Environmental Defense Fund

Please accept the attached comments filed on behalf of the Environmental Defense Fund by Cloelle Danforth, PhD and Nichole Saunders.

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July 3, 2019

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Submitted online: http://wq.wyomingdeq.commentinput.com/?id=f4gaH

RE: Proposed Renewal of Aethon Energy Operating LLC WYPDES Permit WY0002062

Dear Mr. Thomas:

The Environmental Defense Fund (EDF) appreciates the extended opportunity to submit the following comments regarding the above-referenced permit renewal. EDF is an international environmental organization with over two million members and activists worldwide including several thousand in Wyoming, many of whom are deeply concerned about the impacts of oil and gas development on human health and the environment, including water resources.

EDF has a depth of expertise on produced water, including those issues related to the chemical and toxicological characterization and treatment of produced water and respectfully submits these comments for your careful consideration. It is our concern that, without proper permit limits and monitoring conditions, the proposed increase in both treated and untreated discharges of produced water that will pass through two creek segments and eventually reach the Boysen Reservoir and Wind River may present significant public health and environmental risks, including risks to livestock and wildlife.

EDF commends the DEQ for numerous important and necessary additions to this draft permit, such as whole effluent testing, monitoring at the Neptune facility, and some in stream monitoring. However, oil and gas wastewater as a general matter is under characterized and there remain significant associated knowledge gaps and research needs regarding its treatability, toxicity, and risks of its release or reuse.[1] This has implications for the protective nature of existing regulatory programs, including water quality

[1] *See, e.g.* Ground Water Protection Council, Produced Water Report: Regulations, Current Practices and Research Needs (June 2019).

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standards. While Wyoming has reconsidered its standards applicable to produced water in recent years,[2] questions remain regarding whether pollutants of concern are not only identified but appropriately limited and monitored in a manner that definitively protects human health, the environment, and protected water uses. Despite the questions regarding appropriate existing numeric limitations, key applicable narrative standards also apply, including that produced water discharges:

- **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; and**
- **Must not contain toxic materials in concentrations or combinations which are toxic to human, animal or aquatic life.**[3]

EDF questions whether the draft permit can meet these requirements for the following reasons:

1. **Limitations for organics and other constituents of concern are absent:**

The constituents analyzed in the permit application and limited in the draft permit are not appropriately representative of the broad range of constituents of concern potentially present in oil and gas wastewater. Without more comprehensive analysis and monitoring, conclusions regarding toxicity or quality are not – and cannot be – complete.

Produced water contains many constituents including organic and inorganic material, dispersed and dissolved oil compounds, production chemicals, and formation minerals, including radioactive material and heavy metals.[4] Organic compounds known to be in produced water, including contaminants associated with dissolved oil (e.g., naphthalene, phenantherene, polycyclic aromatic hydrocarbons (PAHs), phenols, and benzene, toluene, ethylbenzene, and xylene (BTEX) compounds), along with chemicals from well-maintenance and treatment (solvents, biocides, and scale and corrosion inhibitors), which are added during the oil and gas production process to treat or prevent operational problems, were not analyzed for, despite well-documented accounting of their presence in this type of wastewater.[5] Oil and grease was measured at 6 mg/L in the singular analysis submitted for Aethon's

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[2] *See e.g.*, WYOMING DEP'T. OF ENVTL. QUALITY, WYOMING POLLUTANT DISCHARGE ELIMINATION SYSTEM APPLICATION FOR PERMIT TO SURFACE DISCHARGE PRODUCED WATER FROM OIL & GAS PRODUCTION UNIT DISCHARGES, (Jan. 2019), *available at* http://deq.wyoming.gov/media/attachments/Water%20Quality/Discharge%20Permitting/Individual%20Permit%20Apps%20for%20Discharges/03-WQD-WYPDES-Short-Form-C-for-Oil-and-Gas-Production-Facilities-2019.pdf.

[3] 020-0011-2 WYO. CODE R. app. H.

[4] Fakhru'l-Razi A, Pendashteh A, Abdullah LC, Biak DRA, Madaeni SS, Abidin ZZ. 2009. Review of technologies for oil and gas produced water treatment. Journal of Hazardous Materials. 170(2–3):530–551. doi:10.1016/j.jhazmat.2009.05.044.

[5] Kathrin Hoelzer, Andrew J. Sumner, Osman Karatum, Robert K. Nelson, Brian D. Drollette, Megan P. O'Connor, Emma L. D'Ambro, Gordon J. Getzinger, P. Lee Ferguson, Christopher M. Reddy, Martin Elsner, and Desiree L. Plata. "Indications of Transformation Products from Hydraulic Fracturing Additives in Shale-Gas Wastewater." *Environmental Science & Technology* 2016 50 (15), 8036-8048. DOI: 10.1021/acs.est.6b00430.; see also Maguire-Boyle SJ, Barron AR. 2014. Organic compounds in produced waters from shale gas wells. *Environ Sci: Processes* Impacts. 16(10):2237–2248. doi:10.1039/C4EM00376D.; see also Orem W, Tatu C, Varonka M, Lerch H, Bates A, Engle M, Crosby L, McIntosh J. 2014. Organic substances in produced and formation water from unconventional natural gas extraction in coal and shale. *International Journal of Coal Geology*. 126:20–31. doi:10.1016/j.coal.2014.01.003.; see also Wesolowski D, Broughton A, Hansotte CA, Koraido SM, Fillo JP. 1987. Characterization of Produced Waters from Natural Gas Production Operations. Chicago, Illinois: Gas Research Institute Report No.: GRI-87/0335.3.; see also Tellez GT, Nirmalakhandan N, Gardea-Torresdey JL. 2005. Comparison of purge and trap GC/MS and spectrophotometry for monitoring petroleum hydrocarbon degradation in oilfield produced waters. *Microchemical Journal.*

renewal application. This is a surrogate measure of many types of organic material that correspond to a particular analysis, which only detects nonpolar organic compounds (petroleum based hydrocarbons).[6] Therefore, many polar, water soluble organic compounds associated with oilfield chemicals[7] were not looked for in in the water analysis. This is significant because polar chemicals used as demulsifiers, corrosion inhibitors and biocides (imidazolines, alkylbenzene sulfonates, and quaternary ammonium compounds),[8] are known to be toxic to humans and aquatic organisms.[9]

Collectively considered, the water quality analysis is not comprehensive enough to indicate potential pollutants in the wastewater or inform establishment of appropriate limitations. Aethon's response to the permit application requirement (#13) to "Provide a list of **all** potential pollutants expected to be in the discharge and an explanation of their presence in the discharge" of "trace amount of petroleum hydrocarbons due to oil production and total dissolved solids" was not only woefully lacking but also proven factually incorrect by even the limited analysis required in permit application item #14, Table 2. EDF believes that a more thorough assessment is necessary.

A permit writer's basic responsibility is to understand the nature of a proposed discharge and ensure that permit limits appropriately protect receiving waters and their designated uses. The EPA's NPDES Permit Writers' Manual allows for permit writers to require supplemental information in order to process the permit.[10] Importantly, the permit writer can consider "pollutants otherwise expected to be present in the discharge," described as thus:

> A final category of pollutants of concern includes those pollutants that are not in one of the other categories, but are otherwise expected to be present in the discharge. There might be pollutants for which neither the discharger nor the permitting authority have monitoring data but, because of the raw materials stored or used, products or by-products of the facility operation, or available data and information on similar facilities, the permit writer has a strong basis for expecting that the pollutant could be present in the discharge. Because there are no analytical data to verify the concentrations of these

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81(1):12–18. doi:10.1016/j.microc.2005.01.019.; see also Luek JL, Gonsior M. 2017. Organic compounds in hydraulic fracturing fluids and wastewaters: A review. *Water Research*. 123:536–548. doi:10.1016/j.watres.2017.07.012.; see also Butkovskyi A, Faber A-H, Wang Y, Grolle K, Hofman-Caris R, Bruning H, Van Wezel AP, Rijnaarts HHM. 2018. Removal of organic compounds from shale gas flowback water. *Water Research*. 138:47–55. doi:10.1016/j.watres.2018.03.041.; see also Parker KM, Zeng T, Harkness J, Vengosh A, Mitch WA. 2014. Enhanced Formation of Disinfection Byproducts in Shale Gas Wastewater-Impacted Drinking Water Supplies. *Environmental Science & Technology*. 48(19):11161–11169. doi:10.1021/es5028184.; see also

[6] USPEA. 2010. Method 1664, Revision B: n-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated n-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry. EPA-821-R-10-001. *available at*https://www.epa.gov/sites/production/files/2015-08/documents/method_1664b_2010.pdf

[7] McCormack P. 2001. Analysis of oilfield produced waters and production chemicals by electrospray ionisation multi-stage mass spectrometry (ESI-MSn). *Water Research*. 35(15):3567–3578. doi:10.1016/S0043-1354(01)00070-7.

[8] *Id.*

[9] USEPA. 1995. Reregistration Eligibility Decision (RED) Fact Sheet for Alkyl Imidazoline. EPA-738-F-95-034. a*vailable at:* https://www3.epa.gov/pesticides/chem_search/reg_actions/reregistration/fs_PC-046609_1-Aug-95.pdf; see also Di Nica V, Gallet J, Villa S, Mezzanotte V. 2017. Toxicity of Quaternary Ammonium Compounds (QACs) as single compounds and mixtures to aquatic non-target microorganisms: Experimental data and predictive models. Ecotoxicology and Environmental Safety. 142:567–577. doi:10.1016/j.ecoenv.2017.04.028.; see also Lewis MA. 1991. Chronic and sublethal toxicities of surfactants to aquatic animals: A review and risk assessment. Water Research. 25(1):101–113. doi:10.1016/0043-1354(91)90105-Y.

[10] EPA, NPDES PERMIT WRITERS' MANUAL: CHAPTER 4 NPDES Permit Application Process. p.14 (2010), *available at* https://www.epa.gov/sites/production/files/2015-09/documents/pwm_chapt_04.pdf

> pollutants in the effluent, the permit writer must either postpone a quantitative analysis of the need for WQBELs and generate, or require the discharger to generate, effluent monitoring data, or base a determination of the need for WQBELs on other information, such as the effluent characteristics of a similar discharge. [11]

Given the evidence that produced water quality is variable, complex, and has been demonstrated to contain many types of organic and inorganic compounds, both influents and expected discharges from all potential outfalls (both treated and untreated) must be better characterized in order to properly consider the effectiveness of treatment technologies, understand the potential impacts of untreated discharges, and establish appropriately comprehensive discharge limitations and monitoring requirements necessary to meet numeric and narrative standards.

At a *minimum*, this expanded analysis should include:

- All Volatile Organic Compounds listed in 40 CFR pt. 122, Appendix D, Table II.
- All Base/Neutral and Acid Organic Compounds listed in 40 CFR pt. 122, Appendix D, Table II
- All metals listed in 40 CFR pt. 122, Appendix D, Table III
- All compounds as listed in 40 CFR pt. 122, Appendix D, Table IV except for fecal coliforms
- Compounds from 40 CFR pt. 122, Appendix D, Table V that have been detected in other produced waters.[12]

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[11] EPA, NPDES PERMIT WRITERS' MANUAL: CHAPTER 6 Water Quality-Based Effluent Limitations. p.13 (2010), *available at* http://www.epa.gov/npdes/pubs/pwm_chapt_06.pdf .

[12] Including, for example Cyclohexane and Dimethylphenol (Carey J, Zaidi A, Ribo J. 1992. Specific Toxic Organics in Produced Waters from In-Situ Heavy Oil Recovery Operations in Western Canada. In: Ray JP, Engelhardt FR, editors. Produced Water. New York, NY: Plenum Press. p. 133–150. [accessed 2019 Jan 4]. http://link.springer.com/10.1007/978-1-4615-2902-6_11.); methyl methacrylate (Sirivedhin T, Dallbauman L. 2004. Organic matrix in produced water from the Osage-Skiatook Petroleum Environmental Research site, Osage county, Oklahoma. Chemosphere. 57(6):463–469. doi:10.1016/j.chemosphere.2004.05.034.); quinoline (Orem W, Tatu C, Varonka M, Lerch H, Bates A, Engle M, Crosby L, McIntosh J. 2014. Organic substances in produced and formation water from unconventional natural gas extraction in coal and shale. International Journal of Coal Geology. 126:20–31. doi:10.1016/j.coal.2014.01.003.); acetaldehyde, butyl acetate, and formaldehyde (Lyman SN, Mansfield ML, Tran HNQ, Evans JD, Jones C, O'Neil T, Bowers R, Smith A, Keslar C. 2018. Emissions of organic compounds from produced water ponds I: Characteristics and speciation. Science of the Total Environment. 619–620:896–905. doi:10.1016/j.scitotenv.2017.11.161.); cresol (DiGiulio DC, Jackson RB. 2016. Impact to Underground Sources of Drinking Water and Domestic Wells from Production Well Stimulation and Completion Practices in the Pavillion, Wyoming, Field. Environmental Science & Technology. 50(8):4524–4536. doi:10.1021/acs.est.5b04970.); uranium (Barbot E, Vidic NS, Gregory KB, Vidic RD. 2013. Spatial and Temporal Correlation of Water Quality Parameters of Produced Waters from Devonian-Age Shale following Hydraulic Fracturing. Environmental Science & Technology. 47(6):2562–2569. doi:10.1021/es304638h.); strontium (Nelson AW, May D, Knight AW, Eitrheim ES, Mehrhoff M, Shannon R, Litman R, Schultz MK. 2014. Matrix Complications in the Determination of Radium Levels in Hydraulic Fracturing Flowback Water from Marcellus Shale. Environmental Science & Technology Letters. 1(3):204–208. doi:10.1021/ez5000379.); styrene (Kassotis CD, Klemp KC, Vu DC, Lin C-H, Meng C-X, Besch-Williford CL, Pinatti L, Zoeller RT, Drobnis EZ, Balise VD, et al. 2015. Endocrine-Disrupting Activity of Hydraulic Fracturing Chemicals and Adverse Health Outcomes After Prenatal Exposure in Male Mice. Endocrinology. 156(12):4458–4473. doi:10.1210/en.2015-1375); carbon disulfide, vanadium and zirconium (Thacker J, Carlton D, Hildenbrand Z, Kadjo A, Schug K. 2015. Chemical Analysis of Wastewater from Unconventional Drilling Operations. Water. 7(12):1568–1579. doi:10.3390/w7041568); and xylenes (Wesolowski D, Broughton A, Hansotte CA, Koraido SM, Fillo JP. 1987. Characterization of Produced Waters from Natural Gas Production Operations. Chicago, Illinois: Gas Research Institute Report No.: GRI Report No. GRI-87/0335.1.).

Furthermore, sample analyses for establishment of permit limits/requirements and ongoing monitoring requirements should be timed to provide results that represent seasonal or other substantial variations in operational practices and pollutants of concern in influents, effluents, and discharges.

Finally, we recommend that the methods used to analyze for constituents of concern in produced water be selected with care given the complex nature of produced water. Oetjen et al. (2017)[13] note the confounding nature of chemicals found in produced water (e.g. chemicals inhibiting sample preparation tasks), and Tasker et al. (2019)[14] cite particular difficulty in detecting and quantifying trace metals. Produced water is complex, largely uncharacterized, and often lack of standard analytical methods (as defined in 40 CFR 136) for constituents known to be present. The USEPA noted in their 2016 review of literature on produced water composition "that standard analytical methods are not adequate for detecting and quantifying the numerous organic chemicals, both naturally occurring and anthropogenic, that are now known to occur in produced water."[15]

2. Whole Effluent Toxicity (WET) requirements are inadequate

Given the significant unknowns regarding the chemical and toxicological character of produced waters, EDF strongly supports the inclusion of WET testing as a mechanism for identifying otherwise undetected mixture impacts and commends the WYDEQ for including this important test. The requirement of WET testing in the permit will provide a first line of protection of native fauna exposed to discharged effluent. However, EDF does not believe that the current WET testing requirements are adequate to serve a truly protective function to ensure no toxic substances are discharged in toxic amounts at any time. Because previous permit requirements did not include WET tests, no WET tests appear to have been required in the permit application, and because expected discharge amounts are projected to increase by three-fold, there is little understanding on the actual toxicity of the expected effluent. Moreover, the permittee's use and potential future use of water treatment chemicals, as described in Attachment B of the permit renewal application (RBW213 Water Clarifier, RBW255 Water Clarifier, RBW307 Water Clarifier, and SCW8234 Scale Inhibitor) that contain compounds, including ethylene glycol, aluminum chloride, propargyl alcohol, zinc chloride, zinc oxide, and methanol that have potential toxic effects on humans and/or aquatic organisms (as reported in their respective Material Safety Data Sheets), further supports the need for WET testing.

As mentioned previously, the permit writer can reasonably expect many other organic compounds (in addition to BTEX and oil and grease) such as aromatic compounds, which will contribute to

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[13] Oetjen K, Giddings CGS, McLaughlin M, Nell M, Blotevogel J, Helbling DE, Mueller D, Higgins CP. 2017. Emerging analytical methods for the characterization and quantification of organic contaminants in flowback and produced water. *Trends in Environmental Analytical Chemistry*. 15:12–23. doi:10.1016/j.teac.2017.07.002.

[14] Tasker TL, Burgos WD, Ajemigbitse MA, Lauer NE, Gusa AV, Kuatbek M, May D, Landis JD, Alessi DS, Johnsen AM, et al. 2019. Accuracy of methods for reporting inorganic element concentrations and radioactivity in oil and gas wastewaters from the Appalachian Basin, U.S. based on an inter-laboratory comparison. *Environmental Science: Processes & Impacts*. 21(2):224–241. doi:10.1039/C8EM00359A.

[15] U.S. EPA. 2016. Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States. Washington DC.: U.S. Environmental Protection Agency, Office of Research and Development Report No.: EPA/600/R-16/236Fa. p.7-12.

environmental toxicity, and are not removed during oil/water separation processes.[16] Any water that has not been treated by the High Efficiency Reverse Osmosis (HERO) treatment process at the Neptune Facility will likely contain these and other compounds of concern, noted previously.

Although chemical analysis provides a snap-shot estimate of some known constituents of concern, it does not provide adequate information on the potential toxicity of the actual effluent. Similarly, a single annual WET test may provide a snap-shot in time of toxicity, but does not provide adequate information to monitor impacts of year-round discharges. The variability of produced water[17] coupled with seasonal variations in water flow and chemical usage, necessitates a more thorough assessment of potential toxicity that accounts for this heterogeneity in quantity and quality of produced water. Therefore, WET tests should be, *at a minimum*, conducted on the co-mingled effluent sample on a quarterly basis using both the invertebrate and vertebrate test species, for a minimum of two years or eight quarters. If no failures occur during the two-year period, and no changes occur in the outfalls that cause an increase in flow or water quality, then it may be appropriate to adjust WET testing to quarterly acute tests and a yearly chronic test. It is EDF's position that WET testing of any less frequency than this is inadequate.

Should toxicity occur in the WET test, the permit applicant should begin accelerated monthly testing once a month and perform a toxicity identification evaluation/toxicity reduction evaluation to establish the cause of the toxicity, locate the source(s) of the toxicity, and develop control of, or treatment for, the toxicity.

3. **Scope of analysis and permit limitations are inadequate to support a finding that discharges are of "good enough quality" in line with 40 CFR pt 435(e)**

Although the Wyoming Game and Fish Department has determined 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, EDF believes that the DEQ must still conclusively demonstrate whether all proposed discharges (treated and untreated) are of "good enough quality" to be protective of aquatic habitats, wildlife, and livestock that may live in or nearby all outfalls[18] and provide evidence to support its findings.[19]

Simply put, without a more complete understanding of the produced water quality, the effluent limitations here cannot be assumed to "enhance wildlife propagation and habitat" or be of "good enough quality" as required by federal and state regulation. There are numerous considerations necessary for a comprehensive analysis of quality for these purposes, and a number of relevant

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[16] Fakhru'l-Razi A, Pendashteh A, Abdullah LC, Biak DRA, Madaeni SS, Abidin ZZ. 2009. Review of technologies for oil and gas produced water treatment. *Journal of Hazardous Materials*. 170(2–3):530–551. doi:10.1016/j.jhazmat.2009.05.044.

[17] Orem W, Tatu C, Varonka M, Lerch H, Bates A, Engle M, Crosby L, McIntosh J. 2014. Organic substances in produced and formation water from unconventional natural gas extraction in coal and shale. *International Journal of Coal Geology*. 126:20–31. doi:10.1016/j.coal.2014.01.003.; see also Benko KL, Drewes JE. 2008. Produced Water in the Western United States: Geographical Distribution, Occurrence, and Composition. *Environmental Engineering Science*. 25(2):239–246. doi:10.1089/ees.2007.0026.

[18] 020-0011-2 WYO. CODE R. app. H.

[19] Wyo Stat § 16-3-114.

resources, such as the WYDEQ-funded study regarding water quality for Wyoming livestock and wildlife.[20] EDF would also recommend that the WYDEQ carefully consider the comments of the Wyoming Outdoor Council and its collaborators on this point.

While there are a number of constituents to consider in this analysis, EDF has chosen to provide two illustrative examples we believe call into question the finding that the treated and untreated discharges, as permitted, protect wildlife and livestock:

TDS and Chlorides. The Wyoming Surface Water Quality Standards provisions regarding the protection of aquatic life includes specific numeric standards for toxicants, below which are not protective of aquatic life.[21] The acute and chronic values for chloride are 860 and 230 mg/L, respectively.[22] Although the draft permit allows for a multi-year progression to meet appropriate chloride requirements to protect designated water uses, the interim value of 2,419 mg/L of chlorides allowed in this permit has the potential to severely, and irrevocably impact aquatic life, as salt contamination is long-lived.[23] Has the WYDEQ conclusively established that discharges at this level are of "good enough quality" and not toxic for purposes of the water quality standards?

Total dissolved solids can also have significant negative consequences for habitat, wildlife, and livestock. Scientists assessing protective water qualities for Wyoming livestock and wildlife have concluded the following:

> 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.[24]

With this in mind, EDF also questions whether the DEQ's established produced water discharge standard TDS of 5,000 mg/L (Appendix H) and this permit's allowance of 6,400 mg/L can support a conclusion that discharges from Aethon outfalls are protective of habitat, wildlife and livestock where discharged.

Fluoride. In their analysis, the permit applicant modeled their monthly load limit on Wyoming's water quality standard for fluoride (4,000 ug/L). We support this conservative approach in modeling, and appreciate that fluoride has been included in the effluent limits. However, there does not appear to be an EOP limit. The actual concentration of fluoride in the effluent is unknown because analyzing for fluoride only applies only to new facilities[25] and was not measured by Aethon, which instead reported

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[20] *See, e.g.,* Water Quality for Wyoming Livestock & Wildlife: A Review of Literature Pertaining to Health Effects of Inorganic Contaminants, *available at* http://www.wyomingextension.org/agpubs/pubs/B1183.pdf.
[21] 020-0011-1 WYO. CODE R. §21 app B.
[22] *Id. at app. B.*
[23] Farag AM, Harper DD. 2014. A review of environmental impacts of salts from produced waters on aquatic resources. *International Journal of Coal Geology*. 126:157–161. doi:10.1016/j.coal.2013.12.006.
[24] Water Quality for Wyoming Livestock & Wildlife: A Review of Literature Pertaining to Health Effects of Inorganic Contaminants at 50, *available at* http://www.wyomingextension.org/agpubs/pubs/B1183.pdf.
[25] Wyoming Department of Environmental Quality, Wyoming Pollutant Discharge Elimination system Application for Permit to Surface Discharge Produced Water from Oil & Gas Production Unit Discharges, (Jan. 2019), *available at*

only "not new facility."[26] Wyoming's inclusion of this limit in Form C underscores its understanding that discharges greater than this can cause harm. Fluoride is known to be present in produced water at elevated levels (100 to 1100 mg/L).[27] Fluoride toxicosis has been documented in wildlife (elk, deer, and bison) where corresponding water samples contained 0.5-24 mg/L.[28] It cannot be assumed that fluoride, like any other unmeasured constituent of concern known to be present in produced water, will not exceed dangerous levels for wildlife or livestock—in the receiving waters and throughout stream system ahead of the Boysen Reservoir—particularly given that a large volume of the effluent will be untreated. Without further assessment of chemicals of concern known to be present in produced water, such as fluoride, it cannot be shown that discharges are of "good enough quality" or that no toxics are being discharged in toxic amounts. Therefore, fluoride (*as well as other constituents of concern present in the discharge*) should also be limited at the EOP to be protective of wildlife or livestock.

Furthermore, EDF questions why the WYDEQ has incorporated standards from short form C that apply to "new facilities" for some constituents (e.g., fluoride) and not others. If WYDEQ has determined that certain limits are necessary to protect water and water uses, regardless of grandfathering provisions, it would intuitively call into question a finding of "good enough quality" or "no toxics in toxic amounts" if these standards are knowingly allowed to be exceeded merely due to the original permit date of a facility. See below for a short table of constituents covered by short form C which are either absent from or exceeding numeric limits in the draft permit:

Chemical Constituents	Required Detection Limit[29]	Standard or Limit[30]	Limits in Aethon Energy Operating, LLC's Draft Permit Renewal
Barium, Total**	100 µg/L	2,000 µg/L	absent
Boron, Dissolved**	100 µg/L	5,000 µg/L	absent
Chloride – Technology Based	5 mg/L	2000 mg/L	2,419 mg/L
Chloride, for Class 2A and 2B Waters	5 mg/L	230 mg/L	2,419 mg/L
Chromium, Total	1 µg/L	74.1 µg/L* (hardness dependent)	126 µg/L

http://deq.wyoming.gov/media/attachments/Water%20Quality/Discharge%20Permitting/Individual%20Permit%20Apps%20for%20Discharges/03-WQD-WYPDES-Short-Form-C-for-Oil-and-Gas-Production-Facilities-2019.pdf.

[26] Aethon Renewal Application – Table 2

[27] Thacker J, Carlton D, Hildenbrand Z, Kadjo A, Schug K. 2015. Chemical Analysis of Wastewater from Unconventional Drilling Operations. Water. 7(12):1568–1579. doi:10.3390/w7041568; see also McBeth I, Reddy KJ, Skinner QD. 2003. Chemistry of trace elements in coalbed methane product water. Water Research. 37(4):884–890. doi:10.1016/S0043-1354(02)00382-2.

[28] Raisbeck MF, Riker SL, Tate CM, Jackson R, Smith MA, Reddy KJ, Zygmunt JR. 2008. Water Quality for Wyoming Livestock & Wildlife. Wyoming Department of Environmental Quality Report No.: B-1183.

[29] Required Detection Limit as listed in Wyoming Pollutant Discharge Elimination System Application – Short Form C.

[30] Standards or limits as listed in Wyoming Pollutant Discharge Elimination System Application – Short Form C.

Copper, Dissolved	10 µg/L	9 µg/L* (hardness dependent)	15 µg/L
Iron, for Class 2A and 2AB Waters	50 µg/L	300 µg/L	1000 µg/L
Lead, Dissolved	2 µg/L	2.5 µg/L* (hardness dependent)	0.5 µg/L
Manganese, Dissolved	50 µg/L	1462 µg/L (hardness dependent)	2,083 µg/L*
Manganese, Dissolved for class 2A and 2AB Waters	50 µg/L	50 µg/L	2,083 µg/L
Molybdenum, Dissolved**	100 µg/L	300 µg/L	absent
Nickel, Dissolved	10 µg/L	52 µg/L* (hardness dependent)	90 µg/L
Specific Conductance	5 micromhos/cm	7500 micromhos/cm	absent
Sulfide-Hydrogen Sulfide	0.1 mg/L	2 µg/L	Report only

* According to the Wyoming Pollutant Discharge Elimination System Application – Short Form C, hardness = 100 mg/L as CaCO3 (for metals analyses).
** Applies to new facilities only.

4. Hardness-based modifications to water quality effluent limits should be reconsidered to appropriately protect receiving waters upstream from the Wind River

EDF recognizes that some water quality effluent limits are hardness-dependent because the toxicity of certain metals constituents is a function of hardness. In their modeling, the permit applicant used the hardness of the Wind River (192 mg/L as $CaCO_3$) to calculate their effluent limitations. With this assumption, the concentrations proposed as permit requirements for chromium, copper, and nickel are 126, 15, and 90 µg/L, respectively. However, the Wind River is over 40 stream miles down-gradient from the discharge points. Furthermore, the stream systems are low-flow and should be assumed to be effluent-dominated for at least some of the year. Therefore, EDF would propose that the hardness-dependent metal concentrations should instead be based off the measured hardness of the effluent (47 mg/L $CaCO_3$), so as to be protective of the entire stream system (and therefore prevent both toxics in toxic amounts and support a finding of "good enough quality"). Using the reported hardness of the effluent and the conversion factors cited in Appendix F of Chapter 1 of Wyoming Water Quality Rules and Regulations, the following metals would have lower concentration limits: chromium 40 µg/L; copper 4.7 µg/L; manganese 970 µg/L; and nickel 27.5 µg/L.

5. EDF questions whether antidegradation standards are being appropriately met

The outfalls discharge into an ephemeral tributary, Alkali Creek, which feeds into Badwater Creek, a major input into the Boysen Reservoir, a Class 2AB water system. Class 2AB water systems are designated for protection of aquatic life, livestock and wildlife watering, industrial uses, fishing and drinking water use.[31] Although only non-game fish reportedly inhabit Badwater Creek, Boysen Reservoir designated use includes game fish, drinking water and primary contact recreation. Waters classified as 2AB are considered to be high quality waters. Based on the modeling under worse-case, low-flow receiving system conditions, the increased effluent discharges are not expected to negatively impact pollutant levels or lower the water quality below Wyoming standards of The Wind River; however, the mixing zone for this analysis was assumed to be 40 stream miles away from the discharge facility. Because the outfalls discharge into low flow and non-perennial streams, where there is not any dilution available to mix with the discharge in the receiving water. Therefore, based on EDF's reading of Wyoming's antidegradation standards, "acute and chronic criteria would have to be met in the discharge itself" as per the language below:

> "A mixing zone is a limited area within the receiving water body where initial dilution of a point source discharge of pollution takes place. The establishment of a mixing zone is not appropriate in all circumstances. For example, in nonperennial or low flow streams, there may not be any dilution available to mix with the discharge. Also, there may be instances where background concentrations of specific pollutants in the receiving stream provide no assimilative capacity. In circumstances like these, acute and chronic criteria would have to be met in the discharge itself." [32]

We interpret this to mean that all criteria listed in Appendix B of Chapter 1 of the Wyoming Water Quality Rules and Regulations would have to be met for both aquatic life and human health consumption of fish and drinking water in the discharge itself to meet antidegradation standards.

An increased source of pollution (this permit proposes a three-fold increase in discharged effluent) must not lower water quality below the standards described in Chapter 1 of the Wyoming Surface Water Quality Standards. Specifically, Sections 18 and 21 describe numerical and narrative standards for Human Health and Protection of Aquatic Life, respectively.

Class 2AB and 2A waters cannot exceed the "Human Health Consumption of Fish and Drinking Water" values listed in Appendix B. As previously stated, EDF is concerned that most contaminants of concern listed in Appendix B were not analyzed for and many other constituents of concern may not have been identified yet in the influent. Therefore, EDF questions whether the permit as written can conclusively be shown to meet the antidegradation requirements without further analysis. If WYDEQ undertakes a more expanded analysis, in line with our above recommendations, EDF also believes that additional consideration should be paid to contaminants that have been shown to accumulate in sediment. Recent

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[31] WYDEQ. *Implementation Policies for Antidegradation, Mixing Zones and Dilution Allowances, Turbidity and Use Attainability Analysis*. Wyoming Surface Water Quality Standard. P. 8.
[32] *Id.* at P. 16.

studies have indicated that long-term impacts of NPDES-permitted facilities that discharge low levels of radium (less than 2.22 Bq/L) can lead to high accumulation of radioactive materials in the sediment near the outfalls, which can become a secondary source of radium contamination with changes in effluent or stream conditions.[33]

Conclusion

EDF recognizes that some positive improvements have been made to this permit, including WET testing, routing monitoring at the Neptune treatment unit, and the addition of some instream monitoring points among others. However, we remain seriously concerned that the significant increase in volumes, coupled with many remaining unknowns regarding the character of influent and effluent, limit the ability to justify the proposed limits in an appropriately thorough and scientifically defensible manner. It is unclear from the available data that the agency can make a conclusive determination that the limitations and requirements included in this permit meet Clean Water Act and Wyoming water quality standards as drafted. EDF respectfully urges the WYDEQ to gather additional data and reconsider the limits currently proposed for this permit.

Finally, and importantly, EDF believes that the challenges in this permit underscore the need for scientific advancements to inform development of a more protective baseline regulatory structure for produced water discharge permits in Wyoming. Without advancements, it is likely that future permits will have the same challenges described here and call into question Wyoming's protection of water quality, habitat, wildlife, livestock, and human health in line with its own regulations.

Respectfully submitted,

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[33] McDevitt B, McLaughlin M, Cravotta CA, Ajemigbitse MA, Van Sice KJ, Blotevogel J, Borch T, Warner NR. 2019. Emerging investigator series: radium accumulation in carbonate river sediments at oil and gas produced water discharges: implications for beneficial use as disposal management. *Environmental Science: Processes & Impacts*. 21(2):324–338. doi:10.1039/C8EM00336J.