May 26, 2020

Submitted via Electronic Mail

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Washington, DC 20460

RE: Great River Energy's Alternative Liner Application Under 40 C.F.R. § 257.71(d)(1), for the Upstream Raise 91 Combustion Coal Residual Rule Surface Impoundment at Coal Creek Station.

On behalf of Clean Up the River Environment ("CURE"), Dakota Resource Council, North Dakota Native Voice, and Sierra Club, we submit the attached technical report of Dr. Ranajit Sahu, Ph.D, QEP, which provides a preliminary evaluation of Great River Energy's ("GRE's") November 30, 2020 Alternative Liner Application under 40 C.F.R. § 257.71(d)(1), for the Upstream Raise 91 Combustion Coal Residual Rule Surface Impoundment at Coal Creek Station in North Dakota ("Alternative Liner Application" or "Application").[1]

Under the Coal Combustion Residual ("CCR") Rule, an owner or operator of an existing unlined surface impoundment must cease placing CCR material into the impoundment no later than April 11, 2021, and either retrofit or close the unit. 40 C.F.R. § 257.101(a). The owner of an unlined impoundment may continue to receive CCR material, however, provided they timely

[1] Based on the information available through EPA's Coal Combustion Residuals ("CCR") Part B Implementation website and www.regulations.gov, we understand that EPA is still in the process of reviewing the completeness of GRE's Alternative Liner Application, and that the agency will provide the public with a 20-day comment period before taking final action on whether the application is complete, 40 C.F.R. § 257.71(d)(1)(iii)(C). Because this is the first time that EPA will be reviewing utility filings under Part B of the revised CCR Rule, and due to the significant flaws in GRE's Application, we are submitting these comments now to help inform EPA's review. We look forward to the opportunity to submit additional, more comprehensive comments when EPA proposes action on GRE's Application, or any subsequent demonstration under 40 C.F.R. § 257.71(d)(1)(iv)-(v).

submit a complete alternative liner application and subsequent demonstration showing that "there is no reasonable probability that continued operation of the surface impoundment will result in adverse effects to human health or the environment." 40 C.F.R. §§ 257.71(d), 257.101(a)(3). As EPA made clear in revising the CCR Rule, "it is likely only a small fraction of non-composite lined surface impoundments currently in operation will be able to apply successfully for this demonstration."[2] Moreover, EPA may not approve any alternative liner application or demonstration unless the submission meets all of the requirements of 40 C.F.R. § 257.71(d)(1).

As the attached technical evaluation makes clear, GRE's November 30, 2020 Alternative Liner Application is incomplete and fundamentally flawed, in several ways. ***First***, the Application fails to include documentation sufficient to demonstrate that GRE's groundwater monitoring network "meets all the requirements" of 40 C.F.R. § 257.91, and "is sufficient to ensure detection of any groundwater contamination resulting from the impoundment." 40 C.F.R. § 257.71(d)(1)(i)(B)(1). More specifically, Section 257.91(a)(1) requires each CCR unit owner or operator to install a groundwater monitoring system that "accurately represent[s] the quality of background groundwater that has not been affected by leakage from a CCR unit," and to compare groundwater from downgradient wells to these background wells. *Id*. §§ 257.94, 257.95. Moreover, the "monitoring program must include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide an accurate representation of groundwater quality at the background and downgradient wells." *Id*. § 257.93(a). These requirements are designed to detect spatial differences in groundwater contamination, including the flow rate, direction, and geographical extent of any contamination between upgradient and downgradient monitoring locations.

Here, instead of comparing pollutant concentrations between appropriate background and downgradient monitoring wells, GRE's Application improperly compares *intra*-well concentrations to conclude that the current liner meets the requirements of the CCR Rule. Intra-well analyses are inconsistent with the CCR rule because they do not compare downgradient groundwater to "background." An intra-well analysis compares each well to itself over time. While this kind of analysis can detect temporal trends—*i.e.*, increasing or decreasing contamination at a single monitor—it says nothing about spatial patterns between and among wells. Because intra-well monitoring cannot accurately detect or measure groundwater flow paths or preferential contaminant migration pathways, GRE's submission of intra-well monitoring to satisfy the CCR Rule's monitoring program requirements and the Application is incomplete on its face. 40 C.F.R. § 257.71(d)(1)(i)(B)(1).

In an alternative analysis, GRE's Application does compare pollutant concentrations in upgradient and downgradient wells but inexplicably adds two *new* additional upgradient wells, which the Company did not include in any previous monitoring plan. *See* Sahu Report at 2-3. GRE does not provide any justification for its inconsistent use of additional upgradient wells; and as explained in the attached report, the new monitors serve only to skew the analysis to appear as though there is no statistical difference between the upgradient and downgradient wells. *Id*. at 5. In fact, without the two new upgradient wells, the inter-well comparison of GRE's

[2] 85 Fed. Reg. 12,456, 12,459 (Mar. 3, 2020).

original CCR monitoring wells indicate that the downgradient wells have statistically significant increases in chlorides, total dissolved solids, and boron concentrations, likely as the result of a leaking liner. *Id*. at 5-7. As a result, GRE was required under the CCR Rule to begin assessment monitoring and implement corrective action procedures at the site, but has failed to do so. 40 C.F.R. §§ 257.71(d)(2)(ix), 257.95(a).[3] GRE's Application is incomplete because the Company is not in compliance with the monitoring and corrective action requirements of Section 257.71 and 257.95.

Second, GRE's Application fails to include "documentation of the design specifications for any engineered liner components, as well as all data and analyses the owner or operator of the CCR surface impoundment" sufficient to demonstrate that the liner "materials are suitable for use and that the construction of the liner is of good quality and in-line with proven and accepted engineering practices." 40 C.F.R. § 257.71(d)(1)(i)(C). As Dr. Sahu explains, based on a review of GRE's Application, it is clear that Coal Creek's current liner is not as protective as the composite liner required under the CCR Rule. Sahu Report at 10. Moreover, GRE's Application fails to adequately document the specifications for the CCR liner. Consequently, GRE's liner cannot rationally be characterized as suitable for use or "in-line with proven and accepted engineering practices." 40 C.F.R. § 257.71(d)(1)(i)(C).

Third, GRE's Application fails to include documentation sufficient to demonstrate that the Coal Creek CCR unit meets all the location restrictions of the CCR Rule. 40 C.F.R. § 257.71(d)(1)(i)(B)(3). In particular, a portion of the Coal Creek CCR unit has a bottom separation of less than 5 feet from groundwater. Sahu Report at 10-11. The Application therefore fails, on its face, to demonstrate that CCR unit meets the does not meet the location restriction criteria for an unlined CCR unit under 40 C.F.R. § 257.60(a).

For all of these reasons, EPA should reject as incomplete GRE's Alternative Liner Application for Coal Creek Station, and GRE must either install a compliant liner or close the coal ash impoundment, as required under the CCR Rule, 40 C.F.R. § 257.101 *et seq*. Although the attached technical comments do not attempt to provide a detailed cost analysis, Dr. Sahu estimates, based on first-hand experience managing and designing similar projects, that it would cost $50 million to more than $100 million to retrofit the roughly 75-acre Coal Creek CCR unit with a CCR Rule-compliant composite liner. That does not account for the disposal or disposition of current CCR contents in the unit. Conversely, it would cost as little as $10 to 15 million to close the CCR unit in place with an appropriate cap and groundwater treatment, in accordance with the requirements of the CCR rule, 40 C.F.R. § 257.102(d).

[3] As a result of verified statistically significant increases in chloride concentrations at monitoring well MW-49, GRE conducted alternative source demonstrations purporting to demonstrate that the increased chloride concentrations are not the result of leakage from the Upstream Raise 91 CCR unit. As Dr. Sahu explains, however, GRE's alternative source demonstration improperly attributes the statistically significant increases in chloride concentrations to changes in groundwater concentration resulting from the 2015 closure of Coal Creek's previous impoundment and the construction and expansion of the Drains Pond System.

As noted, we understand that EPA is still in the process of reviewing GRE's Alternative Liner Application, and that the agency will provide the public with an opportunity to submit formal comments before taking final action. Due to the significant deficiencies in GRE's Application, however, we are submitting these comments to help inform EPA's completeness review. We look forward to the opportunity to submit additional, more comprehensive comments when EPA proposes action on GRE's Application or any subsequent Alternative Liner Demonstration. 40 C.F.R. § 257(d)(1)(iv)-(v).

If we can provide any additional information, please do not hesitate to contact us. We look forward to working with EPA, North Dakota, and GRE in implementing Part B of the CCR Rule at Coal Creek Station.

Sincerely,

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Technical Comments on the

Alternate Liner Demonstration Application (ALD) for the CCR Surface Impoundment called "Upstream Raise 91" at the Coal Creek Power Plant, prepared by Golder and Associates pursuant to 40 CFR 257.71(d)(1), dated November 30, 2020.

by

Dr. Ranajit (Ron) Sahu, Consultant

I. Summary

On November 30, 2020, Great River Energy (GRE) submitted to EPA an Alternative Liner Demonstration (ALD) Application under the Combustion Coal Residuals (CCR) Rule, 40 C.F.R. § 257.71(d)(1), for the Upstream coal ash surface impoundment at Coal Creek Station.[1] I have reviewed the ALD and supporting analysis prepared by Golder and Associates and it is my opinion that the Application is inadequate and EPA should deny the application, for the following three reasons.

- First, the technical analysis contained in the ALD, purporting to show that the current liner (consisting of a 40 mil thick HDPE placed over two feet of compacted soils in 1992[2]) is not leaking, is flawed. Instead of comparing pollutant concentrations in the two upgradient wells against the three down gradient wells identified in GRE's most-recent groundwater monitoring plan, the ALD improperly compares *intra*-well concentrations to conclude that the current liner is adequate. In an alternative analysis, the ALD does compare pollutant concentrations in upgradient and downgradient wells but, crucially, adds two additional upgradient wells, which serve to skew the upgradient/downgradient comparison to appear as though there is no statistical difference between upgradient and downgradient wells. No justification for the two additional upgradient wells is provided, and without them, the upgradient/downgradient comparisons would indicate that the current liner is likely leaking and therefore inadequate.
- Second, the current liner consisting of 40-mil HDPE and roughly 2 feet of compacted soil is not as protective of the required composite liner. It is therefore improper to characterize the CCR unit as lined.
- Third, a portion of the CCR unit has a bottom separation of less than 5 feet from groundwater as admitted in the ALD document. Therefore, this unlined CCR unit does not meet the location restriction criteria for a CCR unit.

[1] Golder Associates, Inc., Application to Submit an Alternative Liner Demonstration for the Upstream Raise 91 CCR Surface Impoundment, Great River Energy – Coal Creek Station (Nov. 25, 2020) [hereinafter, "ALD"], *available at* https://ccr.greatriverenergy.com/wp-content/uploads/2020%20Final%20GRE%20Alternative%20Liner%20Application%20Full%20Report.pdf.

[2] ALD at 24.

For all of these reasons, EPA should reject the Alternative Liner Demonstration Application for Coal Creek Station, and GRE must either install a compliance liner or close the coal ash impoundment, as required under the CCR Rule, 40 C.F.R. § 257.101 *et seq*.

These technical comments do not attempt to provide a detailed cost analysis. Based on my experience managing and designing similar projects[3] and my review of the relevant literature[4], however, I estimate that, given the roughly 75-acre size of Upstream Raise 91, the cost of upgrading the CCR unit with a compliant composite liner – i.e., including removal of current wastes, preparing the subgrade, installing the composite liner layers – would be in the **range of $50 million to more than $100 million,** not accounting for disposal or disposition of current CCR contents in the unit. Conversely, it would cost as little as $10-15 million to close the CCR unit in place with an appropriate cap and groundwater treatment in accordance with the requirements of the rule, 40 C.F.R. § 257.102(d).

II. Analysis

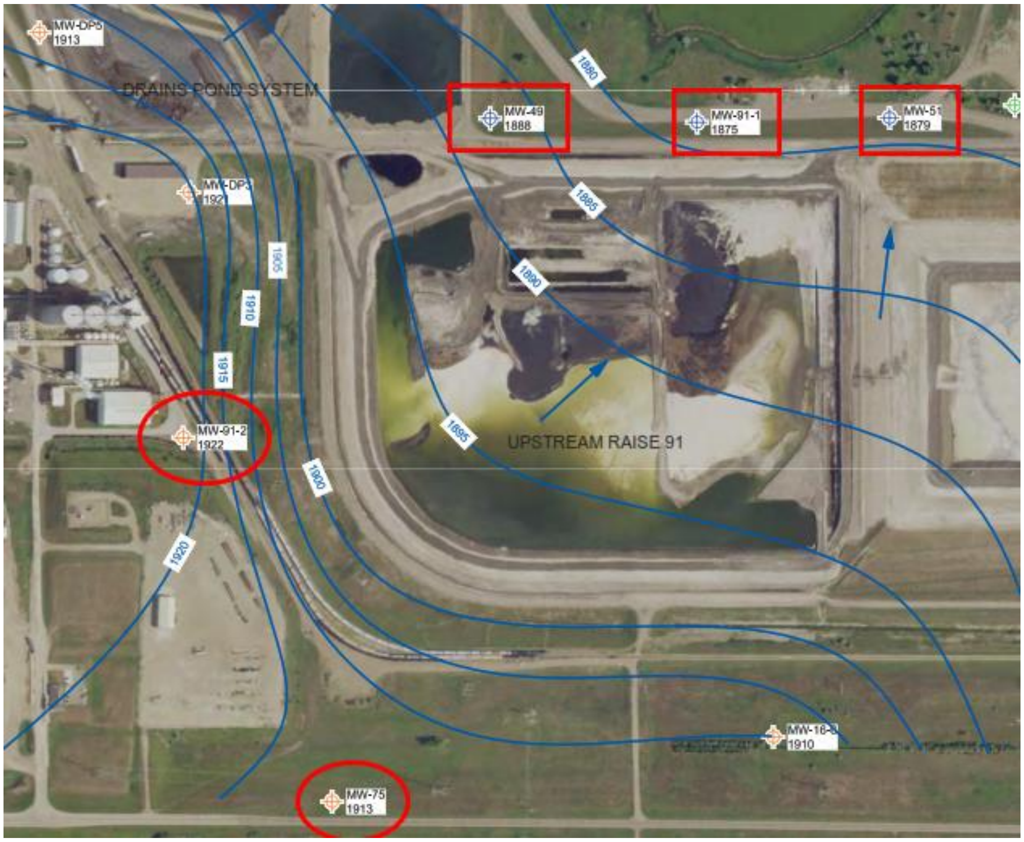
A. Upgradient and Downgradient Well Pollutant Concentration Comparisons

The ALD states that as part of the CCR Rule, a monitoring network meeting the requirements of 40 CFR 257.91 has been used to monitor the groundwater upgradient and downgradient of Upstream Raise 91.[5] It references the groundwater monitoring system certification provided in Appendix B1 of the ALD. That certification, revised on March 8, 2019, states that Upstream Raise 91 has two upgradient and three downgradient monitoring wells. These five monitoring wells, given their location and spacing, are likely inadequate to detect differences in contaminant concentrations in groundwater affected by the Upstream Raise 91 CCR. Setting aside the flawed justification for these five wells, the ALD and March 2019 certification identifies the following monitoring wells for Upstream Raise 91:[6]

Upstream Raise 91	Upgradient	MW-75	7/19/1989
		MW-91-2	11/6/2017
	Downgradient	MW-49	5/20/1988
		MW-51	5/20/1988
		MW-91-1	11/6/2017

The figure below, taken from GRE's March 2019 monitoring system certification,[7] shows the five wells: the two upgradient wells are circled in red ovals, and the three downgradient wells are shown with red boxes.

[3] *See* curriculum vitae of Dr. Ranajit Sahu, PhD, attached.
[4] *See, e.g.*, Office of Resource Conservation and Recovery, US Environmental Protection Agency, Regulatory Impact Analysis For EPA's Proposed RCRA Regulation Of Coal Combustion Residues (CCR) Generated by the Electric Utility Industry, Table ES-A, pp. ES-9 (Dec. 2014).
[5] ALD at 7.
[6] *Compare* ALD at 11, *with* ALD, App'x B1 at 5.
[7] ALD, App'x B1, Figure 1.

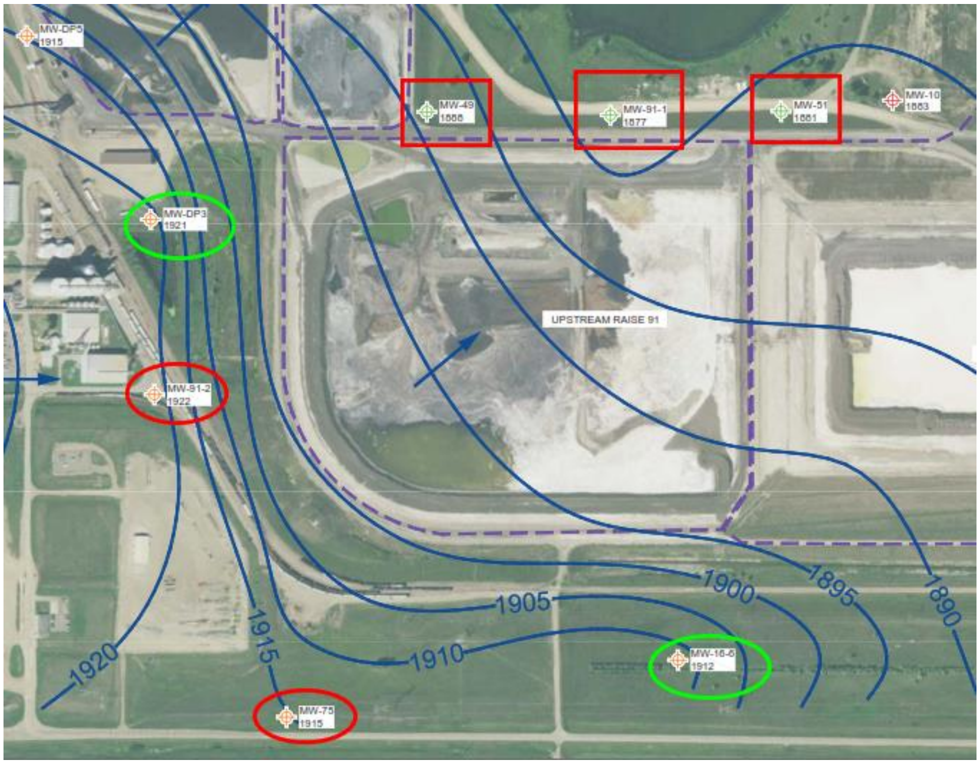


In its discussion of upgradient and downgradient wells submitted on November 30, 2020,[8] the ALD states that there are not two but four upgradient wells along with the three downgradient wells noted above. See table[9] and Figure[10] that follow.

Table 4: Upstream Raise 91 Monitoring Well Screened Lithologies

Location	Well ID	Geologic Unit(s) Screened In
Upgradient	MW-DP3	Fill, Coal, Fat Clay
	MW-91-2	Fat Clay, Coal
	MW-75	Clayey Silt, Silty Sand
	MW-16-6	Sandy Lean Clay, Coal, Lean Clay
Downgradient	MW-49	Sandy Gravelly Clay, Sandy Silt, Fat Clay (Shale)
	MW-51	Silty and Gravelly Sand, Lean Clay
	MW-91-1	Sand with Silt and Gravel, Fat Clay

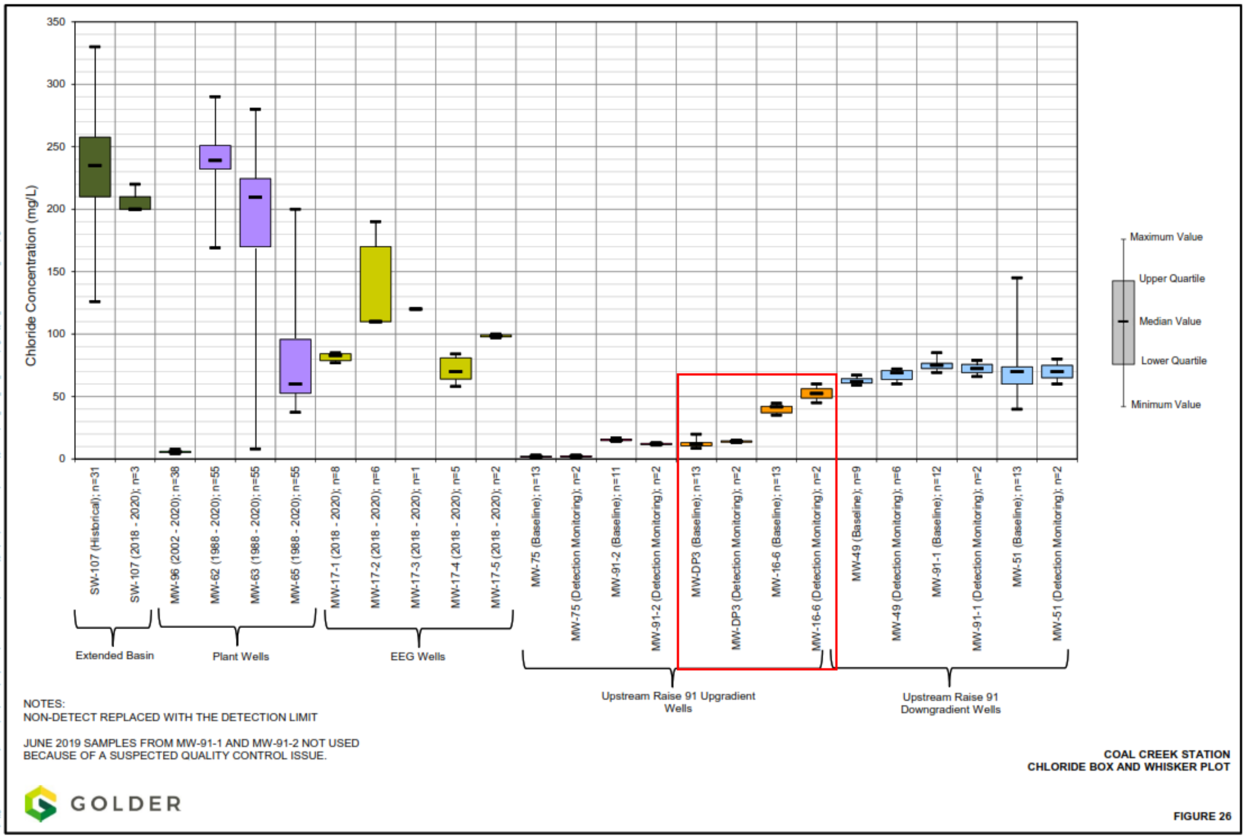
[8] ALD at 10, 11.
[9] ALD, Table 4.
[10] ALD, Figure 6 (at p. 54 of pdf).



In the figure above, I have shown the two newly added upgradient wells, MW-DP3 and MW-16-6 in green ovals. The other red ovals and boxed wells are identical to the 2019 groundwater monitoring plan locations discussed above. The ALD provides no justification for the addition of these two new wells as upgradient wells other than a conclusionary statement that "[A] review of recent groundwater levels indicated that there are four applicable upgradient wells…."[11] The ALD proceeds to conduct an "intra-well" statistical analysis of the spatial differences in groundwater constituent concentrations. Intra-well analyses are highly suspect because they simply compare the groundwater concentrations in each monitoring well to itself over time, and provide no comparison, or information about spatial patterns, between or among monitoring wells. Although the ALD does discuss inter-well analyses generally, it does so for informational purposes only, does not actually conduct any inter-well analysis, and simply asserts that such analyses are not recommended for Coal Creek Station.[12]

In any event, the effect of adding the two new "upgradient" wells is obvious. First, I excerpt the ALD's summary of chloride concentrations in the chart below.[13]

[11] ALD at 13.
[12] ALD at 22.
[13] ALD, Figure 26 (at p. 74 of pdf).



The figure above reflects the four upgradient and downgradient well chloride concentrations for Upstream Raise 91, from the various rounds of sampling. The two original upgradient wells had chloride concentrations of less than 30 mg/L while the three downgradient wells had concentrations between 60-70 mg/L, making them clearly and significantly higher than the upgradient concentrations. However, adding the two new "upgradient" wells, shown in the red box above, skews the comparison because one of the newly added "upgradient" wells (MW-16-6) has chloride concentrations that are between 40-60 mg/L, making it closer to and more comparable with the higher *downgradient* chloride concentrations than a true background well. Thus, adding in MW-16-6 makes it appear that, collectively, the upgradient wells and downgradient wells may have similar concentrations, i.e., the liner may not be leaking. In reality, GRE's originally certified monitors make clear that the downgradient wells have statistically significant increases in pollutant concentrations, likely as the result of a leaking liner.

As a result of verified statistically significant increases in chloride concentrations at monitoring well MW-49, GRE conducted alternative source demonstrations purporting to show that the increased chloride concentrations are not the result of leakage from the Upstream Raise 91 CCR unit.[14] GRE relies on those alternative source demonstrations to conclude that no further action (i.e., assessment monitoring under the CCR Rule) is required. I have several concerns about GRE's

[14] ALD, App'x C-6 and C-7.

alternative source demonstrations. Specifically, those demonstrations inappropriately (and without any analysis or support) attribute the statistically significant increases in chloride concentrations solely to changes in groundwater concentration resulting from the 2015 closure of Coal Creek's previous impoundment and the construction and expansion of the Drains Pond System. In all likelihood, the existing Upstream Raise 91 CCR unit is responsible for some of the increased chloride concentrations, and the unit should therefore be required to undertake assessment monitoring under the CCR Rule.

This same pattern is observed for significant increases in the concentrations of additional pollutants. I use boron and total dissolved solids (TDS), as examples. The three tables below show the boron and TDS concentrations (shown in red boxes in each table) across roughly five years of sampling for each of Coal Creek's three downgradient wells, MW-49,[15] MW-51,[16] and MW-91-1.[17]

Table 6: Sample Results Summary Table - MW-49

		MW-49																	
		Baseline Period									Additional Baseline Data		Detection Monitoring						
	Units	16-Sep-15	4-Nov-15	8-Mar-16	15-Jun-16	2-Aug-16	31-Oct-16	14-Feb-17	2-May-17	12-Jun-17	6-Jun-19	8-Apr-20	16-Oct-17	11-Jun-18	18-Jul-18	16-Oct-18	6-Jun-19	15-Oct-19	8-Apr-20
Water Elevation	ft AMSL	1888.0	1888.0	1887.9	1887.7	1887.6	1887.8	1887.6	1888.5	1888.0	1888.1	1888.4	1887.7	1888.1	1887.9	1887.5	1888.1	1888.8	1888.4
Appendix III Parameters																			
Boron	mg/L	5.40	5.20	4.80	4.74	4.89	5.17	4.94	4.47	4.48	---	---	5.12	5.0	---	4.4	4.2	4.6	4.7
Calcium	mg/L	207	201	207	196	190	187	207	190	207	---	---	195	200	---	180	200	200	210
Chloride	mg/L	60.8	60.3	62.0	67.1	62.5	64.3	65.1	61.4	59.2	---	---	62.3	68	---	72	70	71	60
Fluoride	mg/L	0.18	0.19	0.18	0.18	0.18	0.18	0.20	0.18	0.18	---	---	0.22	0.16 H	0.14	0.15	0.19	0.16	0.16
pH, Field	s.u.	6.94	6.90	6.99	6.95	7.03	7.05	7.31	7.10	7.06	---	---	6.99	7.05	7.08	7.08	6.89	7.02	7.01
Sulfate	mg/L	1340	1280	1110	1300	1390	1340	1170	992	1260	---	---	1240	1400	---	1400	1300	1400	1300
Total Dissolved Solids	mg/L	2700	2680	2650	2560	2620	2600	2610	2630	2650	---	---	2700	2800	---	2800	2600	2800	2700
Appendix IV Parameters																			
Antimony	mg/L	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.0020 U	< 0.0020 U	---	---	---	---	---	---	---
Arsenic	mg/L	0.0037	0.0023	0.0028	0.0025	0.0025	< 0.005 U ^	0.0027	0.0022	0.0023	< 0.0050 U	< 0.0050 U	---	---	---	---	---	---	---
Barium	mg/L	0.0292	0.0262	0.0266	0.0234	0.0262	0.0268	0.0262	0.0264	0.0256	0.027	0.024 F1	---	---	---	---	---	---	---
Beryllium	mg/L	< 0.0005 U	< 0.0005 U	< 0.001 U ^	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0050 U ^	< 0.0010 U	---	---	---	---	---	---	---
Cadmium	mg/L	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---	---
Chromium	mg/L	< 0.01 U ^	< 0.005 U ^	< 0.01 U ^	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.0020 U	< 0.0020 U	---	---	---	---	---	---	---
Cobalt	mg/L	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---	---
Fluoride	mg/L	0.18	0.19	0.18	0.18	0.18	0.18	0.2	0.18	0.18	0.19	0.16	---	---	---	---	---	---	---
Lead	mg/L	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.002 ^	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---	---
Lithium	mg/L	0.23	0.22	0.24	0.21	0.2	0.2	0.26	0.22	0.21	0.23	0.21	---	---	---	---	---	---	---
Mercury	mg/L	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	---	---	---	---	---	---	---
Molybdenum	mg/L	0.0102	< 0.005 ^	< 0.01 ^	< 0.025 ^	0.0021	< 0.002	0.0023	0.0024	0.0022	< 0.0020 U	0.0022	---	---	---	---	---	---	---
Radium-226	pCi/L	< 1 U	< 1 U	< 1 U	< 0.2 U	< 0.2 U	< 0.2 U	0.2 ± 0.1	0.3 ± 0.1	< 0.2 U	0.000 U ± 0.0914	0.0855 U ± 0.0857	---	---	---	---	---	---	---
Radium-228	pCi/L	< 2 U	< 2 U	< 2 U	< 2 U	< 1 U	< 2 U	< 2 U	< 2 U	< 2 U	0.313 U ± 0.300	0.309 U ± 0.266	---	---	---	---	---	---	---
Radium-226 and -228 combined	pCi/L	< 2 U	< 2 U	< 2 U	< 2 U	< 1 U	< 2 U	< 2 U	< 2 U	< 2 U	0.313 U ± 0.314	0.394 U ± 0.279	---	---	---	---	---	---	---
Selenium	mg/L	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.01 U ^	< 0.01 U ^	< 0.005 U ^	< 0.0050 U	< 0.0050 U	---	---	---	---	---	---	---
Thallium	mg/L	< 0.0005 U	< 0.0005 U	< 0.001 U ^	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U F1	---	---	---	---	---	---	---

Table 7: Sample Results Summary Table - MW-51

		MW-51																
		Baseline Period									Additional Baseline Data		Detection Monitoring					
	Units	16-Sep-15	4-Nov-15	8-Mar-16	15-Jun-16	2-Aug-16	31-Oct-16	14-Feb-17	2-May-17	12-Jun-17	6-Jun-19	8-Apr-20	16-Oct-17	11-Jun-18	16-Oct-18	6-Jun-19	15-Oct-19	8-Apr-20
Water Elevation	ft AMSL	1880.2	1879.8	1879.3	1880.0	1879.7	1879.3	1878.9	1881.5	1880.9	1879.3	1881.4	1879.3	1879.3	1878.8	1879.3	1884.1	1881.4
Appendix III Parameters																		
Boron	mg/L	3.76	3.35	3.02	3.62	2.84	3.51	5.65	3.26	3.19	---	---	3.56	3.1	2.8	3.9	7.9	5.4
Calcium	mg/L	311	301	296	300	275	268	369	210	215	---	---	240	220	220	280	420	270
Chloride	mg/L	70	67.8	72.9	76.2	71.7	73.8	145	45.7	39.8	---	---	49.6	61	60	87	80	54 H
Fluoride	mg/L	0.34	0.37	0.35	0.36	0.34	0.38	0.5	0.36	0.36	---	---	0.36	0.28 H	0.29	0.39	0.43	0.28
pH, Field	s.u.	6.92	6.88	7.05	6.95	6.98	7.06	7.31	7.11	7.04	---	---	6.98	7.09	7.26	7.08	6.91	6.99
Sulfate	mg/L	3380	3020	3230	3120	3280	3150	4430	2130	2430	---	---	2770	3300	3000	3100	3600	2600
Total Dissolved Solids	mg/L	5430	5470	5380	5060	5060	5230	6220	4500	4280	---	---	4830	5200	5300	5300	6200	4800
Appendix IV Parameters																		
Antimony	mg/L	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.0020 U	< 0.0020 U	---	---	---	---	---	---
Arsenic	mg/L	0.003	< 0.002 U	0.0021	< 0.002 U	< 0.002 U	< 0.005 U ^	< 0.002 U	< 0.002 U	< 0.002 U	< 0.0050 U	< 0.0050 U	---	---	---	---	---	---
Barium	mg/L	0.0312	0.0287	0.0229	0.0215	0.0247	0.0247	0.0281	0.0166	0.0163	0.023	0.016	---	---	---	---	---	---
Beryllium	mg/L	< 0.0005 U	< 0.0005 U	< 0.001 ^	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0050 U ^	< 0.0010 U	---	---	---	---	---	---
Cadmium	mg/L	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---
Chromium	mg/L	< 0.01 U ^	< 0.005 U ^	< 0.01 U ^	< 0.002 U	< 0.002 U	0.0021	< 0.002 U	< 0.002 U	< 0.002 U	< 0.0020 U	< 0.0020 U	---	---	---	---	---	---
Cobalt	mg/L	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---
Fluoride	mg/L	0.34	0.37	0.35	0.36	0.34	0.38	0.5	0.36	0.36	0.39	0.28	---	---	---	---	---	---
Lead	mg/L	< 0.0005 U	< 0.0005 U	0.0008	< 0.0005 U	< 0.0005 U	< 0.002 U ^	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---
Lithium	mg/L	0.57	< 0.50 U	< 0.50 U @	0.47	0.44	0.51	0.46	< 0.50 U @	0.39	0.47	0.47	---	---	---	---	---	---
Mercury	mg/L	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	---	---	---	---	---	---
Molybdenum	mg/L	0.0069	0.006	< 0.01 U ^	< 0.025 U ^	0.0057	0.0066	0.0081	0.0041	0.0045	0.0081	0.0032	---	---	---	---	---	---
Radium-226	pCi/L	< 1 U	< 1 U	< 1 U	< 0.2 U	0.2 ± 0.1	< 0.2 U	0.3 ± 0.1	< 0.2 U	< 0.2 U	0.0895 U ± 0.0794	0.000811 U ± 0.0659	---	---	---	---	---	---
Radium-228	pCi/L	< 2 U	< 2 U	< 2 U	< 2 U	< 1 U	< 2 U	< 2 U	< 2 U	< 2 U	0.620 ± 0.264	-0.0410 U ± 0.318	---	---	---	---	---	---
Radium-226 and -228 combined	pCi/L	< 2 U	< 2 U	< 2 U	< 2 U	< 1 U	< 2 U	< 2 U	< 2 U	< 2 U	0.709 ± 0.276	-0.0402 U ± 0.325	---	---	---	---	---	---
Selenium	mg/L	0.0196	0.0197	0.0169	0.0151	0.0166	0.0124	0.017	0.018	0.0191	0.015	0.012	---	---	---	---	---	---
Thallium	mg/L	< 0.0005 U	< 0.0005 U	< 0.001 ^	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---

15 ALD, App'x C-1, Table 6 (at p. 953 of pdf).

16 ALD, App'x C-1, Table 7 (at p. 954 of pdf).

17 ALD, App'x C-1, Table 8 (at p. 955 of pdf).

Table 8: Sample Results Summary Table - MW-91-1

		MW-91-1																
		Baseline Period										Additional Baseline Data			Detection Monitoring			
	Units	17-Jan-18	14-Feb-18	20-Mar-18	23-Apr-18	17-May-18	12-Jun-18	18-Jul-18	13-Aug-18	13-Sep-18	17-Oct-18	6-Jun-19	13-Sep-19	8-Apr-20	6-Jun-19	13-Sep-19	15-Oct-19	8-Apr-20
Water Elevation	ft AMSL	1875.4	1875.6	1875.5	1875.8	1876.0	1876.0	1875.9	1875.7	1875.5	1875.4	1876.5	1876.3	1877.1	1876.5	1876.3	1876.8	1877.1
Appendix III Parameters																		
Boron	mg/L	2.87	3.12	3.19	3.06	3.3	3.1	2.8	2.9	2.9	2.8	---	---	---	0.35	2.9	2.7	3.0
Calcium	mg/L	354	245	261	214	216	210	190	200	200	210	---	---	---	270	230	220	230
Chloride	mg/L	76.4	75.2	69.2	72.5	76.2	76	71	73	72	78	---	---	---	16	85	79	66
Fluoride	mg/L	0.26	0.27	0.23	0.25	0.21	< 0.50 U	0.19	0.19	0.16	0.23	---	---	---	< 0.10 U	0.2	0.21	0.22
pH, Field	s.u.	7.04	6.93	6.87	6.99	6.83	6.98	6.98	7.03	6.97	6.96	---	---	---	6.82	6.97	6.94	6.93
Sulfate	mg/L	1160	1200	1010	1200	983	1200	1200	1300	1200	1200	---	---	---	1200	1300	1100	1100
Total Dissolved Solids	mg/L	2240	2240	2300	2300	2250	2400	2300	2300	2300	2300	---	---	---	2000	2300 H	2400	2300
Appendix IV Parameters																		
Antimony	mg/L	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	---	---	---	---
Arsenic	mg/L	0.0299	0.0126	0.0115	0.0023	< 0.0020 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	---	---	---	---
Barium	mg/L	0.66	0.266	0.3026	0.0704	0.0537	0.044	0.048	0.099	0.15	0.063	0.064	0.048	0.04	---	---	---	---
Beryllium	mg/L	0.0029	0.0013	0.0011	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0050 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0050 U ^	< 0.0010 U	< 0.0010 U	---	---	---	---
Cadmium	mg/L	0.0015	0.0006	0.0007	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	---	---	---	---
Chromium	mg/L	0.0616	0.0304	0.0301	0.0037	< 0.0020 U	< 0.0020 U	< 0.0020 U	0.009	0.013	0.0053	< 0.0020 U	< 0.0020 U	< 0.0020 U	---	---	---	---
Cobalt	mg/L	0.0264	0.0109	0.0117	0.0021	< 0.0020 U	0.0011	0.0012	0.0027	0.0043	0.0021	< 0.0010 U	0.0019	0.0011	---	---	---	---
Fluoride	mg/L	0.26	0.27	0.23	0.25	0.21	< 0.50 U	0.19	0.19	0.16	0.23	< 0.10 U	0.20	0.22	---	---	---	---
Lead	mg/L	0.0327	0.0131	0.015	0.001	< 0.0005 U	< 0.0010 U	< 0.0010 U	0.0035	0.0057	0.0021	< 0.0010 U	< 0.0010 U	< 0.0010 U	---	---	---	---
Lithium	mg/L	0.16	0.15	0.14	0.13	0.16	0.13	0.12	0.13	0.14	0.14	0.10	0.14	0.13	---	---	---	---
Mercury	mg/L	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	---	---	---	---
Molybdenum	mg/L	0.0091	0.0102	0.0063	0.0079	0.0053	0.0038	0.0047	0.0035	0.0037	0.0042	< 0.0020 U	0.0047	0.0045	---	---	---	---
Radium-226	pCi/L	< 0.2	0.4 ± 0.1	< 1	< 0.4	0.8 ± 0.2	0.0439 U ± 0.136	0.203 ± 0.0856	0.628 ± 0.199	0.767 ± 0.221	0.354 ± 0.146	0.551 ± 0.225	0.0217 U ± 0.0582	0.114 U ± 0.109	---	---	---	---
Radium-228	pCi/L	< 1	< 2	< 2	< 2	< 2	0.381 U ± 0.270	0.237 U ± 0.261	0.513 U ± 0.550	0.495 U ± 0.559	0.258 U ± 0.310	0.543 U ± 0.379	0.383 U ± 0.320	0.502 U ± 0.337	---	---	---	---
Radium-226 and -228 combined	pCi/L	< 1	< 2	< 2	< 2	< 2	0.425 ± 0.419	0.441 U ± 0.294	1.14 ± 0.585	1.26 ± 0.601	0.612 ± 0.343	1.09 ± 0.441	0.405 U ± 0.325	0.616 ± 0.354	---	---	---	---
Selenium	mg/L	0.0052	< 0.0050 U	0.0119	< 0.0050 U	< 0.010 ^	< 0.0050 U	< 0.025 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	0.011	0.0069	---	---	---	---
Thallium	mg/L	0.0013	< 0.0010 U ^	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	---	---	---	---

Boron concentrations in the downgradient wells ranged from 4.2 to 5.6 mg/L in MW-49; from 2.8 to 7.9 mg/L in MW-51; and from 2.7 to 3.3 mg/L in MW-91-1 (with one exception). Collectively, the boron concentrations from these downgradient wells ranged from 2.7 to 7.9 mg/L.

Similarly TDS concentrations in the three downgradient wells ranged from 2560 to 2800 mg/L in MW-49; from 4280 to 6220 mg/L in MW-51; and from 2000 to 2400 mg/L in MW-91-1. Collectively, the downgradient TDS concentrations ranged from 2000 to 6220 mg/L.

Next, I show the same data for the original two originally-certified upgradient wells, MW-75[18] and MW-91-2,[19] with the boron and TDS concentrations shown in green boxes in each table. For boron, the concentrations ranged from 0.17 to 0.26 mg/L in MW-75; and from 0.24 to 0.45 mg/L in MW-91-2 (with one exception). The overall range, was generally from 0.17 to 0.45 mg/L.

For TDS, the concentrations ranged from 811 to 900 mg/L in MW-75 (with one exception) and from 960 to 2200 mg/L in MW-91-2. Overall, they ranged from 811 to 2200 mg/L.

Comparing the concentrations from the originally-certified upgradient wells with the range of concentrations from the downgradient wells, as explained above, it is clear that the downgradient concentrations are substantially greater than the upgradient concentrations. For boron, for example, the upgradient range was 0.17-0.45 mg/L as compared to a downgradient range of 2.7-7.9 mg/L. For TDS the upgradient range was from 811 to 2200 mg/L as compared to a downgradient range of 2000 to 6200 mg/L. Based on these significant differences, it is my opinion that the Upstream Raise 91 CCR unit is likely leaking.

[18] ALD, App'x C-1, Table 4 (at p. 951 of pdf).
[19] ALD, App'x C-1, Table 3 (at p. 950 of pdf).

Table 4: Sample Results Summary Table - MW-75

		MW-75																
		Baseline Period									Additional Baseline Data		Detection Monitoring					
	Units	16-Sep-15	5-Nov-15	8-Mar-16	15-Jun-16	2-Aug-16	31-Oct-16	12-Feb-17	2-May-17	13-Jun-17	6-Jun-19	7-Apr-20	16-Oct-17	6-Jun-18	16-Oct-18	6-Jun-19	14-Oct-19	7-Apr-20
Water Elevation	ft AMSL	1916.5	1916.0	1914.8	1914.9	1914.8	1915.0	1914.1	1916.2	1915.6	1912.7	1915.2	1914.0	1913.2	1913.0	1912.7	1914.0	1915.2
Appendix III Parameters																		
Boron	mg/L	0.26	0.21	0.21	0.17	0.23	0.21	0.18	0.20	0.18	---	---	0.23	0.22	0.21	0.20	0.20	0.20
Calcium	mg/L	9.0	6.0	6.3	6.2	5.8	5.6	6.0	4.9	5.4	---	---	4.9	4.9	5.1	5.3	5.3	4.7
Chloride	mg/L	2.2	1.9	1.9	1.5	1.2	1.5	1.3	1.5	1.8	---	---	1.1	< 3.0 U	< 3.0 U	< 3.0 U	1.1	< 3.0 U
Fluoride	mg/L	0.45	0.45	0.49	0.52	0.48	0.48	0.55	0.48	0.47	---	---	0.50	< 0.50 U	0.45	0.56	0.46	0.45
pH, Field	s.u.	7.98	7.93	8.12	8.04	8.07	8.10	8.18	8.16	8.15	---	---	8.07	8.19	8.23	8.12	8.22	8.11
Sulfate	mg/L	80.1	69.9	79.6	68.7	74.2	72.8	74.1	70.8	75.1	---	---	56.5	73	75	72	71	73
Total Dissolved Solids	mg/L	841	857	820	823	849	811	837	811	870	---	---	2630	840	900	810	880	860
Appendix IV Parameters																		
Antimony	mg/L	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.0020 U	< 0.0020 U ^	---	---	---	---	---	---
Arsenic	mg/L	< 0.0026 U ^	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.005 U ^	< 0.002 U	< 0.002 U	< 0.002 U	< 0.0050 U	< 0.0050 U	---	---	---	---	---	---
Barium	mg/L	0.0478	0.0371	0.0369	0.0349	0.0363	0.0356	0.0338	0.0312	0.0365	0.035	0.036	---	---	---	---	---	---
Beryllium	mg/L	< 0.0005 U	< 0.0005 U	< 0.001 U ^	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0050 U ^	< 0.0010 U	---	---	---	---	---	---
Cadmium	mg/L	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	0.0008	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---
Chromium	mg/L	< 0.01 ^	< 0.005 ^	< 0.01 ^	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	---	---	---	---	---	---
Cobalt	mg/L	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---
Fluoride	mg/L	0.45	0.45	0.49	0.52	0.48	0.48	0.55	0.48	0.47	0.56	0.45	---	---	---	---	---	---
Lead	mg/L	0.0012	< 0.005 U ^	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.002 ^	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---
Lithium	mg/L	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	0.085	0.077	---	---	---	---	---	---
Mercury	mg/L	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	---	---	---	---	---	---
Molybdenum	mg/L	0.0041	< 0.005 ^	< 0.01 ^	< 0.025 ^	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	---	---	---	---	---	---
Radium-226	pCi/L	< 1 U	< 1 U	< 1 U	< 0.2 U	< 0.2 U	< 0.2 U	0.3 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	-0.0233 U ± 0.104	0.119 U ± 0.0958	---	---	---	---	---	---
Radium-228	pCi/L	< 2 U	< 2 U	< 2 U	< 2 U	3.4 ± 3.0	< 2 U	< 2 U	< 2 U	< 2 U	0.231 U ± 0.253	0.145 U ± 0.246	---	---	---	---	---	---
Radium-226 and -228 combined	pCi/L	< 2 U	< 2 U	< 2 U	< 2 U	3.4 ± 3.0	< 2 U	< 2 U	< 2 U	< 2 U	0.208 U ± 0.274	0.264 U ± 0.264	---	---	---	---	---	---
Selenium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.01 ^	< 0.01 ^	< 0.005 ^	< 0.0050 U	< 0.0050 U	---	---	---	---	---	---
Thallium	mg/L	< 0.0005 U	< 0.0005 U	< 0.001 ^	< 0.0005 U	< 0.0005 U	0.0007	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---

Table 3: Sample Results Summary Table - MW-91-2

		MW-91-2															
		Baseline Period									Additional Baseline Data			Detection Monitoring			
	Units	18-Jan-18	14-Feb-18	23-Apr-18	17-May-18	12-Jun-18	18-Jul-18	13-Aug-18	13-Sep-18	16-Oct-18	6-Jun-19	13-Sep-19	7-Apr-20	6-Jun-19	13-Sep-19	14-Oct-19	7-Apr-20
Water Elevation	ft AMSL	1921.3	1921.3	1921.4	1921.4	1922.0	1922.8	1922.2	1921.8	1922.0	1926.2	1923.7	1922.5	1926.2	1923.7	1926.0	1922.5
Appendix III Parameters																	
Boron	mg/L	0.41	0.44	0.41	0.45	0.41	0.37	0.37	0.4	0.39	---	---	---	2.7	0.38	0.35	0.24
Calcium	mg/L	289	284	261	281	280	250	250	250	250	---	---	---	220	270	240	160
Chloride	mg/L	14.5	16.8	16.5	15.6	14	16	15	15	14	---	---	---	75	15	13	11
Fluoride	mg/L	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.50 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	---	---	---	0.26	< 0.10 U	< 0.10 U	0.11
pH, Field	s.u.	6.16	6.23	6.43	6.05	6.18	6.13	6.22	6.18	6.21	---	---	---	6.09	6.11	6.15	6.52
Sulfate	mg/L	1180	1010	985	938	1100	1100	1200	1100	1100	---	---	---	1100	1100	920	510
Total Dissolved Solids	mg/L	1900	1890	1810	1950	2000	2000	1900	960	1900	---	---	---	2200	2000	1700	1100
Appendix IV Parameters																	
Antimony	mg/L	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U ^	---	---	---	---
Arsenic	mg/L	0.0022	0.0039	0.0022	< 0.0020 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	---	---	---	---
Barium	mg/L	0.0978	0.128	0.091	0.0633	0.05	0.058	0.053	0.058	0.076	0.047	0.048	0.16	---	---	---	---
Beryllium	mg/L	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0050	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0050 U ^	< 0.0010 U	< 0.0010 U	---	---	---	---
Cadmium	mg/L	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	---	---	---	---
Chromium	mg/L	0.0043	0.0064	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	---	---	---	---
Cobalt	mg/L	0.002	0.0025	< 0.0020 U	< 0.0020 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	0.0013	< 0.0010 U	< 0.0010 U	---	---	---	---
Fluoride	mg/L	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.50 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	0.26	< 0.10 U	0.11	---	---	---	---
Lead	mg/L	0.0023	0.0034	0.0012	< 0.0005 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	---	---	---	---
Lithium	mg/L	0.10	0.12	0.10	0.12	0.097	0.092	0.097	0.10	0.094	0.15	0.11	0.035	---	---	---	---
Mercury	mg/L	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	---	---	---	---
Molybdenum	mg/L	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	0.0041	< 0.0020 U	0.0043	---	---	---	---
Radium-226	pCi/L	0.4 ± 0.1	1.0 ± 0.2	1.1 ± 0.2	1.5 ± 0.2	0.502 ± 0.267	0.779 ± 0.181	0.779 ± 0.181	0.807 ± 0.139	0.796 ± 0.371	0.145 U ± 0.111	0.566 ± 0.155	0.398 ± 0.192	---	---	---	---
Radium-228	pCi/L	< 1 U	< 2 U	< 2 U	< 2 U	0.156 U ± 0.314	0.105 U ± 0.305	0.473 ± 0.307	0.272 U ± 0.297	0.238 U ± 0.403	0.440 U ± 0.307	0.451 U ± 0.341	-0.134 U ± 0.341	---	---	---	---
Radium-226 and -228 combined	pCi/L	< 1 U	< 2 U	< 2 U	< 2 U	0.659 ± 0.412	0.884 ± 0.355	1.25 ± 0.356	1.08 ± 0.328	1.03 ± 0.548	0.584 ± 0.326	1.02 ± 0.375	0.264 U ± 0.391	---	---	---	---
Selenium	mg/L	< 0.0050 U ^	< 0.0050 U	< 0.0050 U	< 0.010 U ^	< 0.0050 U	< 0.025	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	---	---	---	---
Thallium	mg/L	< 0.0005 U	< 0.0010 U ^	< 0.0005 U	< 0.0005 U	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010 U	< 0.0010 U	< 0.0010 U	---	---	---	---

Next, I show the same concentrations of boron and TDS, boxed in purple for the two new upgradient wells that were added in the ALD, namely MW-DP-3[20] and MW-16-6.[21] For boron the range was 0.53 to 0.8 mg/L in MW-DP3; and from 3.9 to 5.76 mg/L in MW-16-6.

For TDS, the range was from 2100 to 2400 mg/L for MW-DP3; and from 5370 to 6400 mg/L in MW-16-6.

[20] ALD, App'x C-1, Table 2 (at p. 949 of pdf).
[21] ALD, App'x C-1, Table 5 (at p 952 of pdf).

Table 2: Sample Results Summary Table - MW-DP3

		MW-DP3																	
		Baseline Period									Additional Baseline Data			Detection Monitoring					
	Units	15-Sep-15	4-Nov-15	8-Mar-16	14-Jun-16	2-Aug-16	26-Oct-16	15-Feb-17	2-May-17	13-Jun-17	18-Oct-18	5-Jun-19	7-Apr-20	16-Oct-17	7-Jun-18	18-Oct-18	5-Jun-19	9-Oct-19	7-Apr-20
Water Elevation	ft AMSL	1922.4	1921.9	1920.8	1922.2	1922.0	1921.5	1921.4	1921.6	1921.2	1921.0	1925.5	1921.3	1920.9	1920.8	1921.0	1925.5	1925.0	1921.3
Appendix III Parameters																			
Boron	mg/L	0.80	0.70	0.61	0.61	0.57	0.63	0.67	0.60	0.55	---	---	---	0.61	0.63	0.62	0.62	0.53	0.64
Calcium	mg/L	295	279	253	241	237	249	250	245	261	---	---	---	246	230	220	260	210	240
Chloride	mg/L	13.6	19.8	11.7	9.7	8.6	9.3	13.1	13.3	11.1	---	---	---	10.6	12	13	13	< 15 U	13
Fluoride	mg/L	0.11	0.13	0.11	0.11	0.11	0.12	0.13	0.13	0.12	---	---	---	< 0.10	< 0.50	< 0.10	< 0.10 U	< 0.10 U	0.11
pH, Field	s.u.	6.26	6.28	6.35	6.19	6.28	6.38	6.4	6.45	6.36	---	---	---	6.31	6.37	6.31	6.22	6.40	6.33
Sulfate	mg/L	1270	1260	1340	1320	1230	1290	1140	1050	1090	---	---	---	1080	1200	1200	1200	1200	1200
Total Dissolved Solids	mg/L	2350	2350	2310	2260	2330	2210	2170	2240	2260	---	---	---	2100	2300	2300	2200	2200	2400
Appendix IV Parameters																			
Antimony	mg/L	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.0020 U	< 0.0020 U	< 0.0020 U ^	---	---	---	---	---	---
Arsenic	mg/L	0.0126	0.0061	0.0031	< 0.002 U	< 0.002 U	< 0.002 U	0.0044	< 0.002 U	< 0.002 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	---	---	---	---	---	---
Barium	mg/L	0.68	0.3926	0.0633	0.0588	0.0552	0.0488	0.179	0.0589	0.0572	0.057	0.045	0.062 ^	---	---	---	---	---	---
Beryllium	mg/L	0.0029	< 0.0005 U	< 0.001 U ^	< 0.0005 U	< 0.0005 U	< 0.0005 U	0.0006	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0050 U ^	< 0.0010 U	---	---	---	---	---	---
Cadmium	mg/L	0.0014	0.001	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	0.001	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---
Chromium	mg/L	< 0.01 U ^	0.0278	< 0.01 U ^	< 0.002 U	< 0.002 U	< 0.002 U	0.012	< 0.002 U	< 0.002 U	< 0.0020 U	< 0.0020 U	< 0.0020 U ^	---	---	---	---	---	---
Cobalt	mg/L	0.022	0.0119	0.0022	< 0.002 U	< 0.002 U	< 0.002 U	0.0053	0.0034	0.0028	0.0037	0.0021	0.0028	---	---	---	---	---	---
Fluoride	mg/L	0.11	0.13	0.11	0.11	0.11	0.12	0.13	0.13	0.12	< 0.10 U	< 0.10 U	0.11	---	---	---	---	---	---
Lead	mg/L	0.037	0.0154	0.001	0.0008	0.0008	0.0015	0.0099	0.0013	0.001	< 0.0010 U	< 0.0010 U	0.0012	---	---	---	---	---	---
Lithium	mg/L	0.23	0.2	0.18	0.18	0.16	0.16	0.2	0.17	0.17	0.16	0.16	0.16	---	---	---	---	---	---
Mercury	mg/L	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	---	---	---	---	---	---
Molybdenum	mg/L	< 0.01 U ^	< 0.005 U ^	< 0.01 U ^	< 0.025 U ^	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	---	---	---	---	---	---
Radium 226	pCi/L	< 1 U	1.3 ± 0.2	< 1 U	0.8 ± 0.1	1.1 ± 0.2	0.8 ± 0.2	1.0 ± 0.2	1.4 ± 0.2	0.5 ± 0.1	0.761 ± 0.186	0.468 ± 0.146	0.600 ± 0.203	---	---	---	---	---	---
Radium 228	pCi/L	< 2 U	< 2 U	< 2 U	< 1 U	< 1 U	< 2 U	< 2 U	< 2 U	< 2 U	0.924 ± 0.381	0.958 ± 0.391	0.609 ± 0.373	---	---	---	---	---	---
Radium 226 and 228 combined	pCi/L	< 2 U	< 2 U	< 2 U	< 1 U	1.1 ± 0.2	< 2 U	< 2 U	< 2 U	< 2 U	1.68 ± 0.424	1.43 ± 0.405	1.21 ± 0.425	---	---	---	---	---	---
Selenium	mg/L	< 0.002 U	0.0023	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.01 U ^	< 0.01 U ^	< 0.005 U ^	< 0.0050 U	< 0.0050 U	< 0.0050 U	---	---	---	---	---	---
Thallium	mg/L	< 0.0005 U	< 0.0005 U	< 0.001 U ^	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---

Table 5: Sample Results Summary Table - MW-16-6

		MW-16-6																
		Baseline Period									Additional Baseline Data		Detection Monitoring					
	Units	4-Nov-15	17-Mar-16	22-Jun-16	5-Aug-16	1-Nov-16	15-Feb-17	1-May-17	15-Jun-17	26-Jul-17	6-Jun-19	8-Apr-20	16-Oct-17	6-Jun-18	16-Oct-18	6-Jun-19	14-Oct-19	8-Apr-20
Water Elevation	ft AMSL	1912.0	1911.2	1912.0	1911.6	1911.3	1910.9	1912.1	1911.6	1911.2	1910.4	1912.4	1910.7	1910.8	1910.2	1910.4	1912.0	1912.4
Appendix III Parameters																		
Boron	mg/L	5.31	4.3	4.69	4.63	5.4	4.49	3.98	3.98	4.7	---	---	5.76	4.3	4.6	3.9	5.2	4.8
Calcium	mg/L	550	492	505	505	540	570	490	505	550	---	---	545	480	500	500	530	540
Chloride	mg/L	42.4	40.8	35.5	35.1	41.9	41.8	42.1	42.2	44.6	---	---	43.7	38	35	37	45	35 H
Fluoride	mg/L	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	---	---	< 0.10	0.81 H	< 0.10	< 0.10 U	< 0.10 U	< 0.10 U
pH, Field	s.u.	5.71	5.76	5.72	5.69	5.67	5.68	5.77	5.75	5.77	---	---	5.73	5.76	5.83	5.68	5.94	5.78
Sulfate	mg/L	3460	3390	4250	3860	3380	3870	2940	3360	3810	---	---	3350	3600	3800	3600	3900	3400
Total Dissolved Solids	mg/L	5600	5680	5500	5540	5370	5650	5600	5600	5920	---	---	5810	5900	6100	5900	6400	6000
Appendix IV Parameters																		
Antimony	mg/L	0.0011	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.001 U	< 0.0020 U	< 0.0020 U	---	---	---	---	---	---
Arsenic	mg/L	0.0037	< 0.01 U ^	< 0.002 U	< 0.002 U	< 0.005 U ^	0.0021	< 0.002 U	< 0.002 U	< 0.002 U	< 0.0050 U	< 0.0050 U	---	---	---	---	---	---
Barium	mg/L	0.0612	0.2041	0.0421	0.04	0.0346	0.051	0.0272	0.0296	0.0272	0.028	0.04	---	---	---	---	---	---
Beryllium	mg/L	< 0.0005 U	< 0.0005 U	< 0.001 ^	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0050 U ^	< 0.0010 U	---	---	---	---	---	---
Cadmium	mg/L	< 0.0005 U	< 0.0005 U	< 0.001 ^	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---
Chromium	mg/L	< 0.005 U ^	0.0116	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.0020 U	< 0.0020 U	---	---	---	---	---	---
Cobalt	mg/L	0.0025	0.0036	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	< 0.002 U	0.0018	0.0024	---	---	---	---	---	---
Fluoride	mg/L	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	---	---	---	---	---	---
Lead	mg/L	0.0009	0.0035	< 0.001 U ^	< 0.0005 U	< 0.001 ^	0.0006	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---
Lithium	mg/L	0.54	0.62	0.57	0.57	0.58	0.64	0.54	0.58	0.6	0.59	0.55	---	---	---	---	---	---
Mercury	mg/L	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	---	---	---	---	---	---
Molybdenum	mg/L	0.0058	< 0.005 U ^	< 0.025 U ^	0.0037	0.0029	0.0022	0.0022	< 0.005 U ^	0.0025	< 0.0020 U	0.0023	---	---	---	---	---	---
Radium 226	pCi/L	< 1 U	2.0 ± 0.4	< 0.4 U	0.4 ± 0.1	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	0.2 ± 0.1	0.00155 U ± 0.126	0.0779 U ± 0.104	---	---	---	---	---	---
Radium 228	pCi/L	< 2 U	< 2 U	3.6 ± 2.8	< 1 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	0.332 U ± 0.364	0.532 U ± 0.455	---	---	---	---	---	---
Radium 226 and 228 combined	pCi/L	< 2 U	2.0 ± 0.4	3.6 ± 2.8	< 1 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	0.334 U ± 0.385	0.610 U ± 0.467	---	---	---	---	---	---
Selenium	mg/L	0.0319	0.0278	< 0.025 U ^	0.0208	0.0143	0.0128	< 0.01 U ^	0.0138	0.0155	< 0.0050 U	< 0.0050 U	---	---	---	---	---	---
Thallium	mg/L	0.0005	< 0.0005 U	< 0.001 U ^	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0005 U	< 0.0010 U	< 0.0010 U	---	---	---	---	---	---

By including the two new “upgradient” wells, the range of boron and TDS in the collective four upgradient wells becomes much greater. For boron, the upgradient range went from 0.17-0.45 mg/L (two original wells) to 0.17-5.76 mg/L (collectively for the four wells). For TDS, similarly, the range went from 811-2200 mg/L (two original wells) to 811-6400 mg/L (collectively for the four wells).

As a result, these expanded “upgradient” concentrations are now much closer to the downgradient concentrations: for boron 2.7-7.9 mg/L and for TDS 2000-6200 mg/L. Thus, the inclusion of the two new upgradient wells makes it appear that the liner is not leaking.

It is my opinion that the ALD simply, and without justification, included the two new “upgradient” wells, contrary to its own groundwater monitoring certification, for the purpose of obfuscating the fact that the current liner is leaking and making it appear that it is not.

Finally, I also reviewed the most recent annual groundwater report for 2020, dated January 2021—i.e., created after the ALD submittal in November 2020—which notes that there are just two (and not four) upgradient wells for Upstream Raise 91, per the table below. Notably, in the most recent groundwater report, the new “upgradient” wells, MW-DP3 and MW-16-6, which the ALD relies upon, do not appear as upgradient wells at all.

Upstream Raise 91	Upgradient	MW-75	7/19/1989
		MW-91-2	11/6/2017
	Downgradient	MW-49	5/20/1988
		MW-51	5/20/1988
		MW-91-1	11/6/2017

This provides further support for the conclusion that the ALD included MW-DP3 and MW-16-6 as upgradient wells to make it appear that the current liner is not leaking, which would be the clear conclusion had these two wells not been improperly included as “upgradient” wells.

B. Liner Properties

Portions of Table 8[22] from the ALD shows various properties of geomembrane materials, including the current 40-mil HDPE (first row) and the typical 60-mil HDPE liner used as part of composite liners (red-boxed row). As reflected below, the 60-mil HDPE liner is more protective than the 40-mil HDPE liner, in almost every respect.

Table 8: Comparison of Geomembrane Material Properties

Material	Yield Strength	Yield Elongation	Break Strength	Break Elongation	Tear Resistance	Puncture Resistance
	ASTM D638	ASTM D638	ASTM D638	ASTM D638	ASTM D1004	FTMS 101C 2065
Upstream Raise 91 40-mil HDPE (average)	121 pounds per inch (actual)	18% (actual)	220 pounds per inch (actual)	818% (actual)	37 pounds (actual)	86 pounds (actual) (99 to 116 pounds [1])
Material	**ASTM D6693**	**ASTM D6693**	**ASTM D6693**	**ASTM D6693**	**ASTM D1004**	**ASTM D4833**
40-mil HDPE GRI GM13 (GSI 2019b)	84 pounds per inch (minimum)	12% (minimum)	152 pounds per inch (minimum)	700% (minimum)	28 pounds (minimum)	72 pounds (minimum)
60-mil HDPE (smooth) GRI GM13 (GSI 2019b)	126 pounds per inch (minimum)	12% (minimum)	228 pounds per inch (minimum)	700% (minimum)	42 pounds (minimum)	108 pounds (minimum)

Therefore, it is simply not correct to conclude that the current 40-mil HDPE liner (now almost 30 years old) has the same protective properties as a new 60-mil HDPE liner.

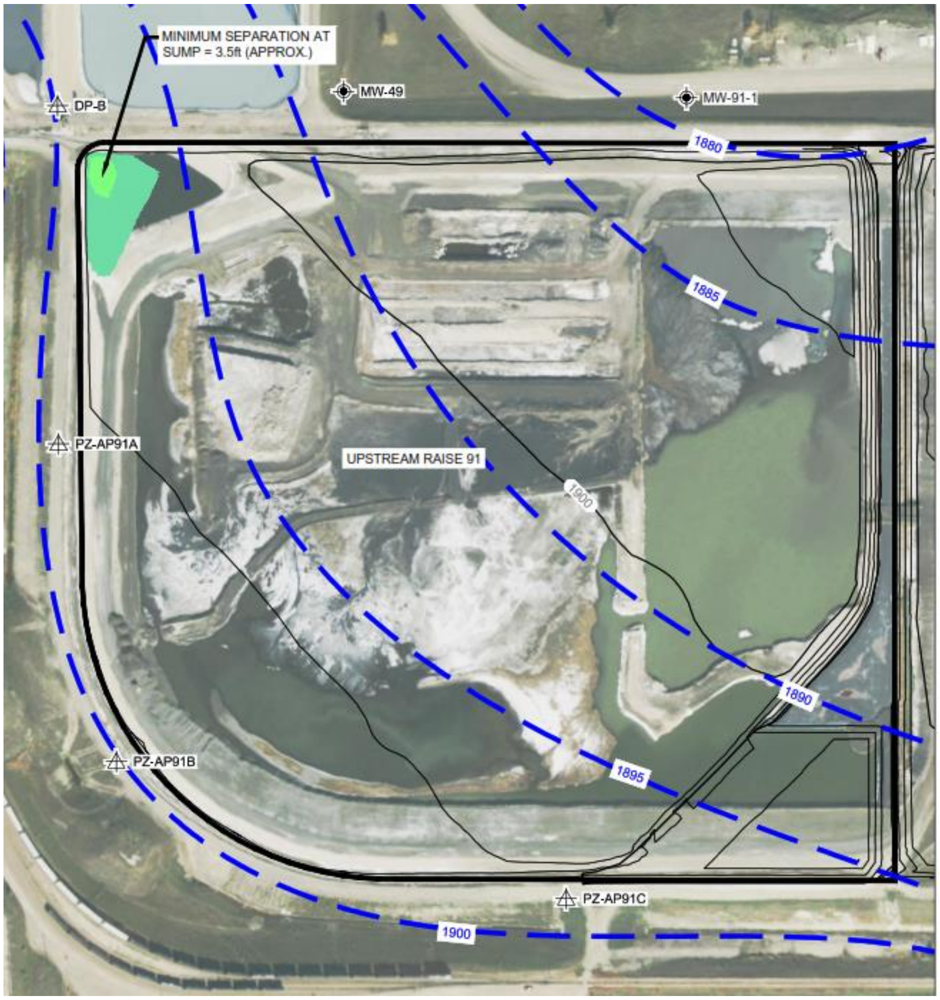
C. Distance to Groundwater

The ALD states, “[m]ost of the Upstream Raise 91 footprint has a separation between the bottom of the composite liner and groundwater greater than 5 feet. A small area in the northwest corner of the facility indicates a minimum separation of approximately 3.5 feet.”[23] Yet, the conclusion of the ALD glosses over this 3.5 foot separation and erroneously states that “the base of the liner system at Upstream Raise 91 is above the upper limits of the uppermost aquifer . . . .” This is

[22] ALD at 28.

[23] ALD, App’x A-2 (Location Restrictions Demonstration at p. 83 of pdf).

factually incorrect. The figure below[24] excerpted from the ALD shows in green shading the portion of Upstream Raise 91 where the groundwater separation is less than the required 5 feet.



It is clear that portions of Upstream Raise 91's non-compliant liner are less than 5 feet from groundwater, and therefore the CCR unit does not satisfy EPA's CCR Rule location restrictions under 40 C.F.R. § 257.60.

III. Conclusion

GRE's Alternative Liner Application for the Upstream Raise 91 CCR surface impoundment at Coal Creek Station is flawed, in numerous respects. First, instead of properly comparing downgradient pollutant concentrations against upgradient background wells, as required under the CCR Rule, the ALD compares *intra*-well monitoring concentrations to conclude that the current

[24] ALD, App'x A-2, Figure 3 (at p. 93 of pdf).

liner is adequate. As a non-binding alternative, GRE compares upgradient and downgradient well concentrations. Based on my evaluation of the upgradient/downgradient monitoring wells used in this analysis, I conclude that the current liner is likely leaking and therefore inadequate. Second, the current liner consisting of 40-mil HDPE and roughly 2 feet of compacted soil is not as protective of the required composite liner. Finally, a portion of the CCR unit has a bottom separation of less than 5 feet from underlying groundwater, and therefore does not meet the location restriction criteria for a CCR unit.