# Wyoming Outdoor Council, et al.

July 3, 2019

Jason Thomas
Department of Environmental Quality
Water Quality Division
200 West 17th Street
Cheyenne, WY 82002

Re: WY0002062 (Aethon Energy)

Dear Mr. Thomas,

Please see attached comments from Wyoming Outdoor Council, Powder River Basin Resource Council, Natural Resources Defense Council, and National Audubon Society concerning Moneta Divide Gas Field Discharge Permit WY0002062 (Aethon Energy).

Thank you.

Dan Heilig
Senior Conservation Advocate
Wyoming Outdoor Council

Transmitted via the DEQ's Public Comment Portal and Email

July 3, 2019

Jason Thomas
Department of Environmental Quality
Water Quality Division
200 West 17th Street
Cheyenne, WY 82002

Re: Comments on Moneta Divide Gas Field Discharge Permit (WY0002062, Aethon Energy)

Dear Mr. Thomas:

These comments are submitted on behalf of the Wyoming Outdoor Council, Powder River Basin Resource Council, Natural Resources Defense Council, and National Audubon Society in response to the State of Wyoming Public Notice dated March 15, 2019, inviting public comments on Aethon Energy's application for a renewal of its Moneta Divide Gas Field Discharge Permit, WY 0002062. Given the complex and technical nature of Aethon's discharge application, we appreciate the DEQ's decision to extend the comment period and hold public meetings in Riverton and Thermopolis.

As discussed in detail below, our review of the application[1] and related materials[2] shows that issuance of the permit would result in unacceptable risks to human health and the environment and must therefore be denied.

## I. DESCRIPTION OF PARTIES

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[1] "Wyoming Pollutant Discharge Elimination System Application for Permit to Surface Discharge Produced Water From Oil and Gas Production Unit Discharges," dated August 8, 2016.

[2] The related materials include: ERM, "Water Quality Compliance Analysis for the Long Range Development Plan at Moneta Divide, Wyoming," April 23, 2018; Boysen Reservoir Modeling Study Update (undated); DEQ Statement of Basis ("SOB"); and proposed Authorization to Discharge Under the Wyoming Pollutant Discharge Elimination System ("draft permit").

The mission of the National Audubon Society is to protect birds and the places they need, today and tomorrow.

The Natural Resources Defense Council's purpose is to safeguard the Earth: its people, its plants and animals and the natural systems on which all life depends. We work to restore the integrity of the elements that sustain life–air, land and water–and to defend endangered natural places.

Powder River Basin Resource Council was founded in 1973 by rural landowners and concerned citizens working to protect their land, water, and air. For 45 years our citizen-based organization has been dedicated to civil society and to the stewardship of Wyoming's human and natural resources. We are committed to community organizing, leadership development, and the empowerment of citizens.

Established in 1967, the Wyoming Outdoor Council is the state's oldest and largest independent conservation organization. Our mission is to protect Wyoming's environment and quality of life for future generations.

Our organizations all have members who use and rely on the waters affected by the proposed discharges. We are not opposed to the expansion of the Moneta Divide oil and natural gas field, but believe that any further development must be carried out in a manner that complies with the law, protects the health and safety of Wyoming's residents, meets water quality standards, and respects the rights of downstream water users.

## II. INTRODUCTION

Aethon Energy Operating LLC ("Aethon"), the operator of the Moneta Divide oil and gas field in Fremont and Natrona Counties, Wyoming, filed an application for a renewal of a WYPDES permit WY 0002062 with the Department of Environmental Quality/Water Quality Division (DEQ) on August 8, 2016. The application–available to the public on the DEQ's website–is not signed, contrary to explicit requirements contained in Chapter 2, Section 5(a)(v) and (vi); and Chapter 2, Section 14. As pointed out in our letter to the DEQ/WQD Administrator dated June 19, 2019, the application is also technically incomplete, and the DEQ erred in both issuing a notice of completeness and by initiating review of the incomplete application. We hereby incorporate our June 19, 2019, letter by reference into these comments as if fully set forth below, and request that the issues raised in that letter be considered together with the following issues, questions, and concerns.

Aethon has proposed a significant expansion of the Moneta Divide field that would add 4,100 new oil and gas wells to the roughly 900 that exist in the field today. *See* Bureau of Land Management ("BLM") Draft Environmental Impact Statement ("DEIS") for the Moneta Divide Project, available online at https://www.blm.gov/press-release/blm-releases-draft-analysis-moneta-divide-oil-and-gas-project . At peak production (year 15 of development), the DEIS estimates that produced water will be discharged at a rate of ***1.4 million barrels per day*** (508 million barrels per year), greatly exceeding existing discharge rates of about 1 million *gallons* per day. The Statement of Basis ("SOB") prepared by the DEQ indicates that the renewed permit would authorize the discharge of up to 8.27 million of gallons per day of untreated and partially treated produced water into surface waters. The permit would authorize an increase in allowable facility-wide load for total dissolved solids (TDS) to **2,161 tons per month** (capped at 908 tons/month in the existing permit) and would add a monthly load limit of 719 tons per month for chloride. The DEQ claims–based on a modeling report prepared by Aethon's contractor, Environmental Resources Management (ERM)–that this increase would not violate water quality standards. Skeptical of those claims, we commissioned an independent scientific review, which found that the report, and the model on which it is based, are fundamentally flawed and cannot be used for regulatory compliance. The DEQ relied on a flawed model developed by the project proponent's contractor that it had no internal capacity to independently verify, resulting in erroneous and insupportable findings and determinations regarding water quality impairment in the receiving waters including the Class 1 segment of the Wind River below Boysen Dam.

According to a July 31, 2018 inspection report, only 4 of the 16 outfalls that have been approved are discharging; we assume that is because the load limit for TDS in the existing permit would be exceeded with any additional discharge. The DEQ has not revealed how many of the almost 900 existing oil and gas wells in the Moneta Divide field are responsible for producing the 1 million gallons/day current rate of produced water, but we surmise that many of those wells have been shut in to avoid exceeding the TDS load limits in the existing discharge permit. What volumes of produced water discharge could be expected if all existing wells were operational?

The SOB indicates (at 2) that Aethon currently has the capacity (at its Neptune RO facility) to treat up to 1.64 million gallons of produced water per day, which has the effect of limiting the total discharge of treated and blended water to 4.37 million gallons per day. The SOB also indicates that "[a]dditional treatment capacity would have to be added in order to reach the 8.27 MGD (197,000 barrels) maximum discharge volume analyzed in this permit revision, and comply with the concentration and load limits for all parameters." SOB at 2.

This begs the question: if new treatment capacity is required to reach 197,000 barrels per day, what is the plan when the Moneta Divide field reaches peak production, and produced water is being discharged at rates 7 times higher, 1.4 million barrels per day? It is clear that the DEQ needs to sit down with BLM and Aethon to figure out a way to deal with these enormous volumes of salty produced water. The previous owner of the field, Encana, proposed to treat all produced water to Class 1 standards and pipe to Boysen Reservoir. *See* Moneta Divide DEIS, Appendix K Water Management Plan, June 2014.[3] Yet the DEQ failed to consider this or any other alternative to the discharge, violating the Environmental Quality Act and its own antidegradation rules in the process. If the DEQ issues this renewal, will it set in motion a series of permit modifications and renewals to accommodate the expanding discharge of produced water that can be expected with expansion of the field?

As discussed below, the existing/current discharge of produce water has caused significant impairment to both Alkali and Badwater creeks. If the DEQ had followed its own rules, this could have been avoided, or at least mitigated. We urge the DEQ to refrain from authorizing greater amounts of pollution until existing problems are dealt with. We outline in

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[3] https://eplanning.blm.gov/epl-front-office/eplanning/docset_view.do?projectId=64352&currentPageId=90686&documentId=170953

detail numerous flaws in the draft permit, and urge the DEQ and Aethon to go back to the drawing board and look at other options for the management and disposal of produced water from the Moneta Divide field.

## III. LEGAL AND REGULATORY CONTEXT

The Clean Water Act (CWA) aims "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." *PUD No. 1 of Jefferson County v. Wash. Dept. of Ecology*, 511 U.S. 700, 704, 114 S.Ct. 1900, 128 L.Ed.2d 716 (1994) (quoting 33 U.S.C. § 1251(a)). In passing the CWA, Congress sought to eliminate the discharge of pollutants into the nation's navigable waters and to attain "an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife." 33 U.S.C. § 1251(a)(1)–(2). The centerpiece of the CWA is section 301(a), which prohibits the discharge of any pollutant from a point source into navigable waters of the United States without a National Pollutant Discharge Elimination System (NPDES) permit. 33 U.S.C. §§ 1311(a), 1342.

The CWA allows for NPDES permits to be issued directly by the EPA Administrator or, if a state's water quality regulation program has been approved by the Administrator, the EPA may delegate its permitting authority to the state regulatory body. *See* 33 U.S.C. § 1342(a), (b). The U.S. Environmental Protection Agency has delegated responsibility for issuing NPDES permits to the Wyoming DEQ. *See* Wyoming, Discharges of Pollutants to Navigable Waters; Approval of Program, 40 Fed. Reg. 12987, 13026 (Mar. 24, 1975). Like all states that have received this delegation, Wyoming must implement its discharge program consistent with minimum federal requirements. 33 U.S.C. § 1342(b). This includes ensuring that effluent concentration limits established in discharge permits protect water quality standards and meet antidegradation policies, discussed below.

CWA Section 303 requires states to develop comprehensive water quality standards setting forth water quality goals for all intrastate waters. *PUD No. 1 of Jefferson County*, 511 U.S. at 704, 114 S.Ct. 1900, 128 L.Ed.2d 716 (citing 33 U.S.C. §§ 1311(b)(1)(C), 1313). A water quality standard (WQS) consists of designated uses, water quality criteria to protect those uses, and an antidegradation policy, which is "a policy requiring that state standards be sufficient to maintain existing beneficial uses of navigable waters, preventing their further degradation." *Id.* Regulations promulgated by EPA implementing the CWA require each state to develop and adopt a statewide antidegradation policy and identify the methods for implementing such policy. 40 C.F.R. § 131.12(a) (2015).[4]

The EPA regulations further require that the state's antidegradation policy and implementation methods must, at a minimum, be consistent with federal standards. These standards establish three levels of water quality protection: Tier 1, Tier 2 and Tier 3. Tier 1 protection establishes the minimum water quality standard and requires that existing instream

[4] Wyoming's antidegradation implementation policy is available here: http://deq.wyoming.gov/media/attachments/Water%20Quality/Surface%20Water%20Quality%20Standards/2013-0924_wqd-wpp-surface-water-standards_Chapter-1-Implementation-Policies.pdf.

water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected. 40 C.F.R. 12(a)(1).[5]

Tier II protection applies when the quality of the waters exceed levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water. 40 C.F.R. § 131.12(a)(2). For these waters, the regulation requires that their quality shall be maintained and protected unless the State finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the State's continuing planning process, that allowing lower water quality is necessary to accommodate important economic and social development in the area in which the waters are located. 40 C.F.R. § 131.12(a)(2). However, in allowing such degradation or lower water quality, the State shall assure water quality adequate to protect existing uses fully. 40 C.F.R. § 131.12(a)(2).[6]

Finally, Tier III protection provides that where high quality waters constitute an outstanding national resource, such as waters of national and state parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected. 40 C.F.R. § 131.12(a)(3).[7]

Wyoming has established a regulatory program to implement the Clean Water Act, including water quality standards and an antidegradation policy which are contained in Chapter 1 of the Water Quality Division Rules and Regulations, and rules governing the issuance and enforcement of discharge permits, set forth in Chapter 2. The statutory underpinning for both water quality standards and point source discharge permits is contained in the Wyoming's Environmental Quality Act ("WEQA"), Article 3, Water Quality, §§ 35-11-301 to 35-11-318.

The WEQA authorizes the administrator to develop water quality standards, effluent limitations, and standards for the issuance of discharge permits as authorized under Section 402(b) of the Clean Water Act. Importantly, and especially relevant here, the WEQA provides that:

> (vi) In recommending any standards, rules, regulations, or ***permits***, the administrator and advisory board shall consider all the facts and circumstances bearing upon the reasonableness of the pollution involved including:
>
> > (A) The character and degree of injury to or interference with the health and well-being of the people, animals, wildlife, aquatic life and plant life affected;
> > (B) The social and economic value of the source of pollution;
> > (C) The priority of location in the area involved;
> > (D) The technical practicability and economic reasonableness of reducing or eliminating the source of pollution; and
> > (E) The effect upon the environment.

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[5] Alkali Creek is a Tier 1 surface water.
[6] Badwater Creek and Boysen Reservoir are classified as Tier 2 "high quality waters."
[7] The Wind River below Boysen Dam until its confluence with "Wedding of the Waters" is a Tier 3 "outstanding national resource water."

Wyo. Stat. 35-11-302(a) (emphasis added).

Federal regulations prohibit the discharge of oil and gas waste. 40 C.F.R. § 435.52(a). The regulations provide a limited exception for discharges of produced water west of the 98th meridian that is "used for agriculture or wildlife propagation." 40 C.F.R. § 435.50. Wyoming regulations incorporate these requirements, which are contained in Chapter 2, Appendix H: *Additional Requirements Applicable to Produced Water Discharges from Oil and Gas Production Facilities*.

The term "use in agricultural or wildlife propagation" is defined in both federal and state regulation. To qualify for the exception to the prohibition on discharges, the produced water must be: (1) "of good enough quality to be used for wildlife or livestock watering or other agricultural uses" and (2) "actually put to such use during periods of discharge." 40 C.F.R. § 435.51(c); Ch. 2, App. H(a)(i).

## IV. THE DRAFT PERMIT DOES NOT COMPLY WITH THE WYOMING ENVIRONMENTAL QUALITY ACT.

As noted earlier, the Wyoming Environmental Quality Act contains explicit requirements governing the content and analysis of discharge permits. Importantly, 35-11-302(a) provides that:

> (vi) In recommending any standards, rules, regulations, or ***permits***, the administrator and advisory board **shall consider all the facts and circumstances bearing upon the reasonableness of the pollution** involved including:
>
> > (A) The character and degree of injury to or interference with the health and well-being of the people, animals, wildlife, aquatic life and plant life affected;
> > (B) The social and economic value of the source of pollution;
> > (C) The priority of location in the area involved;
> > (D) The technical practicability and economic reasonableness of reducing or eliminating the source of pollution; and
> > (E) The effect upon the environment.

Wyo. Stat. § 35-11-302(a) (emphasis added).

Neither the SOB nor the draft permit contain sufficient analysis of these factors because DEQ has not acknowledged the statutory provision and does not proceed with an analysis of each factor. For example, under subsection (c), the rules require an analysis of "[t]he priority of location in the area involved." *Id.* However, a discussion of the value of Boysen State Park was not included in the SOB. This is a significant omission given the value of Boysen State Park as one of the most visited state parks in Wyoming.

The WEQA contains these requirements for a reason—they should not be ignored by the DEQ.

## V. THE DRAFT PERMIT DOES NOT COMPLY WITH WATER QUALITY DIVISION RULES AND REGULATIONS.

### A. The Draft Permit Fails to Satisfy the Regulatory Requirements in Appendix H for the Discharge of Produced Water.

Chapter 2 of the Department of Environmental Quality Water Quality Division's Rules and Regulations regulates point source discharges to waters of the State. Among other things, Chapter 2, Section 5 requires technology-based effluent limitation to be included in all permits. Ch. 2, Section 5(c)(iii)(A). For oil and gas production facilities like Aethon's, Section 5 also requires compliance with technology based effluents "as described in Appendix H." Ch. 2, Sec. 5(c)(iii)(B)(III).

In addition to technology-based limits, Chapter 2 requires water quality based limitations when "necessary to ensure that violations of water quality standards do not occur." Ch. 2, Sec. 5(c)(iii)(C). Water quality based effluent limitations "shall be established for constituents in discharges determined to have a reasonable potential of adversely impacting uses of surface waters of the state or of causing violations of water quality standards." Ch. 2, Sec. 5(c)(iii)(C)(I).

Accordingly, under Wyoming's regulatory scheme, discharges from oil and gas production facilities must not only meet water quality standards and other requirements contained in Chapter 1 and Chapter 2, but also the specific "additional" conditions set forth in Appendix H. Key components of Appendix H that apply to Aethon's facility include:

- The produced water discharged into surface waters of the state shall be of good enough quality to be used for wildlife or livestock watering or other agricultural uses and actually be put to such use during periods of discharge. App. H(a)(i).

- The produced water discharge must not contain toxic materials in concentrations or combinations which are toxic to human, animal or aquatic life. App. H(b)(i).

- Measures must be implemented to minimize erosion of the drainage at the point of discharge. App. H(b)(iv).

- Discharges of produced water must not contain substances that will settle to form sludge, bank or bottom deposits in quantities sufficient to result in significant aesthetic degradation, significant degradation of habitat for aquatic life or adversely affect public water supplies, agricultural or industrial water use, plant life or wildlife. App. H(b)(v).

- Discharges of produced water may not result in the formation of a visible hydrocarbon sheen on the receiving water. App. H(b)(vi).

- An effluent limitation of 10 mg/l for net oil and grease shall apply. App. H(c)(v).

- The discharge of waste pollutants into surface waters of the state from any source (other than produced water) associated with production, field exploration, drilling, well completion, or well treatment (i.e., drilling muds, drill cuttings, and produced sands) is expressly prohibited. App. H(b)(lx).

In addition, produced water discharges are subject to the following effluent limitations for chloride, sulfate, TDS, specific conductance, and pH:

> (A) Chlorides. The chloride content of any produced water discharge shall not exceed 2,000 mg/l in any single properly preserved grab sample except in those cases where a modification is granted in accordance with paragraph (c) of this appendix.
>
> (B) Sulfates. The sulfate content of any produced water discharge shall not exceed 3,000 mg/l in any single properly preserved grab sample except in those cases where a modification is granted in accordance with paragraph (c) of this appendix.
>
> (C) Total dissolved solids and specific conductance. The total dissolved solids content of any produced water discharge shall not exceed 5,000 mg/l for total dissolved solids or 7500 µmhos/cm for specific conductance in any single properly preserved grab sample except in those cases where a modification has been granted in accordance with paragraph (c) of this appendix.
>
> (D) pH. In no case shall the pH of any produced water discharge be less than 6.5 or greater than 9.0 standard units as measured by a single grab sample.

Appendix H avers that the above limits are protective for livestock and wildlife consumption, but recognizes that "[l]imitations on additional parameters or limitations more stringent will be imposed when such limitations are necessary to assure compliance with Wyoming Water Quality Rules and Regulations, Chapter 1." App. H(b)(vii). During the 1978 rulemaking process that led to adoption of Appendix H, the DEQ "took the position that any discharge meeting the [effluent limitations] was suitable for stock and wildlife use, and **assumed** that the water was actually being put to such use." [8] *Id.* (emphasis added). Since then, new science has emerged that suggests the effluent limitations declared safe for livestock and wildlife may no longer be adequate. The DEQ's continued reliance on outdated effluent limitations and unsupported assumptions would not only be irresponsible, but also unlawful under the Wyoming Administrative Procedures Act.

Appendix H contains a provision that allows the DEQ to modify, or "grandfather," previously established effluent limits for chlorides, sulfates, TDS, or pH, if specific **additional** conditions are met:

> For existing permits where the original permit application was submitted prior to September 5, 1978, modification of the effluent limits described above may be granted on a case-by-case basis if a signed "letter of beneficial use" from the land owner was provided specifically requesting that the discharge in question be

[8] Appendix H effluent limits were first promulgated in 1979 and codified in then-existing Chapter 7. *See* EQC Statement of Principal Reasons in the Matter of Chapters 2, 7, 10 and 18, filed August 30, 2004. https://eqc.wyo.gov/Public/ViewPublicDocument.aspx?DocumentId=12041.

> allowed to continue; or a signed statement by the Wyoming Game and Fish Department was provided in which it was stated that the discharge in question is of value to fish or wildlife; or documentation was provided by the owner or operator of the discharging facility that, because of extenuating circumstances (volume of discharge, individual chemical constituents, nature of the area in which the discharge occurs, etc.), an exemption should be considered. The user must have indicated the exact beneficial use of the water (stock watering, irrigation, etc.) and the history of such use. No action taken by the department under this paragraph or any other paragraph of these regulations shall be interpreted as the granting of a water right or any other water use authority.

App. H(c)(i).

Appendix H contains a second option for the issuance of a modification. This option requires the preparation of a Use Attainability Analysis to support a modification of an effluent limit.[9]

> For discharge permit applications filed after the date of adoption of these regulations, modification of effluent limits described above may be granted on a case-by-case basis. The Water Quality Administrator shall review all requests for modification of effluent limits submitted under this section and make a determination based upon the technical merits of a Use Attainability Analysis. Such requests shall also provide a signed "letter of agricultural or wildlife use" by the land owner specifically requesting that the discharge will serve a specific agricultural or wildlife use.

App. H(c)(ii).

Lastly, and perhaps most importantly, Appendix H contains a critical safeguard to limit the possibility that a modification of an effluent limit granted by the DEQ will violate Wyoming's water quality standards: "**In no case will a modification of the effluent limit described above be permitted which would result in a violation of Wyoming Water Quality Rules and Regulations, Chapter 1.**" App. H(c)(iii) (emphasis added).

<u>Discussion</u>

As discussed below, the permit proposed by the DEQ to authorize Aethon to discharge waste water to the surface fails to comply with applicable regulations in Chapter 1, Chapter 2, and Chapter 2 Appendix H. Under these circumstances the DEQ may not lawfully approve Aethon's proposed discharge permit.

In order for Aethon's proposed discharge to be lawful, the DEQ must first determine, as a threshold matter, that the produced water: 1) be of good enough quality to be used for wildlife or

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[9] A previous attempt by the DEQ to establish a site-specific chloride standard for Badwater Creek was unsuccessful. The Statement of Basis notes, however, that Badwater Creek remains a "candidate stream segment" for a relaxed chloride standard.

livestock watering or other agricultural uses, *and* 2) is actually put to such use during periods of discharge. App. H(a)(i). If the DEQ cannot demonstrate that both of these two distinct legal requirements are met, the permit cannot issue. Even if those threshold requirements are satisfied, the DEQ must also ensure that 3) the produced water is free of fracking and well completion/stimulation chemicals and other toxic materials,[10] and that 4) water quality standards are met. And in this instance, because the DEQ is proposing modifications to effluent limitations set forth in Appendix H(b)(vii) for chlorides and total dissolved solids, additional restrictions contained in Appendix H(c)(i) apply. Our review shows that the DEQ has failed to satisfy any of the applicable requirements.[11]

**The quality of the water produced from Aethon's oil and natural gas wells in the Moneta Divide Field is not of good enough quality for wildlife or livestock.**[12] The DEQ's draft permit has proposed a modification to the effluent limits in Appendix H for chloride and TDS, and the DEQ has presented no information indicating that produced water containing the higher concentrations sought by Aethon is of good enough quality for wildlife and livestock.[13] Appendix H sets the chloride limit at 2,000 mg/L. The draft permit increases the permissible concentration to 2,419 mg/L. Appendix H sets the TDS limit at 5,000 mg/L. The draft permit increases the permissible concentration to 6,400 mg/L. The concentration limitations are applied on a facility wide basis (after mixing), which is unlawful. Aethon SOB at 3, note 1.

We presented information to the DEQ in a letter dated June 19, 2019, indicating that the produced water in Aethon's discharge may in fact not be of good enough quality for livestock or wildlife. *See Water Quality for Wyoming Livestock and Wildlife, A Review of the Literature Pertaining to Health Effects of Inorganic Contaminants*, available at: http://www.wyomingextension.org/agpubs/pubs/B1183.pdf

For example, Table 2 of Aethon's application shows a TDS concentration of 5940 mg/L as representative of the quality at each of the outfalls. Yet the DEQ's 2007 water quality report concludes: "We do not recommend relying upon TDS to evaluate water quality for livestock and wildlife; however, if no other information is available, TDS concentrations less than 500 mg/L should ensure safety from almost all inorganic constituents. Above 500 mg/L, the individual constituents contributing to TDS should be identified, quantified, and evaluated." *See* DEQ Water Quality Report at 50. Despite this warning, the draft permit proposes to grandfather a TDS limit of 6,400 mg/L, more than twelve times greater than the threshold recommended in the

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[10] According to the Statement of Basis, "This permit does not cover activities associated with discharges of drilling fluids, acids, stimulation waters or other fluids derived from the drilling or completion of the wells. SOB at 1.

[11] For additional discussion, please see our June 19, 2019, letter to Kevin Frederick, Administrator, Water Quality Division, requesting deferral of agency action on WYPDES Permit No. WY0002062 (Aethon Energy Operating, LLC). We hereby incorporate that letter by reference as if fully set forth below, and ask that it be considered along with the points and arguments made in this comment letter.

[12] Because livestock and wildlife have easy access to the produced water as it flows from the end of the pipe into unnamed drainages, the effluent limits must be met at the end-of-pipe at each outfall, rather than on a "facility wide basis" after mixing as proposed by the DEQ.

[13] Although the DEQ has purportedly determined that the effluent concentration limits contained in Appendix H (b)(vii) (A–D) are protective for stock and wildlife, no such determination has been made for the modified limits proposed by the DEQ in the draft permit.

DEQ's 2007 report. Because the DEQ is proposing to grandfather TDS concentrations that exceed the Appendix H limits, the agency must demonstrate that the higher levels in the effluent will not harm wildlife or livestock. It has not made such a finding, or even presented information that suggests the higher TDS level in the produced water meets the "of good enough quality" standard.

Similarly, we brought to the DEQ's attention in our June 19, 2019 letter that "a wide range of chemicals are used for hydraulic fracturing operations, including chemicals that are toxic or otherwise hazardous, as well as many chemicals with unknown environmental and public health profiles." June 19, 2019 Letter at 3–4. Many of these chemicals are used for hydraulic fracturing in the Moneta Divide oil and gas field, and may be discharged (unlawfully) into surface waters as flowback despite the prohibition against the discharge of any oil field wastes except those found naturally in the produced water.

The DEQ should heed the advice of the experts it paid to produce this report, and identify, quantify, and evaluate the individual constituents comprising the TDS discharged from Aethon's facility. Based on the findings presented in the DEQ's water quality report, the effluent limits for sulfate and TDS contained in the draft permit may be harmful to livestock and wildlife. Additional information is needed to characterize the TDS in the produced water and evaluate the individual constituents before making a determination as to the suitability of the produced water for livestock and wildlife use.

As to fracking chemicals, Paragraph 13 of the DEQ's application for oil and gas production unit discharges requires the applicant to "[p]rovide a list of all potential pollutants expected to be in the discharge and an explanation of their presence in the discharge." In this instance, Aethon merely indicated that "[t]race amount[s] of Petroleum Hydrocarbons due to oil production and Total Dissolved Solids" would be present, without disclosing any other constituents. The DEQ has a legal obligation to ensure that no chemicals or other pollutants—other than those that occur naturally in the produced water—are discharged into the state's surface waters. 40 C.F.R. § 435.50; Wyo. Rules & Regs. Dep't of Envtl. Quality, Water Quality, Ch. 2, App. H(b)(ix).[14]

As required by the second prong of the rule, the **DEQ has also failed to demonstrate that the produced water will actually be put to such use during periods of discharge**. There is no information in the application, Statement of Basis or draft permit addressing this requirement.

Even when the two threshold requirements have been met (i.e., good enough quality and actual use), an applicant seeking a modification of an effluent limit is not out of the woods yet. The effluent limitation modification available under Appendix H(b)(vii) may only be granted on

[14] Aethon has applied for a renewal of a WYPDES permit that authorizes the discharge of produced water to waters of the state. The DEQ defines produced water as "underground water which surfaces through oil and/or gas wells. Ch. 2, Sec. 3(b)(lxxx). Any naturally occurring pollutants in the formation water would be subject to all applicable effluent limitations and would have to comply with water quality standards.

a "case-by-case basis" for a particular "discharge in question" if one or more additional conditions have been satisfied:

- The original permit application was submitted prior to September 5, 1978;[15] *and*

- The modification of the effluent limits described above is considered and granted on a case-by-case basis; *and*

- Any one of the following:

    1. A signed "letter of beneficial use" from the land owner specifically requesting that the discharge in question be allowed to continue; or

    2. A signed statement by the Wyoming Game and Fish Department in which it was stated that the discharge in question is of value to fish or wildlife; or

    3. Documentation from the owner or operator of the discharging facility that, because of extenuating circumstances (volume of discharge, individual chemical constituents, nature of the area in which the discharge occurs, etc.), an exemption should be considered. The user must have indicated the exact beneficial use of the water (stock watering, irrigation, etc.) and the history of such use.

Only when *all* of these conditions are met may the DEQ consider granting a modification of an effluent limitation specified in Appendix H(b)(vii). The June 10, 2002 blanket statement by Wyoming Game and Fish Department that "discharges of produced water from WYPDES-permitted oil production units in Wyoming, *existing as of June 10, 2002*, are being used to enhance wildlife propagation and habitat" does not meet the requirements of 40 CFR Part 435 that requires the determination be made on a case-by-case basis. *See* DEQ Permit Renewal Application at 8. Reliance on a blanket statement is not sufficient to satisfy this case-by-case requirement. This is illustrated by the 2007 Water Quality for Wyoming Livestock and Wildlife published by DEQ, which indicates that produced waters can have negative health effects on wildlife, which is contrary to a blanket statement that produced waters is beneficial to wildlife propagation and habitat. Additionally, the TDS and chloride effluent limits exceed the effluent limits set forth in Appendix H. If Wyoming Game and Fish Department intended a blanket statement in the 2002 letter, the limits for TDS and chloride would have been the Appendix H limits, not the higher limits included in this draft permit.[16] Because DEQ relies on a blanket statement rather than a case-by-case analysis for the beneficial use exception, the DEQ may not lawfully issue the discharge permit.

## B. The Draft Permit Violates Water Quality Standards.

[15] Elsewhere in these comments we argue that any action by the DEQ "grandfathering" effluent limitations contained in the "original" permit application(s) filed before September 5, 1978 would not extend to the pending renewal application for WY0002062.

[16] The DEQ's failure to comply with water quality standards is discussed in detail, below.

**"No person shall cause, threaten or allow violation of a surface water quality standard contained herein."**

*See* Chapter 1, Wyoming Surface Water Quality Standards, Section 1, Authority.

As discussed in detail below, our review shows that effluent limitations and other conditions proposed in Aethon's draft permit do not ensure compliance with Chapter 1, Wyoming Water Quality Standards. Violations of standards (and other requirements) begin at the outfalls,[17] and continue downstream in Alkali Creek, Badwater Creek, Boysen Reservoir, and in the Class 1 segment of the Wind River below Boysen Dam.

A water quality standard consists of a designated use, water quality criteria to protect the use, and an antidegradation policy. By law, numeric and narrative standards contained in Chapter 1 must be used to establish effluent limitations for point source discharges. Effluent limits must be placed on pollutant discharges to protect designated uses and the water quality necessary to support those uses. The effluent limitations and other restrictions contained in the draft permit are not sufficient to ensure compliance with water quality standards in Alkali Creek, Badwater Creek, Boysen Reservoir, and in the Class 1 segment of the Wind River. Each of these surface waters is discussed below.

i. *Alkali Creek*

Alkali Creek is a Class 3B stream. The designated use assigned to this classification is "aquatic life other than fish."

> Class 3B waters are tributary waters including adjacent wetlands that are not known to support fish populations or drinking water supplies and where those uses are not attainable. Class 3B waters are intermittent and ephemeral streams with sufficient hydrology to normally support and sustain communities of aquatic life including invertebrates, amphibians, or other flora and fauna which inhabit waters of the state at some stage of their life cycles. In general, 3B waters are characterized by frequent linear wetland occurrences or impoundments within or adjacent to the stream channel over its entire length. Such characteristics will be a primary indicator used in identifying Class 3B waters.

Ch. 1, Section 4(ii).

As noted earlier, the DEQ is responsible for protecting designated uses. With respect to "Aquatic life other than fish," the rules provide that: "This use includes water quality and habitat necessary to sustain populations of organisms other than fish in proportions which make up diverse aquatic communities common to the waters of the state . . ." Ch. 1, Section 3(g).

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[17] We address Chapter 2 Appendix H end-of-pipe requirements elsewhere in our letter.

The Statement of Basis explains that produced water from the outfalls flows into multiple unnamed drainages and then into Alkali Creek. Our review shows that aquatic life will not be protected by the terms contained in the draft permit, resulting in violations of water quality standards. In particular, we reference a Memorandum ("Bergman-Meyer report") prepared by two renowned aquatic biologists known to many in Wyoming: Dr. Harold Bergman, Professor Emeritus, University of Wyoming, and Dr. Joseph Meyer, former UW faculty member and Chief Scientist, Applied Limnology Professionals, in Golden, Colorado. In their report, the scientists describe numerous critical deficiencies and omissions in the Statement of Basis and draft permit that must be addressed, and project, based on aquatic toxicity modeling developed at the University of Wyoming, acute lethality of aquatic test species in Aethon's produced water. The Bergman-Meyer report is included with this letter as an Exhibit and we hereby adopt and incorporate the Bergman-Meyer report by reference as if fully set forth below.

Protecting designated uses, and the water quality necessary to sustain those uses—which in the case of Alkali Creek, is "aquatic life other than fish"—is a basic requirement of the Clean Water Act and the Wyoming Environmental Quality Act, yet the use is not and cannot be protected under the terms of the permit. The DEQ is prohibited by its rules from issuing a discharge permit that would "cause, threaten or allow" a violation of a water quality standard, and thus may not proceed with the issuance of the Aethon permit renewal.

ii. *Badwater Creek* [18]

Badwater Creek is a Class 2AB water body. Bergman and Meyer note in their report that "adverse effects on aquatic invertebrate communities in Alkali Creek and adverse effects on fish and invertebrates in Badwater Creek would be expected if untreated produced waters are not adequately diluted with good-quality water." Report at 8. Unfortunately, it appears that the scientists are correct. Aethon's modeling report states that "[b]ased on discussions with WDEQ, the stream does not support its classified uses . . ." ERM Report at 24. Given this known and documented impairment (which we understand is related to chloride concentrations that exceed 230 mg/L) the DEQ is forbidden from issuing a discharge permit that would exacerbate the impairment.

iii. *Wind River Below the Dam, Class 1.*

The bulk of the DEQ's Statement of Basis addresses impacts to the Class 1 segment of the Wind River. The DEQ concludes, based on an over 600-page modeling report prepared by Aethon's contractor, Environmental Resources Management, that impacts to the Class 1 segment would be insignificant, and that all regulatory requirements would be achieved. As discussed below, the DEQ's determinations regarding impairment to the Class 1 designation and River are erroneous, and its reliance on the ERM report to justify its determinations is unlawful.[19]

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[18] According to local legend, Badwater Creek was not named due to poor water quality as one might reasonably assume, but rather because Tipis placed by Native Americans along the stream would sometimes be washed away in flood events: hence the name, "Bad Water."

[19] The ERM report contains a significant disclaimer regarding use of the report. It states: "ERM prepared this report for the sole and exclusive benefit and use by Aethon Energy Operating LLC. Notwithstanding

Wyoming Outdoor Council and other signatories to this letter commissioned an independent review of the modeling report prepared by ERM and the model itself. The results of that investigation demonstrate that, because of significant flaws and omissions, the report cannot be used for purpose of regulatory compliance. The report is attached as an exhibit, and is hereby adopted and incorporated by reference herein, as if fully set forth below.

The draft permit prepared by the DEQ for the Aethon's proposed discharge is incomplete, inadequate, unlawful and utterly irresponsible. The DEQ must deny the permit and start over.

**C. The Draft Permit Violates Antidegradation Requirements.**

The Statement of Basis (SOB at 9,10) includes a discussion of the antidegradation review required by Chapter 1. Intended to achieve the Clean Water Act's goal of restoring and maintaining water quality, antidegradation is the third and arguably most important component of a water quality standard. Despite the DEQ's claim of regulatory compliance, our review shows that the draft permit violates Wyoming's antidegradation requirements for Alkali Creek (Class 3B) and Badwater Creek (Class 2AB). Although not disclosed in the SOB or draft permit, evidence exists showing existing and ongoing water quality impairment in both Alkali Creek and Badwater Creek. Next, the SOB lacks any analysis whatsoever to support the agency's antidegradation determination regarding Boysen Reservoir. Last, as discussed in the attached Hydros report, due to a number of significant deficiencies in the model, the ERM modeling report cannot be relied upon by the DEQ to support its determinations regarding degradation, or the absence thereof, in the Class 1 segment of the Wind River.

i. Regulatory requirements.

The DEQ's antidegradation requirements are set forth in Chapter 1, Section 8, and provide as follows:

> (a) Water uses in existence on or after November 28, 1975 and the level of water quality necessary to protect those uses shall be maintained and protected. Those surface waters not designated as Class 1, but whose quality is better than the standards contained in these regulations, shall be maintained at that higher quality. However, after full intergovernmental coordination and public participation, the department may issue a permit for or allow any project or development which would constitute a new source of pollution, or an increased source of pollution, to these waters as long as the following conditions are met:
>
> (i) The quality is not lowered below these standards;

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delivery of this report by ERM or Aethon Energy to any third party, any copy of this report provided to a third party is provided for informational purposes only, **without the right to rely.**" ERM report at 16 (emphasis added).

(ii) All existing water uses are fully maintained and protected;

(iii) The highest statutory and regulatory requirements for all new and existing point sources and all cost effective and reasonable best management practices for nonpoint sources have been achieved; and

(iv) The lowered water quality is necessary to accommodate important economic or social development in the area in which the waters are located.

(b) The Water Quality Administrator (administrator) may require an applicant to submit additional information, including, but not limited to, an analysis of alternatives to any proposed discharge and relevant economic information before making a determination under this section.

(c) The procedures used to implement this section are described in the Antidegradation Implementation Policy.

ii. Discussion

*Alkali Creek (Class 3B).* Alkali Creek is the first classified receiving water downstream of the outfall, and is entitled to the Tier 1 "basic" level of antidegradation protection. SOB at 9. *See* 40 CFR 131.12(a)(l). At its core, Tier 1 protection requires the DEQ to protect existing uses—and the quality of water necessary to maintain those uses. The SOB claims that "[t]he effluent limits for protection of this stream are set to the applicable class 3B standards . . ." suggesting (without evidence) that existing instream uses are protected. SOB at 9. This claim is not true.

Alkali Creek has been severely impaired by oil field wastewater, and the impairment has worsened over time as the Moneta Divide field has expanded to its current size of over 800 oil and gas wells. *See* Moneta Divide DEIS at 1-5. Although neither the SOB nor draft permit discuss the condition of this creek, the BLM's DEIS for the Moneta Divide oil and gas project expansion paints a grim picture regarding the existing condition of this desert stream:

> Discharge of produced water from oil and gas production has created perennial flowing tributaries to Alkali Creek and perennial reaches in Alkali Creek. Discharge water has supported wetland establishment and is used by wildlife and for livestock watering purposes. Perennial flows in those formerly ephemeral drainages have caused disturbance of the drainage beds and inundation and destruction of drainage vegetation, which in turn has led to accelerated erosion. In addition, continuously saturated soils have less strength to withstand scour and erosion, and increased freeze/thaw activity has also increased erosion. In the small ephemeral channels below the outfalls, the dominant fluvial process has been largely degradational with lesser areas of deposition distributed throughout the reaches. In Alkali Creek both degradation (scour) and deposition processes are occurring. Over time, these processes have increased downcutting (downward erosion) in tributary channels, which has created site conditions unfavorable to

> livestock movement, grazing and watering, and increased sediment loading in Alkali Creek (Oasis Environmental 2010). Some upper reaches of Alkali Creek have springs that create intermittent to perennial pools which contain fish.
>
> Aethon conducts ongoing channel stability, erosion, and streamflow monitoring at several locations in Alkali Creek in accordance with the Wyoming DEQ WYPDES Discharge Permit WY0002062. As indicated in the 2018 monitoring report, the surveyed reach of Alkali Creek above the point of discharge is well vegetated, including in the channel bottom. The surveyed reach has been stable, and no scour or aggradation has been noted. In the assessment reaches downstream from discharge points, channel changes include scour, degradation, and aggradation of sediment. Bank loss has occurred at various points. The largest occurrences of channel scour occur during spring runoff or storm runoff where channel scour is facilitated by saturated soils in the channel and loss of channel vegetation because of permanent discharge.
>
> In 2016 ERM performed a stability study on Alkali Creek using the [U.S. Department of Agriculture CONCEPTS] model. The model indicates that for the modeled reach streambed degradation may lower the streambed up to 1.5 feet under a modeled project discharge of 16 cfs combined with storm events for 8 years. For a modeled project discharge of 6.5 cfs, some sections of the streambed would experience downcutting, while others would experience deposition (ERM 2016).

*See* Moneta Divide DEIS, 3.6.2.2 Description of Surface Water Hydrology in Badwater Subbasin, Lower Wind Subbasin East of Boysen Reservoir, and Muskrat Subbasin at 3-59 (internal citations omitted).

The ongoing modification ("grandfathering") through multiple permit renewals of TDS and chloride effluent limitations that exceed limits contained in Appendix H are undoubtedly contributing factors, along with increasing volumes of produced water carrying heavier salt loads, and general neglect of the regulatory agencies and the field operators. Given the conditions reported in the BLM's DEIS, it is disappointing that the DEQ's on-the-ground inspection of this facility in June, 2018 noted no violations of the discharge permit, despite that fact that compliance with Chapter 2, Appendix H and water quality standards is a core requirement of the permit.[20]

The DEQ inspection report did note odors at all operational outfalls (001, 003, 006, and 009) indicating potential violations of Chapter 1, Section 17's restriction on detectable odors. And Professor Bergman's and Dr. Meyer's June 27, 2019 Memorandum indicate that chloride and TDS concentrations authorized in the existing permit are harmful to aquatic life. Although protection of existing uses is a fundamental requirement of the Clean Water Act, it is clear that high chloride concentrations and other pollutants present in the effluent and in Alkali Creek are

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[20] *See* Letter from Eric Moore, WDEQ WYPDES Inspector, to Andrea Taylor, HSE and Regulatory Manager (July 31, 2018), re: WYPDES Discharge Permit: WY0002062 - Frenchie Draw Permit #1 (transmitting a copy of the DEQ written inspection report.)

preventing the attainment of designated "aquatic life" uses in violation of Chapter 1. All evidence suggests that the DEQ is failing to meet the "basic" antidegradation requirements for Tier 1 waters. If the DEQ disagrees with this characterization, it is free to modify its antidegradation review and set the record straight.

*Badwater Creek (Class 2AB).* As bad as the problems are in Alkali Creek, they appear worse in Badwater Creek. As noted in the SOB, Badwater Creek is considered a "Tier 2" high quality surface water. For high quality waters, Chapter 1 provides that: "Those surface waters not designated as Class 1, but whose quality is better than the standards contained in these regulations, shall be maintained at that higher quality." As discussed below, the DEQ has failed not only to maintain the higher water quality required of Tier 2 streams, it has failed to maintain even the most basic Tier 1 level of protection. *See* Ch. 1, Section 8(a). In fact, the agency has failed to comply with every single requirement enumerated in Section 8 for Tier 2 waters:

- The quality of Badwater Creek has in fact been lowered below the applicable standards;

- Existing water uses of Badwater Creek have in fact not been fully maintained and protected;

- The highest statutory and regulatory requirements have in fact not been achieved (indeed, the SOB and draft permit proposed to grandfather chloride and TDS at levels that exceed the minimum regulatory requirements in Appendix H); and

- The DEQ has in fact not made a determination that "lowered water quality is necessary to accommodate important economic or social development in the area in which the waters are located."

The DEQ's assertion in the SOB that "continued discharges from this facility will not result in significant degradation of Badwater Creek" is insupportable. For starters, Aethon's modeling report indicates that, "Based on discussions with WDEQ, the stream does not support its classified uses and did not require assessment of water quality impacts." ERM at 24.[21] Second, due to chloride concentrations that exceed Chapter 1 Appendix B water quality criteria,[22] Badwater Creek has no assimilative capacity for chloride. And the presence of other pollutants, such as temperature, that exceed Appendix B standards is also likely. Third, the review has failed to consider the fate of the large chloride and TDS mass loads from the produced water discharge (up to 719 tons per month for chloride and 2161 tons per month TDS) as it is transported in Alkali and Badwater Creek and into Badwater Bay. The DEQ did not consider the effects of chloride and TDS mass loading that may catalyze chemical reactions that may result in degradation of water in Alkalai Creek or Badwater Creek that would result in exceedances of Class 2AB standards. *See* Mike Wireman report, Comment #3, attached hereto as an Exhibit and incorporated by reference herein as if fully set forth below..

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[21] We obviously disagree with this conclusion—the DEQ is clearly responsible for ensuring that a point source discharge does not violate a water quality standard.

[22] Rather than including a legally required effluent limitation in the permit, the DEQ has proposed a multi-year compliance schedule to address excessive chloride.

Yet the SOB asserts that "WDEQ's review has concluded that continued discharges from this facility will not result in significant degradation of Badwater Creek." Really? The evidence shows that significant degradation—as defined in the DEQ's antidegradation policy—is already occurring; consequently, the DEQ cannot legally move forward with an action that would further degrade a "high quality" Tier 2 surface water, especially when it is not even meeting the basic Tier 1 level of protection.

Were Badwater Creek not so severely impaired, we might be suggesting that the socioeconomic analysis and evaluation of alternatives described in Chapter 1, Section 8(b) be conducted as part of the permitting process, but we do not want to create the impression that this discharge can be authorized, or the impacts would be lessened, with additional study. Those analyses are triggered under the DEQ's antidegradation implementation policy and are based on a determination of significance. Section 4(a)(i). The existing level of impairment in Badwater Creek exceeds all measures of significance as defined in this section, and the time for those studies has long since passed.[23]

*Boysen Reservoir (Class 2AB)*. As noted earlier, due to the complex and technical nature of Aethon's application, we retained the services of a professional engineering firm with considerable experience in the highly specialized field of reservoir water quality modeling. The attached Final Technical Memorandum (July 1, 2019) prepared by Dr. Jean Marie Boyer with Hydros Consulting[24] (hereinafter "Hydros Report") reveals numerous significant flaws with the model and the 600+ page model report provided to DEQ.[25]

With respect to the possible degradation to Boysen Reservoir from the expanded discharge, the SOB indicates that:

> WDEQ has reviewed the expected mixed concentrations of effluent within the Boysen Reservoir system, and has determined that the above condition is maintained. No pollutants from this facility are expected to result in mixed concentrations that consume 20% or more of the available assimilative capacity within the lake. Therefore, WDEQ's review has concluded that continued discharges from this facility will not result in significant degradation of Boysen Reservoir. In addition, the discharges will not result in any impairments of the

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[23] As the DEQ knows, there are viable alternatives to the proposed discharge to Alkali and Badwater Creeks, and the DEQ is responsible under its rules for evaluating them. As described in the BLM's Moneta Divide DEIS, "the proposed treatment strategy would treat water to meet or exceed Class I standards [and pipe to Boysen Reservoir]. The quality of the highly treated produced water would be of equal quality, or better, as that of water exiting the Boysen Reservoir." Moneta Divide DEIS, Appendix K Water Management Plan prepared by Encana Oil & Gas (USA) Inc., dated June 2014, at 9. If Aethon is serious about expanding the Moneta Divide field, we respectfully suggest that it take a close look at Appendix K Water Management Plan prepared by Encana Oil & Gas (USA) Inc., dated June 2014.

[24] Professional licensure in Wyoming pending before the Professional Board of Engineers and Professional Land Surveyors.

[25] We hereby incorporate the Hydros report by reference into our comments as if fully set forth below.

> lake, or lowering of water quality below the criteria established in Wyoming's standards.

SOB at 10.

The DEQ has not provided, nor has it referenced in the single paragraph devoted to this topic, any analysis to support its conclusion that the discharge will not result in any impairments, or significant degradation of Boysen Reservoir.[26] The SOB merely contains unsupported "conclusions" and "determinations" without any explanation of how the agency came to its conclusions. The Hydros Report reveals that "ERM failed to conduct an antidegradation analysis for Boysen Reservoir." Hydros Report at 25. Therefore, the analysis, if it exists, would have to be found in the Statement of Basis. It is not.

Without any discussion of how the DEQ reached its conclusions regarding impairment to Boysen Reservoir, the DEQ's antidegradation determination is deficient on its face and cannot be used to justify or support the agency's findings.

*Wind River Below Boysen Dam (Class 1).* The Statement of Basis correctly points out that Class 1 waters are "Outstanding waters . . . in which no further water quality degradation by point source discharges other than from dams will be allowed. The water quality and physical and biological integrity which existed on the water at the time of designation will be maintained and protected." Ch. 1, Section 4(a). Class 1 waters are subject to the highest level of antidegradation protection, "Tier 3." *Id.*

Despite this clear mandate, the DEQ has determined—through a previously unpublished policy—that "new and expanded discharges to tributaries of Class 1 waters are allowable in Wyoming under certain conditions, as outlined in Section IV of WDEQ's Policy on Establishing Effluent Limits for Permitted Point Source Discharges to Class 1 Water Tributaries (August, 2007).

Based on a modeling report submitted by the applicant,[27] the DEQ determined that the proposed discharge is "consistent with provisions in the above referenced Class 1 policy, and therefore conforms with requirements for achievement of Tier 3 water quality protection in the Wind River below Boysen Dam."[28]

With respect to potential impairment of the Wind River, we fundamentally disagree with the DEQ's conclusions. The agency's conclusions are based on a deeply flawed study, and the

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[26] We assume that is because no such analysis exists. If an antidegradation analysis was conducted by the DEQ as part of its antidegradation review, the agency has failed to document it and share it with the public for review.

[27] The report was prepared by Environmental Resources Management (ERM) based in Malvern, PA. As others have pointed out, ERM is not licensed to practice in Wyoming and the report does not bear the certificate of a Wyoming- licensed professional engineer.

[28] Beyond its obvious flaws, this internal "interim" DEQ policy was not subject to public notice and comment, and was apparently not approved or even reviewed by the Water Quality Advisory Board, and therefore cannot be relied upon in this circumstance.

application of an internal "interim policy" which, up until this matter, had never before seen the light of day.

The Hydros report identified "several severe and alarming issues" concerning ERM's antidegradation review for the Class 1 Wind River and described the implications of this flawed document thusly:

- **The Reservoir Model Cannot be Used for Decision Making; and**
- **The Compliance Analysis Methods and Findings are Incorrect.**

Major deficiencies identified by Hydros are listed in the summary section of their report, excerpted below:

> **SUMMARY**
>
> ERM developed a mechanistic hydrodynamic water-quality model of Boysen Reservoir to support permitting and to determine conditions for Aethon's project that would "protect downstream surface water quality in Badwater Creek, Boysen Reservoir and the downstream Class 1 segment of the Wind River Below Boysen Reservoir, as well as require Aethon to uphold Wyoming's antidegradation policies."
>
> There are very serious issues related to the development, evaluation, and use of the Boysen Reservoir Model. Our review of the reservoir model documentation and reservoir model files revealed critical concerns. Highlights include:
>
> **The Model was not Developed Properly and Does not Account for Factors Important for this Project**
>
> - Density changes anticipated in the future for water flowing into Badwater Bay, (important for flow patterns) were completely ignored.
> - Releases to the Wind River (low-level outlet vs. spills) were not differentiated.
> - Releases to the Wind River were not density based.
> - Wind speeds were severely and unrealistically reduced without discussion.
> - Reservoir evaporation was not considered.
> - Several water balance and water quality input assumptions and adjustments were made without justification.
>
> **Model Performance was Not Evaluated Appropriately and is Misleadingly Communicated**
>
> - ERM misleadingly claims that the reservoir model is calibrated and adequately simulates Wind River (Class I segment) water quality. This is done by comparing water-quality measurements in the river to water quality simulated in the top two feet of the reservoir. This is disturbing, wrong, and was done even though the reservoir stratifies and has a low-level outlet.

- There are numerous instances of excluding meaningful data during the calibration/validation process (including all non-profile reservoir data and all data during periods of highest percent produced water).
- Information was misleadingly concealed from the reader by only displaying the top portion of profile results and observations.
- The model is not calibrated and the results are poor.

**<u>"Compliance Analysis" Methods and Findings are Flawed and Incorrect</u>**

- Baseline conditions for the Class I segment excluded valid USGS data.
- Methods used to show compliance for the Class I segment:
  - Used monthly averages, leading to the conclusion of reduced impacts.
  - Used inflated and incorrect values for standard deviation.
  - Relied on favorable assumptions for Category III constituents
- An antidegradation analysis for Boysen Reservoir was not conducted.

> Based on how the model was developed and the results, the reservoir model cannot be used for projections or decision making. In addition, even if the model adequately simulated water quality, the methods used to determine compliance are inadequate, sometimes wrong, and several assumptions were made to show favorable results.
>
> According to the WDEQ (2019b), "Model was designed to ensure compliance with WQS applicable to Boysen and to maintain existing quality in the Wind River below Boysen." Unfortunately, this is not a true statement.

Hydros Report at 25–26.

Based on the thorough review and analysis detailed in the Hydros report, reliance by DEQ on the ERM report to support its antidegradation findings regarding the Class 1 segment of the Wind River is severely misplaced, and continued reliance on such a fundamentally flawed document would be insupportable.

### D. The DEQ Cannot Lawfully Justify the Practice of "Grandfathering" Harmful Concentrations of Pollutants that Violate Water Quality Standards and Impair Water Quality.

For several decades, the DEQ has authorized the discharge of massive quantities of salt-laden produced water from the Frenchie Draw field into Alkali and Badwater creeks. Previous discharge permits issued by the DEQ show that volumes of produced water and salt loads discharged from this field peaked in 2009–10, with **TDS loads exceeding 3036 tons per month** and effluent concentrations averaging **7456 mg/L**, well above the **5000 mg/L limit** specified in Appendix H. In a January 1, 2009 permit renewal, the Statement of Basis states as a matter of fact that "this facility is exempt from end-of-pipe effluent limits for chlorides, sulfates, specific conductance and total dissolved solids."

As discussed elsewhere in this letter, this exemption has caused and continues to cause significant impairment to Alkali and Badwater creeks, and poses an ongoing threat to water quality in Boysen Reservoir and in the Class 1 segment of the Wind River below the dam. Yet it continues, even though the practice is patently unlawful. The DEQ's own rules prohibit it from approving a modified effluent limit that would result in a violation of water quality standards, yet that is exactly what is happening here. Appendix H makes this perfectly clear: "In no case will a modification as described in paragraph (c)(i) or (c)(ii) of this appendix be permitted which would result in a violation of Wyoming Water Quality Rules and Regulations, Chapter 1." *See* Ch. 2, App. H(c)(iii). This abuse of Appendix H's grandfathering provision has caused unnecessary and unlawful impairment in both Alkali Creek and Badwater Creek and must stop now.

EPA has provided clear and unequivocal guidance regarding "grandfathering"; "grandfathering" discharges is impermissible under the CWA. Specifically, EPA has stated in its NPDES state program guidance that "[o]ther States have attempted to 'grandfather' or exempt discharges already in existence . . . [s]uch schemes are inconsistent with the CWA." Chapter Three: Statutory Authority and the Attorney General's Statement, National Pollutant Discharge Elimination System State Program Guidance for Development and Review of State Program Applications and Evaluation of State Legal Authorities (40 CFR Parts 122–125 and 403) Volume One (July 29, 1986) at 3-6–3-7.

Yet the modification was allowed to continue as the oil field expanded through multiple field ownerships, and through multiple renewals and modifications (both major and minor) of the discharge permit. In several 2010-era permit actions, it appeared that the DEQ was committed to reducing TDS loads from this field "to the pre-2009 grandfathered levels" which the DEQ stated was 908 tons per month. *See, e.g.,* Encana Oil and Gas Company, WY0002062, Statement of Basis for Minor Modification, dated 12/14/2010 (containing a compliance schedule to reduce TDS to 908 tons per month by January 1, 2013). But now, the DEQ is proposing to *increase* TDS limits to 2161 tons per month from 908 tons per month, and effluent concentration limits to 6400 mg/L for TDS (compared to Appendix H limit of 5000 mg/L) and 2419 mg/L for chloride (compared to Appendix H limit of 2000 mg/L).

The DEQ cites Appendix H as justification to modify effluent limits for outfalls 001 to 012. Yet Appendix H applies only "where the original permit application was submitted prior to September 5, 1978." Since the DEQ has not provided a copy of the "original permit application" the public is unable to verify that 12 outfalls were authorized in that original permit.

Assuming (for purposes of discussion only) that grandfathering in any form is lawful, the exception can only extend to the outfall(s) and to the discharge(s) that existed prior to September 5,1978. Were all 12 outfalls permitted and in operation prior to that date? If not, how does the DEQ justify grandfathering discharge permits that were issued after September 5, 1978?

i. History of outfalls.

The DEQ consolidated Encana WY0002062 (single outfall) with eleven other single-outfall permits in a permit "renewal" effective January 1, 2009. *See* Statement of Basis Renewal and Discharge Permit, Encana Oil and Gas Company, signed by the DEQ Director on 12/31/08.

The eleven existing permits that were consolidated with WY0002062 included: WY0002089, WY0002101, WY0025526, WY0025534, WY0025542, WY0027227, WY0027235, WY0027243, WY0027251, and WY0027456. The SOB clearly states that: **"This permit originally established a chloride limit of 230 mg/L at the end of pipe for discharge into Class 3B waters."** (Emphasis added). If that is the case, what is the basis for grandfathering the much higher effluent limits?

ii. <u>Outfalls 013, 014, and 015 were not grandfathered when approved and cannot be grandfathered now.</u>

As noted above, in December 2008, 12 outfalls were consolidated into a single permit, WY002062. In December 2010, the DEQ approved a minor modification to the permit that added two new outfalls, 013 and 014, and set effluent limits for those outfalls based on the limits contained in Appendix H. The Statement of Basis for the modification notes that: "Outfalls 013 and 014 include limits of 2000 mg/L of chloride and 3000 mg/L of sulfate, **a requirement of all non-grandfathered oil production unit WYPDES permits.**" (Emphasis added). The modification also added chloride and sulfate monitoring requirements for outfalls 001–012 for "data collection." This modification added a compliance schedule to ratchet down over a two-year period salt loads from 3036 tons per month to 908 tons per month.

Outfall 015 was added in a Permit Renewal effective 10/21/13, formerly WY0056791, outfall 001. The renewed permit retained Appendix H effluent limits on outfalls 013 and 014, and required the newly added outfall 015 to comply with Appendix H effluent limits for chloride (2000 mg/L); sulfate (3000 mg/L); and specific conductance (7500). In other words, grandfathering was not applied to outfall 015.

iii. <u>Outfall 016 cannot be grandfathered.</u>

Outfall 016 was approved in a Major Modification to the permit in April 2015.[29] This modification also added the Neptune Treatment Facility, established an interim effluent limit for TDS of 1760 tons per month (nearly doubling the existing 908 tons per month limit) during a four month start-up period, and included a compliance schedule that required the facility to limit TDS to no more than 908 tons per month for outfalls 001–016 effective September 1, 2015. The Statement of Basis for this modification indicates that "the new outfall location is at the stilling well at Pink Lake. Because the water source is largely from the grandfathered per Chapter 2 Appendix H sources, it is treated as such and there are no concentration limits for sulfate, chloride, specific conductance, or total dissolved solids." SOB at 1. Oddly, despite the preceding sentence, the modification retained Appendix H-based numeric effluent limits for outfalls 013–015, including effluent limits on chloride, sulfate, and specific conductance. As a newly approved outfall, outfall 016 should not have been grandfathered for the same reasons that 013, 014, and 015 were not grandfathered.

In sum, it is clear that outfalls 013, 014, 015, and 016 fail to meet the DEQ's own requirements for historical grandfathering (pre-September 5, 1978). These outfalls were not

[29] If Outfall 016 was added in April 2015, why does the DEQ's March 2019 SOB propose to "Add outfall 016"?

grandfathered when they came on-line, and there is no basis for grandfathering them now. This game of retroactive grandfathering must end. Not only for outfalls 113–016, but also for 001–012.[30]

**E. The Proposed Mixing Zone in Badwater Bay is Unlawful and May Not be Approved.**

The SOB indicates that a mixing zone will be established in Badwater Bay. As proposed, the mixing zone violates water quality rules and regulations set forth in Chapter 1, Section 9 of the Wyoming Surface Water Quality Standards.

Notwithstanding the legal violations, we believe that a mixing zone in Boysen Reservoir is fundamentally inappropriate and therefore would recommend that the facility achieve compliance with all applicable water quality standards at the point of discharge. Boysen Reservoir is a popular recreation destination and should not be relegated to oil field wastewater treatment. We encourage the DEQ to study alternatives that would avoid the creation of a mixing zone in the reservoir. However, should the DEQ insist on moving forward with this ill-conceived project, we offer the following comments on the proposal to establish a mixing zone in Badwater Bay.

A description of the proposed mixing zone is contained in the Statement of Basis in a single paragraph which is included below.

> Mixing Analysis in Boysen Reservoir: The GEMSS model used a bathymetric (3D) mixing approach to analyze potential impacts from this facility at the confluence of Badwater Creek and Boysen Reservoir. This is not a conventional mixing zone since the discharge facility is located approximately 40 stream miles up from this confluence. However, the permittee was tasked by WDEQ with analyzing potential impacts to the lake itself under worst case scenarios. The model found that complete mixing occurs, even under low natural flow conditions in Badwater Creek, before Badwater Creek fully enters Boysen Reservoir. The mixing area is estimated to be approximately 330 feet long east to west, and 730 feet wide, north to south. The location of this mixing area is at the far east end of Badwater Bay, right at the mouth of Badwater Creek. The mixing area location is not static, however, since the mouth of the creek migrates with lake levels and stream flow conditions. Based on the results of the analysis, WDEQ anticipates that adequate mixing will occur before discharges reach the full body of the lake, and that by setting effluent limits for protection of the Class 1 water below the dam, the water quality within the lake itself is also adequately protected.

SOB at 8.

With respect to regulatory compliance applicable to mixing zones, the DEQ's mixing zone rule provides that:

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[30] Indeed, in this proposed permit renewal, the DEQ recognizes that the practice of continued grandfathering is improper. The draft permit contains a compliance schedule that would require "full compliance with final chloride effluent limits" of 230 mg/L by July 1, 2023.

> Except for acute whole effluent toxicity (WET) values and Sections 14, 15, 16, 17, 28 and 29(b) of these regulations, compliance with water quality standards shall be determined after allowing reasonable time for mixing. Except for the zone of initial dilution, which is the initial 10% of the mixing zone, the mixing zone shall not contain pollutant concentrations that exceed the aquatic life acute values (see Appendix B). In addition, there shall be a zone of passage around the mixing zone which shall not contain pollutant concentrations that exceed the aquatic life chronic values (see Appendix B). Under no circumstance may a mixing zone be established which would allow human health criteria (see Appendix B) to be exceeded within 500 yards of a drinking water supply intake or result in acute lethality to aquatic life. The procedures used to implement this section are described in the *Mixing Zones and Dilution Allowances Implementation Policy.*

Chapter 1, Section 9 Mixing Zones.

In examining potential compliance with the above requirements, the following factors should be considered by the DEQ:

Badwater Bay is a nursery area for sauger, a WGFD sensitive species. The DEQ's mixing zone policy is clear that a proposed mixing zone "may be denied due to concerns about designated and existing uses or the following in the area affected in the discharge: (ii) Biologically important areas such as fish spawning or nursery areas." *See* Section 4(b)((ii).

The DEQ has not analyzed potential toxicity of Aethon's produced water to this species, or to aquatic life in general in Alkali or Badwater creeks. *See* Attached Memorandum prepared by Harold Bergman, Ph.D and Joseph Meyer, Ph.D. Among other things, the DEQ's failure to consider alkalinity and bicarbonate ion concentration, potassium, and pH in Alkali and Badwater creeks, coupled with the failure to consider actual water chemistry, reveals significant flaws in the permitting process that must be addressed before the DEQ can lawfully authorize the expanded discharge.

The water level in the bay fluctuates from year to year and seasonally, so the mixing zone will: 1) move farther out into the reservoir as water levels drop; and 2) lose dilution capacity as water levels drop. What is the basis for the conclusion that "WDEQ anticipates that adequate mixing will occur before discharges reach the full body of the lake, and that by setting effluent limits for protection of the Class 1 water below the dam, the water quality within the lake itself is also adequately protected"? It should be noted that polluted produced water containing high TDS, chloride, and sulfate will be entering Badwater Bay via Badwater Creek. End-of-pipe effluent limits proposed in the draft permit will exceed not only Appendix H limitations for some constituents, but also result in exceedances of in-stream numeric criteria for chloride (230 mg/L) in Badwater Creek. So, the claim that setting effluent limits that are protective of the Class 1 segment of the Wind River will also protect Badwater Bay is unfounded.

Has the geographic area described as "full body of the lake" been mapped and identified? How far out into the lake would the mixing zone need to migrate before it would reach the "full body of the lake"?

Since no actual water quality or flow data for Badwater Creek has been considered, what is the basis for the DEQ's conclusion that the mixing zone will comply with the DEQ's rules? High TDS, chloride, sulfate, and oil field chemicals contained in the existing discharges could already be stressing the sauger and other aquatic life, yet there is no discussion of existing pollution levels or dilution capacity in the receiving waters (i.e., Alkali Creek and Badwater Creek). Section 9 states that "Except for the zone of initial dilution, which is the initial 10% of the mixing zone, the mixing zone shall not contain pollutant concentrations that exceed the aquatic life acute values (see Appendix B)" but that is exactly what will happen in the case of chloride in Badwater Bay, which will exceed 230/mg/L as enters the mixing zone. The ERM modeling report (at 24) indicates that "[b]ased on discussions with WDEQ, the stream does not support its classified uses and did not require assessment of water quality impacts." It is clear that non-compliant concentrations of pollutants will enter the mixing zone at Badwater Bay, violating the DEQ's mixing zone rule. And contrary to the DEQ's claim, an assessment of impacts to Badwater Creek is most definitely required.

With respect to regulatory compliance, we see no reference in the SOB or draft permit to the "zone of initial dilution, which is the initial 10% of the mixing zone." Where is it? How is it identified? And, what happens when the mixing zones migrates due to low water in the bay? Given that the draft permit contains a monitoring requirement for Badwater Bay, which is "intended to monitor water quality in the lake after mixing," how will the permit reflect the location of the monitoring station which will undoubtedly migrate along with the mixing zone itself? *See* SOB at 9.

The Statement of Basis indicates that flows in Badwater Creek are reduced or even "approach zero during certain dry times of the year." SOB at 9. Yet the SOB states that "[t]he model found that complete mixing occurs, even under low natural flow conditions in Badwater Creek, before Badwater Creek fully enters Boysen Reservoir." This statement strains credulity. How can "complete mixing" occur if there is no natural base flow in Badwater Creek?

Aethon's modeling report eliminated pH from the analysis as a parameter of interest, claiming that "since the model was designed such that effluent pH from Aethon is in compliance with water quality standards and therefore will not require a mixing zone." ERM Report at 175. However, water chemistry analysis described in the Bergman-Meyer report explains that the pH of the produced water will likely increase as it flows down Alkali Creek and Badwater Creek, and not remain static. Thus, the failure to consider pH as a factor in the mixing zone study is a fatal flaw in the analysis that must be addressed in a revised permit if Aethon continues to advocate surface discharge into Alkali and Badwater creeks for disposal of produced water.

Regarding the "zone of passage" requirement in Section 9, the Aethon SOB describes a rectangular shaped mixing area "estimated to be approximately 330 feet long east to west, and

750 feet wide, north to south." Yet the DEQ's slide[31] clearly shows that water entering the bay disperses in a fan-shaped plume extending bank-to-bank, revealing both no clear passage way and serious fallacies with the argument that the mixing zone will be confined (in defiance of physics) to an arbitrarily drawn rectangle. Given this reality, where is the zone of passage in this mixing zone, and what is the scientific basis to support the DEQ's conclusions?

The DEQ's mixing zone implementation policy states that "Mixing zones in lakes shall not exceed 5% of the lake surface area or 200 feet in radius, whichever is more limiting." Mixing Zone Policy, Section 4(a)(ii). It appears that the mixing zone proposed by Aethon exceeds the "maximum allowable size" and therefore cannot be approved.

The mixing zone is in a popular recreation area, leading to "potential human exposure to pollutants resulting from . . . recreational activities." Mixing Zone Policy at Section 4(b)(iv). The proposed mixing zone should be rejected due to the potential for human exposure, particularly in children.

**F. The Draft Permit's Whole Effluent Testing Requirements Described are Inadequate.**

The approach described in the Statement of Basis and draft permit for whole effluent toxicity (WET) testing (acute and chronic) is insufficient to ensure compliance with the terms of the permit and other regulatory requirements.

To ensure that Chapter 2 Appendix H requirements are met, including "the produced water shall be of good enough quality to be used for wildlife or livestock watering," WET testing should be required at the end-of-pipe for each outfall, rather than from a sample consisting of "a flow-weighted composite from all discharging outfalls." SOB at 11. Wildlife and livestock will have access to the produced water as it flows from the outfalls into unnamed drainages; therefore the "good enough quality" standard must be met at each outfall, and toxicity testing must be done to ensure this and other Appendix H requirements are met ("Unless otherwise stated in the permit, effluent limitations shall be met at the outfall from the final treatment unit prior to admixture with water in the receiving surface waters of the state or with effluent from other outfalls." Ch. 2 Section 5(c)(iii)(Q)). As we noted in our June 19, 2019 letter, a range of potentially harmful chemicals—naturally occurring and deliberately introduced during the well drilling/completion/fracking process—may be present in the wastewater, and are not removed during the separation process described in the SOB.[32]

In addition to the failure to conduct WET tests at the end-of-pipe at each outfall, the timing and nature of the proposed WET testing fails to meet the requirements of the Clean Water Act. As recommend by Drs. Bergman and Meyers, WET testing should be required quarterly, rather than annually, and should include Ceriodaphnia chronic reproduction.

[31] http://deq.state.wy.us/wqd/WYPDES_Permitting/WYPDES_PNs_and_appr_permits/WYPDES_PNs/WYPDES_PNs_2019/2019-003/Moneta-Public-Meeting-Presentation_2019-0521.pdf

[32] The SOB states: "This facility is a gas production treatment unit that separates gas from formation waters at the surface using a gun barrel technology, and skim ponds and tanks." SOB at 1 (General Description).

EPA Region 8 previously identified deficiencies in WET testing Wyoming has been relying upon in its discharge permits. In July 2015, EPA Region 8 published a National Pollutant Discharge Elimination System (NPDES) Permit Quality Reviews (PQRs) Report for Wyoming, which evaluated a "a select set of NPDES permits to determine whether permits are developed in a manner consistent with applicable requirements established in the Clean Water Act (CWA) and NPDES regulations." United States Environmental Protection Agency Region 8, Region 8 NPDES Permit Quality Review Wyoming (Jul. 7, 2015), https://www.epa.gov/sites/production/ files/2016-03/documents/final_-_wy_pqr_report_2013_7-17-2015-508.pdf at 4. In its recommendations, EPA Region 8 made a series of "critical findings" that it describes as "[m]ost [s]ignificant" and that its "[p]roposed action items will address a current deficiency or noncompliance with respect to a federal regulation." Among these critical findings was that the DEQ's WET determinations do not comply with the CWA. *See id.* at 45. EPA Region.8 recommends the DEQ "document permitting decisions in fact sheets and administrative records of permits. Provide more information in fact sheets on how; WET RP is determined, acute or chronic requirements are selected, species modifications are approved, and how testing reductions are calculated and approved" in order to comply with the CWA and federal regulations. Yet, DEQ has failed to rectify the deficiencies EPA previously identified

### G. DEQ has Not Conducted a Reasonable Potential Evaluation in Violation of DEQ Regulations.

DEQ must establish water quality based effluent limitations (WQBELs) for all constituents in the permitted discharge that have a "reasonable potential" to adversely impact uses of downstream surface waters or cause violations of established water quality standards.

Thus far, the DEQ has not established WQBELs for several constituents that have a reasonable potential of impacting surface waters and causing violations of standards, including but not limited to the BTEX chemicals (benzene, toluene, ethylbenzene, and xylene), chloride, manganese, and temperature. Several other constituents may also require a reasonable potential analysis. Many potentially harmful constituents appear in high levels in either produced water, the receiving waters, or both, but DEQ does not provide a numerical standard for human health for fish consumption or drinking water for those constituents, so the levels must be evaluated against DEQ's narrative standards. This list is not exhaustive, and it is DEQ's responsibility to determine what other constituents may have the reasonable potential to degrade the state's surface waters.

The DEQ's regulations require that:

> (I) Water quality based effluent limitations shall be established for constituents in discharges determined to have a reasonable potential of adversely impacting uses of surface waters of the state or of causing violations of water quality standards. When making reasonable potential determinations, the administrator shall consider the following:
>
> (1.) Existing controls on point and non-point sources of pollution;
> (2.) The variability of the pollutant or pollutant parameter in the effluent;

(3.) For evaluating whole effluent toxicity, the sensitivity of the species to toxicity testing; and
(4.) Where appropriate, the dilution of the effluent in the receiving water.
(5.) Applicable designated uses and water quality standards.

Ch. 2, Sec. 5(c)(iii)(C)(I).

The receiving waters have designated uses and water quality standards that must form the basis of a reasonable potential (RP) evaluation. Alkali Creek is a designated Class 3B water, protecting uses including aquatic life other than fish, recreation, wildlife, industry, agriculture, and scenic value. Ch. 1, Sec. 4(c). Badwater Creek is designated Class 2AB. Class 2 waters support fish and/or drinking water supplies. Badwater Creek's 2AB designation protects its uses as a coldwater game fishery and drinking water source. Ch. 1, Sec. 4 (b)(i). The main stem of the Wind River from the Wedding of the Waters upstream to Boysen is a Class I "Outstanding Water," for which no further water quality degradation by point source discharges other than dams is allowed. Ch. 1, Sec. 4 (a); App. A (a)(iv).

In addition to these narrative standards, DEQ's water quality regulations in Ch. 1, Appendix B establish numerical standards for certain pollutants, listing maximum values that cannot be exceeded in receiving waters. These regulations establish a maximum value for benzene of 2.2 µg/L to support human health including consumption of fish and drinking water uses. They also establish an 860,000 µg/L limit for acute values of chloride and a 230,000 µg/L for chronic values of chloride. DEQ regulations also establish narrative temperature standards for the receiving waters, stating that:

"For Class 1, 2, and 3 waters, pollution attributable to the activities of man shall not change ambient water temperatures to levels which result in harmful acute or chronic effects to aquatic life, or which would not fully support existing and designated uses." Ch. 1, Sec. 25(a).

DEQ's regulations for water temperature also establish numerical temperature increase thresholds when ambient temperatures exceed 60 degrees Fahrenheit. Ch. 1, Sec. 25 (b), (c).

DEQ must conduct an RP evaluation to determine whether any constituents of the permitted produced water discharge may impair these designated uses or cause the established water quality standard for any of these receiving waters to be violated. In determining whether effluent limitations are required, and in establishing WQBELs for these constituents, DEQ must consider all five factors articulated in Ch. 2, Sec. 5(c)(iii)(C)(I).

Several constituents should clearly be evaluated for RP based on their high concentrations in produced water or because insufficient data warrants further investigation. For example, an RP evaluation should analyze BTEX chemicals because high concentrations of hydrocarbons are present in untreated produced water. *See* Moneta Divide DEIS, Appendix M: Water Resources Technical Report (January 2018) at pg. 75 (showing average levels of benzene at 2 mg/L, toluene at 30 mg/L, and xylene at 15 mg/L in untreated produced water). Chloride concentrations are also high in produced water, averaging 3,300 mg/L, well above DEQ's standard for aquatic life. DEQ provides no numerical standard for human health to compare this level to and must consider the reasonable potential that these levels would contribute to a violation of narrative standards. *Id.* Manganese levels in produced water average 50 µg/L, compared to DEQ's numerical standard of 50 µg/L for human consumption. *Id.* Temperature should be considered as well, because the available data do not clarify whether DEQ's Ch 1, Section 25 temperature standards will be met. An RP evaluation for temperature is particularly important because the water temperature of low natural flows in Alkali Creek and in Badwater Creek in later summer could be affected by greater volumes of warm effluent flowing from the outfalls into those streams.[33] Other constituents that could potentially degrade the receiving waters are not reduced through treatment, such as arsenic and mercury, and should be evaluated as well.

An RP evaluation should be done for potassium. According to Drs. Bergman and Meyer,

> – No analyses of K+ were included in Aethon's Table 2 chemistry results. However, based on a number of aquatic toxicity studies, K+ can contribute more to aquatic toxicity than other constituents of typical saline produced waters when at similar concentrations (Mount et al., 1997). Thus, the K+ concentration would be an important determinant for understanding and predicting toxicity of the produced waters to aquatic biota (see Aquatic Toxicity section, below). If K+ was present in the Table 2 production water (which is highly likely) and its concentration had been reported, the estimated alkalinity and bicarbonate concentrations presented in the previous bullet would be even higher.

Bergman-Meyer Report at 2.

A recent NPDES permit renewal for a produced water outfall within the exterior boundaries of the Wind River Indian Reservation is instructive as to what an RP evaluation should entail. While the EPA regulates discharges into surface waters from reservation sources directly, the applicable tribal surface water classifications are nearly identical to DEQ's surface water classifications, such that the RP evaluation in the tribal permit provides a template that may be useful to DEQ. *See* Statement of Basis, Permit No. WY-0020338 at 3 ("Uses designated [in tribal water quality requirements] on Class 3B waters include aquatic life other than fish, primary contact recreation, wildlife, industrial, agricultural, cultural/traditional and aesthetic uses." Compare DEQ regulations at Ch. 1, Section 4 (c), described above).

The RP evaluation for the tribal permit renewal considers effluent monitoring data for pollutants believed to be present as well as "biochemical oxygen demand, chemical oxygen demand, total organic carbon, ammonia, temperature, pH, and actual flow." *Id.* at 7. EPA also reviewed six years of discharge monitoring reports (DMR) for eight pollutants. The RP evaluation includes both a quantitative analysis based on EPA approved water quality standards to ensure designated uses are protected, and a qualitative analysis for constituents with insufficient data.

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[33] The Moneta Divide DEIS indicates that "the portion of the analysis area within the [Lander Field Office] contains thermal springs and aquifers with temperatures that exceed 90 degrees Celsius (about 200 degrees F). DEIS at 3-44.

The quantitative analysis assesses the reasonable potential for pollutants in the effluent discharge to cause or contribute to a violation of water quality standards. This potential "was evaluated for all parameters of concern measured and reported in the permit application, hazard screening, or DMR" after which "the effluent data was compared to applicable acute and chronic aquatic life criteria values . . . after consideration of pollutant variability in the discharge and available dilution in the receiving water." *Id.* The quantitative analysis applied EPA Region 8's RP Tool, "which assess RP from effluent data with statistical procedures consistent with EPA's Technical Support Document for Water Quality Based Toxics Control, March 1991." That analysis identified six pollutants with reasonable potential to cause exceedances: chloride, sulfate, sulfide, fluoride, cadmium, and mercury. However, for fluoride, cadmium, and mercury, insufficient data were available to determine the pollutant's reasonable potential to exceed numeric criteria. Thus, a qualitative analysis of RP for those pollutants was necessary.

Accordingly, EPA conducted a qualitative RP analysis, and included effluent limitations in the permit for pollutants that have a reasonable potential of impairing designated uses or violating water quality standards. EPA imposed an effluent limit for sulfide based on this analysis, and required additional monitoring for fluoride, cadmium, and organic compounds. EPA also required additional monitoring for mercury with a clear trigger level that requires a mercury minimization plan if the established threshold is reached. The RP evaluation was critical in establishing these new safeguards, retaining limits from previous permits, and establishing plans for adaptive management with clear triggers and responses.

The DEQ should conduct a similar RP evaluation here, applying best practices from EPA Region 8's RP Tool. This RP evaluation should identify and review any and all constituents that have a reasonable potential to impair designated uses or contribute to violation of established water quality standards, using quantitative data when available, and qualitative assessment where data is insufficient. The RP analysis must consider all five factors enumerated in DEQ's regulations for RP evaluations.

### H. The DEQ's Decision to Remove the Initial 230 mg/L Chloride Standard Violates the Clean Water Act's Anti-Backsliding Provisions.

The DEQ's decision to remove the initial 230 mg/L chloride standard in the existing 2008 permit violates the Clean Water Act's anti-backsliding provisions. The Clean Water Act generally prohibits backsliding, reducing the stringency of established effluent limitations. CWA §402(o)(1) states:

> General prohibition –In the case of effluent limitations established on the basis of subsection (a)(1)(B) of this section, *a permit may not be renewed, reissued, or modified* on the basis of effluent guidelines promulgated under section 1314(b) of this title subsequent to the original issuance of such permit*, to contain effluent limitations which are less stringent than the comparable effluent limitations in the previous permit*. In the case of effluent limitations established on the basis of section 1311(b)(1)(C) or section 1313(d) or (e) of this title, a permit may not be renewed, reissued, or modified to contain effluent limitations which are less

stringent than the comparable effluent limitations in the previous permit except in compliance with section 1313(d)(4) of this title.

33 U.S.C. § 1342(o)(1) (emphasis added).

The Act provides two independent exceptions from the general prohibition against backsliding. The first exception is outlined in U.S.C. § 1313(d)(4) and provides for backsliding in very limited circumstances, including demonstrated compliance with the Act's antidegradation rule. That provision does not apply here. Instead, the DEQ's existing 2008 permit claims the second exception, outlined in CWA 402(o)(2). That provision enumerates five statutory exceptions to the general prohibition, specific circumstances in which a permit may be renewed, reissued, or modified with a reduced effluent limitation. In the existing permit, the DEQ cites 402(o)2.B.i to justify completely eliminating the established 230 mg/L chloride limitation:

> Anti-Backsliding Provision: This permit originally established a chloride limit of 230 mg/L at the end of pipe for discharge into Class 3B waters. Since the issuance of the original permit, chloride standards established in Chapter 1 of the Wyoming Water Quality Rules and Regulations have changed to excluding aquatic life standards for chloride in Class 3 waters. *Therefore, WDEQ has removed the effluent limit and monitoring requirements for chloride in this permit*. It is WDEQ's determination that removing chloride limit from this permit conforms to the anti-backsliding requirements established in Section 402(o).2.B.i of the Clean Water Act.

WYPDES Permit No. WY0002062 at 2.

However, the DEQ is incorrect in asserting that the permit conforms to the Act's anti-backsliding requirements. In fact, the exception described in 402(o)2.B.i specifically exempts the very basis for backsliding that the DEQ claims. That exception provides:

> **(2) Exceptions -** A permit with respect to which paragraph (1) applies may be renewed, reissued, or modified to contain a less stringent effluent limitation applicable to a pollutant if … (B)(i) information is available which was not available at the time of permit issuance (*other than revised regulations, guidance, or test methods*) and which would have justified the application of a less stringent effluent limitation at the time of permit issuance

33 U.S.C. §1342(o)(2)(B)(i) (emphasis added).

The DEQ's claim that 402(o)2.B.i exempts chloride effluent limitations from the Clean Water Act's general prohibition against backsliding, and therefore justifies the complete removal of chloride limitations, is fundamentally flawed for three reasons.

First, the DEQ claims that it removed the chloride limit to comport with revisions to Wyoming's Water Quality Standards for Class 3 waters. The DEQ's cited exemption from the general prohibition against backsliding explicitly prohibits renewing, reissuing, or modifying a permit to include less stringent effluent limits based on a revised regulation. The well-considered parenthetical in 402(o)2.B.i disallowing exemptions on the basis of revised regulations, guidance, or test methods removes the perverse incentive for an agency to make revisions in order to circumvent the Clean Water Act's anti-backsliding requirements. Second, the enumerated exemptions in 402(o)(2) only allow *less stringent* effluent limitations in certain narrow circumstances and make no allowance for completely *eliminating* an existing effluent limitation. Third, 402(o)2.B.i. only allows less stringent effluent limits when new information would have justified the application of less stringent effluent limits *at the time of permit issuance*.

Here, the DEQ claims an exemption to the Clean Water Act's anti-backsliding requirements based on a regulatory revision the department itself made. This defeats the purpose of the parenthetical exception to 402(o)2.B.i and violates federal law. Further, the DEQ used this baseless exemption claim to completely *eliminate* the permit's existing 230 mg/L chloride limit, not to include less stringent standards as the Act provides. Finally, the DEQ offers no evidence that "new information" (presumably the regulatory revision to Wyoming Water Quality Standards that the DEQ itself made) would have justified less stringent standards at the time of permit issuance.

Even if the DEQ were permitted to backslide on its WQBELs under a statutory exception to the anti-backsliding rule, the Clean Water Act contains a backstop that prohibits relaxation of effluent limitations when relaxed limits would result in a violation of the applicable water quality standard. 33 U.S.C. §1342(o)(3). CWA § 402(o)(3) functions as a floor to how far limitations may backslide when backsliding is permitted by either §303(d)(4) or 402(o)(2). Permits may never contain effluent limits that are less stringent than EPAs current effluent limitation guidelines for that pollutant, or limits that would cause the receiving waters to violate state water quality standards. *Id.*

The prohibition against backsliding is critical to restoring and maintaining the integrity of our nation's waters. The DEQ must abide by the law and restore the original 230 mg/L chloride limitation.

## VII. CONCLUSION

The draft permit violates the Clean Water Act, the Wyoming Environmental Quality Act, and the Department's rules and regulations implementing those laws. The discharge of produced water from this facility has damaged and continues to damage surface waters of the state and threatens downstream communities with undisclosed health risks. The DEQ should encourage Aethon to consider other, less environmental damaging alternatives to the discharge. For the foregoing reasons the permit should be denied.

Sincerely,

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Darcy O'Connor, EPA Region 8,
Assistant Regional Administrator
Office of Water Protection

Enclosures:

Bergman/Meyer Memorandum
Hydros Report
Wireman comments

# **Memorandum**

June 27, 2019

**To:** Dan Heilig, Wyoming Outdoor Council, Lander, WY

**From:** Harold Bergman, PhD, Professor Emeritus, University of Wyoming, Laramie, WY; and Joseph Meyer, PhD, Chief Scientist, Applied Limnology Professionals LLC, Golden, CO

**Regarding:** Analysis of, and comments on, proposed WDEQ Wastewater Discharge Permit for Aethon Energy Operating, LLC – WY0002062 Renewal

We have reviewed a series of documents including WDEQ-WQD's proposed WYPDES discharge permit WY0002062 renewal for Aethon Energy Operating, LLC; Aethon's application for this permit renewal dated August 8, 2016; portions of Environmental Resources Management's (ERM's) Water Quality Compliance Analysis report to Aethon Energy dated April 23, 2018; and ERM's Modeling Study Addendum (undated). We also have reviewed and used a number of peer-reviewed publications on the chemistry of produced waters from oil and gas operations and the toxicity of these waters to aquatic biota, and we have cited these references, as appropriate, in the text below.

In the text that follows, we present our analyses, conclusions and positions related to water chemistry and aquatic toxicity of Aethon's produced water and WDEQ's proposed issuance of a discharge permit renewal for Aethon's discharge. We then present a number of major concerns and recommendations related to this proposed permit renewal.

## **Water Chemistry**

Untreated Produced Water Discharge. The WDEQ's proposed discharge permit for Aethon Energy's proposed Moneta Divide oil and gas field would allow discharge of a maximum of 8.274 MGD[1] (million gallons per day) of oil and gas field produced water, with 2.436 MGD untreated and approximately 5.838 MGD treated by reverse osmosis. Without an accompanying discharge of treated water, 2.856 MGD of untreated water would be allowed. The only measured water quality data presented in the Aethon permit application or the WDEQ proposed discharge permit are in Table 2 of Aethon's application, for a water sample collected on 3/2/2017 from Outfall 006 (see Aethon's Table 2 untreated water chemistry). Thus, this water sample is a raw produced water sample (treated only with a skim pond at Outfall 006) from the "Central Facility separators." This set of water quality analyses is offered by Aethon in their application as "representative of the quality of water being proposed for discharge" (question 14 on page 5 of the Aethon application).

There are several major inadequacies in Aethon's Table 2 "representative" water quality analysis results. In particular, there are no measurements or possibly misleading values for the following important water quality parameters:

[1] For comparison, the treated wastewater discharge for representative Wyoming cities are as follows: Riverton = 1.9 MGD for ~11,000 people, Laramie = 4.5 MGD for ~32,000 people, and Casper = 10 MGD for ~58,000 people.

- Alkalinity and Bicarbonate ion concentration – Alkalinity and bicarbonate ion ($HCO_3^-$) measurements were not included in Aethon's Table 2 chemistry results. However, alkalinity (expressed as mg calcium carbonate/L) along with the reported pH of 7.31 (Table 2 from application) allows calculation of concentrations of bicarbonate, carbonate and hydroxide, that all contribute to total alkalinity. The bicarbonate ion ($HCO_3^-$) concentration is particularly important to know because bicarbonate is an important determinant for understanding and predicting toxicity to aquatic biota (see Aquatic Toxicity section, below). Because the Aethon Table 2 chemistry suffered from a very large charge imbalance (many fewer total negative charges than total positive charges per liter), and because the total charge of a water sample must be neutral, we were able to calculate the following estimate for the alkalinity and bicarbonate concentrations (assuming all of the deficiency of negative charges was due to alkalinity/bicarbonate): Alkalinity ~ 2,732 mg/L as $CaCO_3$; bicarbonate ~ 3,333 mg/L. These are quite high values not typical of most surface waters, but they are not uncommon for co-produced waters from deep oil and gas fields.
- Potassium ($K^+$) – No analyses of $K^+$ were included in Aethon's Table 2 chemistry results. However, based on a number of aquatic toxicity studies, $K^+$ can contribute more to aquatic toxicity than other constituents of typical saline produced waters when at similar concentrations (Mount et al., 1997). Thus, the $K^+$ concentration would be an important determinant for understanding and predicting toxicity of the produced waters to aquatic biota (see Aquatic Toxicity section, below). If $K^+$ was present in the Table 2 production water (which is highly likely) and its concentration had been reported, the estimated alkalinity and bicarbonate concentrations presented in the previous bullet would be even higher.
- Chloride ($Cl^-$) – The water chemistry for Aethon's "representative" discharge presented in Table 2 of Aethon's application shows a one-time analysis for chloride of 1840 mg/L. Yet the level allowed in WDEQ's proposed permit for an end-of-pipe chloride concentration is 2419 mg/L (based on an "historic effluent concentration" according to information in a footnote in WDEQ's proposed permit, though no supporting information is presented). And WDEQ-WQD's special end-of-pipe limit for chloride concentrations in oil and gas produced water discharges is 2000 mg/L (Chapter 2, Appendix H). But Appendix H also specifies that "[i]n no case shall any produced water discharge contain toxic materials in concentrations or combinations which are toxic to human, animal or aquatic life" (Appendix H(b)(i)). To assess the possibility of toxic effects on aquatic life, we need to consult Wyoming's water quality criteria for protection of aquatic life in receiving waters listed in WDEQ-WQD's Chapter 1 (Appendix B). Wyoming's aquatic life criteria for chloride are 860 mg $Cl^-$/L as an acute criterion (to protect for survival) and 230 mg $Cl^-$/L as a chronic criterion (to protect for reproduction and growth). These criteria are in agreement with EPA's recommended acute and chronic criteria listed in EPA's ambient water quality criteria document for chloride https://www.epa.gov/wqc/aquatic-life-ambient-water-quality-criteria-chloride-1988. Thus, to avoid adverse effects on fish and aquatic invertebrates, WDEQ's permitted end-of-pipe chloride discharge concentration of 2419 mg/L in the proposed permit would need to be diluted almost 3-fold to avoid in-stream acute effects (e.g., mortality of fish and aquatic invertebrates) and diluted more than 10-fold to avoid in-stream chronic effects (e.g., reproduction and growth of fish and aquatic invertebrates). Yet, no information is provided for dilution flow or water quality in Alkali or Badwater Creeks in

either Aethon's permit application or in WDEQ's proposed permit. (Also see comment on Alkali and Badwater Creeks, below.)

- Sulfide – Hydrogen Sulfide ($H_2S$) – The WDEQ's water quality standard for $H_2S$ is 2 μg/L. However, the reported measurement in Table 2 of Aethon's application is listed as <40 μg/L (presumably the detection limit for the analytical method used by Aethon), which does not provide assurance that the $H_2S$ concentration meets the water quality standard. [Note that the Required Detection Limit shown in Table 2 for $H_2S$ is 0.1 mg/L (100 μg/L), which is far too high for Aethon and WDEQ to determine whether the discharge meets the 2 μg/L standard; thus we assume that the 0.1 mg/L detection limit for $H_2S$ shown in Aethon's Table 2 is an error].
- Benzene and BTEX – No analytical results are presented for Benzene or BTEX (Benzene, Toluene, Ethylbenzene, Xylene). This is a serious shortcoming, because many oil and gas produced waters can contain quite high concentrations of these very toxic compounds.
- Chemicals associated with treatment of oil and gas wells – These well treatment chemicals often associated with completion or maintenance of oil and gas wells (such as hydraulic fracturing or "fracking" chemicals) can be highly toxic, and may be present in "flow back" water or produced waters from unconventional well completions. Reported effects from these kinds of chemicals can include endocrine disruption with potential adverse human health or environmental effects (Kassotis et al., 2018), yet no information is presented in either Aethon's application or WDEQ's draft permit on presence or potential presence of these chemicals in existing or future discharges from the Aethon facilities.
- pH – The pH value reported by Aethon in Table 2 is 7.31, which is within the acceptable range of pH 6.5 to 9.0 at the outfall. However, we used the reported pH value and other chemistry from Table 2 along with our estimate of the alkalinity concentration in the discharge water from Outfall 006 to determine that, using the Windermere Humic Aqueous Model (WHAM) geochemical-speciation software (Lofts, 2012), the partial pressure of carbon dioxide ($pCO_2$) is highly over-saturated at the elevation of the Aethon facility (note that over-saturated $CO_2$ would be expected from a deep-water well). With Table 2 chemistry, including a calculated alkalinity of 2,732 mg $CaCO_3$/L (see above) and assuming a temperature of 25 $^oC$, the dissolved concentration of $CO_2$ in Aethon's discharge would be approximately 193.6 mg/L, while the concentration of $CO_2$ in water in equilibrium with the atmosphere at Aethon's elevation and 25 $^oC$ would be 0.52 mg/L. Thus, 193.6/0.52 yields approximately 372-fold over-saturation of $CO_2$ at the outfall, given the water chemistry listed in Table 2.

  This means that $CO_2$ will de-gas from the discharge water as it flows downstream in Alkali Creek and Badwater Creek. As $CO_2$ de-gasses from the stream water, the $CO_2$ concentration will approach equilibrium with the atmosphere, the $H^+$ concentration in the water will decrease as a consequence, and thus the pH of the water will increase. The table below demonstrates that the WHAM-predicted pH of the full-strength produced water listed in Table 2 would reach as high as approximately 9.6 if the produced water fully equilibrated with the atmosphere and was not diluted by air-equilibrated water (i.e., the pH values listed in the "Full strength" column of the table, below, are approximately 9.6). That pH would violate the current Wyoming water quality standard (i.e., the pH would exceed the upper limit of pH 9) and would cause toxicity concerns for most fish species and other aquatic biota. Even if diluted to only 1/10$^{th}$ of full-strength water (i.e., 1 part produced water diluted by 9 parts air-equilibrated water), the WHAM-predicted pH in equilibrium with the atmosphere would still be at or near 9 (i.e., pH 8.8-9.0 in the "1/10 Full strength" column, below). Thus, although a 10-fold dilution of the produced water might decrease its salinity to an acceptable concentration for aquatic life in Badwater Creek and/or after subsequent dilution on entry into Badwater Bay on Boysen Reservoir, pH should be recognized as a potentially more important driver for water quality in Badwater Creek and Badwater Bay than is salinity (which is what ERM's acceptable-discharge calculations were based on).

**Summary of WHAM calculations with Table 2 water chemistry for full-strength untreated produced water and produced water diluted with distilled water to 1/2, 1/5, and 1/10 of full strength**

| | Equilibrium pH | | | | | |
|---|---|---|---|---|---|---|
| Temp. (C) | Full strength | 1/2 Full strength | 1/5 Full strength | 1/10 Full strength | $pCO_2$ that produces pH 7.31 (atm CO2) | $CO_2$ super-saturation ratio |
| 0 | 9.59 | 9.38 | 9.05 | 8.79 | 0.104 | 306 |
| 10 | 9.57 | 9.37 | 9.06 | 8.80 | 0.109 | 321 |
| 20 | 9.58 | 9.39 | 9.09 | 8.84 | 0.122 | 359 |
| 30 | 9.61 | 9.43 | 9.15 | 8.91 | 0.148 | 435 |
| 40 | 9.66 | 9.50 | 9.24 | 9.00 | 0.193 | 568 |

These results demonstrate that (1) the alkalinity of the produced waters released from Aethon's operations should not be ignored in a discharge permit, given the type of water chemistry listed in Table 2 in Aethon's permit application; and (2) the pH of this type of produced water at its point of release might be considerably lower than the pH at distances downstream in the receiving drainage, even with (and sometimes especially without) mixing of the produced water with other, air-equilibrated water. Because we are unaware of any measurements of pH and alkalinity in Alkali Creek, Badwater Creek and Badwater Bay that would indicate the extent of pH increase downstream from current discharge points for produced water from the Moneta Divide, we strongly recommend that, at a minimum, the temperature, pH, alkalinity and flow of Alkali Creek and Badwater Creek should be monitored at least monthly immediately upstream and downstream of Aethon's current discharges and also in Badwater Bay. That monitoring should begin at least one year before a final permit is signed, so preliminary knowledge of annual variations of temperature, pH, and alkalinity in Alkali Creek, Badwater Creek and Badwater Bay can be used to better establish acceptable dilution factors for untreated produced water discharged by Aethon. A plume of elevated pH entering Badwater Creek and Badwater Bay could easily degrade the quality of those waterbodies as a nursery for young fish.

In addition to the recommended field monitoring, Aethon should also be required to incorporate these pH and alkalinity concerns into ERM's model that was used to calculate acceptable discharge and dilution rates (which were based on salinity concerns in Aethon's permit application, not on pH and alkalinity concerns). And as an extension, all inputs of produced water to Badwater Creek from both the Aethon and the Burlington operations should be combined in those calculations, to produce a cumulative-effects analysis.

Treated produced water using reverse osmosis. The proposed WDEQ permit specifies that of the maximum of 8.274 MGD ultimately allowed under this proposed permit, 5.838 MGD must be treated with reverse osmosis (RO-treated). Yet, we could find no water chemistry analysis results for discharge from the existing Neptune Water Treatment Facility that uses reverse osmosis; only a process flow diagram is presented in Appendix C of the application, and no water chemistry results are presented in the application or the proposed permit for the water discharged from this Neptune Facility at Outfall 001. Though no water chemistry measurements were presented for outflow from the Neptune Facility RO-treated water in Aethon's application or WDEQ's proposed permit, ERM's consulting report to Aethon presents operator-guaranteed treated Neptune effluent concentrations for several key parameters, as follows (ERM report, page 155):

- TDS = 350 mg/L (ppm)
- Chloride = 150 mg/L
- Sulfate = 40 mg/L
- Oil & Grease = 10 mg/L

Additionally, Aethon's measured post-treatment pH averaged from 3 years of daily measurements was 7.47 (ERM report, page 155).

This lack of actual water chemistry is important, because dilution of produced water with RO-treated water will result in higher salinity and alkalinity and a different pH than if the produced water would be diluted with distilled water. This means that the pH estimates in the table above (which assumed dilution of produced water with distilled water) likely differ from pH estimates that would be based on dilution with RO-treated water. But without reliable chemistry of Aethon's RO-treated water, the extent of the likely underestimates of the equilibrium pH in Badwater Creek is unknown.

Alkali Creek and Badwater Creek. No water chemistry or flow information is presented for Alkali Creek or Badwater Creek above and below the Aethon produced water discharges, and no thorough analysis of potential effects of Aethon's discharge on aquatic biota can be completed without this information. Moreover, monthly water chemistry and flow data for Alkali and Badwater Creeks would be needed for at least a 1-year monitoring period to account for variations in chemistry and flow, due to differences in dilution flows and water quality especially during low-flow periods of an annual hydrologic cycle.

## Aquatic Toxicity

Highly saline co-produced waters from oil and gas operations typically have very poor water quality with very high concentrations of total dissolved solids (TDS) and other constituents. Adverse effects of discharging these saline production waters on aquatic biota have been reported from as early as 1924 (Wiebe, Burr and Faubion, 1924; Clemens and Jones, 1954).

In a study conducted by researchers at the University of Wyoming (UW) from 1988-1990 (Boelter et al., 1992), toxicity tests with larval Fathead Minnows (*Pimephales promelas*) and a water flea (*Ceriodaphnia dubia*) were conducted on water samples collected from Salt Creek and the Powder River below the Salt Creek oil field near Kaycee, Wyoming. Boelter et al. (1992) reported significantly decreased survival and reproduction in 7-day toxicity tests with *C. dubia* and significantly decreased growth in 7-day tests with Fathead Minnow larvae, as compared with reference water samples collected upstream from produced water discharges from the Salt Creek oil field. These significant toxic effects were measured in ambient water samples collected as far as 124 km downstream from produced water discharges in the Salt Creek oil field, particularly during low-flow periods in Salt Creek and the Powder River. It is important to note that analyzed concentrations of alkalinity, sodium, chloride and bicarbonate in Salt Creek and the Powder River producing significant reductions in survival, reproduction and growth of aquatic test organisms in the Boelter et al. (1992) study were approximately one-half to as little as one-tenth the concentrations of these same parameters reported (sodium and chloride concentrations reported in Table 2 in the Aethon application) or calculated for Aethon's untreated produced water at Outfall 6 (calculated alkalinity and bicarbonate concentrations as presented in the Water Chemistry section, above).

In part as a response to EPA's new effluent biomonitoring requirements implemented in the 1980's as Whole Effluent Toxicity (WET) tests, the Gas Research Institute (GRI) funded a series of studies to develop models that could be used to predict the toxicity of produced waters of varying quality from oil and gas operations. These studies were initiated at the University of Wyoming and then continued by former UW graduate students in a series of collaborations that included UW, ENSR Corporation, USEPA, and others (Gulley et al., 1992; Mount et al., 1992; Mount et al., 1997; and Tietge et al., 1997). In this series of studies, almost 3000 toxicity tests were conducted to measure survival of Fathead Minnows and two species of water fleas (*C. dubia* and *Daphnia magna*) exposed to different ionic mixtures that spanned the range of water chemistries typical of produced waters from oil and gas operations. Results from these toxicity tests were incorporated into multivariate logistic regression models that predict the acute (i.e., short-term) survival of the three test species (48-hour survival for the water fleas, 96-hour survival for the Fathead Minnow) based on the major-ion concentrations typical of oil and gas produced waters. The best-fit models for survival of all three species are presented in Table 4 of the paper by Mount et al. (1997), entitled *Statistical Models to Predict the Toxicity of Major Ions to Ceriodaphnia dubia, Daphnia magna and Pimephales promelas (Fathead Minnows)*. The utility of these models for reliably predicting acute lethality of oil and gas produced waters as well as other saline waters is amply illustrated or cited by Mount et al. (1992), Mount et al. (1997) and Tietge et al. (1997) using comparisons of actual measured toxicity from published studies and predicted toxicity using these models.

In addition to the ability to predict the acute lethality of various major-ion mixtures in produced waters to these three species, the researchers were also able to rank the relative toxicity of various ion constituents in typical produced waters (Mount et al., 1997), as follows:

$$K^+ > HCO_3^- \sim Mg^{2+} > Cl^- > SO_4^{2+}$$

These researchers also noted that $Na^+$ and $Ca^{2+}$ were not significant variables in any of the models.

It is important to note that, in spite of this knowledge about relative contributions of various major ions in produced waters to aquatic toxicity, Aethon's reported produced water chemistry (Table 2 in Aethon's application) does not include analyses for $K^+$ or $HCO_3^-$; nor does it include analysis results for alkalinity, which would allow calculation of the $HCO_3^-$ concentration. We presume that this is possibly because WDEQ does not have a water quality standard and monitoring requirements for potassium, bicarbonate or alkalinity. We strongly recommend that any permit that WDEQ issues for the Aethon facility, or for any other discharge of untreated or treated well-field produced water, should include a monitoring requirement and water quality standards for potassium, bicarbonate and alkalinity.

Based on the utility and proven reliability of the Mount et al. (1997) multivariate logistic-regression models for accurately predicting toxicity of saline produced waters, we ran these models using input chemistry from Table 2 in Aethon's permit application, which Aethon claims to be "representative of the quality of water being proposed for discharge" (Aethon permit application). We then supplemented the water chemistry data in Table 2 with our approximations of alkalinity and bicarbonate concentration necessary to achieve charge balance in the Table 2 chemistry (see the Water Chemistry section, above). Results of these model runs are shown in the table below. Note that these model runs with the undiluted, full-strength Aethon produced water predict zero percent (0%) survival for 48-hour lethality tests with *C. dubia* and *Daphnia magna* and zero percent (0%) survival for 96-hour lethality tests with Fathead Minnows. We also ran these models assuming dilution of the Aethon produced water in a series of up to a 10-fold dilution with distilled water. As shown in the table below, it was necessary to dilute Aethon produced water 10-fold with distilled water to achieve close to 100% survival for the three test species.

**Model-predicted acute toxicity of Aethon produced water at full strength and after dilution with distilled water, based on model calculations using final regression equations presented in Table 4 in Mount et al. (1997).**

| Sample of Aethon produced water represented in Table 2 of application (Full Strength or Diluted) | Predicted Survival | | |
|---|---|---|---|
| | ***C. dubia*** **48-hour survival (%)** | ***D. magna*** **48-hour survival (%)** | **FHM 96-hour survival (%)** |
| Table 2 chemistry | 0.0 | 0.0 | 0.0 |
| Table 2 diluted 2x w/ dH2O | 0.0 | 2.7 | 2.2 |
| Table 2 diluted 3x w/ dH2O | 2.4 | 34.8 | 27.6 |
| Table 2 diluted 4x w dH2O | 33.6 | 70.3 | 61.1 |
| Table 2 diluted 5x w/ dH2O | 75.6 | 85.2 | 78.6 |
| Table 2 diluted 10x w/ dH2O | 99.1 | 97.2 | 95.3 |

C. dubia = *Ceriodaphnia dubia*
D. magna = *Daphnia magna*
FHM = Fathead Minnow
dH2O = Distilled water

Note that longer-term effects on reproduction of *Ceriodaphnia* and growth of Fathead Minnows would occur at even greater dilutions of Aethon produced water than shown in the above table for short-term lethality. Thus, adverse effects on aquatic invertebrate communities in Alkali Creek and adverse effects on fish and aquatic invertebrates in Badwater Creek would be expected if untreated produced waters are not adequately diluted with good-quality water.

In fact, given the normal low flow in Alkali Creek (Class 3B with protected uses including aquatic life other than fish), defined in the draft permit (Statement of Basis, page 9) as "a low-flow stream, generally flowing only in response to storm events, snowmelt, or man-made discharges," and given our evaluation of likely pH increases in excess of pH 9 due to $CO_2$ de-gassing and given the predicted lethality of undiluted or modestly diluted historical produced water discharges, we are highly confident that a chemical and biological survey of Alkali Creek below Aethon's discharge would show existing (and likely future) violations of Wyoming water quality standards as well as lack of support of designated uses for aquatic life. Moreover, because Badwater Creek (Class 2AB with protected uses including a cold-water fishery) is also a "relatively low-flow, perennial stream" (Draft Permit, Statement of Basis, page 9), and given our assessment of (1) likely elevated pH exceeding 9 due to $CO_2$ de-gassing and (2) predicted lethality (as well as adverse effects on reproduction and growth of aquatic biota) with insufficient dilution of produced water discharges, we are highly confident that a chemical and biological survey of Badwater Creek would show existing (and likely future) violations of Wyoming water quality standards and lack of support for designated uses for aquatic communities and fish for a considerable distance downstream from the confluence with Alkali Creek.

**Major Concerns and Recommendations**

- The draft permit renewal for WY0002060 should not be approved – The permit renewal application and the draft permit, together, are severely inadequate and missing crucial information that would allow for evaluation of potential violations of end-of-pipe discharge limits, in-stream water quality standards, and effects on aquatic biota as a consequence of the discharges allowed under the proposed permit.
- Monitoring data necessary for evaluation of the proposed permit renewal – At a minimum, the temperature, pH, TDS, chloride, alkalinity, and flow of Alkali Creek and Badwater Creek should be monitored at least monthly immediately upstream and downstream of Aethon's current discharge in Alkali and Badwater Creeks and also in Badwater Bay. That monitoring should begin at least one year before a final permit is signed by WDEQ, so knowledge of annual variations of flow, temperature, pH, TDS, chloride and alkalinity in Alkali Creek, Badwater Creek and Badwater Bay can be used to better establish acceptable dilution factors for untreated produced water discharged by Aethon.
- Predicted elevation of pH above the pH 9 Wyoming water quality standard – The chemistry of untreated produced water discharged by Aethon will worsen as it flows down Badwater Creek (i.e., the pH of the water will increase and might exceed the in-stream Wyoming water quality standard for pH if not diluted adequately), thus posing a hazard for aquatic life in Alkali Creek, Badwater Creek and Badwater Bay. If pH becomes elevated in Badwater Creek and approaches or exceeds the Wyoming water quality standard's upper pH level of 9, Aethon's hydrologic analysis should be repeated to take into account the potential for adverse water chemistry changes downstream in Badwater Creek as the untreated produced water equilibrates with the atmosphere.

Averting such water chemistry changes might necessitate even greater dilution of the untreated produced water than the currently-planned-for salinity constraint in the Wind River downstream of Boysen Reservoir necessitates.

- Predicted toxicity of Aethon's untreated produced water – Based on a published model of the toxicity of saline oil and gas industry produced water to freshwater fish and invertebrates, Aethon's untreated produced water would have to be diluted at least 10-fold to avoid decreasing short-term survival of aquatic organisms; and it is likely that even more dilution would be needed to avoid longer-term, sublethal impairment (e.g., decreased growth and/or reproduction). Thus, averting such adverse effects in Alkali Creek, Badwater Creek and possibly in Badwater Bay might necessitate even greater dilution of the untreated production water than the currently-planned-for salinity constraint necessitates (which is based on projected salinity changes in the Wind River downstream of Boysen Reservoir).
- Contributions of potassium to the toxicity of Aethon's produced water discharge – The lack of an analysis for potassium in the water chemistry reported by Aethon means we have no way of knowing if the reportedly most-toxic major ion in the water ($K^+$) will be present at a high enough concentration to impair survival, growth, or reproduction of fish and other aquatic organisms.
- Inadequate hydrogen sulfide analyses in the permit application – The analytical method used for sulfides in the water chemistry reported by Aethon was not sensitive enough to determine whether the Wyoming water quality standard for sulfide will be exceeded and thus impair survival, growth, or reproduction of fish and other aquatic organisms.
- Cumulative effects of all discharges – Any analysis of the potential effects of Aethon's discharge of produced water should include the cumulative effects of all discharges into the Badwater Creek drainage (i.e., Aethon, Burlington, and any other discharges, current and future). And when evaluating the potential effects in the Wind River downstream of Boysen Reservoir, the cumulative effects of all discharges (current and future) in the entire Boysen Reservoir drainage should be considered.
- Toxicity testing requirements in the permit – To test whether Aethon's produced water discharges might adversely affect fish and/or other aquatic organisms in Alkali Creek, Badwater Creek and Badwater Bay, stricter toxicity testing requirements will be needed in a final discharge permit. Whole Effluent Toxicity (WET) tests should be required quarterly (rather than annually), include each outfall rather than a flow-weighted composite sample, include acute 48-hour lethality tests with *Daphnia magna* and acute 96-hour lethality tests with Fathead Minnows, and include chronic toxicity tests for 7-day larval Fathead Minnow growth and 7-day *Ceriodaphnia magna* reproduction (this *Ceriodaphnia* chronic test is now not included in the draft permit but would be important in evaluating potential effects of the discharge in Alkali Creek and Badwater Creek). Additionally, WDEQ should require Aethon to conduct a preliminary toxicity study before the discharge permit is finalized, to ensure the required dilution of untreated produced water is sufficient to avoid long-term toxicity downstream. To evaluate the possible effects of pH shifts to greater than pH 9 due to $CO_2$ de-gassing, these tests should include testing of both "fresh" untreated produced water and "aged" untreated produced water, with the length of the "aging" determined by the longest projected transit time for water between its discharge into Alkali Creek and its entry into Badwater Bay.

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## Curriculum Vitae for Bergman and Meyer

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EDUCATION
Eastern Michigan University Biology B.A., 1968
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Michigan State University Fisheries Biology Ph.D., 1973

PROFESSIONAL POSITIONS
2011-2013 Department Head, Department of Zoology and Physiology, University of Wyoming
1995-2016 J.E. Warren Distinguished Professor of Energy and Environment, University of Wyoming
1998-2008 Director, William D. Ruckelshaus Institute and Helga Otto Haub School of
Environment and Natural Resources, University of Wyoming
1988 Visiting Scientist, U.S. Environmental Protection Agency, Duluth, Minnesota
1986-1987 Acting Director, Wyoming Water Research Center, University of Wyoming
1984-2016 Professor, Department of Zoology and Physiology, University of Wyoming (Retired 2016)
1984-1999 Director, Red Buttes Environmental Biology Laboratory, University of Wyoming
1975-1984 Asst. & Assoc. Professor, Dept. of Zoology and Physiology, University of Wyoming

PROFESSIONAL AWARDS AND DISTINCTIONS (Selected)
Founder's Award, Society of Environmental Toxicology and Chemistry, 2018
Distinguished Faculty Graduate Mentor Award, University of Wyoming, 2014
Extraordinary Merit in Advising, Arts & Sciences College, University of Wyoming, 2014
Elected Fellow, American Association for the Advancement of Science, 1995
George Duke Humphrey Distinguished Faculty Award, University of Wyoming, 1995
Conservation Educator of the Year, Wyoming Wildlife Federation, 1986
President of the Society of Environmental Toxicology and Chemistry, 1984-85
President of the Water Quality Section, American Fisheries Society, 1982-83
Editorial Board, Environmental Toxicology and Chemistry, 1981-84
EPA Doctoral Traineeship, Michigan State University, 1971-73

STATE, NATIONAL AND INTERNATIONAL ADVISORY & REVIEW PANELS (Selected)
Wyoming Environmental Quality Council, 1983-95; Chairman, 1985-87
National Research Council - National Academy of Sciences Committees/Board
- Ecological Risk Assessment, 1986-87
- Animals as Monitors of Environmental Hazards, 1987-91
- NRC Board of Agriculture and Natural Resources, 2009-2016

Environmental Protection Agency, ORD, Peer Review Panels/Review Committees
- Exploratory Grants Program, Environmental Biology Panel, 1986-96
- National Acid Precipitation Assessment Program, Aquatic Effects Program, Panel Chair, 1987
- Graduate Fellowship Review Panel, 1995-98, 2009-12
- Environmental Protection Agency, Science Advisory Panel for Pesticides (FIFRA), 1984-87
- Science and Technology Achievement Awards, 1986-87
- Water Quality Standards Research Review, 1986
- Ecological Risk Assessment Research Review, 1986
- Environmental Protection Agency, Board of Scientific Councilors, 1996-97

The Royal Society (London), Surface Water Acidification Program Review Panel, 1990
Private Sector Board and Advisory Positions
- PacifiCorp, Inc., Environmental Forum, Portland, OR, 2000-04
- Wyoming Outdoor Council Board, Lander, WY, 2009-2015; 2017-present

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EDUCATION

Lehigh University, Chemical Engineering B.S., 1973
University of Wyoming, Zoology and Physiology Ph.D., 1986

PROFESSIONAL POSITIONS

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| 2016-Present | Chief Scientist, Applied Limnology Professionals LLC, Golden, CO |
| 2012-Present | Affiliated Faculty Member, Department of Chemistry and Geochemistry, Colorado School of Mines, Golden, CO |
| 2007-2016 | Technical Expert and Principal Scientist, Arcadis, Lakewood, Colorado |
| 2005-2007 | Professor, Department of Zoology and Physiology, University of Wyoming |
| 1999-2005 | Associate Professor, Department of Zoology and Physiology, University of Wyoming |
| 1999 2004 | Director, Red Buttes Environmental Biology Laboratory, University of Wyoming |
| 1994-1999 | Assistant Professor, Department of Zoology and Physiology, University of Wyoming |
| 1991-1993 | Coordinator, Wastewater Utilization Graduate Program, Humboldt State University, Arcata, CA |
| 1990-1993 | Lecturer, Department of Fisheries, Humboldt State University, Arcata, CA |
| 1989-1990 | Postdoctoral Researcher, University of Wyoming-National Park Service Research Center, University of Wyoming |
| 1988-1989 | Postdoctoral Researcher, Lake Research Laboratory, Swiss Federal Institute for Water Resources and Water Pollution Control (EAWAG/ETH), Kastanienbaum, Switzerland |
| 1987-1988 | NATO Postdoctoral Research Fellow, Lake Research Laboratory, Swiss Federal Institute for Water Resources and Water Pollution Control (EAWAG/ETH), Kastanienbaum, Switzerland |
| 1987 | Research Scientist, Department of Zoology and Physiology, University of Wyoming |
| 1986 | Graduate Research and Teaching Assistant, Department of Zoology and Physiology, University of Wyoming |
| 1980-1983 | Associate Scientist, Western Aquatics, Inc., Laramie, WY [part-time] |
| 1976-1985 | Research Scientist, Department of Zoology and Physiology, University of Wyoming |
| 1972 | Student Participant, NASA Summer Institute for Biomedical Engineering, Howard University and Goddard Space Flight Center, Greenbelt, MD |

PROFESSIONAL AWARDS AND DISTINCTIONS (Selected)

Fellow of Society of Environmental Toxicology and Chemistry, 2018-Present
President of Rocky Mountain Chapter of Society of Environmental Toxicology and Chemistry, 2004-2005
Member of Editorial Board, *Environmental Toxicology and Chemistry*, 1997-2000
Member of Board of Directors of Rocky Mountain Association of Environmental Professionals, 1983-1984

STATE, NATIONAL AND INTERNATIONAL ADVISORY & REVIEW PANELS (Selected)

U.S. Environmental Protection Agency: Member, Aquatic Life Criteria Consultative Panel of the Science Advisory Board of the U.S. Environmental Protection Agency. 2005.

U.S. Environmental Protection Agency: Member, Health and Ecological Effects Subcommittee of the Advisory Council on Clean Air Compliance Analysis of the Science Advisory Board (SAB) of the U.S. Environmental Protection Agency. 1998-2002.

Environment Canada: Member, Environmental Resource Group for the Assessment of Chloramine under the Canadian Environmental Protection Act. 1996-1999.

U.S. Environmental Protection Agency: Member, Advisory Council on Clean Air Compliance Analysis Physical Effects Review Subcommittee of the Science Advisory Board of the U.S. Environmental Protection Agency. 1994-1997.

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# FINAL TECHNICAL MEMORANDUM

**TO:** Dan Heilig, Wyoming Outdoor Council and
Jill Morrison, Powder River Basin Resource Council
**FROM:** Jean Marie Boyer, PhD, PE, Hydros Consulting Inc.
**SUBJECT:** Review of ERM Water-Quality Modeling Study of Boysen Reservoir
**DATE:** July 1, 2019

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## BACKGROUND

Per your request, I have reviewed the report entitled "Water Quality Compliance Analysis for the Long Range Development Plan at Moneta Divide, Wyoming. A Hydrologic, Hydrodynamic and Water Quality Study of the Boysen Reservoir Watershed" written by Environmental Resources Management (ERM), dated April 23, 2018 (Report). My review focused on the development of the Boysen Reservoir Water-Quality Model developed using GEMSS and the analysis of results. I did not focus on the SWAT modeling, which was conducted to develop daily flows for use in the reservoir model.

My staff and I also briefly reviewed reservoir modeling files, sent to us by ERM. These files provided more detail than what was described in the Report. Given the lack of model documentation and time / resource constraints, model files have not been thoroughly reviewed. However, the review resulted in the identification of several severe and alarming issues, and there may be more.

My comments are summarized in this memorandum and organized under two broad categories:

- The Reservoir Model Cannot be Used for Decision Making; and
- The Compliance Analysis Methods and Findings are Incorrect.

Many of the comments are supported with detailed examples and they are not in order of most important to least important. An overall summary can be found at the end of this document, where the most important concerns are highlighted.

## MAJOR POINT: RESERVOIR MODEL CANNOT BE USED FOR DECISION MAKING

It is very clear that the model developed by ERM cannot be used for decision making. Several comments are made below and they are divided into two categories of reasoning.

1. The Model Was Not Developed Properly; and
2. Model Performance Was Not Appropriately Evaluated.

## Reason 1: Model Was Not Developed Properly

Numerical reservoir water-quality models require numerous types of detailed inputs. This is especially true if one uses a 3-dimensional (3-D) representation of the reservoir, as was chosen by ERM. Issues associated with data inputs, assumptions made, and "adjustments" used in model development are highlighted below and grouped by type of assumption.

### Water Balance Assumptions

A complete and representative water balance for a reservoir is important when modeling its water quality. Boysen Reservoir outflow records are good and the best inflow records are for Wind River above the reservoir and Five-Mile Creek. Distributing the inflows correctly is a critical aspect of modeling water quality in Boysen Reservoir, given the wide range of inflow water quality characteristics in the watersheds of this very large reservoir. A tributary with a low flow and poor concentrations can add a significant load to the reservoir, relative to other sources.

#### 1. Little Data, Yet No Flow Data Collection

Aethon spent 5+ years collecting data to support the analyses needed for project approval, yet chose to focus water-quality data collection at a location with a significant amount of data (below Boysen Reservoir)[1]. Aethon did not collect any flow data to ground-truth the distribution of flows among the 9 simulated tributaries. Therefore, many of the tributaries represented by SWAT-generated flows were uncalibrated and highly uncertain. This could have been avoided.

#### 2. Reservoir Evaporation was Ignored in the Water Balance

Evaporation is an important component of the water balance, especially for Boysen Reservoir. Given its surface area and location, evaporation is significant (on the order of 50,000 AF/year[2]). Correctly accounting for evaporation is important when modeling reservoir water quality in that the process of evaporation tends to increase in-reservoir concentrations (constituents are not removed with the water that is evaporated). If a modeler lumps this into other outflows, the model will unrealistically remove constituents with the outflow. The model as delivered to Hydros by ERM is set up to not include evaporation, as indicated by the model setting in Figure 1.

[1] Aethon did take tributary water quality samples on one day in April 2017

[2] Based on reservoir surface area and NOAA (1982)


**Figure 1. Screen Capture from Model Setup Interface Sent to Hydros**

### 3. <u>Flow Adjustments Made to Badwater Creek</u>

Because the flows simulated by the SWAT model for Badwater Creek (above the produced water discharges) were so poor, they were decreased and re-distributed (described in Appendix D of the Report). This redistribution was based on comparisons made to historic data and a basin-wide water resources planning model. The differences with respect to the planning model were added to four other tributaries (Birdseye, Cottonwood, Tough, and Unnamed Creeks) – apparently selected since "they have the greatest uncertainty compared to larger creeks that were previously well-calibrated with reliable flow."

- Note that there are two other tributaries with no flow data - Poison Creek and Muddy Creek. ERM chose not to re-distribute flow to these tributaries, yet they also have the same level of uncertainty.
- The four tributaries chosen for flow increases as a result of this adjustment have the best water quality (using ERM assumed concentrations.

Also, ERM notes "the amount of flow redistributed and load increases were considered small."

- If the redistributed loads were "considered small", they would not have had the effect mentioned in Appendix D of the Report. ERM notes "These changes highly benefitted the overall water quality calibration of Wind River Below Boysen Reservoir."

In addition, simulated flows from other ungaged tributaries, were not compared to the planning model and adjusted in the same manner. Thus, tributary flows were treated inconsistently.

### 4. <u>"Adjustments" Made to Reservoir Inflows from Wind River</u>

The model was set up to "auto-calibrate" the water balance to user-provided surface water elevations (SWEs). Thus, model inflows were adjusted so that the observed SWEs were simulated. When flow adjustments were needed to complete the water balance, flows were from the Wind River above the reservoir were adjusted. This is the site with the most certainty for inflows (along with Five Mile Creek), yet ERM made adjustments at this location.

## Meteorology Assumptions

Meteorological model inputs are important for correctly simulating reservoir hydrodynamics and mixing. Of the several meteorological inputs to the model, wind plays a particularly key role and needs to be characterized correctly.

## 5. <u>Wind Speeds Were Significantly and Unrealistically Capped</u>

The Wind River basin experiences high wind conditions, as displayed in Figure 2 where wind speed is reported in knots. The model as delivered to Hydros by ERM is set up to "cap" wind speeds to a maximum of 5 m/s (9.7 knots) during the simulation, as indicated by the model setting in Figure 1 above.

Artificially reducing the wind speed serves to reduce mixing and increase stratification (something the model has troubles simulating). It appears that the modeler used this cap to make up for other important model development problems. This significant adjustment was not described anywhere in the Report and the reader is led to believe that the values shown in Figure 2 were used.

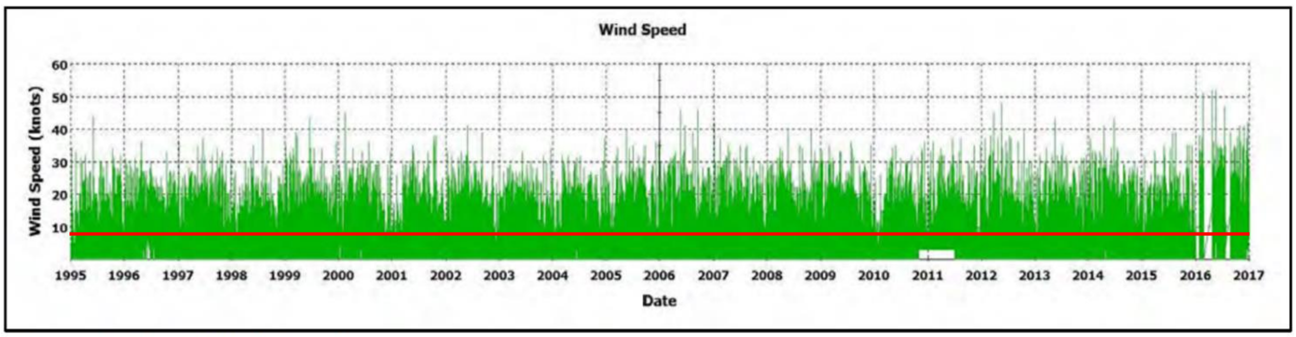


*Figure 4-18 Wind Speed*

**Figure 2. Wind Speed Figure from the ERM Report. Red line added at 5 m/s (9.7 knots)**

## Inflow Water-Quality Assumptions

It is clear that the water quality of the various inflow sources varies considerably. Thus, it is important to base inflow water-quality assumptions on the best available data. Sometimes, additional data collection is necessary to develop a useable model. This should have occurred for this effort. Some of the assumptions made to make up for the lack of data are described below.

## 6. <u>Surrogate for Badwater Creek and Lack of Data Collection</u>

Water-quality characteristics of water flowing into the reservoir from Badwater Creek are obviously critical for this effort. It is surprising to know that Aethon spent 5+ years collecting data to support the analyses needed for project approval, yet only collected tributary inflow water-quality data on one day in April of 2017. These often-single data points are the basis for many of the inflow WQ assumptions. And yet, in the case of Badwater Creek, ERM used the one sample from Tough Creek, as a surrogate for conditions upstream of produced water discharges. There is no reason to believe that the water quality in Tough Creek is similar to that of Badwater Creek and no reason is provided as to why sampling did not occur at such a critical location. Again, this could have been avoided. Inflow water quality at numerous locations over time needs to be measured to be able to consider the impacts of the project. Current available data are insufficient.

## 7. <u>Questionable Use of Method for Quantifying Inflow Concentrations</u>

For some constituents, ERM used the WRTDS (Weighted Regressions on Time, Discharge, and Season) method to describe inflow concentrations for Wind River above the reservoir, 5-Mile Creek, and Muddy Creek (see Appendix F of the Report). The results from using this methodology are questionable and unrealistic in some cases. ERM subjectively capped what was determined to be excessively high concentrations. In addition, odd results sometimes occurred due to extreme values in a single or few data points and certain trends were created that are not described or justified. Examples are shown in Figures 3 and 4. Note that Wind River provides the majority of the inflow into the reservoir (over 70% according to Appendix C of the Report) and its water quality is an important driver of in-reservoir dynamics.

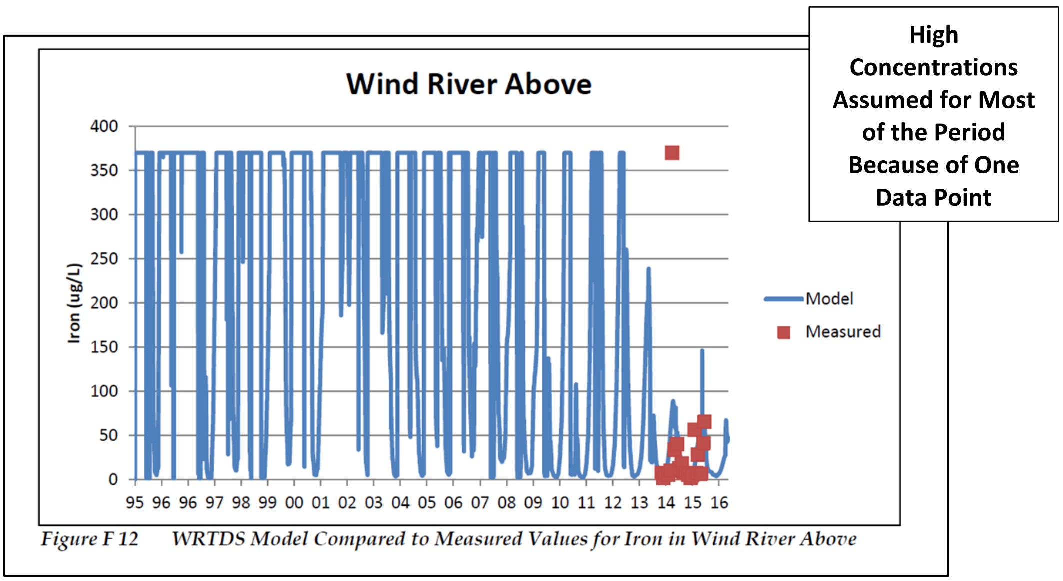


**Figure 3. Assumed Iron Concentrations at the Wind River Above Boysen Reservoir (from Report)**

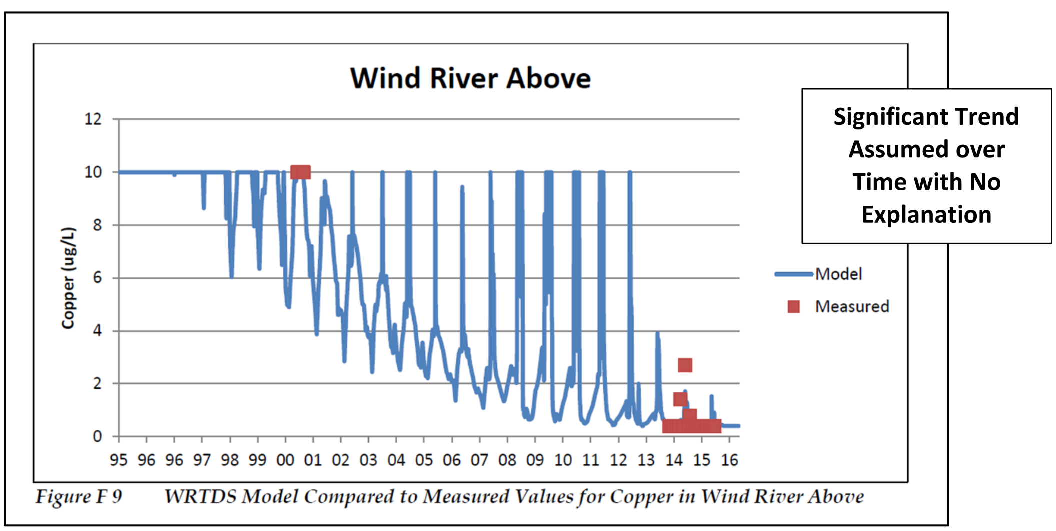


**Figure 4. Assumed Copper Concentrations at the Wind River Above Boysen Reservoir (from Report)**

## 8. Assumption of Permit Concentrations

In several instances, ERM assumed that the water quality of the produced water was at permit limits for the calibration and validation period. This could be far from actual conditions during the 22-year period. The purpose of calibration and validation is to recreate what actually happened. Using permit limits for calibration needs justification.

## 9. Dividing up Badwater Creek into Four Sources

It is very odd that ERM chose to separate the flows into Badwater Bay into four distinct sources (Badwater Creek above Alkali Creek, Burlington, Aethon, and Neptune) and have them all entering the same location of the model grid. It is even more confusing to know that some level of treatment at Neptune has been occurring historically but treatment details and flow amounts over time are not described in the Report. Nor can this information be inferred from the model input files. In addition, samples exist for Badwater Creek ~ 5 miles above the reservoir (where the sources are already mixed and is more representative of what is actually flowing into the reservoir) and these samples are not considered by ERM. For calibration, it is important to capture the blended source of water entering the reservoir at this location. It is unclear why ERM developed the model in this manner, when it could have been considered in a more straight-forward way.

## Inflow Placement into the Reservoir

Tributaries can enter a particular reservoir differently depending on the density of the inflowing water (Figure 5). The higher the salinity, the higher the density of the inflowing water. Since produced water has very high salinity, it is important to capture inflow placement dynamics correctly for this effort, given:

- the increase in density of the inflow water at Badwater Creek Bay with the proposed project;
- the potential for the diving of inflows as an underflow; and
- the low-level outlet works at the dam.

Thus, there is the potential for impacts to the releases downstream that exceed average impacts in the reservoir. Most commonly-used hydrodynamic reservoir water-quality models simulate these types of dynamics.

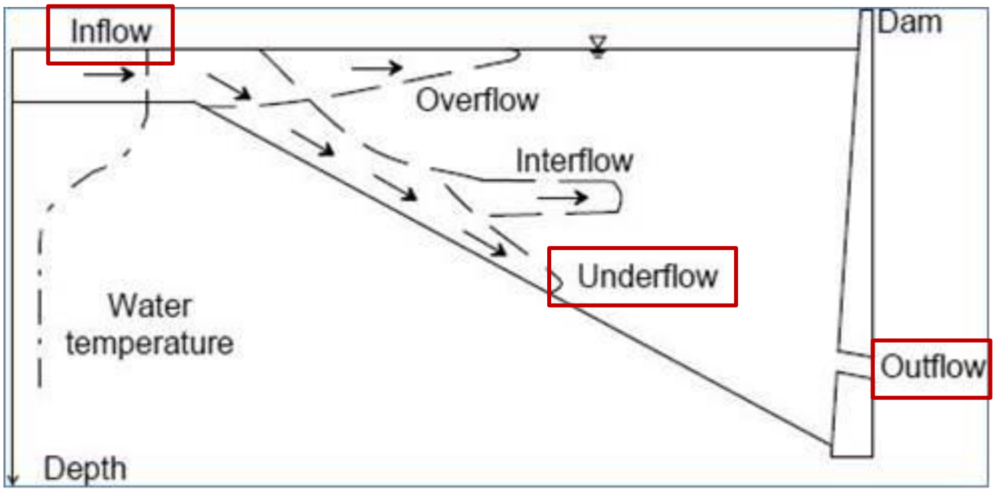


**Figure 5. Generic Reservoir Graphic Showing Density Currents and Possible Inflow Patterns**

### 10. Mischaracterization of Inflow Placement

Although ERM describes the importance of water density and transport processes, the model was not set up to distribute inflows vertically based on the density of the inflow and the density profile of the water in the reservoir. Instead, tributary inflows enter each 2-foot layer of the model grid uniformly[3]. Thus, changes to the density of the inflows (through salinity and temperature changes) from the project do not correspondingly change the vertical distribution of the inflows in the model. This is a serious flaw to the model as flows into Badwater Bay will tend to enter the reservoir lower in the reservoir with the project. This may affect water released at the dam through the low-level outlet differently than it has historically. Also, inflow placement assumptions made by ERM are not described in the Report (as they should have) and were only determined based on review of model files.

## Representation of Reservoir Releases

Releases from Boysen Reservoir to the Wind River occur at two different locations. Flow through the low-level outletworks (at 4,657 feet; USDOI, 1981) provides water to the penstocks for power production. This is the dominant means of withdrawal due to the potential to generate power. Spilling of water near the top of the reservoir can occur if the SWE is above 4,700 feet.

Water leaving through the outletworks (OLW) can have very different characteristics from water leaving via the spillway, due to vertical variations in water quality characteristics, especially during the stratified period (Figure 6). Thus, outlet operations have a direct impact on water quality in the Wind River below Boysen Reservoir (Class I). Most 2-dimensional (2D) and 3-dimensional (3D) reservoir models (including

[3] The control file specifies that for each inflow, the vertical limits are the bottom of the reservoir at the location of the inflow and the water surface. There are no options in the user interface for setting up the control file to select or determine if the placement of the inflows within these boundaries is uniform or density-based. However, based on review of the snapshot output files (e.g., the file received for the calibration run output named "Final Calibration_Restart.snp"), it was clear that the flows output by the model in the "Discharge Boundary Condition" section of the snapshot file that correspond to the inflows are uniformly distributed in the vertical direction.

GEMSS) have the capability to compute a withdrawal zone from which only certain layers contribute to the outflow, based on each structure, each outlet flowrate, and in-reservoir water density. This methodology has been developed to replicate how water is physically discharged from a reservoir. The model can then take that information and output the resulting water quality in the downstream river.

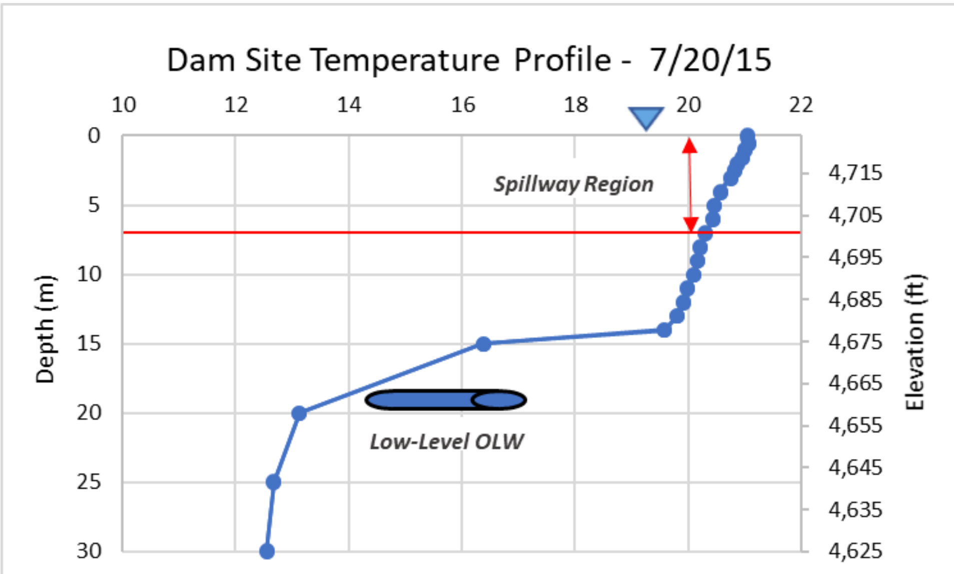


**Figure 6: Temperature Profile Showing Stratification and Elevations of Releases (OLW = Outletworks)**

### 11. Mischaracterization of Reservoir Release

Although the GEMSS model software includes the ability to characterize different structures and compute withdrawal zones, the modelers chose to release water uniformly in the vertical direction within each column - from the top layer of the reservoir to the bottom layer[4]. Thus, there is no differentiation between the outletworks and the spillway and outlet operations that control downstream water quality are completely ignored. Again, this is a serious flaw. Also, the assumptions made are not described in the Report and were only determined based on review of model files.

## Reason 2: Model Performance Was Not Appropriately Evaluated – Erroneous Conclusions Reached

After the model was completed, ERM compared the results to certain targets to show that the model was calibrated, validated, and adequate for use to prediction of future conditions with the project. There are several instances where misleading information is provided. The reservoir model cannot be

[4] For the outflow, the control file specifies that the vertical limits are the bottom of the reservoir at the location of the outflow and the water surface. There is an option to choose either density placement or area-based placement of the outflow within these vertical boundaries. The area-based option was chosen in the control file, as provided. Review of the snapshot output also reveals that the area-based option is equivalent to the vertical uniform distribution of flow for each column of cells where the outflow takes place. Because the outflow takes place in two columns of cells located at the dam of the reservoir, and one column is deeper than the other one, the net vertical distribution of flow is not completely uniform. It is uniform from the water surface to the bottom of the shallowest column and between the bottom of the shallowest column and the bottom of the deepest column. However, overall, there is more flow coming from the upper layers than from the bottom layers, when in reality, more water is likely to flow out from deeper sections due to the low-level outlet location.

considered to be calibrated or adequate for simulating water quality in-reservoir or downstream in the Wind River.

## Evaluation and Reporting of Wind River Simulation Results

The focus of the work conducted by ERM is to ensure protection of the downstream Class I segment of the Wind River. Analyses were conducted to determine produced water flows that would meet antidegradation requirement at that location. Thus, a very critical part of the analysis involves the quantification of model results for release water quality.

### 12. Evaluation and Reporting of Wind River Results are Wrong and Misleading

Through review of the model files, our team determined that the graphs displaying calibration and validation results for the Wind River below the reservoir are misleading and severely flawed. An example graph for temperature is shown in Figure 7. The top of the graph is labeled as “Outflow” and the caption says “Wind River Below Boysen Reservoir.” The data (green markers) are reportedly Aethon’s temperature measurements in the Wind River below the dam. The reader is led to believe that the blue line represents the temperature of the water released from the reservoir (via the low-level outlet and/or the spillway) and delivered to the river.

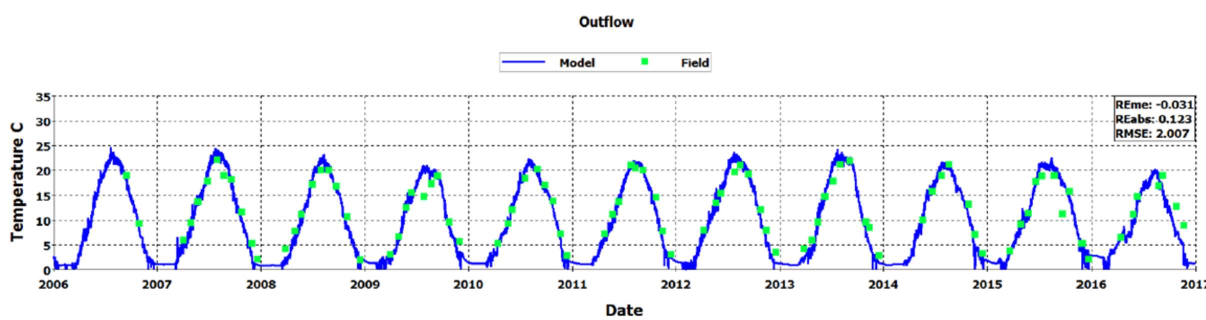


*Figure J 3 Wind River Below Boysen Reservoir Temperature Calibration at Surface Level*

**Figure 7: Temperature Calibration Figure for Outflow (from Report)**

According to the model files, the blue line actually represents the simulated temperature at the top model layer (~top 2 feet) of the most downstream location (at the dam). This is wrong and misleading and it is unclear why this was done. Note that ERM added “at Surface Level” at the end of the caption (Figure 7) and perhaps thinking this makes it not misleading, even though there is a low-level outlet used for power production?

**This is a very serious problem since the water quality at the top two feet of the reservoir is being represented as Wind River water quality** and there are observed (but not simulated) vertical variations in the reservoir. In reality, the water quality at the top of the reservoir is often different from the bottom of the reservoir[5] (see Figure 6). Since water is removed predominantly through the low-level

[5] See Figure 6 as an example for temperature. Many other constituents (e.g. iron, manganese, arsenic) often show significant differences in top versus bottom concentrations in a reservoir, especially during stratification.

outlet, Wind River water quality would generally reflect the water flowing through that outlet or a combination of lower level releases and spills[6].

An example of temperature variations in a stratified reservoir is provided in Figure 8. The location of the outlet is an important factor in determining the water quality of the river downstream. ERM mistakenly compared the simulated reservoir surface temperature (top 2 feet) to the samples in the Wind River.

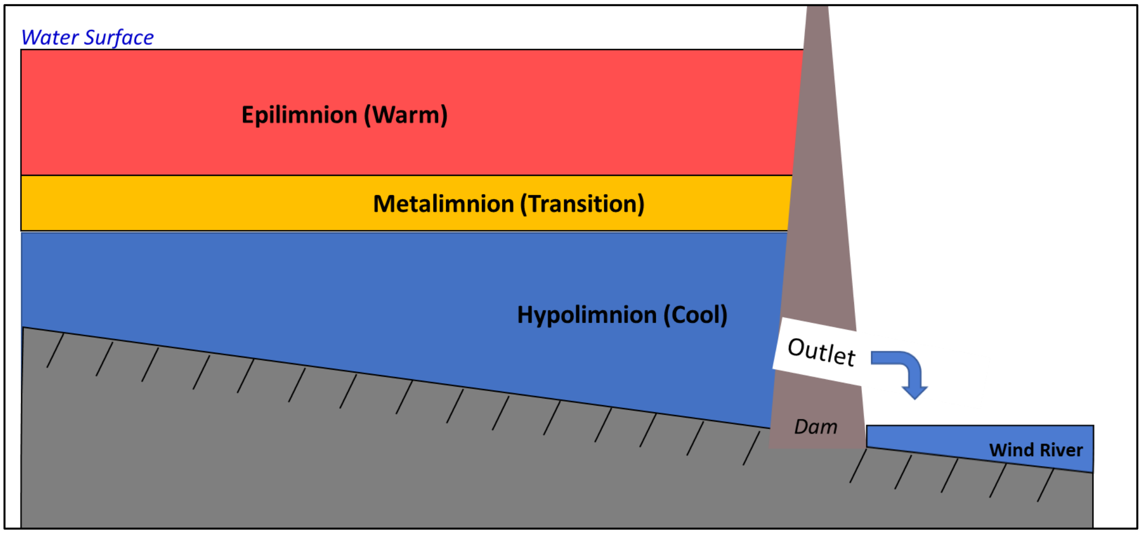


**Figure 8. Temperature Differences in a Stratified Reservoir**

If the modeler had differentiated between the outlets and simulated withdrawal zones, the release water quality output file would have reflected these dynamics. This was not done by ERM and incorrect and very misleading comparisons were made.

## Choice of Observed Dataset Used for Comparisons

During calibration/validation, comparisons are made between observations and simulation results. Thus, the observed dataset used is important when evaluating model performance.

### 13. <u>ERM Removed Numerous Observed Data Points from Analysis without Justification</u>

There are several cases where measured data were removed from the analysis without justification. A few examples are highlighted below:

***Removal of In-Reservoir Data***

Table 5-2 of the Report includes a list of all available data for calibration and validation in Boysen Reservoir (Figure 9). A footnote at the bottom indicates that more than 300 data points were excluded after "thorough QA/QC." There is no discussion to justify the exclusion of all data associated with 15 constituents in the reservoir. The only data that were kept and considered were profile data (conductivity, pH, and temperature).

[6] Unless an outage or maintenance resulted in flow restrictions through the low-level outlet.

As a result, for the reservoir, there is absolutely no calibration or any ground-truthing of numerous constituents, including TDS, chloride, sulfate, and numerous metals.

*Table 5-2 Available Data for Calibration and Validation within the Reservoir*

| Parameter | Total # of Stations | Total # of Data Points | Date Range | Vertical Profiles Available |
|---|---|---|---|---|
| Aluminum (µg/L) | 0 | 0 | N/A | No |
| Arsenic (µg/L) | 1 | 4* | 1999 only | No |
| Barium (µg/L) | 0 | 0 | N/A | No |
| Boron (µg/L) | 0 | 0 | N/A | No |
| Calcium (mg/L) | 1 | 32* | 1999-2001 | No |
| Chloride (mg/L) | 1 | 59* | 1999-2006 | No |
| Chromium (µg/L) | 0 | 0 | N/A | No |
| Conductivity (uS/cm) | 10 | 1226 | 2002-2016 | Yes |
| Copper (µg/L) | 1 | 4* | 1999 only | No |
| Fluoride (mg/L) | 1 | 32* | 1999-2000 | No |
| Iron (µg/L) | 1 | 4* | 1999 only | No |
| Magnesium (mg/L) | 1 | 32* | 1999-2000 | No |
| Manganese (µg/L) | 1 | 4* | 1999 only | No |
| Mercury (µg/L) | 1 | 4* | 1999 only | No |
| Nickel (µg/L) | 1 | 4* | 1999 only | No |
| Oil and Grease (mg/L) | 0 | 0 | N/A | No |
| pH | 11 | 1404 | 1999-2016 | Yes |
| Total Petroleum Hydrocarbons mg/L) | 0 | 0 | N/A | No |
| Total Suspended Solids (mg/L) | 1 | 33* | 1999-2001 | No |
| Radium-226 (pCi/L) | 0 | 0 | N/A | No |
| Sodium (mg/L) | 1 | 32* | 1999-2000 | No |
| Sulfates (mg/L) | 1 | 32* | 1999-2001 | No |
| Sulfides (µg/L) | 0 | 0 | N/A | No |
| Total Dissolved Solids (mg/L) | 1 | 61* | 1999-2006 | No |
| Temperature (°C) | 10 | 1343 | 2002-2016 | Yes |
| Total Hardness (mg/L) | 1 | 33* | 1999-2001 | No |

*These data points were excluded from the analysis after a thorough QA/QC process was performed

**Figure 9: ERM Table Indicating that Over 300 Data Points were Excluded**

***Removal of Winter Data***

Although water-quality impacts in the spring through fall period are very important, the winter period is critical. Due to low tributary flows in the winter, any produced water added will result in the highest % effluent in Badwater Creek (and highest changes in salinity, etc.), as it enters the reservoir. ERM chose to exclude winter data, with no valid justification. ERM states:

> *"temperature data overlapping with model predicted periods of non-zero ice thickness were excluded from the calibration and validation comparisons to field data. This is because grab sample measurements recorded during predicted periods of ice cover are highly uncertain. The uncertainty arises because these samples could have been taken from localized areas that may not have ice or may have been collected from below the ice cover. These field measurements did not contain such information and were deemed unsuitable for comparison to model results."*

The reasons given for exclusion do not make sense and this is unconventional. In fact, several studies focus on accurate modeling under ice-cover conditions and/or simulated conditions over a number of years and include data collected during ice cover (e.g., Brodzeller and McGinley, 2016; LimnoTech, 2016; Hydros Consulting, 2017). It is suspect that ERM chose to remove data from a critical period for this project.

The percent of produced water in the inflow from Badwater Creek into the reservoir (using flows from ERM input files) is displayed in Figure 10. Results from the calibration model run are shown along with the three compliance analysis cases considered by ERM. Large increases are seen in July and August and maximum levels are reached in December and January. The highest percentages occur in the winter months and reach values of over 90% produced water under Case 03 (the case considered in the Statement of Basis). These periods are when "maximum concentrations entering Boysen Bay and the reservoir" occur, as noted by ERM. We acknowledge that a portion of the water is to be treated, but also note that concentrations of several constituents are not reduced via treatment (examples include arsenic, chromium, nickel, magnesium, manganese, copper, sulfide, and mercury – Table 6-4 in the Report).

Winter conditions are critical for this analysis and ERM's exclusion of winter data is unwarranted and wrong.

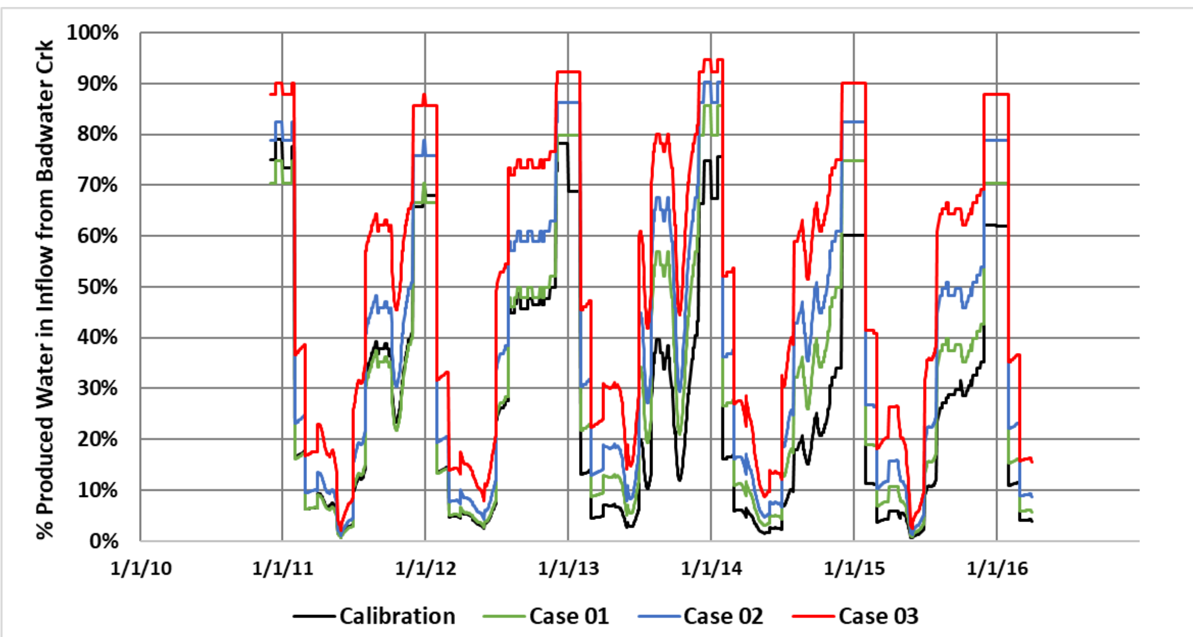


**Figure 10: Proportion of Produced Water in the Inflow from Badwater Creek into the Reservoir**

## Reservoir Model Calibration Targets

Calibration targets are used to evaluate model performance and to determine if the model can be used for desired purposes. This is an important aspect of model development.

## 14. ERM Used Overly-Lenient Calibration Targets

In Section 5.4 of the Report, ERM describes the calibration targets used to evaluate the reservoir water-quality model.

> *"EPA-based metrics for evaluating watershed model performance (Donigian 2000) were used to evaluate the GEMSS model performance for important water quality parameters to the study."*

Although they are evaluating a reservoir model, ERM chose to use targets that were developed for watershed modeling, specifically HSPF. It is easier to more accurately simulate reservoir dynamics than watershed dynamics, due to the smaller spatial scale and greater homogeneity of the physical environment represented. Thus, calibration targets used for reservoir modeling are more stringent and should have been used for this effort. For example, developers of the well-used CE-QUAL-W2 model (from which GEMSS is reportedly based on) note that temperature simulations (important for simulating flow patterns accurately) should have an average mean absolute error within 1 °C. This means that the simulated model value is, on average, within 1 °C of the measured temperature. This target is met by numerous model applications of CE-QUAL-W2 (Cole and Wells, 2016 lists 70 applications in Table 4).

Given that the Boysen Reservoir is developed in 3 dimensions (versus a using 2-dimension assumption for CE-QUAL-W2 applications), one could expect the targets for Boysen Reservoir could be more stringent than the ones used in W2. Note that the commonly-used temperature target for reservoirs is not met by the Boysen Reservoir application (at least at the dam). This indicates that the model is not performing well enough to be called calibrated or adequate for making predictions.

In addition, ERM represents "% differences" in a manner that is highly unusual, dividing the mean of the RMSE by the average model prediction. It is unclear why this metric was created and used for this effort. In addition, ERM does not present the % differences computed. Only the final categories are presented (fair, poor, etc.) for a particular constituent. Thus, the actual % differences computed are not disclosed anywhere in the text, which results in lack of transparency.

## Display of Results

Modeling results need to be complete and transparent. This is not the case for the Report reviewed.

## 15. Information Was Concealed by Limiting Bottom Elevations Displayed on Profile Graphs

In-reservoir observed and simulated results are shown in the Report in Appendices J and K for temperature, TDS, and pH with depth. All of the graphs provide data and results for elevations above 4,680 feet. This elevation is not at the bottom of the reservoir (at least near the dam) and cutting off the elevations in the figures leads the reader to assume that the reservoir is typically well-mixed summer and does not stratify or have much vertical variation. In addition, the model results show something similar. An example is shown in ERM's Figure K 39 (Figure 11) for July 30, 2002 near the dam, where the reservoir appears to be well-mixed with good model predictions (and hot from top to bottom).

However, the full profile of observed data indicates stratified conditions (Figure 12). In addition, Figure 12 shows that ERM failed to display about 90% of the observed profile. The bottom of ERM's model grid at the calibration location is also indicated, showing that the model grid is not deep enough near the dam. Nor is it deep enough to reach the lower-level outlet. This also highlights significant issues with the development of the model grid (which isn't deep enough to reach the lower-level outlet).

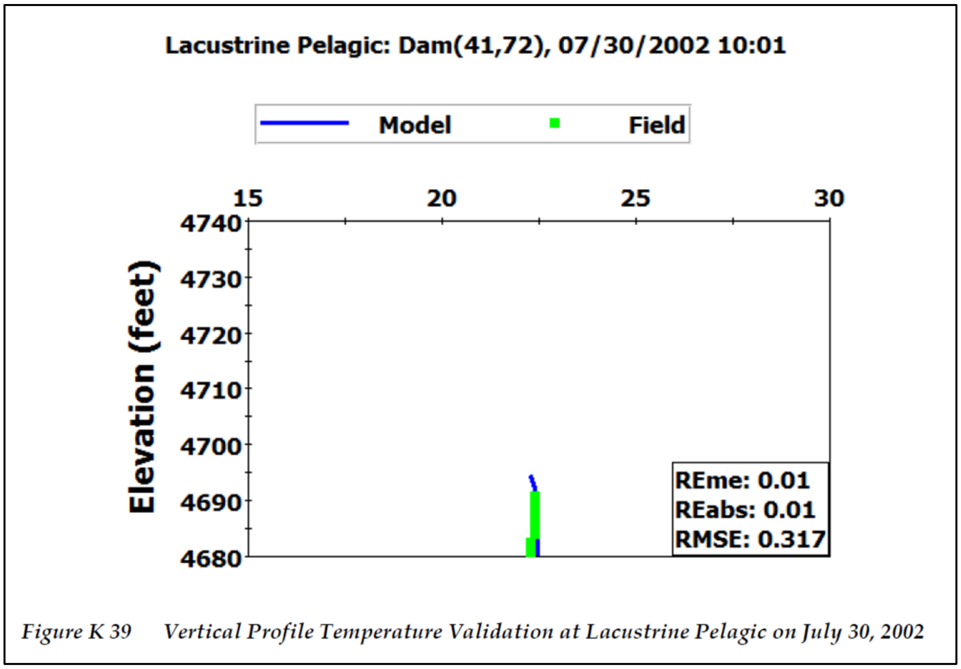


**Figure 11. ERM's Figure Showing Observed and Simulated Temperature Profiles**

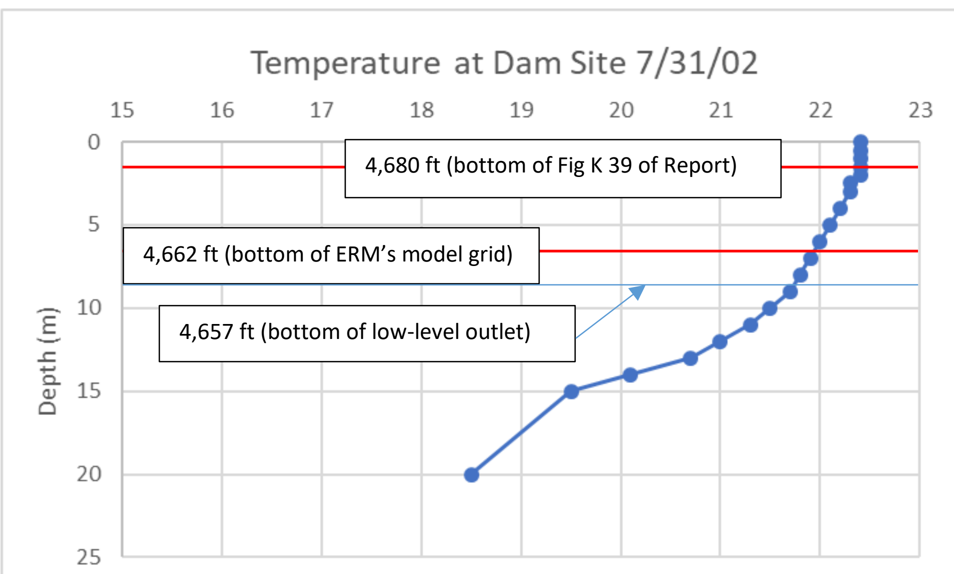


**Figure 12. Full Profile at the Calibration Site Closest to the Dam**

## 16. <u>Information Was Omitted by Failing to Include All Profile Dates</u>

In-reservoir observed and simulated results are shown in the Report in Appendices J and K for temperature, TDS, and pH. Several profiles were omitted, including temperature profiles near the dam for 2014-2016. It is not clear why this is the case.

## Actual Model Performance

### 17. Simulation Results are Poor

Capturing observed flow patterns and hydrodynamics with the model is important. This is necessary to be able to use the model to predict conditions with increased flows at higher concentrations at Badwater Creek. Fortunately, a few temperature and specific conductivity profiles are available. Both of these constituents are good indicators of flow and thermal patterns and hydrodynamics.

Even though a number of adjustments were made during model development and calibration, the model results are very poor. Temperature profiles near the dam (Figure 13) show that the model is not capturing observed stratification in the summer and shows very little variation top to bottom. Reservoir temperature calibration is an initial and very important step in modeling. Recall that water in Boysen Reservoir is released to the Wind River via a low-level outlet (elevation 4,657 ft) and an upper spillway, at times. This makes it even more critical to be able to capture the vertical variations. As described earlier, using commonly-accepted calibration targets, the ERM model is not adequate for use. Also note that the bottom of the model grid at this calibration location is so high that water in the bottom 35 feet of the reservoir is ignored. Thus, water quality in this region (near the lower level OLW) is not even simulated.

Instances where modeled outflow temperatures to the Wind River correspond closely with observed temperatures downstream are strong indications of poor reservoir model performance. This is because the observed temperatures were compared to the temperatures at the top 2 feet of the reservoir near the dam, as described previously. The observed downstream temperatures should be the result of outflows that depend on release location (low level outlet, spillway), amount released at that location, and vertical density distribution. Thus, even when the reported model results seem to be acceptable, they are not generated as a result of a physically realistic simulation. This renders modeled predictions at the Wind River Class I segment unreliable.

Specific conductivity profiles are shown in Figure 14. Again, the vertical variations are not captured and sometimes the magnitudes are overestimated by 100's of uS/cm. Note that most of these are in mid-summer, when the % produced water increases (see Figure 10).

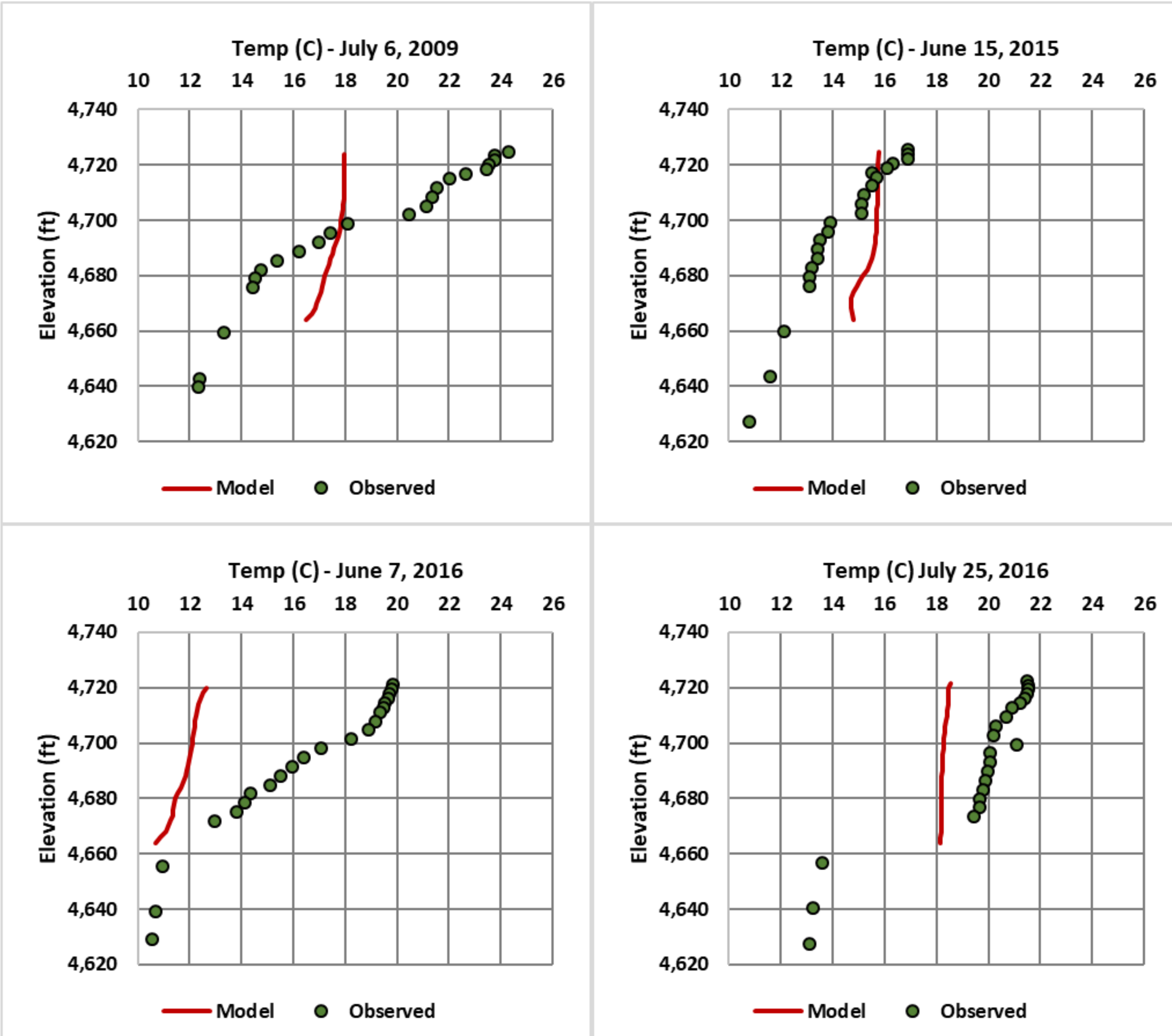


**Figure 13. Example Temperature Profiles Displaying All Observations and Model Results from Top to Bottom of the Reservoir. Data from Lacustrine Pelagic: Dam Site**

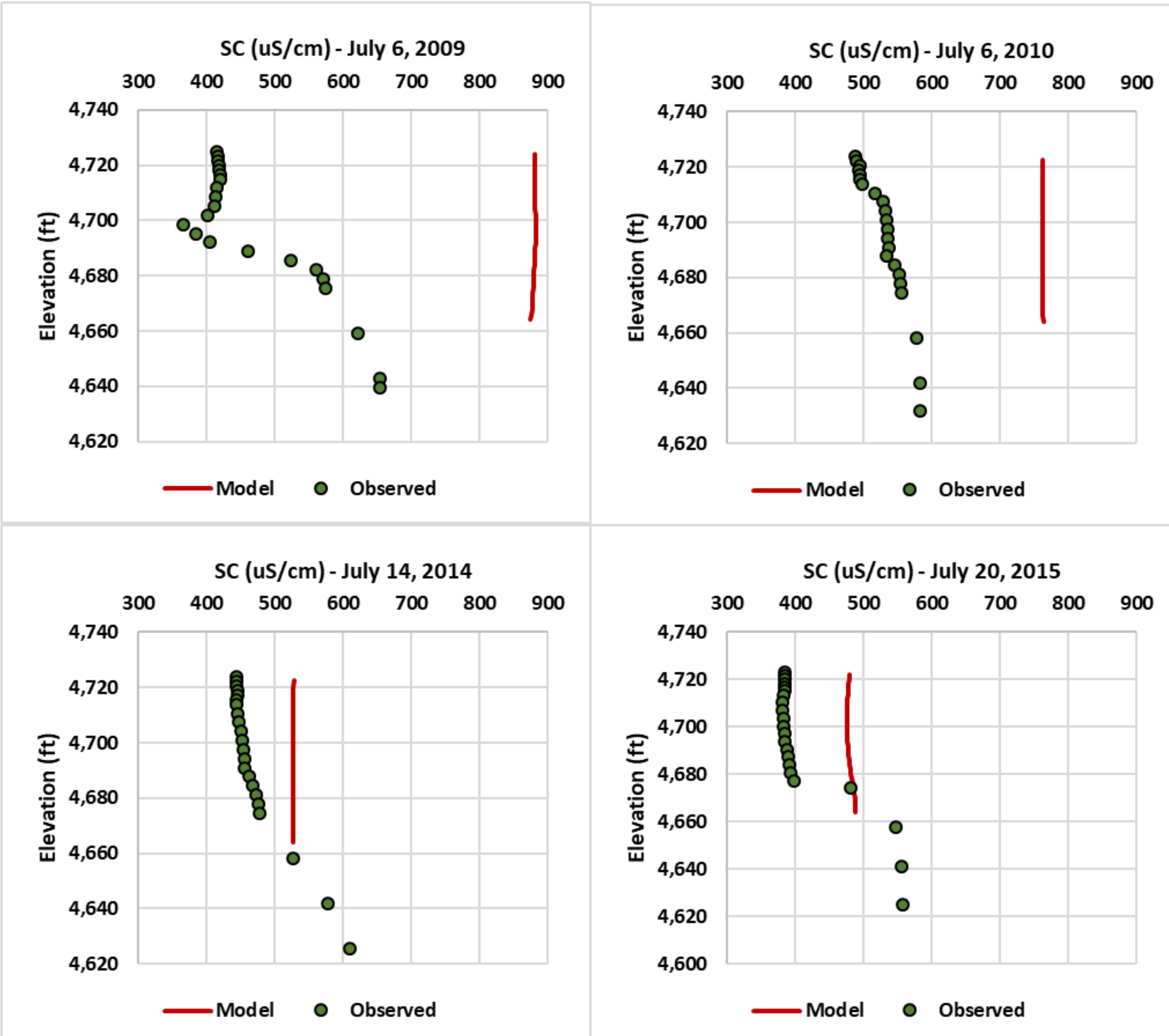


**Figure 14. Example Specific Conductivity Profiles Displaying All Observations and Model Results from Top to Bottom. Data from Lacustrine Pelagic: Dam Site**

## MAJOR POINT: "COMPLIANCE ANALYSIS" METHODS AND FINDINGS ARE INCORRECT

Even if the reservoir model was developed adequately, the methodology used by ERM to evaluate compliance is severely flawed and is biased. Comments below are considered in 3 areas:

1. Data Used to Define Baseline Conditions in Class 1 Section;
2. How ERM Shows Compliance; and
3. Boysen Reservoir Antidegradation.

### Data Used to Define Baseline Conditions in Class 1 Section

Baseline conditions in the Wind River are very important because these conditions are the basis for protection.

**18. <u>ERM Failed to Use USGS Data for Defining Baseline in Class I Segment</u>**

Only Encana/Aethon-collected data were considered when defining baseline conditions for the Class I segment of the Wind River. Yet, there are hundreds of approved water-quality measurements from the USGS below the reservoir for the period ERM defined as baseline (December 2010 – March 2016). Approved USGS data are considered to be of very high quality. In some instances, there are more data from the USGS in this period (Encana/Aethon did not report data for 8 months of the baseline period; Figure 15). In addition, there is much more variability in much of the data collected by Encana/Aethon than the USGS (see Figure 15 as an example). This variability would serve to increase a standard deviation.

In addition, the Encana / Aethon baseline data provided to Hydros Consulting did not appear to be raw data. The forms of the constituents were not noted (dissolved or total). The dates were often the 1st of the month and appear to be reported as a monthly value. The values could be averages or single points, and this is not clear. Aethon switched labs (going from "Lab 1" to "Lab 2") in November 2013. This resulted in an increase in detection limit for 12 of 14 metals, most of which were already below detection limits.

Baseline conditions should be defined using USGS data which is of higher quality and more complete, in most cases.

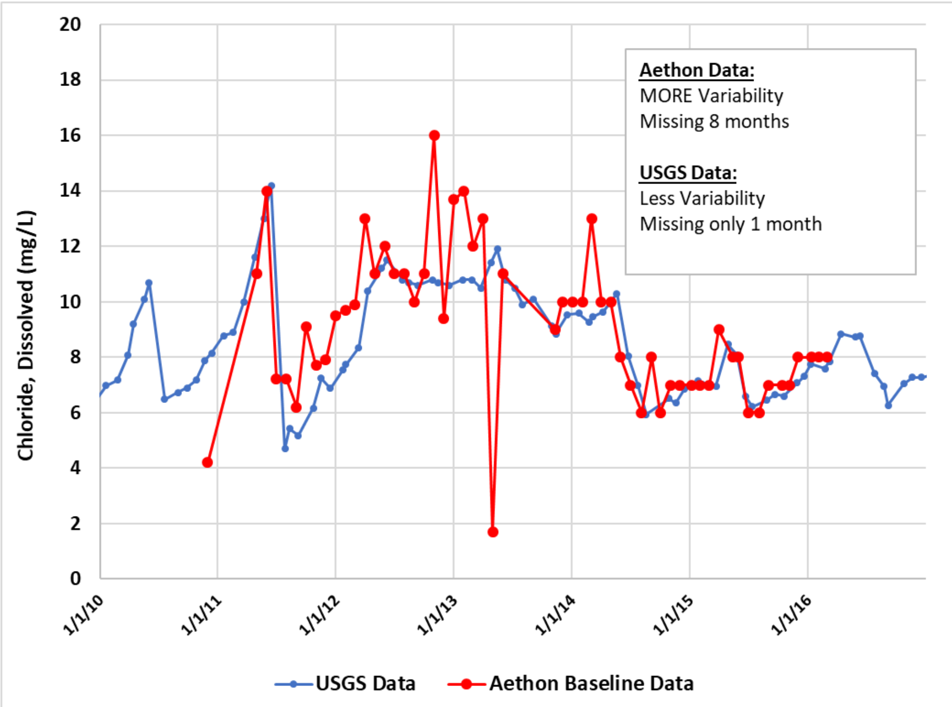


**Figure 15: Chloride Observations in the Wind River below Boysen Reservoir (2010-2016)**

## How ERM Shows Compliance in Class I Segment

### 19. Used Monthly Averages, Obscuring Results

ERM chose to complete the compliance analysis on an average monthly basis. So, all Januarys are averaged together, Februarys are averaged together etc. This method lumps the data, reduces observed variability, and also serves to hide important differences that occur year-to-year, especially since time-series of the results are not displayed. This point is illustrated for chloride in Figure 16.

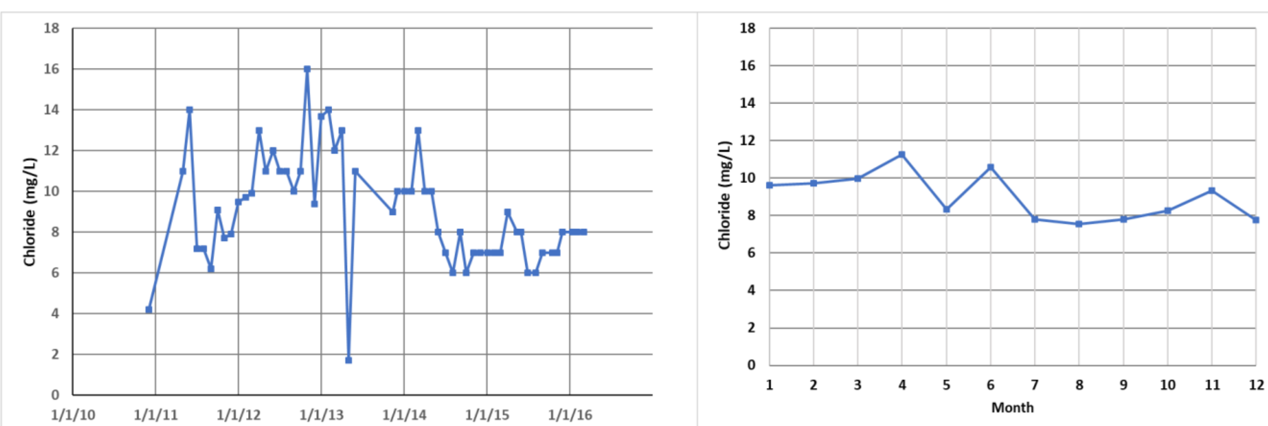


**Figure 16: Chloride Measurements, Wind River Below Boysen Reservoir, Aethon Data.** Individual Measurements (Left); Lumped Average Monthly Values (Right); Illustration of Reduction in Variability.

ERM did display chloride results in an attempt to justify the model "spin-up" period and to only focus on model results from December 2010 – March 2016 (Figure 17). Note that the project results in lower chloride concentrations in the "outflow" (top 2 feet of the reservoir) in 2010-2011.

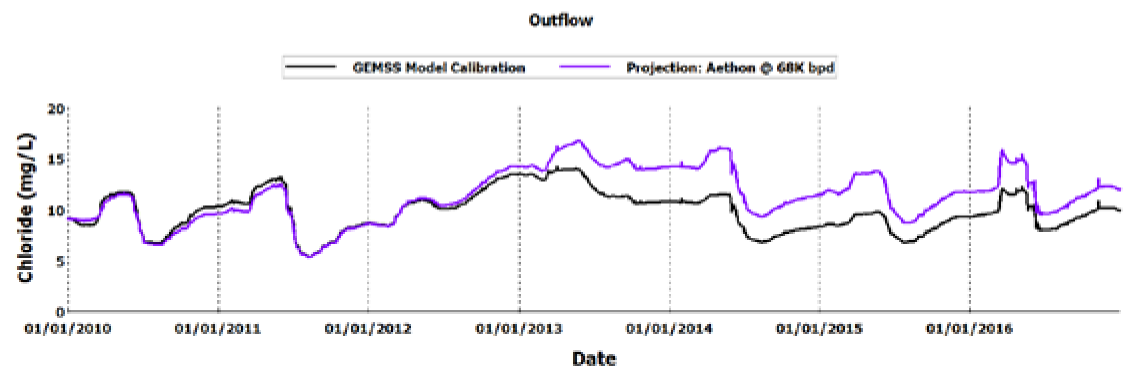


*Figure 6-4 Projected Chloride Concentrations Compared to the Calibrated Model to Demonstrate the Model Spin-Up Period*

**Figure 17. Model Output for "Outflow" (Top 2 ft of the Reservoir); Model Calibration and Case 01**

The results are clearly not due to "spin-up" if one considers the flow inputs into the model (Figure 18).

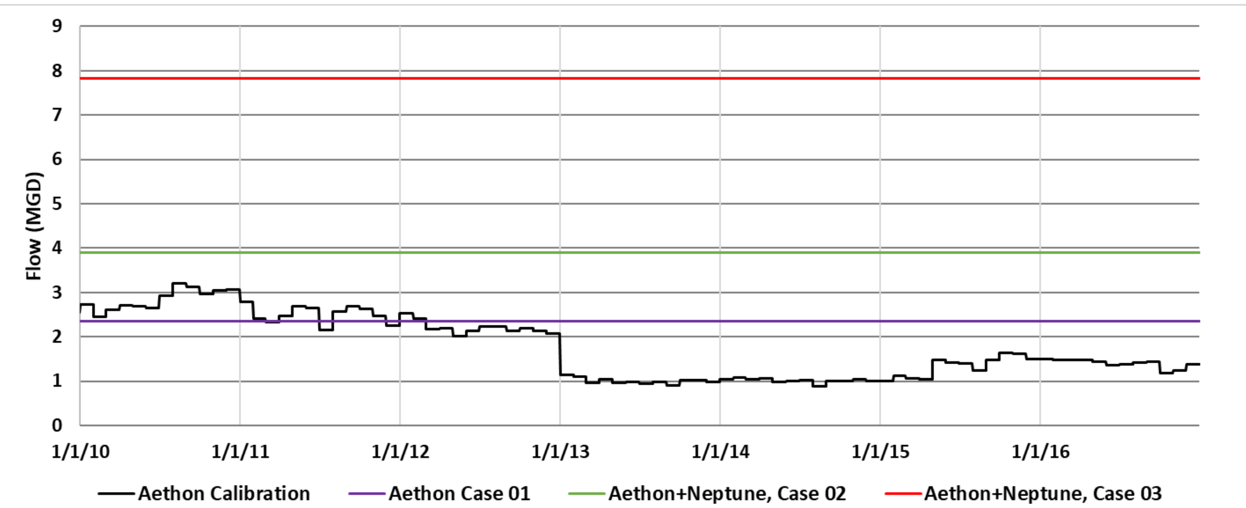


**Figure 18. Aethon Produced Water Flowrate Assumptions**

Because the projection flows (68,000 bpd; Case 01) are lower than what actually occurred in 2010 and 2011, the model shows an improvement (lower concentrations) with the project. Starting in 2013, when the projection flows are much higher than the actual, the model shows some significant increases in concentrations (Figure 17).

This is an additional illustration as to why the method of lumping into monthly averages is inappropriate. In this case, the conclusion reached depends on the period analyzed. If one only considered the period 2010 – 2012, the results would show an improvement with the project. If, on the other hand, one only considered the period 2013-2016, the results would show a greater impact than reported in the Report.

The analysis should be presented on a daily basis so that periods of larger impact are transparent. For example, from Figure O 1 (Figure 19), the reader could assume that April concentrations may only increase by up to 2.7 mg/L chloride, while the time-series data (Figure 17) show increases of up to 4.6 mg/L at times.

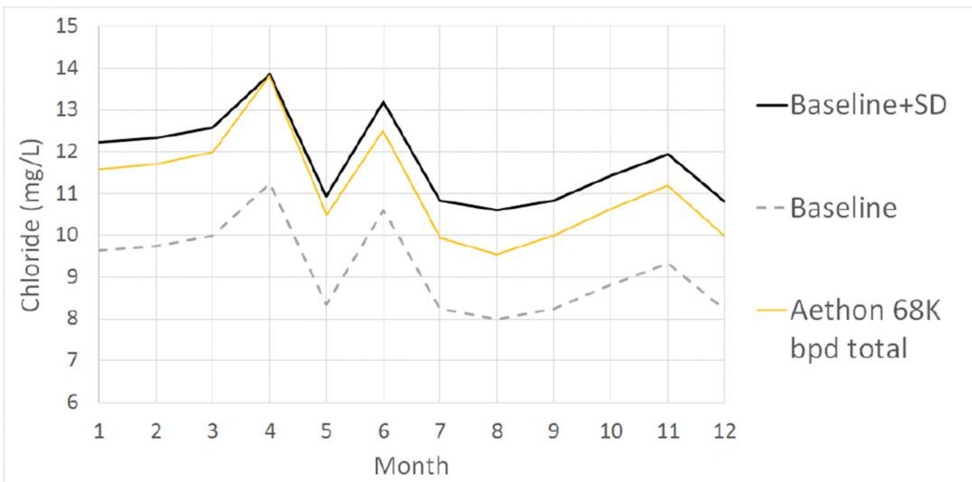


*Figure O 1 Chloride Resulting in Wind River Below Boysen Dam from Aethon's Projected Discharge of 68,000 bpd Total (Modeling Case 01)*

**Figure 19. ERM Figure Showing Impact of the Project for Case 01**

## 20. <u>Used Inflated Standard Deviation</u>

As described above, ERM chose to conduct the analysis on a monthly basis. If this is done to quantify the baseline and if the analysis is to be based on a standard deviation, the estimate of the baseline + 1 standard deviation (SD) must be performed using the SD of the lumped monthly data. ERM chose to use the SD of the original data points. This is incorrect and results in allowing a greater load to the reservoir.

For the example above (Figure 16), the SD for the un-lumped data (left) is 2.7 mg/L, while the SD for the lumped data (right) is 1.2 mg/L. This makes a considerable difference in the antidegradation analysis, since the larger SD allows for larger decreases in water quality (Figure 20).

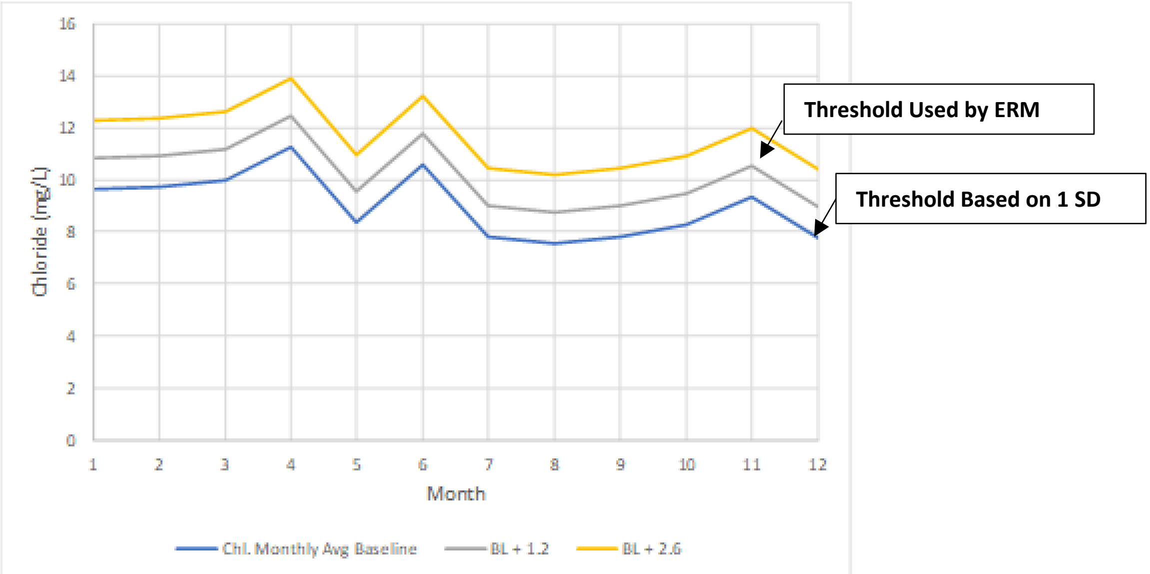


**Figure 20. Impacts of Different Standard Deviations**

## 21. Favorable Assumptions Made for Category III Constituents

ERM created an analysis category to include constituents that are present in Aethon's discharge above required detection limits, yet are often below detection limits (more than 50% of the time) in the Wind River below the reservoir. This was called Category III and includes total chromium, dissolved copper, dissolved nickel, dissolved aluminum, and dissolved mercury. ERM chose to evaluate these constituents for compliance by:

- Taking the model results simulated at the top 2 feet of the reservoir near the dam. (which is not representative of the outflow)
- Lumping the results together on a monthly basis and averaging (thus removing observed variability and eliminating the need to display a time series of results and changes each year)
- Comparing the results to the detection limit.

ERM noted that the detection limits varied over time (since they changed labs in 2013, most often resulting in an increased detection limit for some reason), so the decision was made to use the maximum detection limit. Issues associated with this decision include:

- It makes it easier to show compliance; and
- It is inconsistent with use of ½ the DL in the rest of the analyses.

As an example, more detail is provided here for dissolved nickel. For the Aethon sampled Wind River data (which was exclusively used to determine baseline versus using USGS data), the detection limit was 0.5 ug/L from December 2010 through June 2013. Then a different lab was used for November 2013 – March 2016[7] and reported a 5 ug/L detection limit. It is not clear why the detection limit would

[7] No data were collected for the 4-month period between July 2013 – October 2013.

increase, in light of the fact that of the 27 samples collected before the lab change, 13 were below the detection limit[8].

Using the approach developed by ERM, the results are displayed as Figure O 28 in Appendix O (see Figure 21). Using the threshold of 5 ug/L (based on the 2nd lab's detection limit), it appears that the project will not result in degradation in the Class I section. However, if the lab change had not occurred (or if the minimum DL was chosen), then the conclusion would be that degradation would occur.

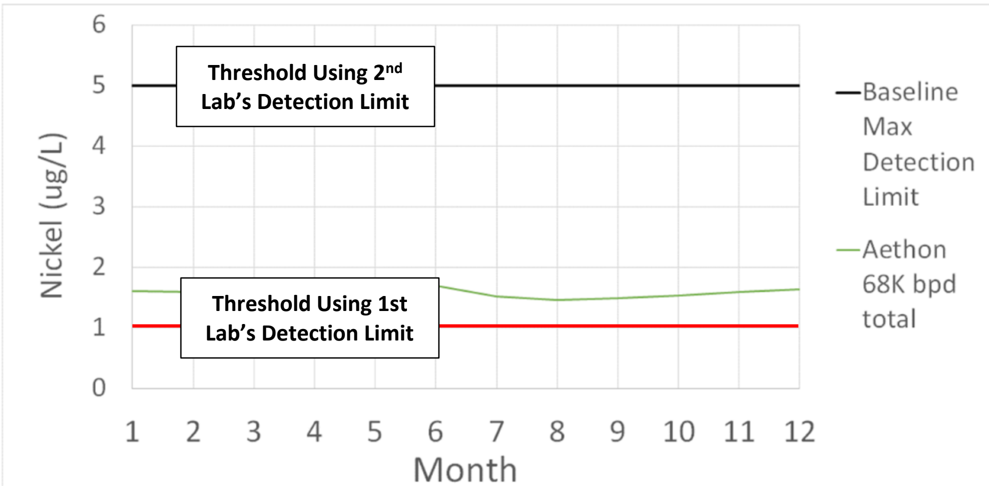


*Figure O 28 Nickel Resulting in Wind River Below Boysen Dam from Aethon's Projected Discharge of 68,000 bpd Total (Modeling Case 01)*

**Figure 21. ERM Results for the Compliance Analysis for Dissolved Nickel (Red Line and Two Text Boxes Added)**

Overall, this method and its implementation are flawed.

## 22. Created Alternative Threshold for Aluminum

Extending the discussion for Comment 22 for an in-depth look at how dissolved aluminum was evaluated (another Category III constituent), it appears that an alternative tactic was used. For this constituent, the 1st lab's detection limit was 4 ug/L and the 2nd lab's detection limit was actually lowered to 3 ug/L. The observed data are shown in Figure 22, along with USGS data for comparison (which were not considered to quantify baseline conditions).

[8] Although it is interesting that the 50% threshold for Category III constituents was being approached.

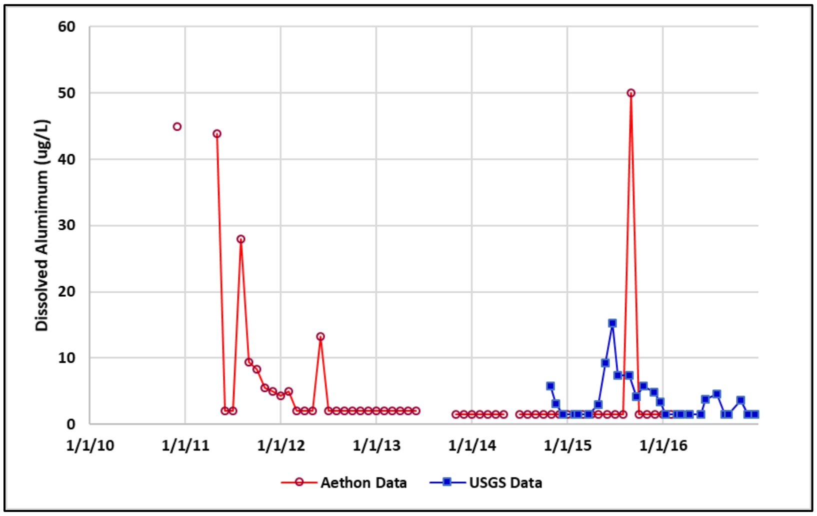


**Figure 22. Dissolved Aluminum Data for Wind River below Boysen Reservoir**

After lumping the model results and applying the adjustment factor (described above), the monthly model results are in the range of ~22-33 ug/L (Figure 23). This would show a problem if one compares these values to the 3-4 ug/L detection limits. ERM chose to set an alternative threshold of 50 ug/L and using that threshold, the project would not result in degradation.

The source of the 50 ug/L threshold appears to be the required detection limit for dissolved aluminum at the end of the pipe (WDEQ, 2019a). This 50 ug/L detection limit does not apply to the Class I segment of the Wind River (since it is not effluent) and use of this value by ERM for compliance is wrong.

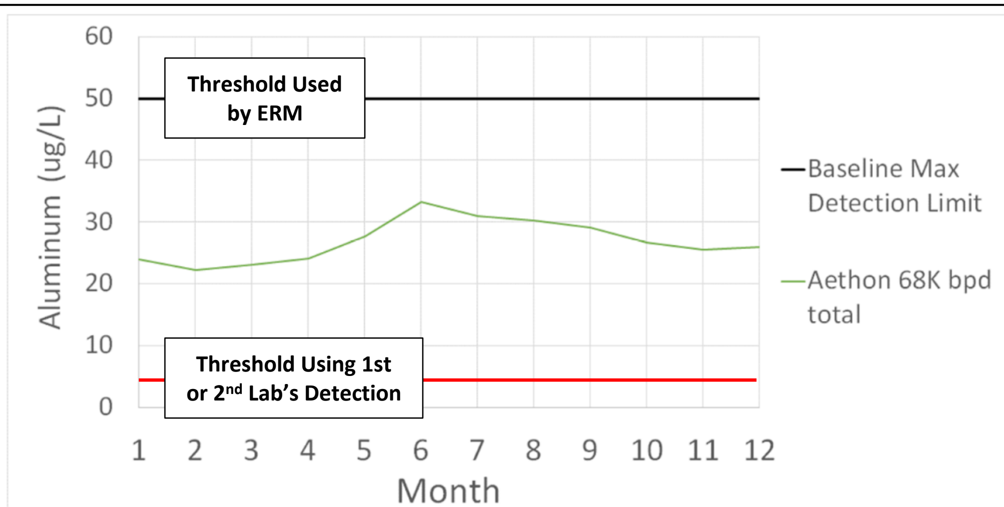


*Figure O 31 Aluminum Resulting in Wind River Below Boysen Dam from Aethon's Projected Discharge of 68,000 bpd Total (Modeling Case 01)*

**Figure 23. ERM Results for the Compliance Analysis for Dissolved Aluminum (Red Line and Two Text Boxes Added)**

## Boysen Reservoir Antidegradation

### 23. <u>ERM Did Not Conduct an Antidegradation Analysis for Boysen Reservoir</u>

For Boysen Reservoir, which is classified as a High Quality Water (Class 2AB), "a lowering of water quality may be allowed if it is determined that the amount of degradation is insignificant" (WDEQ, 2013). The determination of significance of the degradation is to be determined using either of the following tests:

- The increased loading is less than 10% of the existing total load for critical constituents; or
- The increased loading will consume, after mixing, less than 20% of the assimilative capacity for critical constituents.

The only time loading to the reservoir is described in the Report is in Chapter 8, which focuses exclusively on chloride. ERM assumes that Aethon can discharge 23.8 tons/day of chloride to the reservoir, based on a flow of 68,000 bpd (Case 01 – no treatment) and a concentration of 2,000 mg/L end-of-pipe limit. ERM states *"This resulting load is the total allowable chloride load that can be discharged by Aethon's operations while complying with the Antidegradation criteria."* This is <u>not</u> based on Boysen Reservoir antidegradation, but on the Wind River below. ERM did not consider the 10% load increase criterion for Boysen Reservoir.

The only time project impacts to the water in Boysen Reservoir were considered in the Report is in Chapter 7, the Mixing Zone Study. ERM describes a mixing zone and claims that *"Chronic water quality criteria outside the mixing zone within the reservoir is (sic) met in all three flow conditions."* Thus, ERM considered it to be acceptable to consume all of the assimilative capacity in the reservoir for this project. ERM did not consider the 20% limit for assimilative capacity.

Thus, ERM failed to conduct an antidegradation analysis for Boysen Reservoir.

## SUMMARY

ERM developed a mechanistic hydrodynamic water-quality model of Boysen Reservoir to support permitting and to determine conditions for Aethon's project that would "protect downstream surface water quality in Badwater Creek, Boysen Reservoir and the downstream Class 1 segment of the Wind River Below Boysen Reservoir, as well as require Aethon to uphold Wyoming's antidegradation policies."

There are very serious issues related to the development, evaluation, and use of the Boysen Reservoir Model. Our review of the reservoir model documentation and reservoir model files revealed critical concerns. Highlights include:

**<u>The Model was not Developed Properly and Does not Account for Factors Important for this Project</u>**

- Density changes anticipated in the future for water flowing into Badwater Bay, (important for flow patterns) were completely ignored.
- Releases to the Wind River (low-level outlet vs. spills) were not differentiated.
- Releases to the Wind River were not density based.
- Wind speeds were severely and unrealistically reduced without discussion.
- Reservoir evaporation was not considered.

- Several water balance and water quality input assumptions and adjustments were made without justification.

**<u>Model Performance was Not Evaluated Appropriately and is Misleadingly Communicated</u>**

- ERM misleadingly claims that the reservoir model is calibrated and adequately simulates Wind River (Class I segment) water quality. This is done by comparing water-quality measurements in the river to water quality simulated in the <u>top two feet</u> of the reservoir. This is disturbing, wrong, and was done even though the reservoir stratifies and has a low-level outlet.
- There are numerous instances of excluding meaningful data during the calibration/validation process (including all non-profile reservoir data and all data during periods of highest percent produced water).
- Information was misleadingly concealed from the reader by only displaying the top portion of profile results and observations.
- The model is not calibrated and the results are poor.

**<u>"Compliance Analysis" Methods and Findings are Flawed and Incorrect</u>**

- Baseline conditions for the Class I segment excluded valid USGS data.
- Methods used to show compliance for the Class I segment:
  - Used monthly averages, leading to the conclusion of reduced impacts
  - Used inflated and incorrect values for standard deviation
  - Relied on favorable assumptions for Category III constituents
- An antidegradation analysis for Boysen Reservoir was not conducted.

Based on how the model was developed and the results, the reservoir model cannot be used for projections or decision making. In addition, even if the model adequately simulated water quality, the methods used to determine compliance are inadequate, sometimes wrong, and several assumptions were made to show favorable results.

According to the WDEQ (2019b), "Model was designed to ensure compliance with WQS applicable to Boysen and to maintain existing quality in the Wind River below Boysen." Unfortunately, this is not a true statement.

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# Jean Marie Boyer, Ph.D., P.E.

Principal, Senior Water Resources Engineer / Water Quality Modeler

## Professional Summary

Dr. Boyer is an engineer and project manager with over 25 years' experience in surface water-quality modeling and analysis; lake and reservoir planning and management, watershed studies, and design, development and application of decision support systems. She has provided expert witness testimony (deposition and trial) in a number of cases involving surface water quality and groundwater contamination. Her experience includes analysis of a variety of properties and constituents including water clarity, temperature, nutrients, dissolved oxygen, toxic substances, sediment, salinity, and pathogenic microorganisms in lakes, reservoirs, and streams.

## Professional Qualifications

Professional Engineer (PE), CO # 30510, NM # 15712, OK # 21235

## Education

Ph.D., Civil (Environmental) Engineering, University of Colorado, 1993

M.S., Chemical Engineering, University of Colorado, 1988

B.S., Chemical Engineering, University of Wisconsin-Madison, 1981

## Memberships

Member, North American Lake Management Society

North American Lake Management Society: Region 8 Director (2003-2005)

Member, American Society of Limnology and Oceanography

Member, Water Environment Federation

Member, Water Pollution Control Federation Research Committee (1989 - 1992)

Colorado Lake and Reservoir Management Association (CLRMA):

- Chair, Membership Committee (1996 - 1999)
- Director at Large (1997 - 1999)
- President - Elect, President, Past President, (2000-2002)

Member, Colorado Non-Point Source Council (2002-2007)

## Summary of Core Skills

Water-Quality Modeling and Analysis; Watershed Management; Management of Lakes, Reservoirs, and Streams for Water-Quality Purposes; Source Water Assessment and Protection (SWAP); Eutrophication Studies; Watershed-based Trading, TMDLs, NPDES Permitting; Design, Development and Application of Decision Support Systems; Water Resources Planning and Management.

## Employment History

| | |
|---|---|
| 2010 - Present | Principal, Hydros Consulting Inc. |
| 1994 - 2010 | Senior Project Engineer, AMEC Earth & Environmental, Inc. (formerly Hydrosphere Resource Consultants) Water-quality modeling. Water-quality analyses. Computer modeling of water resources systems. Water resources planning and management.<br>Member of the Hydrosphere Board of Directors (1997 to 2003) and Hydrosphere Vice-President (2001 to 2007). |
| 1991 - 1994 | Hydraulic Engineer/Project Manager, U.S. Bureau of Reclamation. Led research and managed development and implementation of integrated river-basin management models. |
| 1989 - 1991 | Research Engineer, CADSWES (Center for Advanced Decision Support for Water & Environmental Systems), University of Colorado. Designed and developed decision support systems for water and environmental systems. Focused on river-basin management, reservoir operation, and water-quality modeling. |
| 1986 - 1988 | Teaching Assistant, University of Colorado. Instructed Chemistry and Introduction to Engineering Computations. |
| 1988 | Independent Water-Quality Consultant. |
| 1985 - 1986 | Project Manager, Foth & Van Dyke and Associates, Inc. Project manager and consultant to the papermaking industry. |
| 1981 - 1984 | Process Engineer / Project Manager, Procter & Gamble Paper Products Company. |
| 1981 | Technical Services Engineer, Eastman Kodak Co. Provided technical services to papermaking and film making divisions. |
| 1979 - 1980 | Technical Services Engineer, Procter & Gamble Paper Products Company. Responsible for technical coordination and support to manufacturing division. |

## Representative Projects

**Three Lakes Water-Quality Technical Support and Modeling, CO** The Three Lakes System (Grand Lake, Shadow Mountain Reservoir, and Granby Reservoir) is an important part of the Colorado-Big Thompson Project. Dr. Boyer has led technical analyses on behalf of the Three Lakes Technical Committee for over a decade. Work has included:

- Development and Use of an EXCEL-based Integrated Dynamic Water-Quality Model for all Three Water Bodies;
- Development and Use of a CE-QUAL-W2-based Integrated Dynamic Water-Quality Model for all Three Water Bodies (to be used for NEPA evaluations);
- Performing Model Runs to Aid in Operational Planning;

- Use of the CE-QUAL-W2-based model as part of the Adaptive Management Process to improve Grand Lake Clarity;
- General Technical Support for the Adaptive Management Process;
- Model Sensitivity Analyses;
- Technical Support for Development of a Clarity Standard for Grand Lake; and
- General Technical Support to the Stakeholder Group.

**Cherry Creek Reservoir Water-Quality Model, CO** Dr. Boyer was the project manager for a CE-QUAL-W2 model developed for the Cherry Creek Basin Water-Quality Authority. Key issues include evaluating the performance of an existing destratification system and understanding algal dynamics (including cyanobacteria) for meeting the chlorophyll *a* standard.

**Chatfield Reservoir Water-Quality Model, CO** Dr. Boyer is the project manager for a CE-QUAL-W2 model application for the Reallocation of Chatfield Reservoir. Key issues focus on the sediment-water interactions at soon-to-be areas of inundation.

**McLellan Reservoir and South Platte Reservoir Water Quality, CO** Dr. Boyer is providing technical services to better understand and manage problematic algae blooms and the impacts in reduced filter run times at a drinking water facility.

**Northern Integrated Supply Project (NISP) EIS / 401 Certification, CO** Dr. Boyer is the project manager for water-quality and temperature modeling services to the lead EIS contractor for Northern Water's NISP FEIS and to Northern Water for 401 Certification application development. This work includes a water-quality model and temperature model of the Cache la Poudre River, as well as CE-QUAL-W2 models for two of the reservoirs (Glade Reservoir and Cactus Hill Reservoir) proposed under the NISP alternatives. The use of these models is focused on potential project impacts in the Poudre River, as well as in the two proposed reservoirs, which would be used for drinking water, irrigation, and river flow augmentation. Mitigation activities are also being evaluated.

**Ziegler Reservoir, CO** Providing technical support to a contractor working on water treatment issues for the Town of Snowmass, CO. Water treatability issues arise due to source water in Ziegler Reservoir and include taste and odor problems, as well as filter runtime issues.

**Water-Quality Standards – Technical Support, CO** Provided technical guidance and testimony before the Colorado Water Quality Control Commission in support of the establishment of a Direct Use Water Supply Classification and chlorophyll *a* standard for Pueblo Reservoir, CO. The work was conducted on behalf of the Pueblo Board of Water Works.

**Water-Quality Standards – Technical Support, CO** Provided technical guidance and testimony before the Colorado Water Quality Control Commission in support of the establishment of a chlorophyll *a* standard for Standley Lake, CO. The work was conducted on behalf of the City of Westminster.

**Horsetooth Reservoir Water-Quality Model, CO** Project Manager and modeler for the development of a hydrodynamic water-quality model for Horsetooth Reservoir, near Fort

Collins, Colorado.  Concerns include low metalimnetic dissolved oxygen concentrations, total organic carbon, manganese, and taste and odor events.

**Windy Gap Firming Project EIS, CO**  Provided water-quality services to the lead EIS contractor for Northern Water's Windy Gap Firming Project EIS.  This work (2003-2011) involved dynamic water-quality modeling and estimating water-quality conditions under possible future alternatives for the Upper Colorado River, Grand Lake, Shadow Mountain Reservoir, Granby Reservoir, Horsetooth Reservoir, Carter Lake and Ralph Price Reservoir.  In addition, water-quality conditions for four proposed reservoirs were predicted.  Nutrients, algal production, water clarity, and temperature were of primary concern.

**Operational and Water Clarity Assessment – Grand Lake, CO**  Developed a report summarizing water operations and the effect on water quality and clarity in Grand Lake and Shadow Mountain Reservoir in recent years.

**Expert Witness Services – 401 Certification Appeal, CO**  Provided expert witness services during the appeal of the 401 Certification for the Southern Delivery Project to the Colorado Water Quality Control Commission.  The work involved standards assessments and application of antidegradation rules.

**Moffat Collection System Project EIS, CO**  Providing water-quality services to the lead EIS contractor for Denver Water's Moffat Collection System Project EIS.  The work involves modeling and prediction of water quality in the Fraser River and in the Three Lakes System (predominantly Grand Lake) for various alternatives being considered.  Nutrient, algal growth, and water clarity are of primary concern.

**Bear Creek Watershed Study, CO**  Conducted a watershed assessment for Denver Water focused on identifying and evaluating management alternatives to improve raw water quality.  Constituents of concern included nutrients, total organic carbon, microorganisms, and emerging contaminants.  Numerous options were evaluated and compared based on cost and anticipated water-quality impacts.

**Zebra/Quagga Mussel Veliger Transport Model, CO**  Project Manager for the development of a veliger transport model to determine the risk of mussel infestation of a downstream reservoir by an upstream reservoir via transport down the connecting stream.  The risk of infestation of Cheesman Reservoir from Tarryall Reservoir was investigated for Denver Water.

**Fountain Creek Antidegradation Designation, CO**  Conducted a study to assess conditions on Fountain Creek for purposes of antidegradation designation.  The study included investigating if the stream is effluent dominated.  Services included testimony before the Colorado Water Quality Control Commission.

**Zebra Mussel Impacts and Prevention, CO**  Project Manager and lead investigator in providing assistance to a drinking water utility concerned about potential zebra or quagga mussel infestations in their water supply reservoir.  Potential impacts in the areas of water treatment, recreation, and lake ecology were provided along with a review of other's prevention activities and levels of success.

**Dillon Reservoir Spill Model, CO** Project Manager for the development of a two-dimensional, hydrodynamic model of Dillon Reservoir to simulate how potential spills move through the reservoir. Concentrations of contaminants at the drinking water intake are predicted based on spill location, contaminant, volume and duration of the spill, and time of year. The results are incorporated into a decision support tool that is used by the operators to influence reservoir management.

**Lake DeSmet Water-Quality Monitoring and Assessment, WY** Project Manager to establish baseline water-quality conditions and to assess the general water quality of Lake DeSmet, a large reservoir in Wyoming. Baseline conditions are important for the evaluation of future anticipated activities which include development, coal-bed methane production, and the use of the reservoir for a drinking water supply. The work included the development of a water-quality sampling and analysis plan, field work, and data analysis. The results were reported as part of the Buffalo / Sheridan Area Water Supply / Lake DeSmet Level I Study.

**Standley Lake Watershed Model, CO** Project Manager for the development of a flow and water-quality model for the Clear Creek watershed (400 $mi^2$). This watershed is the source of water for a 43,000 AF drinking water reservoir which has experienced taste and odor complaints due to algal growth. The WARMF model is being used to characterize flow and nutrient concentrations on a daily basis throughout the basin.

**Cherry Creek Reservoir, Destratification / Oxygenation Feasibility Study, CO** Provided water-quality technical services for a study investigating the feasibility of vertically mixing or providing for hypolimnetic oxygenation for a eutrophic reservoir. The goal of the project was to reduce algal growth. Much of the work focused on quantifying internal loading of nutrients from the sediments, before and after project implementation.

**Mariano Exchange Ditch System Assessment, CO** Project Manager for an assessment of a reservoir / exchange ditch system that is contributing sediment and nutrients to the Big Thompson River. The project involved monitoring, data analysis, and recommendations for best management practices.

**Impacts of Recreation of Reservoir Water Quality, CO** Investigated the impacts of recreation on Standley Lake, a reservoir used for drinking water purposes and is the sole supply of drinking water for the City of Westminster, Colorado.

**Arkansas River Basin Water-Quality, CO** Provided water-quality environmental assessment services to the City of Aurora. The work involved stream and reservoir modeling and focuses on salinity and selenium.

**Lake Mead Water-Quality Model Review, NV** Member of an expert panel to review a three-dimensional hydrodynamic and water-quality model of the Boulder Basin of Lake Mead. The models used for this effort were ELCOM and CAEDYM.

**Lake Okeechobee Northern Tributaries TMDL, FL** In support of litigation, provided expert witness services regarding a draft phosphorus TMDL. The work involved deposition and trial testimony.

**Barr Lake / Milton Reservoir Watershed Study, CO** Project Manager for the first and second phases of a Clean Lakes Watershed Study. The phase one work involved the development of a comprehensive and defensible database and assessment of different modeling approaches for two hyper-eutrophic plains reservoirs. The second phase involved a detailed water-quality assessment for each reservoir. This work helps to lay the foundation for upcoming TMDL's and nutrient criteria setting.

**Water-Quality Impacts from Coal Bed Methane Produced Water, WY** Provided comments on a draft EIS for a coal bed methane project in Wyoming. The analysis included investigating the potential impacts of produced water on the North Platte River and Seminoe Reservoir.

**Gore Creek Algae Study, CO** Conducted a study to determine the cause of increased algal growth in a high-altitude stream. The project involved the development of a sampling plan, sampling activities, data analysis, and modeling.

**Upper Big Thompson Water Quality, CO** Project Manager for the review, assessment, and presentation of water-quality conditions in the Upper Big Thompson Watershed.

**Three Lakes Clean Lakes Study, CO** Project Manager and Lead Water-Quality Modeler for a Clean Lakes Study for the Three Lakes System. This system (Grand Lake, Granby Reservoir, and Shadow Mountain Reservoir) is located just west of Rocky Mountain National Park. The project focused on the impact of nutrients and related parameters that indicate trophic status and involved the development of dynamic, integrated water-quality models for the three lakes and the contributing watersheds.

**Standley Lake Strategic Planning, CO** Providing assistance to three municipalities, who use Standley Lake as a drinking water source, in developing a long-term reservoir management plan.

**Gunnison River Temperature Model and Analysis, CO** Lead Scientist and Project Manager for data analysis, assessment, and modeling to determine potential impacts of operational modifications to three reservoirs on the Gunnison River and river temperature 40 miles downstream. The three reservoirs involved are part of the Aspinall Unit (Blue Mesa, Morrow Point, and Crystal Reservoirs) and were modeled using CE-QUAL-W2. The Gunnison River downstream of the reservoirs was modeled using QUAL2K. The effort is part of the Upper Colorado Recovery Program and is focused on improving conditions for the Colorado pikeminnow.

**Village at Wolf Creek, CO** Conducted review and provided comments on development plans for a new waste water treatment facility and the anticipated impacts to the receiving stream.

**Pecos River Salinity, NM** Conducted water-quality analyses on the Pecos River to support the preparation of the Long-Term Miscellaneous Proposal and Contract EIS for the Carlsbad Project on behalf of the New Mexico Interstate Stream Commission.

**Colorado Source Water Assessment and Protection (SWAP) - Contaminant Inventory.** Project Manager for the GIS portion of Colorado's SWAP Contaminant Inventory effort. This project involved defining the locations of potential source of contamination (PSOCs) and creating maps displaying PSOCs in source water assessment areas.

**Aurora Reservoir Water-Quality Model, CO** Project Manager and Lead Modeler for the development of a eutrophication model (CE-QUAL-W2) for a drinking-water supply reservoir located on the Front Range of Colorado. The project includes the development of a watershed model to estimate nutrient loadings to the reservoir and model runs to predict future conditions with watershed development.

**Standley Lake Water-Quality Model, CO** Developed a dynamic, mechanistic nutrient/food chain model for a reservoir in Colorado experiencing long periods of hypolimnetic anoxia. The EXCEL-based model offered an intermediate level of analysis –between a simplistic empirical approach and a more complicated hydrodynamic modeling effort. Also applied CE-QUAL-W2 to the reservoir to predict the impacts of modifying the outlet works elevation.

**USBR Water Conservation Guidebook** Responsible for writing the section of the guidelines concerned with the impact of water conservation practices on return flow water quality and the water quality of the receiving water body.

**Santa Clarita Valley Chloride Source Study, CA** Provided expert review of a study to determine sources and amounts of chloride loading to a wastewater treatment facility.

**Drinking Water Supply Water-Quality Analysis, NM** Provided expert review of a report and lab analyses conducted to evaluate the water quality of a school's drinking water supply.

**Oregon Effluent Trading Resource Guide, OR** Project Manager for the development of a resource guide for effluent trading in the State of Oregon. The resource guide was developed to aid stakeholders and watershed councils throughout the state in determining how effluent trading could help meet water-quality restoration plans and TMDL goals.

**Clear Creek Orphan Sites Study - Phases I, II, and III, CO** Project Manager in a feasibility study of a market-based system for the adoption of “orphan” non-point pollution sources for credit, consistent with the intent of the Clean Water Act. Examined technical, institutional and public acceptance issues associated with adoption and uses of credits and approaches to developing a credit banking system within the Clear Creek Basin.

**City of Boulder NPDES Permitting, CO** Provided technical support for NPDES permitting for the City of Boulder’s wastewater treatment plant on located Boulder Creek. Activities included water-quality analyses, stream water-quality modeling, and sampling design.

**Eagle Mine Superfund Site, CO** Technical review of documents produced through the CERCLA Remedial Investigation/Feasibility Study Process. Analyzed, evaluated, and monitored remedial activities with regard to generation of acid mine drainage and the impact on water quality.

**USCOE Waterways Experiment Station** Developed a dynamic water-quality model to assess the impact of contaminated sediments on surface water. The model predicts the concentration of toxics in the water column and sediments of a lake as a function of time.

**Phoenix TCE Groundwater Contamination, AZ** In support of litigation, project manager and lead expert for 1) the development of a comprehensive groundwater database and 2) the development of recharge estimates to support groundwater modeling efforts. The purpose of the modeling was to reconstruct historical groundwater conditions over a 40-year period using MODFLOW and MT3D. The database contained more than 30,000 well records in a 500 square-mile area. Recharge rate estimates were made for numerous types of land uses and land use conditions (since 1953) were reconstructed from aerial photographs and other sources. Provided expert testimony (deposition and trial) for three separate cases.

**Metropolitan Water Supply Investigation, CO** As part of a State of Colorado-sponsored cooperative investigation involving over 40 Denver area water providers, evaluated options for direct and indirect effluent reuse for agricultural, non-potable urban irrigation, and industrial purposes as a means of increasing the regional municipal water supply. Reviewed and commented on published irrigation water-quality requirements and thresholds for a variety of agricultural crops. Also investigated the feasibility of implementing interruptible supply contracts (dry year options).

**Santa Ana Watershed Project Authority, CA** Designed and developed a decision support system, built around EPA's stream water-quality model, QUAL2E-UNCAS for use on the Santa Ana River.

**Shasta Reservoir Temperature Model, CA** Developed a one-dimensional, object-oriented, reservoir temperature model for Shasta Reservoir. This model was coupled with a stream model to predict temperatures at a point downstream on the Sacramento River where specific temperature objectives were to be met to protect endangered salmon.

**Boulder Creek Watershed Management, CO** Developed a concept paper describing a watershed approach to water management on Boulder Creek. The document describes a process of municipal planning to address a broad range of current and future issues surrounding the Boulder Creek Watershed.

**Great Lakes Nutrient Model** Developed an integrated object-oriented model to simulate phosphorus concentrations in the Great Lakes system. Model includes water-sediment interactions.

**Flaming Gorge Reservoir Water Quality** Used TVA's two-dimensional reservoir model, BETTER, to simulate water-quality interactions in Flaming Gorge Reservoir in Wyoming and Utah. Developed data display tools to aid in analysis and interpretation of results.

**Oklahoma Source Water Assessment and Protection (SWAP)** QA/QC Manager for the GIS portion of Oklahoma's SWAP effort.

**Groundwater Contamination, CA** Provided litigation support in a case involving TCE contamination in Burbank CA.

**Jasper Reservoir Flood Inundation, CO** Provided oversight for a dam break analysis for a reservoir in the Boulder Creek watershed.

**Vail Mountain, CO** Performed a dam break analysis for a reservoir located on steep, mountainous terrain. Used BREACH and DAMBRK models, developed by the National Weather Service.

## Publications / Presentations

Boyer, J.M., C. Hawley, T. Adams, and K. Bierlein. 2017. Analyzing Lake Data – Finding Patterns and How to Avoid Being Led Down the Wrong Road. Presented at the North American Lake Management Society 37th International Symposium. Denver, CO. November 7-9, 2017.

Boyer, J.M., S. Chapra, and C. Hawley. 2012. "Simulating Water Clarity Using a Lake Eutrophication Model." Presented at the North American Lake Management Society 32nd International Symposium. Madison, WI. November 7-9, 2012.

Hawley, C., Boyer, J.M. and E. Vincent. 2012. "Development of Water-Quality Index for Evaluation of Modeling Scenario Results." Presented at the North American Lake Management Society 32nd International Symposium. Madison, WI. November 7-9, 2012.

Boyer, J.M. and M. Fabisiak. 2010. "Development of a Chlorophyll *a* Standard to Protect Drinking Water Supplies." Presented at the North American Lake Management Society 30th International Symposium. Oklahoma City, OK. November 3-5, 2010.

Boyer, J.M. M. Van Nostrand, and R.B. Hanna. 2009. "The Use of a Hydrodynamic Model for Reservoir Management During a Contaminant Spill." Presented at the North American Lake Management Society 29th International Symposium. Hartford, CT. October 28-30, 2009.

Boyer, J.M. N. Sperandeo, and R.B. Hanna. "A Transport Model to Determine the Risk and Timing of Zebra/Quagga Mussel Infestation." Presented at the North American Lake Management Society 29th International Symposium. Hartford, CT. October 28-30, 2009.

Happe, M, M Fabisiak, and J.M. Boyer. 2008. "Zebra and Quagga Mussels – How One City is Protecting Its Water Supply." Presented at the North American Lake Management Society 28th International Symposium. Lake Louise, Alberta, Canada. November 12-14, 2008.

McGregor, R., A. Horne, and J.M. Boyer. 2006. "Managing Chlorophyll a Levels in Cherry Creek Reservoir with Aggressive In-lake Mixing". Presented at the North American Lake Management Society 26th International Symposium. Indianapolis, IN. November 6-10, 2006.

Boyer, J.M. 2005. "Converting Two Hyper-Eutrophic Reservoirs from Irrigation to Drinking Water Use: Defining the Approach." Presented at the North American Lake Management Society 25th International Symposium, Madison, Wisconsin. November 9-11, 2005.

Boyer, J.M. 2005. "Algae Growth in Streams with Wastewater Treatment Plant Discharge." Presented at the Eleventh Annual Vail Professional Wastewater Operators Seminar,

sponsored by the Rocky Mountain Water Environment Association, Inc., October 28, 2005.

Boyer, J.M. and A. Cutler. 2004. “Modeling a System of Reservoirs to Determine How Reservoir Operations Impact Downstream River Temperatures.” Presented at the North American Lake Management Society 24th International Symposium, Victoria, British Columbia. November 3-5, 2004.

Boyer, J.M. 2004. “Colorado Lakes and Reservoirs.” Presented at the Rocky Mountain Water Quality Analysis Association 2004 Convention. September 24, 2004.

Boyer, J.M. 2004. "Colorado Lakes and Reservoirs -- An Overview." Presented at the NALMS / CLRMA Rocky Mountain Regional Lake and Reservoir Management Conference. May 14, 2004.

Boyer, J.M. and A. Cutler. 2004. "The Gunnison River / Aspinall Unit Temperature Study -- A Look at How Reservoir Operations Impact Downstream Temperatures." Presented at the NALMS / CLRMA Rocky Mountain Regional Lake and Reservoir Management Conference. May 13, 2004.

Boyer, J.M. 2004. "Water Quality of the Upper Big Thompson Watershed." Presented at the Big Thompson Watershed Forum 2004 Annual Meeting. Loveland, Colorado. February 19, 2004.

Hydrosphere Resource Consultants. 2003. "Three Lakes Clean Lakes Watershed Assessment, Final Report." Submitted to the Three Lakes Technical Advisory Committee. December 5, 2003.

Boyer, J.M. 2003. "The Three Lakes Clean Lakes Study." Presented at the Big Thompson Watershed Forum 2003 Annual Meeting. Loveland, Colorado. February 20, 2003.

DiNatale, K., T. Settle, J.M. Boyer and C. Brady. 2001. "Water-Quality Monitoring Results for Colorado Front Range Drinking Water Reservoirs." Presented at the North American Lake Management Society 21st International Symposium, Madison, Wisconsin. November 7-9, 2001.

Boyer, J.M. 2001. "Water-Quality of the Three Lakes System -- Grand Lake, Shadow Mountain Reservoir, and Granby Reservoir." Presented at the Colorado Lake and Reservoir Association Annual Fall Conference, Westminster, CO. October 3, 2001.

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Boyer, J.M., L.T. Rozaklis, R. M. Weaver, and A. R. Oliveira. 2000. "A Watershed-Based Trading Program for Cleaning up Orphan Sites -- Testing the Concepts." Proceedings, ASCE Watershed Management 2000, June 21-24, 2000. Fort Collins, CO.

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Boyer, J.M. 1994. "Addressing Central Valley Project Policy Issues Using a General Purpose Model," Proceedings of the 21st Annual Conference, ASCE Water Resources Planning and Management Division, Denver, CO, May 23-26, 1994.

Johnson, R.C. and J.M. Boyer. 1994. "Global Models in Engineering Education: An Update," European J. Engin. Education, 19(1):83-92.

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Chapra, S.C., J.M. Boyer, and R.L. Runkel. 1993. "Advanced Decision Support Systems for Environmental Simulation Modeling," Proceedings of the 20th Anniversary Conference, ASCE Water Resources Planning and Management Division, K. Hon (Ed.), Seattle, WA, May 1-5, 1993.

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June 24, 2019

MEMORANDUM

To: Dan Heilig, Wyoming Outdoor Council
Jill Morrison, Powder River Basin Resources Council

From: Mike Wireman, Granite Ridge Groundwater

Re: Review of:

1. March 13, 2019 WDEQ *Statement of Basis* (SOB) for the proposed renewal of a current Aethon Energy WPDES discharge permit

2. Draft *Authorization to Discharge Under the Wyoming Pollutant Discharge Elimination System*

I have reviewed the above referenced documents. The following comments summarize my review:

**Summary of proposed discharge**

- Aethons Energy's planned, expanded development of gas deposits may increase the produced water discharge currently permitted under WYPDES permit WY0002062, from about 4.37 mgd (104,000 barrels) to a maximum of 8.27 mgd (197,000 barrels).

- In the permit renewal application Aethon Energy proposes one new outfall (16) to be added to the 15 existing outfalls. Discharge of produced water will occur through the outfalls to Alkalai Creek via unnamed ephemeral stream channels. The SOB (p2) states that all blended water discharge will occur through outfall 1.Alkalai Creek is an ephemeral tributary to Badwater Creek which flows into Badwater Bay in Boysen Reservoir located about 40 miles downstream of the outfall locations. The permit renewal requests that the produced water be transported via Badwater Creek to a mixing zone in Badwater Bay on the eastern side of Boysen Reservoir.

- Aethon Energy retained Environmental Resources Management (ERM) of Melvern, PA to conduct a modeling evaluation of effects of Aethon Energy’s increased produced water discharge on the water quality in the Class 1 segment of the Wind River below Boysen Reservoir.

- The SOB proposes:

  - effluent limits of 2419 mg/l for chloride and 6400 mg/l for total dissolved solids (TDS)
  - monthly mass load limits of 719 tons for chloride and 2161 tons for TDS.

  These limits are based on the mixing model analysis and compliance with antidegradation requirements applicable to the Class 1 segment of the Wind River below Boysen reservoir. The SOB states that the results of the modeling *"indicated that total monthly loads of chloride and TDS could be as high as 719 tons/month and 6571 tons/month respectively without exceeding the class 1 antidegradation targets on the Wind River below Boysen dam."* The chloride limits are also based on historical, grandfathered discharge effluent concentrations for permitted outfalls 1-15.

- Aethon Energy's Neptune treatment facility currently has the capacity to treat about 39,000 bpd (1.64 mgd). This limits the total produced water discharge to 4.37 mgd to assure compliance with applicable effluent limits. According to the Statement of Basis (based on the modeling report) Aethon Energy will need to treat 5.84 mgd (139,000 barrels) at the estimated maximum discharge (8.27 mgd) to meet standards required to protect the Class 1 section of the Wind River below Boysen Res. The remaining 2.43 mgd (58,000 barrels) will either be blended or discharged directly to Alkalai Creek. Additional treatment capacity would be needed to allow the maximum discharge of 8.27 mgd. It is unclear if the WDEQ is requiring an upgrade to the Neptune treatment facility to a capacity of (5.84 mgd). The SOB and the draft permit are clear that additional treatment capacity will be required if Aethon is required to meet the effluent limit of 230 mg/l for chloride (based on chloride standard for Class 2AB streams (Badwater Creek). However, Aethon Energy has requested a site-specific chloride standard for Badwater Creek. If this effort is successful -will WDEQ sill require additional treatment capacity at the Neptune treatment facility?

**<u>Major Comments</u>**

1. The focus of the watershed model (SWAT) and the mixing model (GEMSS) was to assess the impact of Aethon Energy's increased discharge of produced water to the Class 1 reach of the Wind River below Boysen Reservoir. The SOB does not include or refer to any empirical data that was used to characterize or assess the effects of mixing produced water discharges with water in Alkali Creek or Badwater Creek. Apparently, no analysis has been conducted to evaluate the impact of discharge of produced water to the quality of water, the physical stability or the aquatic environments in Alkali Creek and Badwater Creek. It is necessary to consider any 2nd or 3rd order chemical reactions that may occur in Alkali Creek or Badwater Creek and to consider the wide range of flow conditions in the lower part of Badwater Creek. Both Alkali Creek (3B) and Badwater Creek (2AB) are classified streams in Wyoming and established water quality standards are applicable to both creeks. A mixing analysis should be completed to help ensure that the applicable water quality standards in both creeks are not exceeded. In

addition, WDEQ should provide the water quality and flow data that was used to characterize and assess impacts to Alkali and Badwater Creeks.

2. A modification to permit WY0002062 was issued to Encana by WDEQ on April 27, 2015. This modification indicates that produced water will be discharged to Alkali Creek via Reservoir Creek and Pink Lake. There is no mention of these water bodies in the current SOB or draft permit. Apparently, these water bodies have been designated Class 3B. WDEQ should clarify whether these are regulated water bodies and they are not included in the proposed permit.

3. There is no discussion of the fate of the large chloride and TDS mass loads from the produced water discharge (up to 719 tons per month for chloride and 2161 tons per month TDS) as it is transported in Alkali and Badwater Creek and into Badwater Bay. The ERM report states that the model runs are conservative because they assume that all mass moves through the Reservoir and to the Wind River. The model did not consider the effects of chloride and TDS mass loading that may catalyze chemical reactions that may result in degradation of water in Alkalai Creek or Badwater Creek that would result in exceedances of Class 2AB standards. The chemical and biological fate of these large mass loads should be included in a water quality mixing analysis (see Major Comment 1).

4. Because Boysen Reservoir water is used for drinking water - an analysis of changes to the quality of the Reservoir water as a result of the inflow of Aethon Energy's produced water should be conducted. This analysis should include modeling the fate and transport of all major constituents contained in the inflows to Boysen Reservoir as these inflows mix with and disperse within the reservoir.

5. The Statement of Basis envisions a mixing zone in Badwater Bay where Badwater Creek flow enters Boysen Reservoir. The mixing zone will encompass an area 330 ft long and 730 wide and presumably extending from the surface to the bottom of the Bay. Establishment of a mixing zone within the Reservoir Bay is very problematic. Water levels and inflows to Badwater Bay fluctuate greatly and in drought years the Bay could be dry. How do these varying conditions affect use of the Bay water for mixing?

   The SOB contains confusing information regarding the mixing zone. On page 9 of the SOB it states *that "critical low flows below this facility (Aethon outfalls) historically approach zero during certain times of the year."* On page 8 the SOB states that *"the model found that complete mixing occurs, even under natural flow conditions in Badwater Creek before Badwater Creek fully enters Boysen Reservoir."* How can complete mixing occur if there is no base flow in the lower reaches of Badwater Creek?

   Chapter 1 Section 9 of the rules and Regulations for Wyoming Surface Water Quality Standards requires that *"Except for the zone of initial dilution, which is the initial 10% of the mixing zone, the mixing zone shall not contain pollutant concentrations that exceed the aquatic life acute values. In addition, there shall be a zone of passage around the* *mixing zone which shall not contain pollutant concentrations that exceed the aquatic life chronic values."* There is no discussion of how compliance with these requirements will be achieved in the SOB or in Water quality Compliance Analysis report prepared by ERM. Given the significant annual fluctuations in Badwater Bay and the likelihood of future below average annual precipitation, how will the zone of passage be delineated? How will compliance be verified?

6. The SOB states that *"This permit does not cover activities associated with discharges of drilling fluids, acids, stimulation fluids or other fluids from drilling or completion of the wells."* How will this be achieved? What disposal method will be used for these fluids? Flowback water, produced in the early stages of drilling, well completion and production contain these fluids mixed with produced formation water. Aethon Energy should provide details on the technology /methods that will be used to separate and segregate these fluids from produced water.

7. On page 2 of the SOB it is stated: *For permitting purposes in Wyoming, the background quality of a Class 1 water is considered to be the range between the upper and lower first standard deviations of the mean background concentrations for each parameter of interest.* Is this a policy or is it included in the promulgated regulations? Does it conform with the applicable regulation? The Standard Deviations shown in Table on page 3 of SOB are very high. For seven of the constituents included the standard deviation is greater than the mean. This indicates that the water quality data values have a large range, likely a result of sparse background data. Use of the upper standard deviation as an allowable background condition allows for a much higher discharge effluent concentration. This will result in new baseline in the Class I Wind River below Boysen that will likely be used by future potential dischargers.

8. Wyoming's antidegradation policy includes two important principles with respect to class I waters: (1) existing discharges may not increase the level of pollution that existed at the time the water was designated class I and, (2) point source discharges to tributaries of Class I waters will be limited to the extent that the existing quality of the Class I segment will not be degraded, i.e. no measurable decrease in water quality. Per Chapter 1, section 4 of the Wyoming Water Quality Rules and Regulations – *"the water quality and physical and biological integrity which existed on the water at the time of designation will be maintained and protected."* The ERM model is based on data from 2010-2016 not on data from 1979 when the segment of the Wind River below Boysen reservoir was designated as Class I. Reportedly data does exist from the 1979 period and should have been used. With respect to the 2$^{nd}$ point – the use of the upper standard deviation values as compliance limits will clearly result in measurable increase in regulated contaminants.

9. The SOB does not include any discussion of other point source discharges located within the Badwater Creek watershed. If there are NPDES permits issued by US EPA, other WYPDES permits, stormwater disposal permits or UIC permits within the watershed, information should be provided on the location, discharge volumes and discharge chemistry. The cumulative impacts should be addressed.

*10.* Existing outfalls 1-12 have been grandfathered since they were permitted prior to September 5, 1978 and pre-date the designation of the Class 1 reach of the Wind River below Boysen Reservoir and the designation of Badwater Creek as a class 2AB stream. Since the recently permitted outfalls 13-15 and the new proposed outfall (16) are part of the same permit, WDEQ proposes to grandfather these outfalls as well and allow an effluent discharge standard of 2419 mg/l for chloride based on historical effluent concentrations. In the Antidegradation discussion on pages 9 and 10 of the SOB the WDEQ states that the increased discharge flows with the same Cl concentrations will not degrade Badwater Creek because the new discharge will have chloride concentrations that are lower than historical discharges. To further support this conclusion WDEQ cites Section 4(a)(i)(A)(IV) of the Wyoming Surface Water Quality Standards Implementation Policy for Antidegradation which states that *" a permitted discharge activity shall be considered not to result in significant degradation if the activity will result in only temporary or short term changes in water quality."* This is a highly qualitative conclusion that is based only on the assumption that chloride concentrations will not increase in the new permitted discharge. WDEQ fails to adequately consider the change in flow/ annual water budget in Badwater Creek and the increased chloride and TDS mass load that the produced water discharge will deliver to Badwater Creek. The changes to water quality in Alkali and Badwater Creek will likely be significant and long term. This further supports the need for a water quality mixing analysis for Badwater Creek.

11. The chloride standard for Badwater Creek is 230 mg/l. The SOB proposes a 4-year compliance schedule to allow Aethon energy to add additional treatment capacity to be able to achieve a 230 mg/l effluent limit. However, Aethon Energy has requested a site-specific chloride standard for Badwater Creek which would require a use attainability analysis and concurrence by the US EPA. If approved, there would be little incentive for Aethon Energy to add the additional treatment required to prevent further degradation of Badwater Creek. It is my understanding that WDEQ has the discretion to discontinue the grandfathered standards. WDEQ should use this new permit application to bring the facility into compliance by requiring effluent standards aimed at protecting designated uses in Alkali Creek, Badwater Creek, Boysen Reservoir and the Wind River and stop historical loading. This would eliminate the need for a site-specific chloride standard.

12. Per Chapter 1, Section 8 (Antidegradation) of the Wyoming Water Quality Rules and Regulations, WDEQ should require an economic analysis to evaluate the feasibility of treating 100 % of the produced water discharge. Treatment should include treating to drinking water standards for those constituents that have drinking water standards and treatment to remove any compounds associated with drilling, formation stimulation, ad well development and completion. The economic analysis should include piping the treated effluent to Boysen Reservoir. If feasible, this would eliminate impacts to water quality and aquatic life in Alkalai creek and Badwater Creek and would significantly minimize water quality changes in Boysen Reservoir. It seems reasonable to analyze the economics and environmental impacts for alternatives to using Badwater Creek as a conveyance for contaminated produced water.

13. The SOB does not include any discussion of potential impacts to groundwater in alluvial aquifers along Badwater Creek. The WDEQ has designated the shallow alluvial aquifer in the vicinity of Lysite and Lost cabin as a high-priority aquifer (Bedessem, et, al, 2005). High-priority aquifers are those aquifers that serve as drinking water sources and / or are most susceptible to point and non–point source pollution. The permit applicant should be required to analyze potential impacts to these aquifers as a result of increased flow and contaminant loading to Alkali and Badwater Creeks and the potential for contaminated water in from these Creeks discharging to the shallow, surficial, high-priority aquifers.

14. The SOB indicates that WDEQ will require instream monitoring at four locations: (1) Alkali Creek below project area (below outfalls), (2) Badwater Creek, (3) Badwater Bay and (4) the Wind River below Boysen reservoir

    a. Samples from these locations will be analyzed for TDS, chloride, oil & grease, pH and temperature. In addition, the samples from Alkali Creek below the project area will be analyzed for benzene, toluene, ethylbenzene and xylene. These constituents do not include any Category 4 or 5 parameters (per table -page 3 SOB). This is a serious omission since these parameters have water quality standards.
    b. The SOB states that the instream monitoring locations are *"for data collection purposes only and do not constitute a regulated discharge point."* These data should be used to help assure that the water quality in Alkali Creek, Badwater Creek and the Class 1 segment of the Wind River meets or exceeds the applicable classification standards. The sampling results made available to the public.

15. The SOB indicates that instream monitoring location on Alkali Creek (DMP1) will be monitored for BTEX constituents, including benzene. Since benzene is highly toxic (EPA MCL is 5 ug/l) and a known compound in naturally occurring oil and gas. WDEQ should require monitoring for benzene in the discharged effluent and Badwater Creek.

**Reference**

2005, Bedessem, M.E, B. Casey, K. Frederick, and N. Nibbelink. 2005. Aquifer Prioritization for Ambient Groundwater Monitoring. Ground Water Monitoring & Remediation 25, no. 1: 150-158. Map 11.