Journal of Geophysical Research: Biogeosciences

RESEARCH ARTICLE
10.1002/2017JG003788

This article is a companion to Myrbo et al. (2017), https://doi.org/10.10022017JG003787 and Pollman et al. (2017), https://doi.org/10.10022017JG003785.

Key Points:
- Sulfate addition increased organic matter mineralization in wetland sediment, releasing C, N, P, and Hg to the water column
- Sulfate reduction caused not only higher methylmercury concentrations but higher total mercury concentrations in the surface water
- Increased sulfate loading to freshwaters can cause deleterious effects separate from direct sulfide toxicity to organisms

Supporting Information:
- Supporting Information S1
- Figure S1
- Data Set S1

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Increase in Nutrients, Mercury, and Methylmercury as a Consequence of Elevated Sulfate Reduction to Sulfide in Experimental Wetland Mesocosms

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Abstract Microbial sulfate reduction (MSR) in both freshwater and marine ecosystems is a pathway for the decomposition of sedimentary organic matter (OM) after oxygen has been consumed. In experimental freshwater wetland mesocosms, sulfate additions allowed MSR to mineralize OM that would not otherwise have been decomposed. The mineralization of OM by MSR increased surface water concentrations of ecologically important constituents of OM: dissolved inorganic carbon, dissolved organic carbon, phosphorus, nitrogen, total mercury, and methylmercury. Increases in surface water concentrations, except for methylmercury, were in proportion to cumulative sulfate reduction, which was estimated by sulfate loss from the surface water into the sediments. Stoichiometric analysis shows that the increases were less than would be predicted from ratios with carbon in sediment, indicating that there are processes that limit P, N, and Hg mobilization to, or retention in, surface water. The highest sulfate treatment produced high levels of sulfide that retarded the methylation of mercury but simultaneously mobilized sedimentary inorganic mercury into surface water. As a result, the proportion of mercury in the surface water as methylmercury peaked at intermediate pore water sulfide concentrations. The mesocosms have a relatively high ratio of wall and sediment surfaces to the volume of overlying water, perhaps enhancing the removal of nutrients and mercury to periphyton. The presence of wild rice decreased sediment sulfide concentrations by 30%, which was most likely a result of oxygen release from the wild rice roots. An additional consequence of the enhanced MSR was that sulfate additions produced phytotoxic levels of sulfide in sediment pore water.

Plain Language Summary In the water-saturated soils of wetlands, which are usually anoxic, decomposition of dead plants and other organic matter is greatly retarded by the absence of oxygen. However, the addition of sulfate can allow bacteria that respire sulfate, instead of oxygen, to decompose organic matter that would not otherwise decay. The accelerated decay has multiple consequences that are concerning. The bacteria that respire sulfate "breathe out" hydrogen sulfide (also called sulfide), analogous to the conversion or respiration of oxygen to CO_2. Sulfide is very reactive with metals, which makes it toxic at higher concentrations. In addition to the release of sulfide, the sulfate-accelerated decomposition of plants releases phosphorus and nitrogen, fertilizing the waterbody. Decomposition also mobilizes mercury (which is everywhere, thanks to atmospheric transport) into the surface water. The microbes that convert sulfate to sulfide also methylate mercury, producing methylmercury, the only form of mercury that contaminates fish. This study demonstrates that adding sulfate to a wetland can not only produce toxic levels of sulfide but also increase the surface water concentrations of nitrogen, phosphorus, mercury, and methylmercury.

1. Introduction

Organic matter (OM) accumulates in the sediments of aquatic systems when sediment concentrations of terminal electron acceptors (TEAs) are too low for microbes to completely decompose OM, especially when the supply of the most energy-efficient TEA, oxygen, is low. In water-saturated, organic-rich sediment, microbial sulfate reduction (MSR) can be a dominant pathway for the respiration of OM because oxygen is depleted in the uppermost sediment (Boye et al., 2017). Dissolved sulfate (SO_4) concentrations in continental surface

waters are often low (less than 50 mgL^{-1} or 0.5 mmol L^{-1}) (e.g., Gorham et al., 1983) compared to ocean concentrations (2,800 mg L^{-1} or 29 mmol L^{-1}). Because of lower SO_4 concentrations, and because MSR rates can be limited by SO_4 concentrations (Holmer & Storkholm, 2001), the biogeochemical significance of MSR is often considered minimal in freshwater and low-salinity systems (e.g., Capone & Kiene, 1988; Nielsen et al., 2003; Stagg et al., 2017). However, absolute rates of MSR are not clearly lower in freshwater systems than in marine systems (Pallud & Van Cappellen, 2006), and in some cases, rapid cycling between oxidized and reduced forms of S can occur (Hansel et al., 2015).

In this study, we investigated the cascade of biogeochemical effects associated with increased MSR that result from increased surface water SO_4. We simultaneously quantified three different categories of biogeochemical responses related to MSR: (1) mineralization of organic matter and associated release of dissolved C, N, P, and Hg; (2) methylation of Hg; and (3) production of sulfide.

The stoichiometric release of the constituents of OM during MSR, notably C, N, and P, is a phenomenon long recognized by marine scientists. For instance, Boudreau and Westrich (1984) constructed a model of the MSR-mediated decomposition of marine sediment. They showed that SO_4 is reduced to sulfide (H_2S) in stoichiometric proportion to the mineralization of C, N, and P according to the reaction

$$2(CH_2O)_x(NH_3)_y(H_3PO_4)_z + xSO_4^{2-} \rightarrow 2xHCO_3^- + xH_2S + 2yNH_3 + 2zH_3PO_4 \quad (1)$$

C is released as both dissolved inorganic carbon (DIC, from complete oxidation, produced as bicarbonate alkalinity in stoichiometric proportion to sulfide (reaction (1); Boudreau & Westrich, 1984)) and dissolved organic carbon (DOC, from partial oxidation). The nutrients N and P are released in forms that are readily taken up by plants; N is released as ammonia, and P as phosphate. The mineralization of sediment organic matter associated with MSR releases sulfide (S^{2-}) into sediment pore water, which speciates, depending on the pH, into hydrogen sulfide (H_2S) and bisulfide (HS^-), henceforth collectively termed sulfide. If reduced S compounds accumulate in the sediment, there may be additional consequences to an aquatic system, such as toxic concentrations of sulfide in pore water (Lamers et al., 2013; Pastor et al., 2017; Myrbo et al., 2017) or conversion of sediment Fe(III) to FeS compounds, which enhances the mobilization of P (Curtis, 1989; Maynard et al., 2011).

The multiple biogeochemical consequences of MSR in freshwater systems have been investigated and documented in more than two dozen publications (Table S1 in the supporting information), which typically address a single issue, such as the production of alkalinity that neutralizes atmospherically deposited H_2SO_4 (Baker et al., 1986; Cook et al., 1986; and others) or the methylation of Hg (Gilmour et al., 1992; Branfireun et al., 1999, 2001; and others). Experimental studies addressing SO_4 reduction, sulfide production, associated OM mineralization, and release of nutrients have been broader (Lamers et al., 2001, 2002; Weston et al., 2006, 2011; and others), but aside from the results reported in this paper, only the experiments of Gilmour, Krabbenhoft, et al. (2007) and Gilmour, Orem, et al. (2007) have investigated all three categories of biogeochemical consequences of SO_4 reduction: OM mineralization, Hg methylation, and sulfide accumulation (Table S1). We also investigated the potential for Hg to be released by mineralization, a phenomenon proposed by Regnell and Hammar (2004).

Sulfate-driven enhanced mineralization of sediment OM and release of dissolved sulfide, N, P, DOC, DIC, and associated increases in alkalinity and pH have the potential to change the nature of an aquatic ecosystem. The immediate release is to the sediment pore water, but these dissolved materials can diffuse into the surface water. Increased internal loading of N and P can drive a system toward eutrophy, which can increase carbon fixation and amplify the cascade of biogeochemical effects associated with increased MSR. Increases in DOC also have the potential to fundamentally change the nature of a waterbody. DOC influences many processes in freshwater ecosystems, including light availability for macrophyte growth, thermal stratification, and bioavailability of metals, P, and C. In addition, DOC interferes with drinking water purification (Williamson et al., 1999). Increases in DIC, alkalinity, and pH can also change the nature of a system. Aquatic macrophyte and algal species often have different optimal alkalinity concentrations (e.g., Moyle, 1945; Vestergaard & Sand-Jensen, 2000), so increases in alkalinity may change aquatic community composition. Because pH is a master variable in aquatic systems (Stumm & Morgan, 2012), increases in pH can cause changes in both aquatic chemistry and the biota that dominate a system, as best documented by changes in diatom assemblages (Patrick et al., 1968).

The release of sulfide into sediment pore water has multiple biological and geochemical consequences, several of which are related to the reactivity of sulfide with metals. If dissolved sulfide accumulates in pore water, it can negatively affect multicellular organisms inhabiting the sediment because sulfide can denature a range of metal-containing biomolecules, including cytochrome C oxidase, which is essential for respiration by both animals and plants (Bagarinao, 1992). Because aquatic sediment is a primary site of sulfide production, plants that root in sediment are vulnerable to toxic sulfide concentrations (Lamers et al., 2013; Pastor et al., 2017). However, if the watershed supplies sufficiently high loading of reactive Fe or other metals to the sediment, pore water sulfide concentrations may stay below toxic levels even while MSR proceeds as an important mineralization process (Pollman et al., 2017). The formation of FeS compounds effectively detoxifies sulfide (e.g., Marbà et al., 2007; Van der Welle et al., 2007). When Fe availability exceeds the production of sulfide, the accumulation of FeS is a measure of cumulative SO_4 reduction, which can be quantified as acid-volatile sulfide (AVS) (Heijs & van Gemerden, 2000). In addition, phosphorus is mobilized when oxidized Fe compounds with significant capacity to bind phosphate are converted to FeS compounds, which are incapable of binding phosphate (Lamers et al., 1998; Maynard et al., 2011). Thus, MSR mobilizes P both by mineralization of P-containing OM and by changing the form of Fe in sediment.

In addition to releasing C, N, and P, producing potentially toxic concentrations of sulfide, and reducing the solubility of metals, MSR is a primary process leading to the formation of MeHg, the bioaccumulative form of Hg (Gilmour et al., 1992; Hsu-Kim et al., 2013), although other microbial groups can also methylate Hg (Podar et al., 2015). In some cases, MSR can lead to toxic levels of MeHg higher in the food chain. The relationship between SO_4 concentrations and MeHg production is complex, however, and both field and laboratory studies in freshwater and saline ecosystems suggest that there is a dual effect of S on Hg methylation. At low SO_4 concentrations, the addition of SO_4 can stimulate MSR and Hg methylation (Jeremiason et al., 2006). At higher SO_4 concentrations, a greater abundance of inorganic sulfide appears to decrease the availability of inorganic Hg for Hg methylation (Hsu-Kim et al., 2013; Johnson et al., 2016). Because it has been observed that low SO_4 additions often increase Hg methylation and higher SO_4 concentrations decrease methylation, it has been proposed that there is a range of SO_4 and sulfide concentrations are optimal for Hg methylation, above which methylation is inhibited (Hsu-Kim et al., 2013). There is some debate regarding the underlying mechanism, but there is substantial evidence suggesting that dissolved inorganic sulfide above concentrations of 300–3,000 $\mu g\ L^{-1}$ has an inhibitory effect on Hg methylation (Bailey et al., 2017).

This study presents results from 30 wetland mesocosms in which the surface waters were treated to maintain a wide range of SO_4 concentrations over the course of 5 years (2011–2015) to assess the impact on wild rice, *Zizania palustris* (Pastor et al., 2017). We took advantage of this experiment to analyze the geochemical conditions in surface and pore water in the mesocosms during late summer 2013, 3 years into the experiment. Pastor et al. (2017) specifically examined the effect of increased SO_4 loading on wild rice, whereas this paper examines the broader biogeochemical impact of augmenting SO_4 to a low-SO_4 system.

2. Materials and Methods

2.1. Experimental Design

The experimental setup (Figure S1 in the supporting information), described in detail by Pastor et al. (2017), consisted of thirty 375 L polyethylene stock tanks containing sediment from a wild rice lake (Rice Portage Lake; +46.6987°, −92.6886°) in which wild rice was grown in self-perpetuating populations at five SO_4 treatment levels (control, 50, 100, 150, and 300 $mg\ L^{-1}$). SO_4 concentrations in six replicate mesocosms were routinely monitored, and amendments of SO_4 were added as Na_2SO_4 during the growing season as SO_4 was removed by MSR (Figure 1). Due to MSR, the mesocosm surface waters actually had time-weighted average concentrations of 7, 27, 59, 93, and 207 $mg\ L^{-1}$, respectively. Local well water containing an average of 10.6 $mg\ L^{-1}$ SO_4 was added as needed to compensate for evapotranspiration. Precipitation in the region contains an average of 2.1 $mg\ L^{-1}$ SO_4, and Rice Portage Lake has an average SO_4 concentration of 2.2 $mg\ L^{-1}$ (Fond du Lac Band, 2016), so the control was slightly elevated above the ambient SO_4 concentration of the sediment source for the experiment. During the ice-free period (generally May through October), the surface water temperature (T) measured in the morning was correlated with the previous day's mean air temperature (mesocosm T = 0.72 air T + 4.4 °C; R^2 = 0.65). Peak air temperature is reached in July, when the average

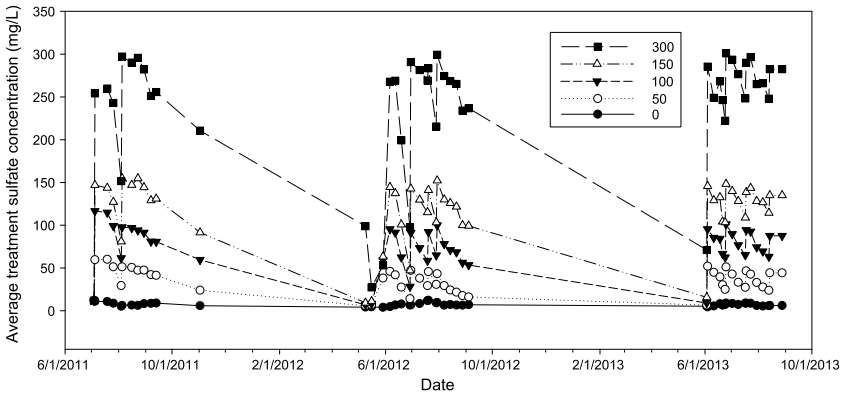


Figure 1. SO_4 concentrations in surface waters of each treatment, showing repetitive depletion and periodic amendment with Na_2SO_4 (average of six mesocosms per treatment on each sampling date).

temperature is 18.8°C (based on 1981–2010 air temperatures measured at the Duluth, Minnesota, airport, 10 km from the experimental site).

The experiments had been in progress for three growing seasons at the time of the sampling for this study, 27 and 28 August 2013, and for five growing seasons at the time of the second, less intensive, sampling (August 2015). The sediment of each mesocosm was divided into two parts for the 2013 growing season by a clear acrylic plate and all wild rice plants removed from one side in order to evaluate the effects of plant root presence on the geochemistry of the sediments. The plate was situated near one end of each mesocosm, such that about 10% of the surface area of 0.6 m^2 was plant-free (Figure S1). The plate was positioned to segregate the sediment without impeding the circulation of the surface water above all of the sediment. Sediment chemistry results presented here are from the side with wild rice plants present, except when analyzing the difference in AVS between the two sides.

2.2. Methods

2.2.1. Sample Collection

Rhizon™ samplers with a 10 cm long, 2.5 mm diameter, cylindrical porous tip (hydrophilic membrane pore size 0.12–0.18 μm (Rhizosphere.com, Netherlands; Shotbolt, 2010)), were connected by Teflon-taped Luer-Lok connectors and silicone tubing to a syringe needle. The sampler was inserted into the sediment, and the needle was then inserted through the 20 mm thick butyl rubber septum of an evacuated serum bottle (Bellco Glass) to initiate pore water draw through the tubing and displace air. After water was observed entering the serum bottle, the needle was removed from the first sacrificial bottle and inserted through the septum of a second evacuated serum bottle to collect the sample. One Rhizon and bottle were used to collect a sample for dissolved iron, preserved with 20% nitric acid. A second Rhizon and evacuated, N_2 gas-flushed sealed bottle, preloaded with 0.2 mL 2 N zinc acetate, 0.5 mL 15 M NaOH, and a stir bar, was used to collect a sample for dissolved sulfide analysis. Each Rhizon was positioned to sample pore water from the top 10 cm of sediment and to avoid collecting water from above the sediment surface. However, it is conceivable that some surface water was able to follow the path of the Rhizon into the sediment and dilute or partially oxidize the pore water sample.

Surface water in each mesocosm was collected for analysis of nitrate + nitrite, TP, TN, DOC, pH, temperature, and alkalinity from 5 cm below the surface of the water. Surface water samples for analysis of total Hg (THg) and MeHg were collected using clean hands/dirty hands protocols in September 2013, filtered through 0.45 μm glass fiber filters, and immediately acidified with 0.5% (by volume) trace metal hydrochloric acid. Samples were stored on ice during transport and at 4°C until analysis.

Pore water P availability was measured with three mixed bed ion exchange bags (Fisher Rexyn 300 resin) placed in the sediment of each tank in spring and harvested at the end of the growing season in 2013. A 3.8 cm diameter piston corer was used to obtain 10 cm long sediment samples for various analyses. Sediment samples for the analysis of AVS were taken monthly from June to October 2013 from replicate mesocosms of four SO_4 treatments (control, 50 150, and 300 mg L^{-1}; no mesocosm was sampled more

than once). Sediment samples were also taken on 8 October 2013 for the analysis of THg in bulk sediment and on 6 October 2015 for the analysis of total organic carbon (TOC).

2.2.2. Laboratory Analyses

Surface water and pore water analyses were conducted by the Minnesota Department of Health Environmental Laboratory (MDHEL). Total P was measured by in-line ultraviolet/persulfate digestion and flow injection (APHA, 2005, 4500 P-I), DOC by persulfate-ultraviolet oxidation and IR CO_2 detection (APHA, 2005, 5310-C), and alkalinity by automated titration (APHA, 2005, 2320-B). Pore water sulfide samples were prepared for inline distillation and flow injection colorimetric analysis using procedures that avoided exposure to oxygen. The sulfide serum bottle was weighed to determine the amount of sample collected and to adjust for the slight dilution factor of an alkaline antioxidant that was added by injection through the stoppers. The sealed samples were then placed on a stir plate for at least 1 h and subsamples withdrawn for analysis through a needle. Reanalysis of sealed, processed samples 12 months later shows no significant difference in sulfide concentrations, indicating that the sulfide samples were stable prior to analysis (data not shown). SO_4 concentration was measured using a Lachat QuikChem 8000 Autoanalyzer (Lachat Method 10-116-10-1-A). The resin was eluted using a KCl solution and analyzed for PO_4 using a Lachat Autoanalyzer, following the methods of Walker et al. (2006).

An aliquot of the nitrate + nitrite/TP/TN/DOC serum bottle was filtered in the lab within 10 days of sampling using a 0.45 μm filter, preserved to a pH $<$ 2 with 10% sulfuric acid, and transferred to a 250 mL polyethylene bottle for DOC analysis. The remaining sample was preserved to a pH $<$ 2, with 10% sulfuric acid and transferred to 250 mL polyethylene bottle for nitrate + nitrite/TP/TN analysis. The contents of the metal serum bottle were transferred to a 250 mL polyethylene bottle and preserved to a pH $<$ 2 with 10% nitric acid. Analyses were conducted within 30 days of sampling.

THg in surface water and bulk sediment were analyzed with EPA method 1631 by MDHEL, and surface water MeHg was analyzed with EPA method 1630 by Frontier Global Sciences (Bothell, Washington). Inorganic Hg (iHg) was calculated as the difference between THg and MeHg. Sediment AVS was analyzed colorimetrically, as above for pore water sulfide, following acid distillation and in-line alkaline trapping (APHA, 2005; SM 4500-S2). Sediment TOC was analyzed following SM5310C (APHA, 2005), using an OI Analytical Aurora 1030 at Pace Analytical Services, Virginia, Minnesota.

3. Data Analysis

3.1. Sulfate Depletion as the Independent Variable

Because SO_4 is relatively unreactive under oxidized conditions, its loss is attributable to diffusion or transpiration-driven advection (Bachand et al., 2014) into sediment and conversion to sulfide by bacteria. Surface water SO_4 concentrations decreased partly due to dilution by precipitation but largely from loss after movement into the sediment and reduction to sulfide. Sulfide would largely be retained in the sediment as FeS compounds, although some could be lost to the atmosphere as H_2S gas (Bagarinao, 1992) or as volatile organic sulfur compounds (Lomans et al., 2002). The cumulative SO_4 lost from surface water was calculated from a mass balance for each mesocosm from the inception of the experiment in spring 2011 through fall 2013; this quantity, termed here SO_4 depletion, $(SO_4)_{Depl}$, is used as a proxy for net MSR, following Weston et al. (2006). The surface water remained frozen from approximately 1 December to 1 April each winter, and the mesocosms were covered with plastic from November to late April each year and not amended with SO_4. SO_4 reduction was the major biogeochemical process altered by the experimental treatments, and therefore, $(SO_4)_{Depl}$ is the independent variable used in subsequent data analyses. It was only possible to perform a complete mass balance for SO_4, the only parameter consistently quantified in source water, precipitation, and overflow water.

3.2. Calculation of DIC From Measured Alkalinity

Dissolved inorganic carbon (DIC ≡ $[CO_3^{2-}]$ + $[HCO_3^-]$ + $[CO_2^*]$, where $[CO_2^*] = [CO_{2(g)}] + [H_2CO_3]$) was calculated from measured alkalinity and speciated using pH, temperature, and specific conductance of the surface water. At the pH range of the mesocosms (7.60–8.84), 95–98% of DIC is in the form of HCO_3^-, so DIC concentration on a molar basis is nearly the same as alkalinity (ALK) on an equivalent basis (DIC = 0.988 ALK + 0.077, R^2 = 0.995). In studies of freshwater, most inorganic carbon data are presented in terms of alkalinity because

alkalinity is a familiar metric; however, in comparisons with DOC, inorganic carbon data are presented as DIC so that the units are directly comparable. PHREEQC version 3 geochemical modeling software (Parkhurst & Appelo, 2013) was used to calculate saturation indices for carbonate minerals.

3.3. Statistical Analysis

Statistical analysis was conducted with R version 3.2.3 and STATA (StataCorp, 2015). The effect of increased sulfate availability was assessed through both categorical analysis of the sulfate treatments (Kruskal-Wallis ANOVA test, followed by Dunn's test for multiple comparisons with Holm-Sidak corrections) and through linear regression and nonparametric Spearman rank correlations. We rely primarily on regressions against SO_4 depletion to detect the effects of enhanced sulfate-reduction driven mineralization, rather than categorical analysis of the sulfate treatment results, because (a) biogeochemical changes are not driven directly by SO_4 concentration, but rather by MSR, quantified as SO_4 depletion; (b) although SO_4 depletion may be highly correlated to SO_4 concentration, deviations between experimental mesocosms develop over time, so cumulative SO_4 depletion values eventually no longer align exactly with treatment categories, but rather become continuous variables; and (c) regression provides more statistical power than ANOVA and builds models that allowed us to describe the relationships between SO_4 depletion and response variables (Cottingham et al., 2005). However, when the relationship is not linear, ANOVA and comparison of treatments through Dunn's analysis can help describe the nature of a relationship.

4. Results and Discussion

4.1. The Impact of SO_4 Reduction on Mineralization of Sediment Organic Matter

Increased concentrations of surface water SO_4 resulted in increased sulfate reduction, which necessarily increased the mineralization of organic carbon, as described by reaction (1). Concentrations of surface water DOC and DIC increased in proportion to sulfate reduction, as measured by $(SO_4)_{Depl}$ (Table 1 and Figure 2). The marine literature generally assumes complete mineralization of particulate organic carbon (POC) to DIC in the water column (e.g., Boudreau & Westrich, 1984) (reaction 1), but in freshwater systems and especially wetlands, not all carbon is completely oxidized during decomposition, and a portion of POC may be mobilized as DOC (Howes et al., 1985; Selvendiran et al., 2008). In principle, the constituents of organic matter, such as the nutrients N and P, are mobilized in proportion to the mass of carbon mineralized as a result of MSR-driven decomposition. Surface water DOC and DIC, and the sum DOC + DIC, are therefore used as indicators of OM mineralization in interpreting the mobilization of N, P, and Hg to surface waters (Figure 2 and Tables 2 and 3).

In contrast to many marine systems, it is likely that SO_4 reduction in these sediments was limited more by SO_4 than by organic carbon, given that $(SO_4)_{Depl}$ was linearly proportional to the average SO_4 concentration (Figure S2a; R^2 = 0.87), without any obvious curvature to the relationship that would indicate saturation of MSR.

Regressions of surface water DOC and DIC against SO_4 depletion demonstrate that, on a net basis, about 60% more DIC than DOC was mobilized to the surface water as a result of MSR-driven mineralization (slope of 0.235 mM C per unit SO_4 depletion compared to 0.148; Table 2). The significantly positive slope of the DIC:DOC ratio against SO_4 depletion (Table 2) indicates that increasingly more DIC than DOC was observed in the surface water as sulfate depletion increased. Some mineralization of DOC to DIC likely occurs in the surface water as a result of exposure to oxygen, aerobic bacteria, and sunlight, processes that could have a larger effect as DOC increases.

Not only did surface water DIC and DOC increase in concert with sulfate reduction, but parallel increases occurred in surface water concentrations of constituents of organic matter: N, P, and Hg (Table 1 and Figure 2). DIC, DOC, total P, total N, ammonia, and total Hg in surface water all had increases from the control to the highest SO_4 addition of about twofold, (2.3, 1.7, 1.9, 1.8, 1.7, and 2.6-fold, respectively, Table 1). However, available phosphate in the sediment, an estimate of P availability in pore water, had a larger increase (7.5-fold). MSR consumes acidity as the DIC-based alkalinity is produced (Baker et al., 1986), which increased the average pH from 7.57 to 7.81, a 44% decrease in hydrogen ion concentration (Table 1). If the sulfide subsequently oxidizes (which could happen in a natural system during drought (Laudon et al., 2004) or intentional dewatering), a proportional quantity of alkalinity is consumed as acid is produced

Table 1
Summary of Effects of Experimentally Increased SO_4 Concentrations on SO_4 Reduction (Quantified as SO_4 Depletion), Organic Matter Mineralization, and Mercury Methylation

		Average of each sulfate treatment (n = 6 for each treatment)						Correlation with SO_4 depletion (Spearman)	
Variable	Matrix	Control	50	100	150	300	Max/Min	Rho	p value
Variables mainly associated with SO_4 reduction									
SO_4 (T-W mean mg SO_4 L^{-1})	sw	6.7^{a}	26.9^{ab}	58.5^{abc}	93.2^{BC}	206.5^{c}	31.0	0.93	<0.0001
SO_4 depletion (mg S cm^{-2})	sw	0.14^{a}	2.52^{ab}	3.63^{abc}	4.28^{BC}	6.90^{c}	48.5	1	
Pore water sulfide (μg S L^{-1})	pw	69^{a}	184^{a}	224^{a}	393^{b}	728^{b}	10.5	0.81	<0.0001
Pore water iron (μg L^{-1})	pw	$12{,}883^{a}$	$11{,}122^{ab}$	$6{,}808^{abc}$	$4{,}483^{BC}$	$3{,}032^{c}$	4.25	−0.82	<0.0001
AVS (mg S kg^{-1})	sed	102^{a}	483^{ab}	NA	826^{ab}	$1{,}413^{b}$	13.8	0.77	<0.0001
pH	pw	7.57^{a}	7.52^{a}	7.55^{a}	7.75^{a}	7.81^{a}	1.03	0.39	=0.03
H^+ ion (μmol L^{-1})	pw	0.027	0.030	0.028	0.018	0.015	1.72	0.39	=0.03
Variables mainly associated with mineralization of organic matter									
TOC (% dry mass)	sed	9.26^{a}	7.90^{a}	8.18^{a}	7.17^{a}	8.22^{a}	1.29	−0.34	=0.065
DIC (mg C L^{-1})	sw	28.9^{a}	47.2^{ab}	56.3^{BC}	56.7^{BC}	66.3^{c}	2.30	0.94	<0.0001
DOC (mg C L^{-1})	sw	16.3^{a}	21.4^{a}	26.8^{BC}	24.0^{abc}	28.3^{bc}	1.74	0.79	<0.0001
Total N (mg N L^{-1})	sw	1.42^{a}	1.75^{a}	2.35^{BC}	2.03^{abc}	2.57^{BC}	1.81	0.77	<0.0001
Ammonia (mg N L^{-1})	sw	0.09^{a}	0.09^{a}	0.10^{a}	0.10^{a}	0.16^{a}	1.70	0.38	=0.04
Total P (μg P L^{-1})	sw	13^{a}	16^{ab}	22^{ab}	21^{ab}	25^{b}	1.92	0.73	<0.0001
Available P (μg P g^{-1} resin)	Resin in sed	0.34^{a}	0.40^{a}	0.59^{ab}	0.92^{ab}	2.56^{b}	7.45	0.86	<0.0001
Total Hg (ng L^{-1})	sw	1.83^{a}	2.09^{a}	3.61^{ab}	3.25^{ab}	4.80^{b}	2.63	0.82	<0.0001
Variables mainly associated with Hg methylation									
Methylmercury (ng Hg L^{-1})	sw	0.20^{a}	0.49^{ab}	1.21^{b}	1.08^{b}	1.18^{b}	5.91	0.66	<0.0001
Inorganic Hg (ng L^{-1})	sw	1.63^{a}	1.60^{ab}	2.40^{abc}	2.17^{BC}	3.62^{c}	2.22	0.80	<0.0001
Percent methylmercury	sw	$11\%^{a}$	$23\%^{ab}$	$30\%^{b}$	$32\%^{b}$	$23\%^{ab}$	2.90	0.45	=0.02

Note. Matrix abbreviations: sw = surface water, pw = pore water, sed = bulk sediment. Averages with superscript letters in common are not significantly different at the 0.05 level.

(Hall et al., 2006). However, the sulfide reoxidation does not reverse the mobilization of the constituents of organic matter (C, N, P, and Hg) or the production of methylmercury (MeHg; see below). Rather, any production of SO_4 from sulfide oxidation creates the potential for additional MSR-driven OM mineralization and Hg methylation (Coleman Wasik et al., 2015; Hansel et al., 2015).

The slope of linear regressions of the C, N, and P in surface water against $(SO_4)_{Depl}$ is an estimate of the increase of that variable in mesocosm surface waters per unit SO_4 reduction (Table 2). The regression slopes provide a basis for estimates of stoichiometric ratios of the constituents mobilized from the sediment solid phase, similar to the calculation that Weston et al. (2006) performed for pore water. The calculation of stoichiometric ratios from the slopes of regressions with $(SO_4)_{Depl}$ is more accurate than calculating ratios from surface water concentrations alone, as the use of slopes accounts for the concentrations of the control (the intercept of the linear regression).

The regression slopes of surface water C versus surface water N, P, and Hg in mesocosms are estimates of the net release of each element relative to that of C (Table 3). These estimates can then be compared to the ratio of these constituents in the primary source material—the sediment—to determine the efficiency of mobilization of sediment N, P, and Hg to surface water, compared to C (Table 3). Although we present efficiency relative to only DOC and only DIC, calculating efficiency relative to the sum of mineralized OM (DOC + DIC) represents the overall net efficiency of mineralization, which ranges from 8% to 38% for the three constituents (Table 3). Although the increases in surface water N, P, and Hg are consistent with the hypothesis that those elements were released to the surface water through sulfate-enhanced mineralization of sediment OM, their lower mobilization efficiencies relative to carbon suggest that other processes were operating to either increase carbon, decrease N, P, and Hg mobilization relative to carbon, and/or increase N, P, and Hg losses. It is likely that some carbon was introduced to the surface waters from sources other than the sediment (e.g., photosynthetic fixation of atmospheric carbon) and that there were losses for N, P, and Hg from the surface water (though adsorption, settling, biological uptake, or atmospheric evasion of N and Hg).

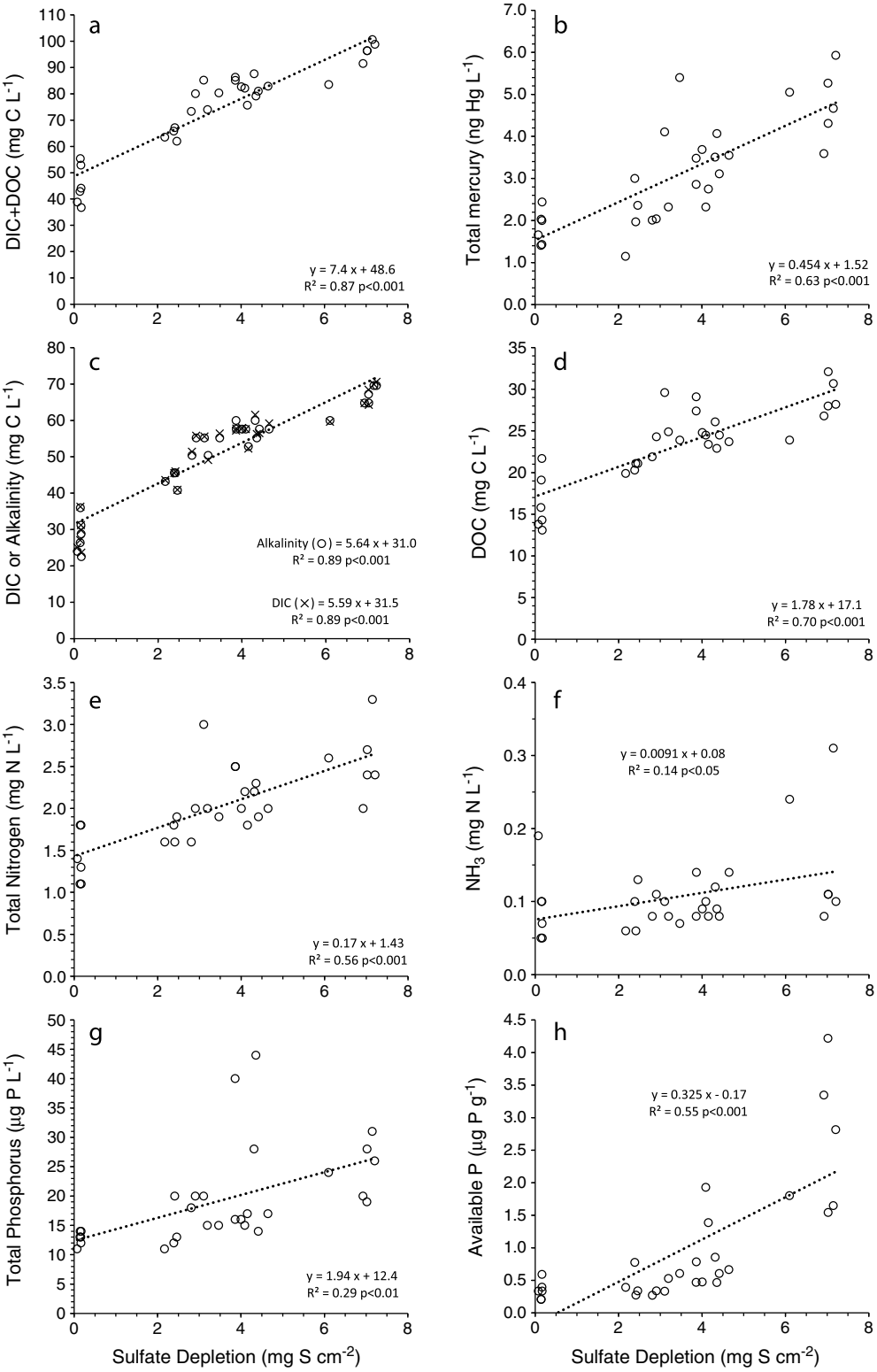


Figure 2. The release of constituents of sedimentary organic matter as a function of SO_4 depletion, showing linear regressions (dotted lines). (a) Sum of surface water DIC and DOC; (b) surface water total mercury; (c) surface water alkalinity and DIC (symbols ○ and ×, respectively; the two regressions are superimposed); (d) surface water DOC; (e) surface water total nitrogen; (f) surface water ammonia; (g) surface water total phosphorus; (h) available phosphate in the sediment, as quantified on ion-exchange resin.

Table 2
Slopes of Regressions of Surface Water Parameters (mM) Against SO_4 Depletion (mg S cm^{-2})

Surface water variable (molar basis)	Regression against $(SO_4)_{Depl}$ (mg S cm^{-2})		
	Slope	R^2	p
DIC	0.235	0.89	<0.0001
DOC	0.148	0.70	<0.0001
DIC + DOC	0.383	0.84	<0.0001
DIC: DOC	0.044	0.56	<0.0001
TN	0.0121	0.56	<0.0001
TN: DIC	−0.0028	0.25	<0.01
TN: DOC	0.0004	0.01	NS
TN: DIC + DOC	−0.0006	0.08	NS
TP	6.26E−05	0.29	<0.002
TP: DIC	−7.00E−06	0.03	NS
TP: DOC	7.00E−06	0.02	NS
TP: DIC + DOC	−1.00E−07	0.00	NS
THg	2.26E−09	0.63	<0.0001
THg: DIC	9.00E−06	0.46	<0.0001
THg: DOC	6.00E−06	0.23	<0.01
THg: DIC + DOC	2.00E−05	0.42	<0.0001

Note. When a sediment constituent's ratio to DIC or DOC has a significant slope against sulfate depletion, it indicates that the constituent was mobilized to the surface water at a significantly different rate than the DIC or DOC.

In addition to increases of TP in the surface water, the sediment pore water in the highest SO_4 treatment contained 7.5-fold greater available phosphate than the controls, as quantified with ion-exchange resin (Table 1 and Figure 2h). In comparison, the increase in surface water TP was only 1.9-fold (Table 1 and Figure 2g). The difference between phosphorus response in the resin and the surface water may be partly due to (a) loss of TP from the surface water after mobilization or (b) irreversible trapping of mobilized P on the resin. If phosphorus is released from sediment en masse in response to an S-induced shift from iron oxides to iron sulfides, the sediment pore water would experience this release first, while release to surface waters would take longer due to diffusion-limited transport and potentially an iron-oxide barrier at the sediment-water (anoxic-oxic) interface.

DIC in surface water is not conservative, being subject to exchange across the air-water interface, carbonate mineral precipitation, and photosynthetic uptake. Surface water pCO_2 in all mesocosms was above saturation with respect to atmospheric equilibrium by a factor of 1.4–15.5 (based on the DIC speciation calculations discussed earlier; data not shown), so the mesocosms were losing, not gaining, C through gas exchange with the atmosphere. The pCO_2 values in the mesocosms are similar to those reported from epilimnia of small, organic-rich, temperate lakes of low to moderate salinity (Cole et al., 1994; Myrbo & Shapley, 2006). With respect to mineral precipitation, based on geochemical equilibrium calculations, surface waters were undersaturated with respect to all carbonate minerals. Thus, although DIC in surface water is subject to several transport and transformation processes, the sustained presence of CO_2 at quantities significantly above saturation with respect to the atmosphere and the observation of increasing DIC and DOC with increasing $(SO_4)_{Depl}$ (Table 1) provide strong evidence of sulfate-induced increases in net carbon mineralization in the mesocosms.

In addition to the carbon originally present in the sediment, organic carbon was also photosynthetically fixed by wild rice and algae in the mesocosms and subsequently subjected to respiration and some decomposition, adding to the DIC and DOC in surface waters. DOC may also have been released into sediment pore water as an exudate from the wild rice roots (Rothenberg et al., 2014; Windham-Myers et al., 2009). Exudate DOC, however, does not account for the observed increase in DOC, since a negative relationship between the number of wild rice plants and DOC was observed (Spearman's rho = −0.63, $p < 0.001$, Table S2).

4.2. Effects of SO_4 Reduction on Mercury and Methylmercury in Surface Water

We interpret Hg mobilization to the surface water in an analogous manner to C, N, and P, as Hg tends to associate strongly with organic matter in sediment (Feyte et al., 2010). In the mesocosm surface waters,

Table 3
Elemental Ratios in Sediment and Surface Water Across the Range of SO_4 Depletion

Molar ratio in sediment[a]		Molar ratio in surface water[b]			Efficiency of mobilization of sediment N, P, or Hg to surface water, relative to carbon		
		DIC	DOC	DOC + DIC	DIC	DOC	DOC + DIC
C: N	12[a]	19	12	32	63%	100%	38%
C: P	463[a]	3,752	2,366	6,118	12%	20%	8%
C: Hg	1.90E + 07	1.04E + 08	6.5E + 07	1.69E + 08	18%	29%	11%

Note. Together, the ratios are used to calculate the efficiency of mobilization of the constituents of particulate organic matter into the surface water.
[a]Sediment data from Hildebrandt, Pastor, and Dewey (2012), a mesocosm study that obtained sediment from the same natural wild rice stand. [b]Regression slopes of C versus N, P, and Hg in mesocosm surface waters; calculations are made based on surface water DIC alone, surface water DOC alone, and the sum of surface water DOC + DIC.

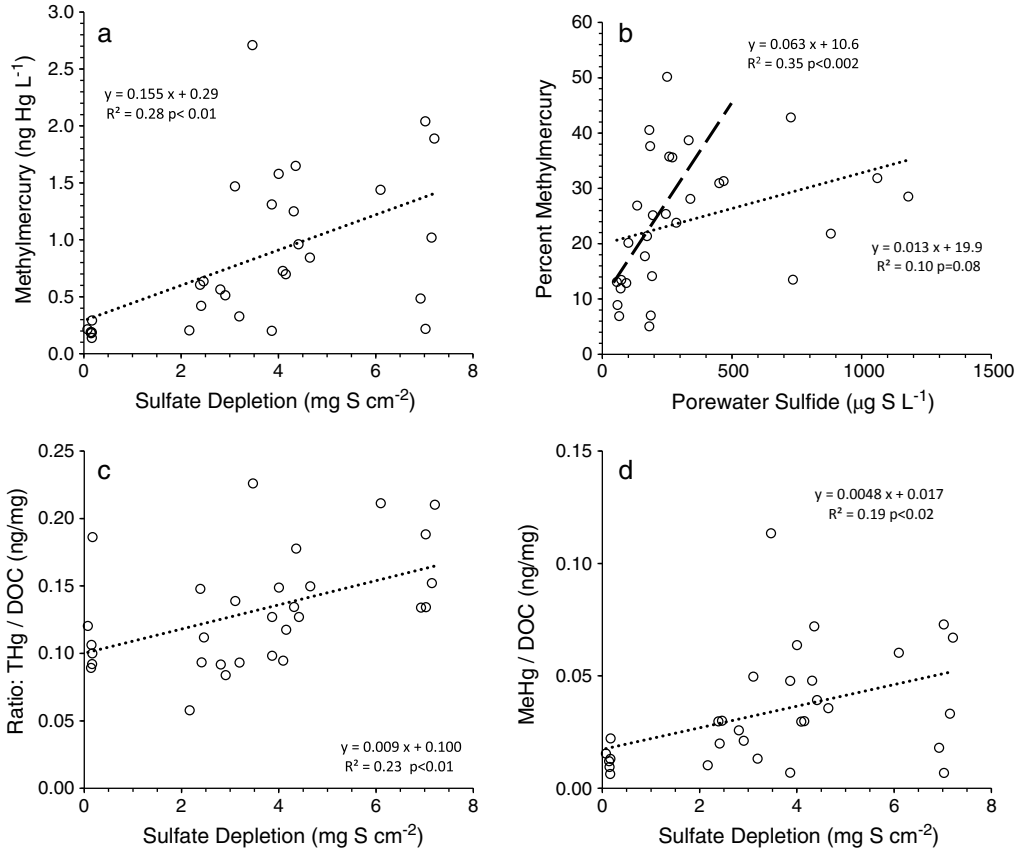


Figure 3. The response of surface water Hg variables to SO_4 depletion and the production of pore water sulfide, showing linear regressions. (a) MeHg as a function of SO_4 depletion; (b) percent MeHg as a function of pore water sulfide, showing regressions for all data (dotted line) and for the subset of data extending only to a pore water sulfide concentration of 468 µg S L^{-1} (dashed line); (c) ratio of THg to DOC as a function of SO_4 depletion; (d) ratio of MeHg to DOC as a function of SO_4 depletion.

THg, inorganic Hg (iHg), and MeHg all increased significantly with increased $(SO_4)_{Depl}$ (Table 1 and Figures 2b and 3a, $p < 0.0001$) and were greater in the highest sulfate amendment by factors of 2.6, 2.2, and 5.9, respectively (Table 1). The relative increase in THg (2.6-fold) is greater than that for DIC, DOC, TN, and TP, which range from 1.7 to 2.3-fold (Table 1). DOC enhances the solubility of both iHg and MeHg and can facilitate the movement of Hg from sediment into surface water (Ravichandran, 2004). The 5.9-fold increase in MeHg indicates that MeHg flux to surface waters was enhanced by sulfate loading disproportionately more than sedimentary release of THg (2.6-fold) and the increase in surface water DOC (1.7-fold).

The genes required to methylate Hg have been found in a wide variety of anaerobic bacteria, including SO_4-reducing bacteria, iron-reducing bacteria, and methanogens (Podar et al., 2015). Though some pure culture and experimental evidence exist for mercury methylation by other bacteria, extensive pure culture, experimental, and landscape-scale observations suggest SO_4-reducing bacteria dominate Hg methylation in many freshwater and marine environments. The relatively large increase in surface water MeHg in response to increased $(SO_4)_{Depl}$ in this experiment supports the assumption that MSR was responsible for most of the observed production of MeHg. It is likely that increased SO_4 loading to low-SO_4 aquatic systems with organic sediment will result in increased Hg methylation even though the relative importance of Hg methylation in the environment by different groups of bacteria is still a subject of debate (Paranjape & Hall, 2017).

If movement of DOC from sediment to surface water were the sole mechanism for the Hg increase in surface water, a constant Hg:DOC ratio would be expected on the $(SO_4)_{Depl}$ gradient. However, THg:DOC, iHg:DOC, and MeHg:DOC ratios in surface water are all significantly correlated with SO_4 depletion (Table S2 and Figures 3c and 3d). Therefore, all forms of Hg (THg, iHg, and MeHg) increase in surface waters more than

does DOC, indicating that a sulfate-induced enhancement of carbon mineralization may act in combination with either enhanced methylation or an enhanced capacity of DOC to carry Hg. Changes to the binding strength of the DOC in heavily S-impacted mesocosm sediment are possible, as thiol groups on DOC are dominant binding sites for Hg (Skyllberg, 2008). The dual role of organic carbon and sulfur in driving both the production of MeHg and the transport of MeHg could be responsible for the substantially larger maximum increase in MeHg:DOC ratio relative to the increase in the THg:DOC ratio (an average 206% increase relative to a 63% increase, Figures 3c and 3d), as postulated by Bailey et al. (2017).

Regnell and Hammar (2004) identified three MSR-driven processes that might cause mobilization of Hg from sediment in a wetland, (1) mineralization of organic matter; (2) extraction of iHg by reduced S compounds, which could be associated with mobilized DOC; and (3) enhanced production of MeHg, which is more mobile than iHg. They argued that enhanced production of MeHg explained THg mobilization in the minerotrophic peat bog that they studied. However, in this study, increases in surface water MeHg concentrations (Figure 3a) are not sufficient to explain the linear increase in THg observed in this experiment (Figure 2b) because most (67%) of the increase is iHg (Table 1). Some of the increase in surface water iHg could be the result of increased production of MeHg that moved to surface water and was subsequently demethylated. Regardless of the underlying mechanism, our observations clearly show increases in surface water Hg that were greater than the increases in C, N, and P (Table 3); this corroborates other studies (Bouchet et al., 2013; Merritt & Amirbahman, 2007; Regnell & Hammar, 2004) that suggest sediment Hg may be synergistically mobilized to surface waters through mineralization, methylation, and enhanced mobility with DOC.

Recent research has shown that in many ecosystems, higher concentrations of pore water sulfide may inhibit MeHg production through either thermodynamically or kinetically controlled reactions with inorganic Hg (Benoit et al., 2003; Hsu-Kim et al., 2013). We plotted %MeHg, rather than the MeHg concentration, against pore water sulfide because we are interested in identifying the pore water sulfide zone of greatest efficiency for the methylation and mobilization of mercury. In this experiment the MSR-driven mineralization of OM released THg to surface water in addition to producing pore water sulfide. Accordingly, because THg is not constant, plotting %MeHg is the most accurate way to identify peak methylation efficiency. In principle, the restricted bioavailability of Hg to methylating bacteria results in a maximum in MeHg production at intermediate concentrations of pore water sulfide. Consistent with previous research in sulfate-impacted freshwater ecosystems (Gilmour et al., 1998; Gilmour, Krabbenhoft, et al., 2007, Gilmour, Orem, et al., 2007; Bailey et al., 2017), MeHg production was most efficient at intermediate sulfide concentrations. In the control, where average sulfide was 69 $\mu g\ S\ L^{-1}$, MeHg averaged only 11% of THg in surface waters. In the intermediate SO_4 treatments, which had average sulfide concentrations of 224 and 393 $\mu g\ S\ L^{-1}$, MeHg production efficiency peaked significantly higher, at averages of 30% and 32%, respectively (Table 1). %MeHg declined to an average of 23% in the highest SO4 treatment, which had an average sulfide concentration of 728 $\mu g\ S\ L^{-1}$. Given the relatively great scatter in the relationship between %MeHg and sulfide (Figure 3b), it would be most defensible to conclude that the decrease in %MeHg began to occur somewhere between 300 and 700 $\mu g\ S\ L^{-1}$. There is a strong positive relationship ($p < 0.001$) between sulfide and %MeHg if the five sulfide concentrations greater than 727 $\mu g\ S\ L^{-1}$ are excluded from the regression (which leaves only sulfide concentrations less than 468 $\mu g\ S\ L^{-1}$, since there is a gap in sulfide concentrations; Figure 3b). Other studies have identified sulfide zones of peak methylation roughly comparable to that found here. In South Florida, Orem et al. (2011) found that sulfide ranging from 5 to 150 $\mu g\ S\ L^{-1}$ did not inhibit methylation but that sulfide concentrations greater than 1,000 $\mu g\ S\ L^{-1}$ did. In a subboreal Minnesota wetland enriched in SO_4 from mining discharge, Bailey et al. (2017) found that sulfide concentrations above ~650 $\mu g\ S\ L^{-1}$ inhibited methylation.

The relationship between surface water SO_4 and Hg methylation can be strongly affected by site-specific conditions. Because of the variable conversion of SO_4 in surface water to sulfide in pore water—primarily due to differences in OM and Fe availability (Pollman et al., 2017)—researchers have found a broad range in the SO_4 concentration associated with maximum efficiency of Hg methylation. For example, Orem et al. (2014) observed that two different areas in the Everglades Protection Area had peak surface water MeHg concentrations at SO_4 concentrations of 2 and 10–15 $mg\ L^{-1}$. In the mesocosms presented here peak surface water %MeHg was observed in the two sulfate treatments that averaged 59 and 93 $mg\ L^{-1}$ (Table 1).

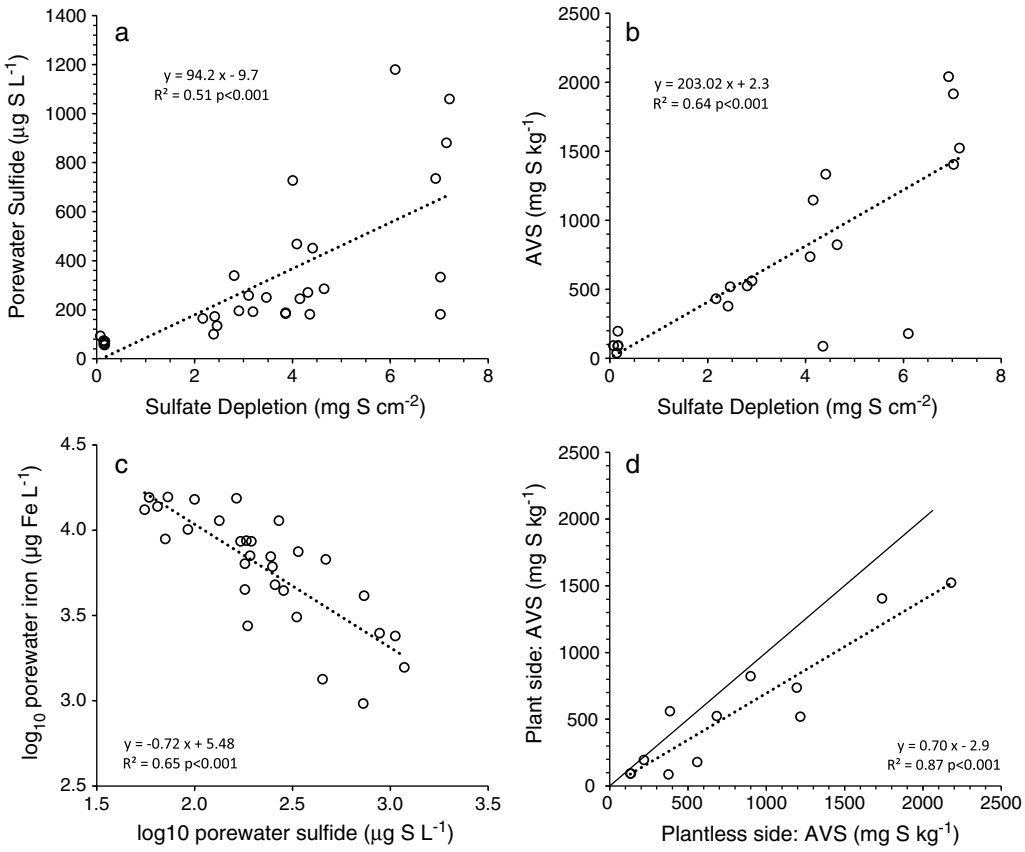


Figure 4. AVS and pore water sulfide, as related to SO_4 depletion, pore water iron, and presence of rooted plants. (a) Pore water sulfide as a function of SO_4 depletion; (b) AVS from the vegetated side of the mesocosms as a function of SO_4 depletion; (c) pore water iron as a function of pore water sulfide; (d) AVS compared between the vegetated side and nonvegetated side. The solid 1:1 line shows that in almost all mesocosms more AVS is found in the side without plants.

4.3. Effects of SO_4 Reduction on Pore Water and Sediment Sulfide

Pore water sulfide increased at higher $(SO_4)_{Depl}$, although with greater variance at higher $(SO_4)_{Depl}$ (Figure 4a), possibly as a result of variable oxidation of sulfide that may depend on the proximity of the Rhizon sampler to plant roots (Schmidt et al., 2011) or of variable bioturbation by invertebrates (Lawrence et al., 1982). When SO_4 is reduced through MSR, the sulfide produced has a number of nonexclusive potential fates: the sulfide could (1) be oxidized within the sediment; (2) remain in the sediment pore water as free sulfide; (3) diffuse into oxygenated surface water, to be oxidized; (4) react with metals in the sediment, forming insoluble precipitates (dominated by iron-sulfide compounds); or (5) be lost to the atmosphere as H_2S gas or as volatile organic sulfur compounds. Because precipitation reactions are fast relative to redox reactions and diffusion, most of the sulfide probably forms metal precipitates if metals are available. When precipitation dominates the fate of sulfide produced from MSR, the continuous reduction of SO_4 and precipitation of iron sulfides form quasi-steady states between surface water SO_4 and pore water sulfide (Figure S2b) and between pore water sulfide and pore water iron (Figures 3 and 4c). The overall mass of sulfide in the mesocosm sediment, quantified through analysis of AVS (from sediment in the vegetated area), is closely correlated with SO_4 depletion (Figure 4b) even though AVS may not include all the reduced sulfide in sediments. It is likely that most of the AVS in these sediments is present as an FeS precipitate because other metals are at low concentrations in these sediments, which came from a relatively pristine (unpolluted) lake (Fond du Lac Band, 2016; Pastor et al., 2017). Note that there are two mesocosms with especially low AVS concentrations (Figure 4b). It is possible that the AVS in the specific location in these mesocosms where sediment core samples were collected was influenced by

a spatially heterogeneous oxidization process (e.g., root oxygen or benthic invertebrates) that limited the accumulation of sulfide.

AVS was 30% lower in the vegetated side of the mesocosms, suggesting that wild rice released oxygen into the sediment, inhibiting the production of sulfide and/or decreasing sulfide concentrations through oxidation (Figure 4d; Wilcoxon paired test, $p = 0.007$). It is notable that this 30% difference developed in just one growing season, despite the previous 2 years of sulfate treatment. Pore water sulfide showed no statistically significant difference between the two sides owing to high variability within treatments. Numerous investigations have found that rooted aquatic plants release oxygen from their roots, a phenomenon that is usually interpreted as an adaptation to limit the toxicity of reduced chemical species in the pore water, especially sulfide (Lamers et al., 2013). Although oxygen release has been observed in white rice, *Oryza sativa* (Colmer, 2002), it has never been documented in wild rice, which is in the same tribe (Oryzeae) of grasses as white rice, and also develops aerenchyma (Jorgenson et al., 2013), plant structures that provide a low-resistance internal pathway for movement of oxygen to the roots. Since the growth and reproduction of rooted plants can be inhibited by sulfide (Pastor et al., 2017), there may be a tipping point of exposure to sulfide above which oxygen release is insufficient to mitigate phytotoxic effects, and the plant population declines over time, possibly to extirpation. In this experiment, in the third treatment year, the increase in pore water sulfide was the apparent cause of a decrease in the average number of wild rice stems from 17 in the control mesocosms to 3 in the highest-sulfate treatment mesocosms (Pastor et al., 2017).

4.4. Mesocosms as Models for Ecosystem-Scale Effects of SO_4 Reduction

Although mesocosms, as contained ecosystems, are useful because they mimic ecological and biogeochemical processes that occur in the field, extrapolating findings to nature is challenging when plastic walls have prevented exchange of water and materials (Petersen et al., 2009). These wall-based challenges are manifest in three phenomena in this experiment, (1) relatively long surface water residence times due to the lack of a constant throughflow; (2) the presence of the wall itself, which provides a surface for periphyton; and (3) lack of either overland or groundwater loading of external materials:

1. Relatively long surface water residence times: the increased loading of N, P, C, Hg, and MeHg to the surface water of the mesocosms was readily detected because the lack of hydraulic loading from a watershed minimized dilution and loss through the outflow. The impact of an increase in SO_4 loading on surface water concentrations of N, P, C, Hg, DIC, and DOC would be lower in waters with shorter residence times. For instance, Baker and Brezonik (1988), in modeling increases in alkalinity from atmospheric SO_4 loading, noted that net increases in alkalinity would be most important in waters with long residence times ($>$5 years) and that there would be little increase in alkalinity in waters with much shorter residence times ($<$1 year). However, the measured concentrations may not represent the maximum impact of MSR-driven mineralization because the mesocosm wall may enhance removal from the surface water (point number 2, below).
2. Presence of the mesocosm wall: the mesocosms have a relatively high ratio of wall and sediment surfaces to the volume of overlying water, enhancing the removal of surface water nutrients and Hg to periphyton or inorganic sinks such as iron oxyhydroxides. Natural aquatic systems have less proportional loss to surfaces. The quantitative estimates of internal loading of N, P, and Hg in response to MSR-induced carbon mineralization may have been underestimated by the measured surface water concentrations, given that significant loss of these constituents to periphyton may have occurred. In addition, THg was filtered prior to analysis, which would have removed any Hg associated with phytoplankton or other suspended particles.
3. Lack of either overland or groundwater loading of particulate and dissolved material, specifically iron: the availability of iron in sediment is a primary controller of the fate of MSR-produced sulfide (Pollman et al., 2017). In natural aquatic systems, iron would be supplied at a relatively constant rate from the system's watershed over the long term, although varying in magnitude from watershed to watershed (Maranger et al., 2006; Winter, 2001). This experiment was not an accurate long-term mimic of pore water sulfide concentrations because the external supply of iron was cut off at the inception of the experiment. With no loading of iron, but continued loading of SO_4, the continued production of sulfide would be expected to eventually consume all available Fe, allowing pore water sulfide levels to exceed those expected in a natural system at equivalent surface water SO_4 concentrations. This mesocosm experiment provides

evidence for just such a result. The experiment continued for 2 years after the 2013 sampling presented here. In the fifth year (August 2015) pore water sulfide was much greater than had been observed in 2013, and disproportionately so in the highest SO_4 treatment, which was most likely to consume available Fe. Between the 2013 and 2015, pore water sulfide increased in the control SO_4 treatment (about 7 mg SO_4 L^{-1}) from an average value of 69 μg L^{-1} in 2013 to 116 μg L^{-1} in 2015, a 68% increase. Pore water sulfide in the highest treatment (nominally 300 mg SO_4 L^{-1}, Table 1) increased from an average value of 728 μg L^{-1}in 2013 to 9,350 μg L^{-1} in 2015, a 1,184% increase (Pastor et al., 2017). In a survey of 108 Minnesota waterbodies with a wide range of surface water sulfate, only two exceeded a pore water sulfide level of 3,200 μg L^{-1} (Myrbo et al., 2017).

5. Conclusions

This study demonstrates that increased SO_4 loading to inland waters with organic-rich sediments can significantly increase the decomposition of sedimentary organic matter, which increases internal loading to surface water of the chemical constituents of organic matter, including DIC, DOC, P, N, and Hg. Associated changes include increased production of sulfide and methylmercury and increased alkalinity and pH. Any one of these changes could alone cause significant secondary changes in the structure of an aquatic ecosystem but, taken together, could cause a cascade of primary and secondary environmental changes: increased availability of nutrients (N and P), which can alter dominant plant species, organic carbon production, oxygen consumption, and redox; increased pore water sulfide, which can be toxic to benthic animals and plants; increased MeHg production, which can affect fish and other consumers in the aquatic food web; increased DOC, which can alter light transmission, thermal stratification, and aquatic chemistry; and increased DIC production, which increases alkalinity and pH, affecting aquatic chemistry and biota. Each of these changes resulting from higher surface water SO_4 and consequent increases in MSR has been documented in the literature, but the entire suite of associated changes in aquatic chemistry has not heretofore been demonstrated in an integrated fashion. The degree to which an increase in SO_4 loading affects the ecological structure of the receiving water will depend on the relative increases in N, P, DIC, DOC, Hg, MeHg, pH, and sulfide, which will be a function of background geochemistry and hydrology of the specific system. In this experiment, the changes in these parameters were linearly proportional to SO_4 reduction, which, in turn, was linearly proportional to the time-weighted average SO_4 concentration. The linear responses of the parameters to SO_4 additions suggest that ecologically significant changes may occur even when SO_4 concentrations are elevated only modestly and that dramatic changes may occur with higher sulfate loading.

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EXHIBIT 35

MPCA Allfish (mercury in fish tissue) data for O'Brien Lake, O'Brien Reservoir, and Swan Lake, through January 19, 2024.

MPCA Allfish Data (through 2024-01-19) Mercury in Fish Tissue
O'Brien Lake and Swan Lake

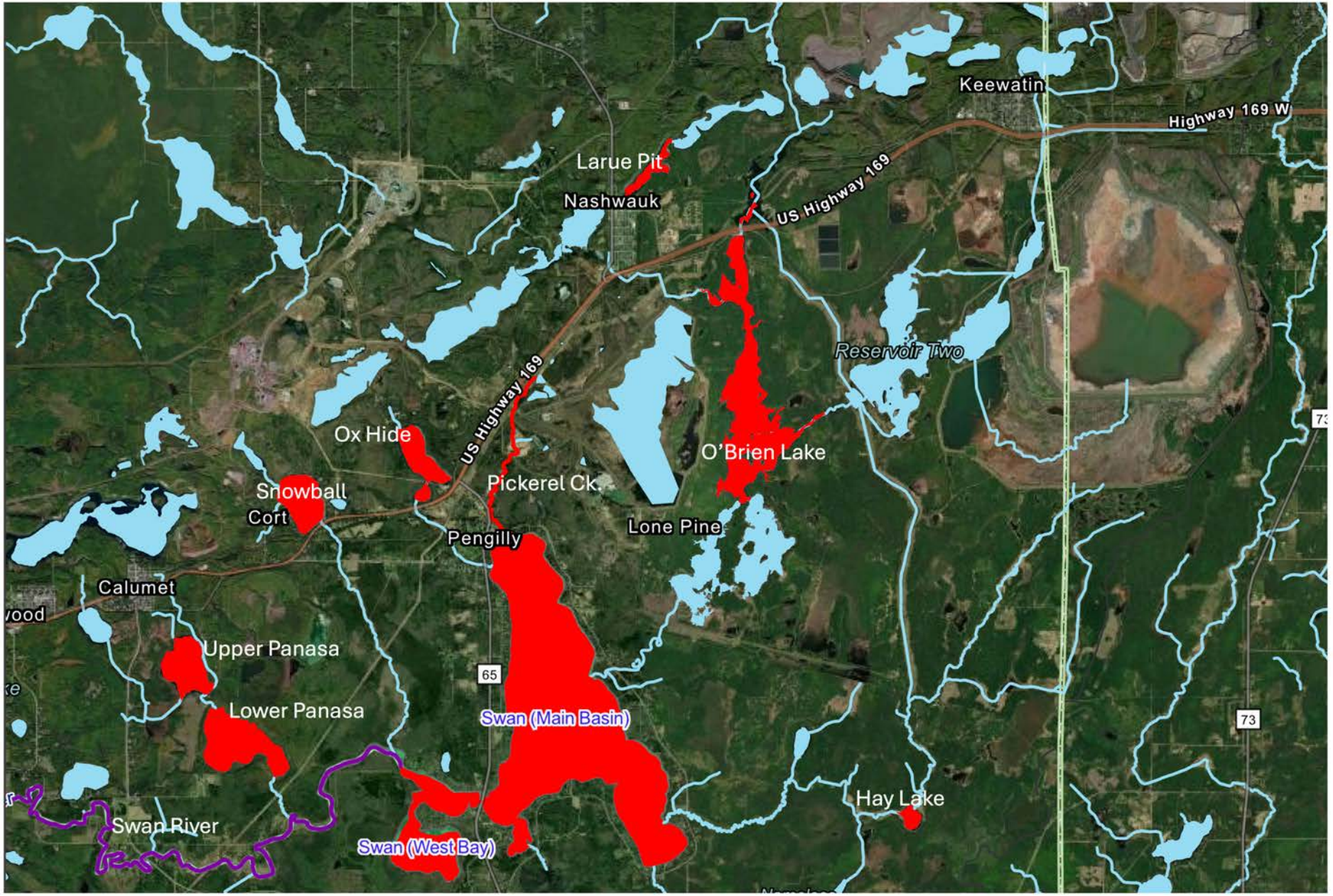
SAMPLENO	OWNER	WATERWAY	TYPE	LOCATION	DOWID	SYS_LOC_CODE	CTY	AREANEW	DATECOL	DATECOL2	YEARCOLL	SPEC	FCACAT	ANATHG	NOFISH	LGTHIN	WTLB	WTKG	AGE	AVG	HGPPM
930364	MN	O'BRIEN	Lake	2 MI SW OF SHWAUK, S OF HWY 169	31-0032-00	31-0032-01-201		Grand Rapids	19930625	6/25/1993	1993	BLG	1	FILSK	10	6.6	0.2				0.13
930365	MN	O'BRIEN	Lake	2 MI SW OF SHWAUK, S OF HWY 169	31-0032-00	31-0032-01-201		Grand Rapids	19930625	6/25/1993	1993	WTS	2	FILSK	1	18	2.7				0.098
930366	MN	O'BRIEN	Lake	2 MI SW OF SHWAUK, S OF HWY 169	31-0032-00	31-0032-01-201		Grand Rapids	19930625	6/25/1993	1993	NOP	2	FILSK	8	19	1.6				0.4
930367	MN	O'BRIEN	Lake	2 MI SW OF SHWAUK, S OF HWY 169	31-0032-00	31-0032-01-201		Grand Rapids	19930625	6/25/1993	1993	NOP	2	FILSK	5	21.4	2.3				0.58
930368	MN	O'BRIEN	Lake	2 MI SW OF SHWAUK, S OF HWY 169	31-0032-00	31-0032-01-201		Grand Rapids	19930625	6/25/1993	1993	NOP	2	FILSK	7	26.4	4.4				0.66
930369	MN	O'BRIEN	Lake	2 MI SW OF SHWAUK, S OF HWY 169	31-0032-00	31-0032-01-201		Grand Rapids	19930625	6/25/1993	1993	NOP	2	FILSK	2	32.1	7.9				0.74
																				AVG	0.4347
897800	MN	O'BRIEN RES. #4	Lake	AT SHWAUK	31-1225-00			Grand Rapids	19890727	7/27/1989	1989	BLC	1	FILSK	6	6.4	0.2				0.16
897801	MN	O'BRIEN RES. #4	Lake	AT SHWAUK	31-1225-00			Grand Rapids	19890727	7/27/1989	1989	NOP	2	FILSK	2	23	2.7				0.57
897802	MN	O'BRIEN RES. #4	Lake	AT SHWAUK	31-1225-00			Grand Rapids	19890727	7/27/1989	1989	WAE	2	FILSK	1	15.1	1.2				0.59
897803	MN	O'BRIEN RES. #4	Lake	AT SHWAUK	31-1225-00			Grand Rapids	19890727	7/27/1989	1989	WTS	2	FILSK	3	17.5	2.5				0.21
890396	MN	O'BRIEN RES. #4	Lake	RES. #4	31-1225-00			Grand Rapids	1989XXXX		1989	CRP	1	FILSK	6	6.4	0.2				0.16
890397	MN	O'BRIEN RES. #4	Lake	RES. #4	31-1225-00			Grand Rapids	1989XXXX		1989	WAE	2	FILSK	1	15.1	1.2				0.59
890398	MN	O'BRIEN RES. #4	Lake	RES. #4	31-1225-00			Grand Rapids	1989XXXX		1989	NOP	2	FILSK	2	23	2.7				0.57
890399	MN	O'BRIEN RES. #4	Lake	RES. #4	31-1225-00			Grand Rapids	1989XXXX		1989	WTS	2	FILSK	3	17.5	2.5				0.21
930347	MN	O'BRIEN RES. #4	Lake	AT SHWAUK, N OF HWY 169	31-1225-00			Grand Rapids	19930729	7/29/1993	1993	BLC	1	FILSK	6	7.7	0.3				0.17
930348	MN	O'BRIEN RES. #4	Lake	AT SHWAUK, N OF HWY 169	31-1225-00			Grand Rapids	19930729	7/29/1993	1993	WTS	2	FILSK	4	16.9	2.1				0.13
930349	MN	O'BRIEN RES. #4	Lake	AT SHWAUK, N OF HWY 169	31-1225-00			Grand Rapids	19930729	7/29/1993	1993	WTS	2	FILSK	2	19.9	3.3				0.27
930350	MN	O'BRIEN RES. #4	Lake	AT SHWAUK, N OF HWY 169	31-1225-00			Grand Rapids	19930729	7/29/1993	1993	NOP	2	FILSK	5	17.9	1.2				0.28
930351	MN	O'BRIEN RES. #4	Lake	AT SHWAUK, N OF HWY 169	31-1225-00			Grand Rapids	19930729	7/29/1993	1993	NOP	2	FILSK	8	21.8	2.6				0.53
930352	MN	O'BRIEN RES. #4	Lake	AT SHWAUK, N OF HWY 169	31-1225-00			Grand Rapids	19930729	7/29/1993	1993	NOP	2	FILSK	4	26.2	4.5				0.41
930353	MN	O'BRIEN RES. #4	Lake	AT SHWAUK, N OF HWY 169	31-1225-00			Grand Rapids	19930729	7/29/1993	1993	LMB	2	FILSK	3	9.9	0.5				0.28
930354	MN	O'BRIEN RES. #4	Lake	AT SHWAUK, N OF HWY 169	31-1225-00			Grand Rapids	19930729	7/29/1993	1993	LMB	2	FILSK	1	13	1.2				0.53
930355	MN	O'BRIEN RES. #4	Lake	AT SHWAUK, N OF HWY 169	31-1225-00			Grand Rapids	19930729	7/29/1993	1993	WAE	2	FILSK	1	14.1	0.9				0.37
930356	MN	O'BRIEN RES. #4	Lake	AT SHWAUK, N OF HWY 169	31-1225-00			Grand Rapids	19930729	7/29/1993	1993	WAE	2	FILSK	1	20	2.7				0.52
20132225	MN	O'BRIEN RES. #4	Lake	AT SHWAUK	31-1225-00		31	Grand Rapids	20130729	7/29/2013	2013	LMB	2	FILSK	1	11.8		0.41			0.475
20132226	MN	O'BRIEN RES. #4	Lake	AT SHWAUK	31-1225-00		31	Grand Rapids	20130729	7/29/2013	2013	LMB	2	FILSK	1	16.6		1.14			0.674
20132227	MN	O'BRIEN RES. #4	Lake	AT SHWAUK	31-1225-00		31	Grand Rapids	20130729	7/29/2013	2013	NOP	2	FILSK	1	21.9		1.32			0.51
20132228	MN	O'BRIEN RES. #4	Lake	AT SHWAUK	31-1225-00		31	Grand Rapids	20130729	7/29/2013	2013	NOP	2	FILSK	1	17.5		0.53			0.536
20132229	MN	O'BRIEN RES. #4	Lake	AT SHWAUK	31-1225-00		31	Grand Rapids	20130729	7/29/2013	2013	NOP	2	FILSK	1	19.3		0.86			0.649
20132230	MN	O'BRIEN RES. #4	Lake	AT SHWAUK	31-1225-00		31	Grand Rapids	20130729	7/29/2013	2013	NOP	2	FILSK	1	21.4		1.01			0.686
20132231	MN	O'BRIEN RES. #4	Lake	AT SHWAUK	31-1225-00		31	Grand Rapids	20130729	7/29/2013	2013	WTS	2	FILSK	5	17.1		0.94			0.061
20132232	MN	O'BRIEN RES. #4	Lake	AT SHWAUK	31-1225-00		31	Grand Rapids	20130729	7/29/2013	2013	YEP	1	FILSK	5	10.9		0.33			0.232
																				AVG	0.399
20132692	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	NOP	2	FILSK	1	19.3		0.8			0.274
20132693	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	NOP	2	FILSK	1	21.3		1.06			0.29
20132694	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	NOP	2	FILSK	1	24.7		1.56			0.338
20132695	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	NOP	2	FILSK	1	20		0.87			0.367
20132696	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	NOP	2	FILSK	1	22.4		1.14			0.396
20132697	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	NOP	2	FILSK	1	30.8		3.24			0.462
20132698	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	NOP	2	FILSK	1	24.2		1.42			0.555
20132699	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	NOP	2	FILSK	1	31.6		3.05			0.629
20132700	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	WAE	2	FILSK	1	15		0.42			0.308
20132701	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	WAE	2	FILSK	1	21.6		1.56			0.643

20132702	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	WAE	2	FILSK	1	19.2		0.92			0.652
20132703	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	WAE	2	FILSK	1	20.8		0.96			0.685
20132704	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	WAE	2	FILSK	1	19.7		1.16			0.706
20132705	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	WAE	2	FILSK	1	20.5		1.22			0.757
20132706	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	WAE	2	FILSK	1	23.3		1.97			1.064
20132707	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	WTS	2	FILSK	5	16.6		0.958			0.044
20132708	MN	SWAN	Lake	AT PENGILLY	31-0067-00	31-0067-00-100	31	Grand Rapids	20130819	8/19/2013	2013	YEP	1	FILSK	5	6.8		0.064			0.149
																				AVG	0.4894

WaterLegacy September 22, 2025 Comments on U.S. Steel Corp NPDES/SDS Permits for Keetac Mining Area (MN0031879) and Keetac Tailings Basin (MN0055948) and on U.S. Steel Corp Application for Variance from Wild Rice Sulfate Standard

EXHIBIT 36

Map of Additional Keetac Area Impaired Waters.


Keewatin
Highway 169 W
Larue Pit
Nashwauk
US Highway 169
US Highway 169
Reservoir Two
Ox Hide
O'Brien Lake
Snowball
Cort
Pickerel Ck.
Pengilly
Lone Pine
Calumet
Upper Panasa
65
Lower Panasa
Swan (Main Basin)
73
Hay Lake
Swan River
Swan (West Bay)