REPORT

Annual Groundwater Report - 2020

Great River Energy - Coal Creek Station

Submitted to:

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Executive Summary

This report presents the results from groundwater monitoring events that occurred at Great River Energy's Coal Creek Station (CCS) in 2020 to meet the requirements of the United States Environmental Protection Agency's Coal Combustion Residuals rule (40 Code of Federal Regulations 257.90 through 257.98). The facilities entered 2020 under a detection monitoring program and remain in a detection monitoring program at the conclusion of 2020. The following items of statistical significance were identified in 2020 for the comparative statistical analysis of the fourth quarter (Q4) 2019 and second quarter (Q2) 2020 detection monitoring events:

- Verified Statistically Significant Increases (SSIs):
  - MW-49 (downgradient, Upstream Raise 91), Chloride
    - Verified Q4 2019, ongoing in Q2 2020.
    - Successful alternative source demonstration completed May 13, 2020 (Appendix A); reconfirmation of validity of alternative source demonstration completed October 27, 2020 (Appendix B).
  - MW-16-6 (upgradient, Upstream Raise 92), Total Dissolved Solids
    - Verified Q4 2019, ongoing in Q2 2020.
    - As an upgradient location, the facility was determined not to be the source of the verified SSI based on a review of site observations and measured groundwater levels as well as the geographic location of the well. Per the Statistical Methods Certification (Golder 2019b), no alternative source demonstration has been conducted for MW-16-6 as an upgradient location.
  - MW-72 (upgradient, Southeast Section 16), Chloride
    - Verified Q4 2019, ongoing in Q2 2020.
    - As an upgradient location, the facility was determined not to be the source of the verified SSI based on a review of site observations and measured groundwater levels as well as the geographic location of the well. Per the Statistical Methods Certification (Golder 2019b), no alternative source demonstration has been conducted for MW-72 as an upgradient location.
  - MW-DP4 (downgradient, Drains Pond System), Fluoride
    - Verified Q2 2020.
    - Successful alternative source demonstration completed October 27, 2020 (Appendix B).
  - MW-10 (downgradient, Upstream Raise 92), Total Boron, Fluoride, Field pH
    - Verified Q2 2020.
    - Successful alternative source demonstration completed October 27, 2020 (Appendix B).
  - MW-16-1 (downgradient, Upstream Raise 92), Field pH
    - Verified Q2 2020.

  - Successful alternative source demonstration completed October 27, 2020 (Appendix B).

- Potential Exceedances and False-Positives:
  - The potential exceedance identified in Q2 2019 for chloride at MW-DP4 (downgradient, Drains Pond System) was found to be a false-positive through confirmatory re-sampling during the Q4 2019 sampling event.
  - The potential exceedances identified in Q2 2019 for chloride and sulfate at MW-16-1 (downgradient, Upstream Raise 92) were found to be false-positives through confirmatory re-sampling during the Q4 2019 sampling event.
  - The potential exceedance identified in Q2 2019 for chloride at MW-42 (upgradient, Southeast Section 16) was found to be a false-positive through confirmatory re-sampling during the Q4 2019 sampling event.
  - The potential exceedance identified in Q4 2019 for total boron at MW-51 (downgradient, Upstream Raise 91) was found to be a false-positive through confirmatory re-sampling during the Q2 2020 sampling event.
  - The potential exceedance identified in Q4 2019 for field-measured pH at MW-16-6 (upgradient, Upstream Raise 92) was found to be a false-positive through confirmatory re-sampling during the Q2 2020 sampling event.
  - The potential exceedance identified in Q4 2019 for total boron at MW-16-0 (downgradient, Upstream Raise 92) was found to be a false-positive through confirmatory re-sampling during the Q2 2020 sampling event.
  - The potential exceedance identified in Q4 2019 for fluoride at MW-16-1 (downgradient, Upstream Raise 92) was found to be a false-positive through confirmatory re-sampling during the Q2 2020 sampling event.
  - A potential exceedance was identified in Q2 2020 for field-measured pH at MW-DP4 (downgradient, Drains Pond System). Confirmatory re-sampling was conducted in Q4 2020, with associated statistical analysis to occur in the first quarter of 2021 (Q1 2021).
  - A potential exceedance was identified in Q2 2020 for sulfate at MW-10 (downgradient, Upstream Raise 92). Confirmatory re-sampling was conducted in Q4 2020, with associated statistical analysis to occur in Q1 2021.
  - A potential exceedance was identified in Q2 2020 for total boron at MW-16-1 (downgradient, Upstream Raise 91). Confirmatory re-sampling was conducted in Q4 2020, with associated statistical analysis to occur in Q2 2021.

Following successful alternative source demonstrations for the verified SSIs identified in Q4 2019 and Q2 2020, the Coal Creek Station facilities remained in detection monitoring for the Q4 2020 sampling event. Confirmatory re-sampling for the potential exceedances identified in Q2 2020 occurred during the Q4 2020 sampling event. Comparative statistical analysis for the Q4 2020 detection monitoring event will be completed within 90 days of data finalization, in Q1 2021. As described in the Coal Combustion Residuals Groundwater Monitoring System Certification, Revision 1 (Golder 2019a) and the Coal Combustion Residuals Groundwater Monitoring Statistical

Methods Certification, Revision 1 (Golder 2019b), the groundwater monitoring and analytical procedures meet the general requirements of the CCR rule, and modifications to the monitoring networks and sampling program are not recommended at this time.

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Golder Associates Inc. (Golder) has prepared this report for the 2020 groundwater sampling and comparative statistical analysis for Great River Energy's (GRE) Coal Creek Station (CCS) to meet the requirements of the Coal Combustion Residuals (CCR) rule's sections on groundwater monitoring and corrective action, 40 Code of Federal Regulations (CFR) Sections 257.90 through 257.98.

1.1 Purpose

The CCR rule established specific requirements for reporting of actions related to groundwater monitoring and corrective actions in 40 CFR 257.90 and as amended. In accordance with part (e) of 40 CFR 257.90, owners and operators of CCR units must prepare an annual groundwater monitoring and corrective action report.

1.2 Site Background

GRE's Coal Creek Station is a coal-fired electric generation facility located in McLean County, North Dakota, approximately 10 miles northwest of Washburn, North Dakota. CCRs are managed in composite-lined surface water impoundment cells and dry waste facilities regulated and permitted by the North Dakota Department of Environmental Quality (NDDEQ) in accordance with North Dakota Administrative Code Article 33-20, Solid Waste Management and Land Protection.

Coal Creek Station has four CCR facilities that are within the purview of the United States Environmental Protection Agency (USEPA) CCR rule:

- Drains Pond System CCR Surface Impoundment (Drains Pond System)
- Upstream Raise 91 CCR Surface Impoundment (Upstream Raise 91)
- Upstream Raise 92 CCR Surface Impoundment (Upstream Raise 92)
- Southeast Section 16 CCR Landfill (Southeast 16)

Each CCR facility is monitored by a separate monitoring network, in accordance with Revision 1 to the Coal Combustion Residuals Groundwater Monitoring System Certification (Golder 2019a). Locations of the facilities, groundwater monitoring network units, and groundwater monitoring wells are shown in Figure 1 and Figure 2.

2.0 GROUNDWATER MONITORING NETWORK PROGRAM STATUS

The CCR groundwater monitoring system at CCS consists of 23 monitoring locations (eight upgradient and fifteen downgradient wells). The monitoring locations are shown in Figure 1 and Figure 2 and listed in Table 1. Additional information on the groundwater monitoring system can be found in the Coal Combustion Residuals Groundwater Monitoring System Certification, Revision 1 (Golder 2019a). Each CCR facility is part of a monitoring network consisting of at least one upgradient and three downgradient monitoring wells.

- The Drains Pond System has two upgradient and four downgradient monitoring wells.
- Upstream Raise 91 has two upgradient and three downgradient monitoring wells.
- Upstream Raise 92 has two upgradient and three downgradient monitoring wells.
- Southeast 16 has two upgradient and five downgradient monitoring wells.

2.1 Completed Key Actions in 2020

The following key actions were completed in 2020:

- The 2019 annual CCR groundwater monitoring and corrective action report was completed and placed in the operating record and on the publicly accessible CCR website (Golder 2020).
- Prior to conducting the comparative statistical analysis for the Q4 2019 detection monitoring sampling event, the baseline period used to establish the statistical limits for eligible well-constituent pairs was reviewed for the potential to update the baseline period, following the steps defined in Revision 1 of the Coal Combustion Residuals Groundwater Monitoring Statistical Methods Certification (Golder 2019b) and in accordance with recommendations found within the USEPA's Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance (USEPA 2009). Further detail is presented in Section 3.3. Comparative statistical analysis conducted after the baseline update uses the statistical limits from the updated baseline periods.
- Three baseline samples were collected between January and March 2020 from well MW-DP2B, associated with the Drains Pond System, following well installation in November 2018. Six baseline samples were collected between June and December 2019. The December 2019 sampling analytical results had not been received at the time of reporting for the 2019 annual groundwater monitoring and corrective action report and are included within this report in Table 6 in addition to results collected throughout 2020.
- Detection monitoring samples were collected in April (Q2) and October (Q4) 2020 from the program wells and analyzed for the Appendix III constituent list associated with the CCR rule. Additionally, the Q2 2020 samples were analyzed for the Appendix IV constituent list associated with the CCR rule for ongoing collection of baseline data.
- Comparative statistical analysis was completed for the Q4 2019 and Q2 2020 detection monitoring samples, collected in October 2019 and April 2020, respectively, within 90 days of receipt of the final analytical results.
- A successful alternative source demonstration (ASD) was completed for the verified SSI for chloride identified for MW-49 following the Q4 2019 comparative statistical analysis. This ASD is included as Appendix A. Further information is included in Section 4.1.1.
- Successful ASDs were completed for the verified SSIs identified following the Q2 2020 comparative statistical analysis. These ASDs are included as Appendix B. Further information is included in Section 4.1.3.
- Between the Q2 and Q4 2020 sampling events, the MW-10 well casing was extended to allow for continued access to the well with increasing slope heights associated with site road and stormwater improvements.

2.2 Installation and Decommissioning of Wells

No wells were installed or decommissioned from the CCR monitoring well networks in 2020.

To allow for continued access with increasing slope heights, the well casing at MW-10 was extended between the Q2 and Q4 2020 sampling events. The slope heights have increased because of improvements to the site road and stormwater controls.

2.3 Problems and Resolutions

As in 2018 and 2019, no samples were able to be collected from MW-DP2 during 2020. Well MW-DP2 will continue to be monitored as part of the CCR monitoring program and samples will be collected when enough water is present within the well. Well MW-DP2B (installed November 2018) has been incorporated into the Drains Pond System monitoring program as an additional point of compliance to continue to adequately monitor the Drains Pond System.

During the Q2 2020 sampling event, chloride for several locations was initially reported as non-detects with dilutions, elevating the detection limits at the following wells: MW-51, MW-16-6, MW-10, MW-16-0, MW-42, MW-72, and MW-16-4. Re-analysis was requested on the undiluted samples, resulting in detected values reported out of hold-time. The results are marked with H qualifiers on the associated tables. No additional issues were noted related to the chemical analysis for the Q2 2020 monitoring event.

During the Q4 2020 sampling event, chloride for several locations was initially reported as non-detects with dilutions, elevating the detection limits at the following wells: MW-DP3 and MW-91-2. Re-analysis was requested on the undiluted samples, resulting in detected values reported out of hold-time. The results are marked with H qualifiers on the associated tables. No additional issues were noted related to the chemical analysis for the Q4 2020 monitoring event.

2.4 Key Activities for 2021

The following key activities are anticipated to be completed in 2021:

- The 2020 annual CCR groundwater monitoring and corrective action report will be completed and placed in the operating record and on the publicly accessible CCR website.
- Comparative statistics will be completed for the Q4 2020 detection monitoring samples within 90 days of receipt of the final analytical results.
- Detection monitoring sampling events will occur in Q2 and Q4 2021, and will consist of sampling, data review, and comparative statistics. Comparative statistics for both the Q2 2021 and Q4 2021 detection monitoring samples will be completed within 90 days of receipt of the final analytical results.

3.0 GROUNDWATER MONITORING ANALYTICAL PROGRAM STATUS

Analytical activities associated with the groundwater monitoring program are described below.

3.1 Collected Samples

For most wells, detection monitoring samples were collected by GRE staff in April (Q2) 2020 and October (Q4) 2020. Precise dates vary between locations and can be found in Table 2 through Table 24. Three baseline samples were collected for MW-DP2B between January 2020 and March 2020. Further, samples were collected and analyzed for the Appendix IV constituent list for additional baseline information in Q2 2020 for wells within the CCR rule well networks. Results for the various samples collected throughout 2020 are summarized in Table 2 through Table 24.

Samples were collected using low-flow methodology with dedicated bladder pumps installed at each monitoring well. The sampling procedures and analytical testing methods were conducted in accordance with USEPA accepted procedures.

3.1.1 Groundwater Elevation and Flow Rate

Depths to groundwater were measured in each well during each sampling event prior to purging. Groundwater elevations can be found in Table 2 through Table 24. Groundwater elevations and interpolated groundwater contours from the Q2 2020 detection monitoring event are shown in Figure 1. Groundwater elevations and interpolated groundwater contours from the Q4 2020 detection monitoring event are shown in Figure 2. Based on both the Q2 (April) 2020 and Q4 (October) 2020 groundwater elevations and contours, the shallow groundwater at the CCR facilities generally follows surface topography, flowing to the east and north. The dates for groundwater information shown in the figures generally display site seasonal variability in groundwater levels between the spring/summer and fall/winter.

The groundwater flow rate across each facility was estimated with the equation $V_s = k \times i / n_e$, where:

- V_s is the groundwater flow rate, in feet per day (ft/day)
- k is the hydraulic conductivity in ft/day, estimated from slug testing results from system wells
- i is the hydraulic gradient in feet per feet (ft/ft), calculated based on groundwater elevations for each monitoring event
- n_e is the effective porosity, a unitless parameter, which is estimated to be 0.3 for unfractured glacial till, reflective of site soils (Ohio EPA 2006)

The range of groundwater flow rates calculated for each unit during the Q2 2020 and Q4 2020 detection monitoring sampling events are shown below. Groundwater flow rates are presented based on a range of measured hydraulic conductivity values for each unit, also shown below.

- Drains Pond System (range of k values: 0.35 ft/day to 21.60 ft/day)
  - Q2 2020: 0.03 – 1.80 ft/day
  - Q4 2020: 0.03 – 1.82 ft/day
- Upstream Raise 91 (range of k values: 0.35 ft/day to 12.96 ft/day)
  - Q2 2020: 0.01 – 0.43 ft/day
  - Q4 2020: 0.01 – 0.44 ft/day
- Upstream Raise 92 (range of k values: 0.35 ft/day to 12.96 ft/day)
  - Q2 2020: 0.01 – 0.52 ft/day
  - Q4 2020: 0.01 – 0.53 ft/day
- Southeast 16 (range of k values: 1.51 ft/day to 2.59 ft/day)
  - Q2 2020: 0.01 – 0.01 ft/day
  - Q4 2020: 0.01 - 0.02 ft/day

3.2 Monitoring Data (Analytical Results)

Analytical results for samples collected in 2020 for monitoring wells within the networks are shown in Table 2 through Table 24.

3.3 Statistical Baseline Update

Prior to comparative statistical analysis for the Q4 2019 detection monitoring event, the baseline (or background) period for each well-constituent pair within the program was reviewed following the methodology outlined in the Groundwater Monitoring Statistical Methods Certification (Golder 2019b). Baseline periods for most program wells were previously established prior to conducting comparative statistical analysis for the first detection monitoring sampling event conducted in October 2017. The USEPA recommends reviewing the baseline period for the potential to update the baseline every two to three years when using intra-well analysis and sampling on a semi-annual basis, or every four to eight collected comparative samples (USEPA 2009). For most wells within the program, results from four samples collected between October 2017 and June 2019 were reviewed for the potential to update the statistical baseline periods.

Additionally, baseline was established for well MW-DP2B in March 2020 following collection of the minimum number of samples recommended by the Unified Guidance (eight samples), allowing comparative statistical analysis to be conducted beginning with the Q2 2020 sample.

A full description of the steps taken for the statistical baseline update can be found in the Groundwater Monitoring Statistical Methods Certification (Golder 2019b), available on GRE’s publicly accessible CCR website. The current baseline update, as well as any future baseline update, included a review of any revisions to federal and state regulations and USEPA statistical guidance documents that may have been promulgated since the initial baseline was established or the previous baseline statistical update was conducted. The baseline period for a specific well-constituent pair was not reviewed for the potential to be updated if either a potential exceedance where confirmatory sampling had not yet occurred, or a verified statistically significant increase (SSI) was identified for that well-constituent pair and a successful ASD had not yet been completed. Compliance results that were previously determined to be false-positives during comparative statistical analysis were reviewed for potential inclusion in the updated baseline. If a successful ASD had been conducted for a verified SSI that determined that the SSI was not related to a release from the facility in question, the recent compliance data were reviewed for potential inclusion in a baseline update.

3.3.1 Results of the Baseline Update

Either a parametric or non-parametric method was used to generate the updated baseline statistical limit for each well-constituent pair. The statistical method varied between constituents and was selected based on the percentage of non-detect values in the proposed baseline period and the baseline data distribution for each constituent at each well, in accordance with the Unified Guidance (USEPA 2009).

The baseline periods for most well-constituent pairs were able to be updated through incorporation of data following the end of the previously established baseline periods for the CCR detection monitoring program. Inclusion of available data does not preclude removal of outliers as appropriate per the Groundwater Monitoring Statistical Methods Certification (Golder 2019b). Updated statistical limits resulting from the baseline update are shown in Tables 25 through 47. If a dataset was found to have statistical seasonality, the dataset was deseasonalized for updating the statistical limit.

3.3.2 Baseline Periods Not Updated

Certain well-constituent pairs were unable to be updated during the current baseline statistical update. Those well-constituent pairs fall under the following categories:

- Too few comparative samples collected since establishment of the original baseline

- Potential exceedances identified in Q2 2019 where confirmatory re-sampling was scheduled for Q4 2019
- Wilcoxon Rank-Sum test results where statistical significance was identified between the baseline and prospective new data
- Identification of statistically significant trends in the proposed baseline periods

3.4 Comparative Statistical Analysis

The comparative statistical analysis for the Q4 2019 and Q2 2020 detection monitoring events is summarized below, with the results presented in Table 25 through Table 47. Comparative statistical analysis for the Q4 2020 detection monitoring event will occur within 90 days of data review following receipt of the analytical data. Based on the timing of receipt of the analytical results for the Q4 2020 detection monitoring sample, comparative statistical analysis for the Q4 2020 event will be completed during first quarter (Q1) 2021. A full description of the steps taken for comparative statistical analyses can be found in the Coal Combustion Residuals Groundwater Statistical Method Certification, Revision 1, Great River Energy – Coal Creek Station (Golder 2019b), available on GRE's publicly accessible CCR website.

Comparative statistical analysis is conducted following each detection monitoring event, consisting of the Appendix III parameters (USEPA 2015). For both Shewhart-CUSUM limits and non-parametric prediction limits NPPL, the comparative statistical analysis consists of a comparison of detection monitoring results collected during the period of interest (the compliance period) to the statistical limit calculated from the baseline period. For constituent-well pairs with increasing trends identified during the baseline period, an alternative trend test, as described by the Electric Power Research Institute (EPRI 2015), has been used to determine statistical significance. For constituent-well pairs with decreasing trends identified during the baseline period, a Sen's Slope trend test was used to assess the results. A detailed discussion of the methodology used for comparative statistical analysis is discussed in the Coal Combustion Residuals Groundwater Monitoring Statistical Methods Certification, Revision 1 (Golder 2019b).

3.4.1 Definitions

The following definitions will be used in discussion of the comparative statistical analysis:

- <u>Elevated CUSUM</u> – an elevated CUSUM occurs when the CUSUM is greater than the Shewhart-CUSUM limit established by the baseline statistical analysis, but the analytical result does not exceed the Shewhart-CUSUM limit. An elevated CUSUM is an indication that concentrations are gradually increasing and that analytical results may exceed the Shewhart-CUSUM limit in the future. For elevated CUSUMs in the case of two-tailed analysis (field-measured pH), the CUSUM value may also be below the lower Shewhart-CUSUM limit established by the baseline statistical analysis.
- <u>Potential Exceedance</u> – is defined as an initial elevated CUSUM or an initial analytical result that exceeds the Shewhart-CUSUM limit or non-parametric statistical limit established by the baseline statistical analysis. Confirmatory resampling will determine if the potential exceedance is a false-positive or a verified statistically significant increase (SSI). Non-detect results that exceed either the Shewhart-CUSUM limit or the non-parametric statistical limit are not considered potential exceedances.
- <u>False-positive</u> – is defined as an analytical result that exceeds the statistical limit that can clearly be attributed to laboratory error, changes in analytical precision, or is invalidated through confirmatory re-sampling. False-positives are not used in calculation of any subsequent CUSUMs.

- Confirmatory re-sampling – is designated as the next scheduled sampling event.
- Verified SSI – is interpreted as two consecutive exceedances (the original sample and the confirmatory re-sample for analytical results, or two consecutive elevated CUSUMs) for the same constituent at the same well.

3.4.2 Potential Exceedances

The following potential exceedances were identified during the comparative statistical analysis for the Q4 2019 detection monitoring event:

- MW-DP4 (downgradient, Drains Pond System) – Fluoride
- MW-51 (downgradient, Upstream Raise 91) – Total Boron
- MW-16-6 (upgradient, Upstream Raise 92) – Field pH
- MW-10 (downgradient, Upstream Raise 92) – Total Boron
- MW-10 (downgradient, Upstream Raise 92) – Fluoride
- MW-10 (downgradient, Upstream Raise 92) – Field pH
- MW-16-0 (downgradient, Upstream Raise 92) – Total Boron
- MW-16-1 (downgradient, Upstream Raise 92) – Fluoride
- MW-16-1 (downgradient, Upstream Raise 92) – Field pH

Confirmatory re-sampling for these constituent-well pairs occurred during the Q2 2020 detection monitoring sampling event, with results discussed in the following sections.

The following potential exceedances were identified during comparative statistical analysis for the Q2 2020 detection monitoring event:

- MW-DP4 (downgradient, Drains Pond System) – Field pH Elevated CUSUM
- MW-10 (downgradient, Upstream Raise 92) – Sulfate
- MW-16-1 (downgradient, Upstream Raise 92) – Total Boron

Confirmatory re-sampling for these constituent-well pairs occurred during the Q4 2020 detection monitoring event. Comparative statistics of the Q4 2020 detection monitoring event will be completed within 90 days of data review for the final analytical results, in Q1 2021.

3.4.3 False-Positives

Following confirmatory re-sampling in Q4 2019, the following false-positives were identified for the Q2 2019 detection monitoring event:

- MW-DP4 (downgradient, Drains Pond System) – Chloride
- MW-16-1 (downgradient, Upstream Raise 92) – Chloride
- MW-16-1 (downgradient, Upstream Raise 92) – Sulfate

- MW-42 (upgradient, Southeast Section 16) - Chloride

Following confirmatory re-sampling in Q2 2020, the following false-positives were identified for the Q4 2019 detection monitoring event:

- MW-51 (downgradient, Upstream Raise 91) – Total Boron
- MW-16-6 (upgradient, Upstream Raise 92) – Field pH
- MW-16-0 (downgradient, Upstream Raise 92) – Total Boron
- MW-16-1 (downgradient, Upstream Raise 92) – Fluoride

3.4.4 Verified SSIs

The following verified SSIs were confirmed during the Q4 2019 detection monitoring event:

- MW-49 (downgradient, Upstream Raise 91), Chloride
- MW-16-6 (upgradient, Upstream Raise 92), Total Dissolved Solids
- MW-72 (upgradient, Southeast Section 16), Chloride

Associated steps following identification of the verified SSIs are described in Section 4.1.1.

The following verified SSIs were confirmed during the Q2 2020 detection monitoring event:

- MW-DP4 (downgradient, Drains Pond System) – Fluoride
- MW-49 (downgradient, Upstream Raise 91) – Chloride (previously verified in Q4 2019, with an alternative source demonstration completed)
- MW-16-6 (upgradient, Upstream Raise 92) – Total Dissolved Solids (previously verified in Q4 2019)
- MW-10 (downgradient, Upstream Raise 92) – Total Boron
- MW-10 (downgradient, Upstream Raise 92) – Fluoride
- MW-10 (downgradient, Upstream Raise 92) – Field pH
- MW-16-1 (downgradient, Upstream Raise 92) – Field pH
- MW-72 (upgradient, Southeast Section 16) – Chloride (previously verified in Q4 2019)

Associated steps following identification of the SSIs are described in Section 4.1.1.

3.4.5 Trending Data

During establishment and updating of statistical baseline periods, a few wells at the site were found to have trending data, preventing establishment of a statistical limit using data solely from the baseline sampling period. A description of the methods used for determining statistical significance at these wells follows.

Increasing Trends:

- MW-DP2 (downgradient, Drains Pond System), Total Dissolved Solids: As noted in Section 2.3, MW-DP2 had insufficient volume to sample during the Q4 2019 and Q2 2020 detection monitoring sampling events.

Following collection of further data, the total dissolved solids data will be reassessed to determine if a baseline period can be established based on non-trending data.

Decreasing Trends:

- MW-DP2 (downgradient, Drains Pond System), Fluoride: As noted in Section 2.3, MW-DP2 had insufficient volume to sample during the Q4 2019 and Q2 2020 detection monitoring sampling events. Following collection of further data, the fluoride data will be reassessed to determine if a baseline period can be established based on non-trending data.
- MW-DP2B (downgradient, Drains Pond System), Chloride: A statistically significant decreasing trend was identified through the samples used for establishing the initial baseline period for MW-DP2B. With inclusion of the Q2 2020 detection monitoring sample, the data set continues to show a statistically significant decreasing trend at the target confidence level of 99 percent. Following collection of further data, the chloride data for MW-DP2B will be reassessed to determine if a baseline period can be established based on non-trending data.
- MW-91-2 (upgradient, Upstream Raise 91), Calcium: With inclusion of the Q4 2019 result and the Q2 2020 result, the complete data set for calcium at MW-91-2 continues to have a statistically significant downward trend, based on Sen’s Slope analysis following each event. Following collection of further data, the calcium data for MW-91-2 will be reassessed to determine if a baseline period can be established based on non-trending data.

4.0 PROGRAM TRANSITIONS

Beginning in Q4 2017, the groundwater monitoring programs at CCS transitioned from the baseline period to detection monitoring for the majority of program wells. During the baseline period, at least eight independent samples from the wells within the program were collected and analyzed for the constituents listed in Appendix III and Appendix IV of the rule prior to October 17, 2017, as specified in 40 CFR 257.94(b). The first detection monitoring samples were collected in Q4 2017.

4.1 Detection Monitoring

The site is currently in detection monitoring. Samples for the detection monitoring program are collected on a semi-annual basis, beginning with the samples collected in Q4 2017. GRE plans to collect semi-annual samples for the detection monitoring program in Q2 and Q4 of 2020.

40 CFR 257.94(e) states the conditions under which a CCR unit must transition to assessment monitoring or complete an alternative source demonstration (ASD): “If the owner or operator of the CCR unit determines, pursuant to § 257.93(h) that there is a statistically significant increase over background levels for one or more of the constituents listed in Appendix III to this part at any monitoring well at the waste boundary specified under § 257.91(a)(2), the owner or operator must: (1) Except as provided for in paragraph (e)(2) of this section, within 90 days of detecting a statistically significant increase over background levels for any constituent, establish an assessment monitoring program meeting the requirements of § 257.95. (2) The owner or operator may demonstrate that a source other than the CCR unit caused the statistically significant levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.”

4.1.1 Alternative Source Demonstration – Q4 2019

GRE pursued an ASD after identifying the verified SSI for chloride at MW-49 during the Q4 2019 detection monitoring event. A successful ASD was completed within 90 days of identification of the verified SSI for chloride at MW-49 in Q4 2019 and is included as Appendix A. As a result of the successful ASD, GRE remained in detection monitoring for the Q2 2020 sampling event.

4.1.2 Upgradient Verified SSIs – Q4 2019 and Q2 2020

Per the Groundwater Monitoring Statistical Methods Certification (Golder 2019b), an ASD will only be completed for verified SSIs identified in downgradient wells. ASDs were not completed for the verified SSIs identified during Q4 2019 and Q2 2020 for upgradient wells MW-16-6 (Upstream Raise 92, total dissolved solids) and MW-72 (Southeast Section 16, chloride), as the facility was determined to not be the cause of the verified SSIs, based on groundwater flow and direction.

4.1.3 Alternative Source Demonstration – Q2 2020

GRE pursued ASDs after identifying the verified SSIs for chloride at MW-49, fluoride at MW-DP4, boron, fluoride, and field pH at MW-10, and field pH at MW-16-1 during the Q2 2020 detection monitoring event. Successful ASDs were completed within 90 days of identification of the verified SSIs from the Q2 2020 detection monitoring event, and are included as Appendix B. As a result of the successful ASD outcomes, GRE remains in detection monitoring for the Q4 2020 sampling event.

4.2 Assessment Monitoring

With the completion of the successful ASDs, the results of the comparative statistical analysis through Q2 2020 at Coal Creek Station do not trigger the need to implement assessment monitoring as described in 40 CFR 257.95.

4.3 Corrective Measures and Assessment

Results to date from the CCR groundwater monitoring program at Coal Creek Station do not trigger the need to assess or implement corrective measures. Since the CCR groundwater monitoring program does not require corrective measures, an assessment of corrective measures, as described in 40 CFR 257.96, has not been initiated and no actions are required.

5.0 CLOSING

This report presents the analytical results from the Q2 2020 and Q4 2020 detection monitoring events of the CCR groundwater monitoring program at Coal Creek Station. Comparative statistics for the Q4 2019 and Q2 2020 detection monitoring events are also included, as well as a review of the baseline statistical update. Comparative statistics for the Q4 2020 detection monitoring event conducted in October 2020 will occur within 90 days of finalizing data review (during Q1 2021). The groundwater monitoring and analytical procedures implemented meet the requirements of the CCR rule and are consistent with the approach described in Revision 1 to the Groundwater Monitoring System Certification (Golder 2019a) and Revision 1 to the Groundwater Monitoring Statistical Methods Certification (Golder 2019b). Comparative statistics and the ASDs presented within this report support remaining in detection monitoring, and do not trigger assessment monitoring nor an assessment of corrective measures.

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ELH/TJS/mp/mb/rm

https://golderassociates.sharepoint.com/sites/120551/project files/6 deliverables/19136224c/reports/12-r-gre_ccs_ccr_2020/12-r-1/19136224c-12-r-1-gre_ccs_2020_22feb21.docx

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Tables

Table 1: Monitoring Network Well Summary

Facility	Location	Well ID	Date Constructed	TOC Elevation (ft AMSL)	Ground Surface Elevation (ft AMSL)	Completion Depth (ft)	Drilled Depth (ft)	Screen Interval (ft bgs)	Top of Screen Elevation (ft AMSL)	Bottom of Screen Elevation (ft AMSL)	Sand Pack Interval (ft bgs)	Geologic Unit(s) Completed In
Drains Pond System	Upgradient	MW-DP3	4/3/2015	1,932.7	1,929.6	19.0	21.0	9.0-19.0	1,920.6	1,910.6	6.0-19.0	fill, coal, clay
		MW-DP5 [1]	11/18/2015	1,939.2	1,935.0	--	--	18.0-43.0	1,919.0	1,892.0	16.0-43.0	sandy lean clay, clayey sand
	Downgradient	MW-DP1 [2]	6/10/2014	1,913.6	1,911.1	45.0	46.0	25.0-45.0	1,886.1	1,866.1	21.0-45.0	silt with sand, silty sand
		MW-DP2	4/3/2015	1,898.1	1,894.9	17.0	18.0	7.0-17.0	1,887.9	1,877.9	5.0-17.0	sandy lean clay, clay sand
		MW-DP2B [3]	11/20/2018	1,898.6	1,895.6			12.0-22.0	1,883.6	1,873.6	10.0-22.0	sandy lean clay, sand with silt/gravel, silty sand
		MW-DP4	4/3/2015	1,917.4	1,914.2	29.0	31.0	19.0-29.0	1,895.2	1,885.2	17.0-29.0	sandy clay, sand with silt/gravel, clay, clayey sand
Upstream Raise 91	Upgradient	MW-75	7/19/1989	1,941.4	1,938.9	40.0	40.5	30.0-40.0	1,908.9	1,898.9	27.7-40	clayey silt, silty sand
		MW-91-2	11/6/2017	1,938.5	1,938.7	31.0	31.0	21.0-31.0	1,917.7	1,907.7	19.0-31.0	fat clay, coal
	Downgradient	MW-49	5/20/1988	1,905.9	1,903.6	19.9	25.0	9.85-19.85	1,893.8	1,883.8	4.85-19.85	sandy gravelly clay, sandy silt, shale (rock)
		MW-51	5/20/1988	1,896.9	1,895.5	18.8	20.0	8.8-18.8	1,886.7	1,876.7	3.8-18.8	sand with silt and gravel
		MW-91-1	11/6/2017	1,905.1	1,902.0	26.0	26.0	16.0-26.0	1,886.0	1,876.0	14.0-26.0	sand with silt and gravel, fat clay
Upstream Raise 92	Upgradient	MW-16-6	7/14/2015	1,917.2	1,913.9	13.0	16.0	4.0-14.0	1,909.9	1,899.9	3.0-14.0	sandy lean clay, coal, lean clay
		MW-16-7	7/14/2015	1,889.1	1,886.6	32.0	33.0	22.0-32.0	1,864.6	1,854.6	20.0-32.0	fat clay, clayey sand, sandy clay
	Downgradient	MW-10 [4]	11/2/1979	1,910.6	1,907.6	38.0	42.0	28-38	1,877.2	1,867.2	26-38	sand
		MW-16-0	12/8/2017	1,883.4	1,880.4	9.5	9.5	4.5-9.5	1,875.9	1,870.9	2.5-9.5	lean clay with sand
		MW-16-1	10/31/2007	1,879.5	1,876.1	11.5	16.0	6.5-11.5	1,869.6	1,864.6	4.5-11.5	silty sand
Southeast Section 16 Facility	Upgradient	MW-42	5/28/1986	1,881.6	1,878.8	14.4	21.5	9.4-14.4	1,869.4	1,864.4	9-14.4	silty sand, lean clay
		MW-72	7/18/1989	1,884.6	1,882.4	23.0	24.0	7.5-17.5	1,874.9	1,864.9	6.5-23.0	silty clay, silty sand
	Downgradient	MW-15	11/7/1979	1,877.3	1,874.3	20.0	38.0	10-20	1,864.3	1,854.3	9-20	sand, clay till
		MW-16-2	10/31/2007	1,880.6	1,877.8	12.0	16.0	7-12	1,870.8	1,865.8	5-12	sandy lean clay
		MW-16-3	10/31/2007	1,878.5	1,875.6	12.0	16.0	7-12	1,868.6	1,863.6	5-12	sandy lean clay
		MW-16-4	10/31/2007	1,877.5	1,874.6	17.0	16.0	7-17	1,867.6	1,857.6	5-17	sandy lean clay
		MW-16-5	10/31/2007	1,880.2	1,877.1	11.5	16.0	6.5-11.5	1,870.6	1,865.6	4.5-11.5	sand with silt and gravel

Notes:
TOC: top of casing
ft AMSL: feet above mean sea level
ft bgs: feet below ground surface
1. For MW-DP5, the ground surface elevation is taken from the original borehole log, but is inconsistent with the available survey for the top of casing.
2. For MW-DP1 only the top of casing elevation was provided. The PVC riser is assumed to be 2.5 ft above ground surface.
3. For MW-DP2B only the top of casing elevation was provided. The PVC riser is assumed to be 3.0 ft above ground surface.
4. The casing for MW-10 was extended in 2020. Only the updated top of casing elevation was provided. The PVC riser is assumed to be 3.0 ft above ground surface.
Well construction measurements are from the original borehole log, well data sheet, or well construction form.
For some wells, elevations have been updated with more recent survey information than the original driller's logs.

Table 2: Sample Results Summary Table - MW-DP3

		MW-DP3		
		Additional Baseline Data	Detection Monitoring	
	Units	7-Apr-20	7-Apr-20	19-Oct-20
Water Elevation	ft AMSL	1921.3	1921.3	1920.7
Appendix III Parameters				
Boron	mg/L	---	0.64	0.64
Calcium	mg/L	---	240	230
Chloride	mg/L	---	13	9.9 H
Fluoride	mg/L	---	0.11	< 0.10 U
pH, Field	s.u.	---	6.33	6.31
Sulfate	mg/L	---	1200	1100
Total Dissolved Solids	mg/L	---	2400	2300
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U ^	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.062 ^	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U ^	---	---
Cobalt	mg/L	0.0028	---	---
Fluoride	mg/L	0.11	---	---
Lead	mg/L	0.0012	---	---
Lithium	mg/L	0.16	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	< 0.0020 U	---	---
Radium 226	pCi/L	0.600 ± 0.203	---	---
Radium 228	pCi/L	0.609 ± 0.373	---	---
Radium 226 and 228 combined	pCi/L	1.21 ± 0.425	---	---
Selenium	mg/L	< 0.0050 U	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 3: Sample Results Summary Table - MW-DP5

		MW-DP5		
		Additional Baseline Data	Detection Monitoring	
	Units	7-Apr-20	7-Apr-20	19-Oct-20
Water Elevation	ft AMSL	1915.1	1915.1	1914.0
Appendix III Parameters				
Boron	mg/L	---	0.10	0.11
Calcium	mg/L	---	290	320
Chloride	mg/L	---	66	62
Fluoride	mg/L	---	0.20	0.20
pH, Field	s.u.	---	7.16	7.14
Sulfate	mg/L	---	3300	3100
Total Dissolved Solids	mg/L	---	5500	5500
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U ^	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.030	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	0.0046	---	---
Cobalt	mg/L	0.0022	---	---
Fluoride	mg/L	0.20	---	---
Lead	mg/L	0.0017	---	---
Lithium	mg/L	0.45	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	0.0022	---	---
Radium 226	pCi/L	0.526 ± 0.246	---	---
Radium 228	pCi/L	0.578 U ± 0.504	---	---
Radium 226 and 228 combined	pCi/L	1.10 ± 0.561	---	---
Selenium	mg/L	0.26	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
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Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 4: Sample Results Summary Table - MW-DP1

		MW-DP1		
		Additional Baseline Data	Detection Monitoring	
	Units	7-Apr-20	7-Apr-20	20-Oct-20
Water Elevation	ft AMSL	1883.8	1883.8	1882.6
Appendix III Parameters				
Boron	mg/L	---	0.69	0.77
Calcium	mg/L	---	55	53
Chloride	mg/L	---	< 3.0 U	< 3.0 U
Fluoride	mg/L	---	0.26	0.25
pH, Field	s.u.	---	7.39	7.40
Sulfate	mg/L	---	500	450
Total Dissolved Solids	mg/L	---	1300	1400
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U ^	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.03	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	0.002	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	0.26	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.13	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	< 0.0020 U	---	---
Radium 226	pCi/L	0.303 ± 0.157	---	---
Radium 228	pCi/L	0.499 U ± 0.344	---	---
Radium 226 and 228 combined	pCi/L	0.802 ± 0.378	---	---
Selenium	mg/L	< 0.0050 U	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 5: Sample Results Summary Table - MW-DP2

		MW-DP2 Detection Monitoring	
	Units	**7-Apr-20**	**20-Oct-20**
Water Elevation	ft AMSL	***	***
Appendix III Parameters			
Boron	mg/L	---	---
Calcium	mg/L	---	---
Chloride	mg/L	---	---
Fluoride	mg/L	---	---
pH, Field	s.u.	---	---
Sulfate	mg/L	---	---
Total Dissolved Solids	mg/L	---	---
Appendix IV Parameters			
Antimony	mg/L	---	---
Arsenic	mg/L	---	---
Barium	mg/L	---	---
Beryllium	mg/L	---	---
Cadmium	mg/L	---	---
Chromium	mg/L	---	---
Cobalt	mg/L	---	---
Fluoride	mg/L	---	---
Lead	mg/L	---	---
Lithium	mg/L	---	---
Mercury	mg/L	---	---
Molybdenum	mg/L	---	---
Radium 226	pCi/L	---	---
Radium 228	pCi/L	---	---
Radium 226 and 228 combined	pCi/L	---	---
Selenium	mg/L	---	---
Thallium	mg/L	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Notes:
*** - Samples have not been collected at MW-DP2 since 2017 because the well has been dry.

Table 6: Sample Results Summary Table - MW-DP2B

		MW-DP2B						
		Baseline Period				Additional Baseline Data	Detection Monitoring	
	Units	**18-Dec-19**	**23-Jan-20**	**20-Feb-20**	**23-Mar-20**	**7-Apr-20**	**7-Apr-20**	**20-Oct-20**
Water Elevation	ft AMSL	1880.6	1880.5	1880.5	1880.7	1880.8	1880.8	1879.3
Appendix III Parameters								
Boron	mg/L	2.4	2.4 F1	2.6 F1	2.8	---	2.2	2.8
Calcium	mg/L	260	250	250	280	---	240	250
Chloride	mg/L	64	62	60	49	---	62	60
Fluoride	mg/L	0.99	0.82	0.81	0.81	---	0.79	0.84
pH, Field	s.u.	6.83	6.90	6.96	6.95	---	6.90	6.97
Sulfate	mg/L	2000	1900	1900	1700	---	2000	1800
Total Dissolved Solids	mg/L	3600	3700	3700	3600	---	3700	4000
Appendix IV Parameters								
Antimony	mg/L	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U ^	---	---
Arsenic	mg/L	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	---	---
Barium	mg/L	0.05	0.045	0.049	0.035	0.032	---	---
Beryllium	mg/L	< 0.0010 U	< 0.0010 U	< 0.0010 U^	< 0.0010 U	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	---	---
Chromium	mg/L	0.0028	0.0022	0.0029	< 0.0020 U	< 0.0020 U	---	---
Cobalt	mg/L	0.0049	0.0044	0.0048	0.0041	0.0037	---	---
Fluoride	mg/L	0.99	0.82	0.81	0.81	0.79	---	---
Lead	mg/L	0.0014	0.001	0.0015	< 0.0010 U	< 0.0010 U	---	---
Lithium	mg/L	0.26	0.26	0.26	0.3	0.25	---	---
Mercury	mg/L	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	< 0.0002 U	---	---
Molybdenum	mg/L	0.0095	0.0024	0.0027	0.0024	0.0034	---	---
Radium 226	pCi/L	0.218 ± 0.116	0.183 U ± 0.157	0.172 U ± 0.159	0.225 U ± 0.229	0.122 ± 0.0768	---	---
Radium 228	pCi/L	0.0965 U ± 0.275	1.04 ± 0.579	0.229 U ± 0.305	0.495 ± 0.306	-0.120 U ± 0.188	---	---
Radium 226 and 228 combined	pCi/L	0.315 U ± 0.298	1.23 ± 0.600	0.401 U ± 0.344	0.721 ± 0.382	0.00153 U ± 0.203	---	---
Selenium	mg/L	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	< 0.0050 U	---	---
Thallium	mg/L	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.
At the time of reporting for the 2019 annual report, analytical results for the December 2019 sample had not been received.

Table 7: Sample Results Summary Table - MW-DP4

		MW-DP4		
		Additional Baseline Data	**Detection Monitoring**	
	Units	**7-Apr-20**	**7-Apr-20**	**20-Oct-20**
Water Elevation	ft AMSL		1897.3	1894.0
Appendix III Parameters				
Boron	mg/L	---	0.48	0.56
Calcium	mg/L	---	170	260
Chloride	mg/L	---	32	80
Fluoride	mg/L	---	0.28	0.16
pH, Field	s.u.	---	7.24	7.13
Sulfate	mg/L	---	2400	2500
Total Dissolved Solids	mg/L	---	4000	4800
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U ^	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.034	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	0.0024	---	---
Cobalt	mg/L	0.001	---	---
Fluoride	mg/L	0.28	---	---
Lead	mg/L	0.0016	---	---
Lithium	mg/L	0.29	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	0.0028	---	---
Radium 226	pCi/L	0.172 ± 0.123	---	---
Radium 228	pCi/L	-0.112 U ± 0.223	---	---
Radium 226 and 228 combined	pCi/L	0.0605 U ± 0.255	---	---
Selenium	mg/L	0.15	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
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Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 8: Sample Results Summary Table - MW-91-2

		MW-91-2		
		Additional Baseline Data	Detection Monitoring	
	Units	7-Apr-20	7-Apr-20	20-Oct-20
Water Elevation	ft AMSL	1922.2	1922.2	1921.5
Appendix III Parameters				
Boron	mg/L	---	0.24	0.37
Calcium	mg/L	---	160	230
Chloride	mg/L	---	11	9.6 H
Fluoride	mg/L	---	0.11	< 0.10 U
pH, Field	s.u.	---	6.52	6.21
Sulfate	mg/L	---	510	760
Total Dissolved Solids	mg/L	---	1100	1500
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U ^	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.16	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	0.11	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.035	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	0.0043	---	---
Radium 226	pCi/L	0.398 ± 0.192	---	---
Radium 228	pCi/L	-0.134 U ± 0.341	---	---
Radium 226 and 228 combined	pCi/L	0.264 U ± 0.391	---	---
Selenium	mg/L	< 0.0050 U	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 9: Sample Results Summary Table - MW-75

		MW-75		
		Additional Baseline Data	Detection Monitoring	
	Units	7-Apr-20	7-Apr-20	20-Oct-20
Water Elevation	ft AMSL	1915.2	1915.2	1914.5
Appendix III Parameters				
Boron	mg/L	---	0.2	0.22
Calcium	mg/L	---	4.7	5.1
Chloride	mg/L	---	< 3.0 U	< 3.0 U
Fluoride	mg/L	---	0.45	0.46
pH, Field	s.u.	---	8.11	8.27
Sulfate	mg/L	---	73	72
Total Dissolved Solids	mg/L	---	860	870
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U ^	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.036	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	0.45	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.077	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	< 0.002 U	---	---
Radium 226	pCi/L	0.119 U ± 0.0958	---	---
Radium 228	pCi/L	0.145 U ± 0.246	---	---
Radium 226 and 228 combined	pCi/L	0.264 U ± 0.264	---	---
Selenium	mg/L	< 0.0050 U	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 10: Sample Results Summary Table - MW-49

		MW-49		
		Additional Baseline Data	Detection Monitoring	
	Units	8-Apr-20	8-Apr-20	20-Oct-20
Water Elevation	ft AMSL	1888.4	1888.4	1887.8
Appendix III Parameters				
Boron	mg/L	---	4.7	4.8
Calcium	mg/L	---	210	200
Chloride	mg/L	---	60	64
Fluoride	mg/L	---	0.16	0.15
pH, Field	s.u.	---	7.01	7.08
Sulfate	mg/L	---	1300	1200
Total Dissolved Solids	mg/L	---	2700	2800
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.024 F1	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	0.16	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.21	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	0.0022	---	---
Radium 226	pCi/L	0.0855 U ± 0.0857	---	---
Radium 228	pCi/L	0.309 U ± 0.266	---	---
Radium 226 and 228 combined	pCi/L	0.394 U ± 0.279	---	---
Selenium	mg/L	< 0.0050 U	---	---
Thallium	mg/L	< 0.0010 U F1	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 11: Sample Results Summary Table - MW-91-1

		MW-91-1		
		Additional Baseline Data	Detection Monitoring	
	Units	8-Apr-20	8-Apr-20	21-Oct-20
Water Elevation	ft AMSL	1880.2	1880.2	1879.2
Appendix III Parameters				
Boron	mg/L	---	3.0	2.7
Calcium	mg/L	---	230	200
Chloride	mg/L	---	66	54
Fluoride	mg/L	---	0.22	0.19
pH, Field	s.u.	---	6.93	7.06
Sulfate	mg/L	---	1100	970
Total Dissolved Solids	mg/L	---	2300	2100
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.04	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	0.0011	---	---
Fluoride	mg/L	0.22	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.13	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	0.0045	---	---
Radium 226	pCi/L	0.114 U ± 0.109	---	---
Radium 228	pCi/L	0.502 U ± 0.337	---	---
Radium 226 and 228 combined	pCi/L	0.616 ± 0.354	---	---
Selenium	mg/L	0.0069	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 12: Sample Results Summary Table - MW-51

		MW-51		
		Additional Baseline Data	Detection Monitoring	
	Units	8-Apr-20	8-Apr-20	21-Oct-20
Water Elevation	ft AMSL	1881.2	1881.2	1879.6
Appendix III Parameters				
Boron	mg/L	---	5.4	4.3
Calcium	mg/L	---	270	240
Chloride	mg/L	---	54 H	51
Fluoride	mg/L	---	0.28	0.25
pH, Field	s.u.	---	6.99	6.99
Sulfate	mg/L	---	2600	2800
Total Dissolved Solids	mg/L	---	4800	5400
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.016	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	0.28	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.47	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	0.0032	---	---
Radium 226	pCi/L	0.000811 U ± 0.0659	---	---
Radium 228	pCi/L	-0.0410 U ± 0.318	---	---
Radium 226 and 228 combined	pCi/L	-0.0402 U ± 0.325	---	---
Selenium	mg/L	0.012	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 13: Sample Results Summary Table - MW-16-6

		MW-16-6		
		Additional Baseline Data	**Detection Monitoring**	
	Units	**8-Apr-20**	**8-Apr-20**	**21-Oct-20**
Water Elevation	ft AMSL	1912.4	1912.4	1911.3
Appendix III Parameters				
Boron	mg/L	---	4.8	5.4
Calcium	mg/L	---	540	540
Chloride	mg/L	---	35 H	29
Fluoride	mg/L	---	< 0.10 U	< 0.10 U
pH, Field	s.u.	---	5.78	5.80
Sulfate	mg/L	---	3400	3400
Total Dissolved Solids	mg/L	---	6000	6100
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.04	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	0.0024	---	---
Fluoride	mg/L	< 0.10 U	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.55	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	0.0023	---	---
Radium 226	pCi/L	0.0779 U ± 0.104	---	---
Radium 228	pCi/L	0.532 U ± 0.455	---	---
Radium 226 and 228 combined	pCi/L	0.610 U ± 0.467	---	---
Selenium	mg/L	< 0.0050 U	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 14: Sample Results Summary Table - MW-16-7

		MW-16-7		
		Additional Baseline Data	Detection Monitoring	
	Units	8-Apr-20	8-Apr-20	21-Oct-20
Water Elevation	ft AMSL	1881.6	1881.6	1877.7
Appendix III Parameters				
Boron	mg/L	---	< 0.10 U	< 0.10 U
Calcium	mg/L	---	320	350
Chloride	mg/L	---	61	100
Fluoride	mg/L	---	< 0.10 U	< 0.10 U
pH, Field	s.u.	---	6.96	6.99
Sulfate	mg/L	---	2100	2300
Total Dissolved Solids	mg/L	---	4200	4400
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.016	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	< 0.10 U	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.38	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	< 0.0020 U	---	---
Radium 226	pCi/L	0.152 ± 0.0911	---	---
Radium 228	pCi/L	0.572 ± 0.355	---	---
Radium 226 and 228 combined	pCi/L	0.723 ± 0.367	---	---
Selenium	mg/L	0.15	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 15: Sample Results Summary Table - MW-10

		MW-10		
		Additional Baseline Data	Detection Monitoring	
	Units	8-Apr-20	8-Apr-20	27-Oct-20
Water Elevation	ft AMSL	1880.0	1880.0	1879.1
Appendix III Parameters				
Boron	mg/L	---	4.6	2.6
Calcium	mg/L	---	260	280
Chloride	mg/L	---	11 H	23
Fluoride	mg/L	---	0.37	0.17
pH, Field	s.u.	---	7.54	6.81
Sulfate	mg/L	---	1500	1100
Total Dissolved Solids	mg/L	---	2800	2600
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.035	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	0.37	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.14	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	0.0074	---	---
Radium 226	pCi/L	0.0256 U ± 0.0710	---	---
Radium 228	pCi/L	0.533 ± 0.344	---	---
Radium 226 and 228 combined	pCi/L	0.559 ± 0.351	---	---
Selenium	mg/L	0.011	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 16: Sample Results Summary Table - MW-16-0

		MW-16-0		
		Additional Baseline Data	Detection Monitoring	
	Units	8-Apr-20	8-Apr-20	27-Oct-20
Water Elevation	ft AMSL	1876.2	1876.2	1874.4
Appendix III Parameters				
Boron	mg/L	---	9.7	9.1
Calcium	mg/L	---	290	460
Chloride	mg/L	---	11 H	25
Fluoride	mg/L	---	0.18	0.17
pH, Field	s.u.	---	7.40	7.20
Sulfate	mg/L	---	1600	2700
Total Dissolved Solids	mg/L	---	2700	4400
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.01	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	0.18	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.066	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	0.0041	---	---
Radium 226	pCi/L	0.0335 U ± 0.0561	---	---
Radium 228	pCi/L	0.286 U ± 0.281	---	---
Radium 226 and 228 combined	pCi/L	0.320 U ± 0.287	---	---
Selenium	mg/L	0.04	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 17: Sample Results Summary Table - MW-16-1

		MW-16-1		
		Additional Baseline Data	Detection Monitoring	
	Units	8-Apr-20	8-Apr-20	27-Oct-20
Water Elevation	ft AMSL	1874.2	1874.2	1870.5
Appendix III Parameters				
Boron	mg/L	---	16	15
Calcium	mg/L	---	460	490
Chloride	mg/L	---	120	220
Fluoride	mg/L	---	0.57	0.28
pH, Field	s.u.	---	7.43	7.24
Sulfate	mg/L	---	3500	2900
Total Dissolved Solids	mg/L	---	5700	4800
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.012	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	0.57	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.11	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	0.12	---	---
Radium 226	pCi/L	0.0359 U ± 0.0504	---	---
Radium 228	pCi/L	0.309 U ± 0.260	---	---
Radium 226 and 228 combined	pCi/L	0.345 U ± 0.265	---	---
Selenium	mg/L	< 0.0050 U	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 18: Sample Results Summary Table - MW-72

		MW-72		
		Additional Baseline Data	Detection Monitoring	
	Units	9-Apr-20	9-Apr-20	21-Oct-20
Water Elevation	ft AMSL		***	1878.2
Appendix III Parameters				
Boron	mg/L	---	0.16	0.16
Calcium	mg/L	---	720	760
Chloride	mg/L	---	27 H	30
Fluoride	mg/L	---	0.17	0.16
pH, Field	s.u.	---	6.72	6.74
Sulfate	mg/L	---	2800	3200
Total Dissolved Solids	mg/L	---	4900	5800
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.021	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	0.17	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.18	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	0.0028	---	---
Radium 226	pCi/L	0.0187 U ± 0.0973	---	---
Radium 228	pCi/L	0.366 U ± 0.296	---	---
Radium 226 and 228 combined	pCi/L	0.385 U ± 0.312	---	---
Selenium	mg/L	< 0.0050 U	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.
*** - A water level was not able to be measured during the April 2020 sampling event, due to ice blocking movement of the conductivity probe within the casing. A sample was still able to be

Table 19: Sample Results Summary Table - MW-42

		MW-42		
		Additional Baseline Data	**Detection Monitoring**	
	Units	**9-Apr-20**	**9-Apr-20**	**21-Oct-20**
Water Elevation	ft AMSL	1876.8	1876.8	1875.5
Appendix III Parameters				
Boron	mg/L	---	0.79	1.1
Calcium	mg/L	---	300	280
Chloride	mg/L	---	24 H	17
Fluoride	mg/L	---	0.21	0.21
pH, Field	s.u.	---	7.35	7.31
Sulfate	mg/L	---	1400	1300
Total Dissolved Solids	mg/L	---	2500	2600
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.064	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	0.21	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.13	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	0.0029	---	---
Radium 226	pCi/L	0.142 ± 0.0893	---	---
Radium 228	pCi/L	0.322 U ± 0.296	---	---
Radium 226 and 228 combined	pCi/L	0.464 U ± 0.309	---	---
Selenium	mg/L	< 0.0050 U	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 20: Sample Results Summary Table - MW-16-2

		MW-16-2		
		Additional Baseline Data	Detection Monitoring	
	Units	9-Apr-20	9-Apr-20	27-Oct-20
Water Elevation	ft AMSL	1874.2	1874.2	1870.6
Appendix III Parameters				
Boron	mg/L	---	9.7	10
Calcium	mg/L	---	440	360
Chloride	mg/L	---	180	150
Fluoride	mg/L	---	0.52	0.57
pH, Field	s.u.	---	7.20	7.18
Sulfate	mg/L	---	2400	2100
Total Dissolved Solids	mg/L	---	4200	3700
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.017	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	0.52	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.11	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	< 0.0020 U	---	---
Radium 226	pCi/L	0.0713 U ± 0.0663	---	---
Radium 228	pCi/L	0.360 ± 0.217	---	---
Radium 226 and 228 combined	pCi/L	0.432 ± 0.227	---	---
Selenium	mg/L	< 0.0050 U	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 21: Sample Results Summary Table - MW-16-3

		MW-16-3		
		Additional Baseline Data	Detection Monitoring	
	Units	9-Apr-20	9-Apr-20	27-Oct-20
Water Elevation	ft AMSL	1873.7	1873.7	1870.2
Appendix III Parameters				
Boron	mg/L	---	19	20
Calcium	mg/L	---	410	390
Chloride	mg/L	---	580	550
Fluoride	mg/L	---	1.3	1.4
pH, Field	s.u.	---	7.14	7.11
Sulfate	mg/L	---	5200	5000
Total Dissolved Solids	mg/L	---	8000	9100
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.015	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	1.3	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.2	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	< 0.0020 U	---	---
Radium 226	pCi/L	0.0590 U ± 0.0672	---	---
Radium 228	pCi/L	0.247 U ± 0.237	---	---
Radium 226 and 228 combined	pCi/L	0.306 U ± 0.246	---	---
Selenium	mg/L	< 0.0050 U	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 22: Sample Results Summary Table - MW-16-4

		MW-16-4		
		Additional Baseline Data	Detection Monitoring	
	Units	**9-Apr-20**	**9-Apr-20**	**22-Oct-20**
Water Elevation	ft AMSL	1873.0	1873.0	1869.1
Appendix III Parameters				
Boron	mg/L	---	0.54	0.61
Calcium	mg/L	---	310	450
Chloride	mg/L	---	24 H	19
Fluoride	mg/L	---	0.27	0.25
pH, Field	s.u.	---	6.96	6.80
Sulfate	mg/L	---	2700	3200
Total Dissolved Solids	mg/L	---	3900	6400
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.0038	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	0.0024	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	0.27	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.58	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	0.014	---	---
Radium 226	pCi/L	-0.0333 U ± 0.0943	---	---
Radium 228	pCi/L	-0.0768 U ± 0.190	---	---
Radium 226 and 228 combined	pCi/L	-0.110 U ± 0.212	---	---
Selenium	mg/L	< 0.0050 U	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 23: Sample Results Summary Table - MW-15

		MW-15		
		Additional Baseline Data	Detection Monitoring	
	Units	**9-Apr-20**	**9-Apr-20**	**22-Oct-20**
Water Elevation	ft AMSL	1875.2	1875.2	1872.1
Appendix III Parameters				
Boron	mg/L	---	27	26
Calcium	mg/L	---	400	460
Chloride	mg/L	---	220	190
Fluoride	mg/L	---	0.44	0.38
pH, Field	s.u.	---	7.23	7.02
Sulfate	mg/L	---	3600	3300
Total Dissolved Solids	mg/L	---	6300	4800
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.017	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	0.44	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.27	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	< 0.0020 U	---	---
Radium 226	pCi/L	-0.0172 U ± 0.0778	---	---
Radium 228	pCi/L	0.247 U ± 0.237	---	---
Radium 226 and 228 combined	pCi/L	0.230 U ± 0.249	---	---
Selenium	mg/L	< 0.0050 U	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 24: Sample Results Summary Table - MW-16-5

		MW-16-5		
		Additional Baseline Data	Detection Monitoring	
	Units	9-Apr-20	9-Apr-20	22-Oct-20
Water Elevation	ft AMSL	1873.3	1873.3	1870.5
Appendix III Parameters				
Boron	mg/L	---	11	15
Calcium	mg/L	---	320	390
Chloride	mg/L	---	91	120
Fluoride	mg/L	---	0.72	0.71
pH, Field	s.u.	---	7.28	7.14
Sulfate	mg/L	---	2000	2500
Total Dissolved Solids	mg/L	---	3500	4000
Appendix IV Parameters				
Antimony	mg/L	< 0.0020 U	---	---
Arsenic	mg/L	< 0.0050 U	---	---
Barium	mg/L	0.017	---	---
Beryllium	mg/L	< 0.0010 U	---	---
Cadmium	mg/L	< 0.0010 U	---	---
Chromium	mg/L	< 0.0020 U	---	---
Cobalt	mg/L	< 0.0010 U	---	---
Fluoride	mg/L	0.72	---	---
Lead	mg/L	< 0.0010 U	---	---
Lithium	mg/L	0.14	---	---
Mercury	mg/L	< 0.0002 U	---	---
Molybdenum	mg/L	0.0023	---	---
Radium 226	pCi/L	0.0205 U ± 0.0799	---	---
Radium 228	pCi/L	0.507 U ± 0.398	---	---
Radium 226 and 228 combined	pCi/L	0.528 U ± 0.406	---	---
Selenium	mg/L	0.0085	---	---
Thallium	mg/L	< 0.0010 U	---	---

Legend:
--, not analyzed
ft AMSL, feet above mean sea level
mg/L, milligrams per liter
s.u., standard units for pH
pCi/L, picocuries per liter

Laboratory Provided Qualifiers:
U (general chemistry) = Not detected above the shown practical quantitation limit
U (radiochemistry) = Result is less than the sample detection limit (varies by sample)
^ (samples after June 2018) = ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK, or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time.

Notes:
Samples collected prior to June 2018 were analyzed by Minnesota Valley Testing Laboratories, with radiochemical analysis subcontracted to Intermountain Laboratories.
Samples collected from June 2018 to present were analyzed by Eurofins TestAmerica Laboratories.
In changing analytical laboratories, some differences have been noted in analytical methodologies and associated reporting limits. Methods used are EPA-approved.
Non-detects have been listed at the reported practical quantitation limit.
Metal results represent the total concentration (i.e. samples have not been filtered).
Precision was not recorded for samples with radiological concentrations below the reporting limit by Intermountain Laboratories for Radium-226 samples reported using SM 7500 Ra-B or Radium-228 samples reported using the Georgia Tech method.
Radium-226 and -228 combined has been reported as the calculated sum of Radium-226 and Radium-228 results, or the reporting limit for non-detect results.

Table 25: MW-DP3 (U) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**9-Oct-19**			**7-Apr-20**		
Boron, Total	mg/L	CUSUM	0.90	0.53	0.63	Yes	0.64	0.63	Yes
Calcium, Total	mg/L	CUSUM	330	210	251	Yes	240	251	Yes
Chloride	mg/L	CUSUM	25	< 15 U	12	Yes	13	12	Yes
Fluoride	mg/L	CUSUM	0.14	< 0.10 U	0.11	Yes	0.11	0.11	Yes
pH, Field-Measured	s.u.	CUSUM	6.02, 6.62	6.4	6.32, 6.33	Yes	6.33	6.32, 6.32	Yes
Sulfate	mg/L	CUSUM	1577	1200	1205	Yes	1200	1205	Yes
Total Dissolved Solids	mg/L	CUSUM	2559	2200	2260	Yes	2400	2325	Yes

Notes:

mg/L, milligrams per liter

s.u., standard units for pH

CUSUM: Parametric Shewhart-CUSUM Control Chart

U: Not detected at the shown reporting limit

Table 26: MW-DP5 (U) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**9-Oct-19**			**7-Apr-20**		
Boron, Total	mg/L	NP-PL	0.50	0.11	---	Yes	0.10	---	Yes
Calcium, Total	mg/L	CUSUM	387	270	293	Yes	290	293	Yes
Chloride	mg/L	CUSUM	95	66	80	Yes	66	80	Yes
Fluoride	mg/L	CUSUM	0.36	0.16	0.24	Yes	0.20	0.24	Yes
pH, Field-Measured	s.u.	CUSUM	6.92, 7.41	7.16	7.16, 7.16	Yes	7.16	7.16, 7.16	Yes
Sulfate	mg/L	CUSUM	5161	3300	3426	Yes	3300	3426	Yes
Total Dissolved Solids	mg/L	CUSUM	5829	5200	5311	Yes	5500	5370	Yes

Notes:
mg/L, milligrams per liter
s.u., standard units for pH
NP-PL: Non-Parametric Prediction Limit
CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 27: MW-DP1 (D) Comparative Statistics

Appendix III Analytes	Units	Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result 14-Oct-19	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result 7-Apr-20	CUSUM Value	Within Compliance?
Boron, Total [1]	mg/L	CUSUM	1.18	0.71	0.82	Yes	0.69	0.83	Yes
Calcium, Total	mg/L	CUSUM	274	51	110	Yes	55	110	Yes
Chloride	mg/L	CUSUM	69	1.6	7.0	Yes	< 3.0 U	7.0	Yes
Fluoride	mg/L	CUSUM	0.34	0.25	0.28	Yes	0.26	0.28	Yes
pH, Field-Measured	s.u.	CUSUM	7.05, 7.66	7.47	7.35, 7.39	Yes	7.39	7.35, 7.35	Yes
Sulfate	mg/L	CUSUM	2120	470	601	Yes	500	601	Yes
Total Dissolved Solids	mg/L	CUSUM	2824	1300	1470	Yes	1300	1300	Yes

Notes:

mg/L, milligrams per liter

s.u., standard units for pH

CUSUM: Parametric Shewhart-CUSUM Control Chart

U: Not detected at the shown reporting limit

1. Statistical limit for Boron is deseasonalized, and may vary slightly between events.

Table 28: MW-DP2 (D) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**14-Oct-19**			**7-Apr-20**		
Boron, Total	mg/L	CUSUM	3.59	***	---	---	***	---	---
Calcium, Total	mg/L	CUSUM	357	***	---	---	***	---	---
Chloride	mg/L	CUSUM	87	***	---	---	***	---	---
Fluoride	mg/L	Decreasing Trend	NLS	***	---	---	***	---	---
pH, Field-Measured	s.u.	CUSUM	6.63, 7.12	***	---	---	***	---	---
Sulfate	mg/L	CUSUM	1949	***	---	---	***	---	---
Total Dissolved Solids	mg/L	Increasing Trend	NLS	***	---	---	***	---	---

Notes:

mg/L, milligrams per liter

s.u., standard units for pH

CUSUM: Parametric Shewhart-CUSUM Control Chart

Trend: Trends were identified in the background period. See text for discussion of significance.

NLS: No limit set due to trending data.

*** - See discussion in text regarding lack of samples.

Table 29: MW-DP2B (D) Comparative Statistics

		Statistical Method	Statistical Limit	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**7-Apr-20**		
Boron, Total	mg/L	CUSUM	3.4	2.2 F1	2.4	Yes
Calcium, Total	mg/L	CUSUM	306	240	256	Yes
Chloride	mg/L	Trend	---	62	---	---
Fluoride	mg/L	CUSUM	1.13	0.79	0.84	Yes
pH, Field-Measured	s.u.	CUSUM	6.71, 7.09	6.90	6.90, 6.90	Yes
Sulfate	mg/L	CUSUM	2453	2000	1944	Yes
Total Dissolved Solids	mg/L	CUSUM	4117	3700	3667	Yes

Notes:

mg/L, milligrams per liter

s.u., standard units for pH

F1: MS and/or MSD recovery exceeded associated control limits.

Results collected prior to Q2 2020 were used to develop the baseline statistics. Results collected in Q2 2020 are the first detection monitoring resu

Trend: Trends were identified in the background period. See text for discussion of significance.

NLS: No limit set due to trending data.

Table 30: MW-DP4 (D) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**14-Oct-19**			**7-Apr-20**		
Boron, Total	mg/L	CUSUM	0.69	0.66	0.58	Yes	0.48	0.59	Yes
Calcium, Total	mg/L	CUSUM	384	210	274	Yes	170	274	Yes
Chloride	mg/L	CUSUM	70	30	45	Yes - Prior Result Was a False Positive	32	45	Yes
Fluoride	mg/L	CUSUM	0.24	0.25	0.23	No - Potential Exceedance	0.28	0.34	No - Verified SSI
pH, Field-Measured	s.u.	CUSUM	6.70, 7.29	7.21	7.00, 7.23	Yes	7.24	7.00, 7.41	No - Potential Exceedance
Sulfate	mg/L	CUSUM	3531	2600	2532	Yes	2400	2532	Yes
Total Dissolved Solids	mg/L	CUSUM	5611	4300	4221	Yes	4000	4221	Yes

Notes:

mg/L, milligrams per liter

s.u., standard units for pH

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 31: MW-91-2 (U) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**14-Oct-19**			**7-Apr-20**		
Boron, Total	mg/L	CUSUM	0.53	0.35	0.41	Yes	0.24	0.41	Yes
Calcium, Total	mg/L	Decreasing Trend	NLS	240	---	---	160	---	---
Chloride	mg/L	CUSUM	20	13	15	Yes	11	15	Yes
Fluoride	mg/L	NP-PL	0.50	< 0.10 U	---	Yes	0.11	---	Yes
pH, Field-Measured	s.u.	CUSUM	5.74, 6.66	6.15	6.20, 6.20	Yes	6.52	6.20, 6.42	Yes
Sulfate	mg/L	CUSUM	1469	920	1079	Yes	510	1079	Yes
Total Dissolved Solids	mg/L	CUSUM	2203	1700	1919	Yes	1100	1919	Yes

Notes:
mg/L, milligrams per liter
s.u., standard units for pH
NP-PL: Non-Parametric Prediction Limit
CUSUM: Parametric Shewhart-CUSUM Control Chart
Trend: Trends were identified in the background period. See text for discussion of significance.
NLS: No limit set due to trending data.
U: Not detected at the shown reporting limit

Table 32: MW-75 (U) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**14-Oct-19**			**7-Apr-20**		
Boron, Total	mg/L	CUSUM	0.30	0.20	0.21	Yes	0.20	0.21	Yes
Calcium, Total	mg/L	CUSUM	7.6	5.3	5.5	Yes	4.7	5.5	Yes
Chloride	mg/L	CUSUM	3.2	1.1	1.5	Yes	< 3.0 U	2.5	Yes
Fluoride	mg/L	CUSUM	0.64	0.46	0.49	Yes	0.45	0.49	Yes
pH, Field-Measured	s.u.	CUSUM	7.76, 8.44	8.22	8.10, 8.14	Yes	8.11	8.10, 8.10	Yes
Sulfate	mg/L	CUSUM	92	71	73	Yes	73	73	Yes
Total Dissolved Solids	mg/L	CUSUM	948	880	853	Yes	860	847	Yes

Notes:

mg/L, milligrams per liter

s.u., standard units for pH

CUSUM: Parametric Shewhart-CUSUM Control Chart

U: Not detected at the shown reporting limit

Table 33: MW-49 (D) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**15-Oct-19**			**8-Apr-20**		
Boron, Total	mg/L	CUSUM	6.3	4.6	4.8	Yes	4.7	4.8	Yes
Calcium, Total	mg/L	CUSUM	233	200	198	Yes	210	201	Yes
Chloride	mg/L	CUSUM	74	71	83	No - Verified SSI	60	85	No - Previously Verified SSI
Fluoride	mg/L	CUSUM	0.26	0.16	0.18	Yes	0.16	0.18	Yes
pH, Field-Measured	s.u.	CUSUM	6.71, 7.32	7.02	7.01, 7.01	Yes	7.01	7.01, 7.01	Yes
Sulfate	mg/L	CUSUM	1752	1400	1280	Yes	1300	1271	Yes
Total Dissolved Solids	mg/L	CUSUM	2956	2800	2726	Yes	2700	2691	Yes

Notes:

mg/L, milligrams per liter

s.u., standard units for pH

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 34: MW-91-1 (D) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**15-Oct-19**			**8-Apr-20**		
Boron, Total	mg/L	CUSUM	3.8	2.7	3.0	Yes	3.0	3.0	Yes
Calcium, Total	mg/L	CUSUM	319	220	216	Yes	230	216	Yes
Chloride	mg/L	CUSUM	88	79	84	Yes	66	74	Yes
Fluoride	mg/L	CUSUM	0.39	0.21	0.23	Yes	0.22	0.23	Yes
pH, Field-Measured	s.u.	CUSUM	6.66, 7.25	6.94	6.96, 6.96	Yes	6.93	6.96, 6.96	Yes
Sulfate	mg/L	NP-PL	1300	1100	---	Yes	1100	---	Yes
Total Dissolved Solids	mg/L	NP-PL	2400	2400	---	Yes	2300	---	Yes

Notes:

mg/L, milligrams per liter
s.u., standard units for pH
NP-PL: Non-Parametric Prediction Limit
CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 35: MW-51 (D) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**15-Oct-19**			**8-Apr-20**		
Boron, Total	mg/L	NP-PL	5.7	7.9	---	No - Potential Exceedance	5.4	---	Yes - Prior Result Was a False Positive
Calcium, Total	mg/L	CUSUM	458	420	373	Yes	270	326.1	Yes
Chloride	mg/L	CUSUM	195	80	69	Yes	54 H	68.97	Yes
Fluoride	mg/L	CUSUM	0.60	0.43	0.38	Yes	0.28	0.3578	Yes
pH, Field-Measured	s.u.	CUSUM	6.56, 7.55	6.91	7.03, 7.06	Yes	6.99	7.06, 7.06	Yes
Sulfate	mg/L	CUSUM	5249	3600	3103	Yes	2600	3103	Yes
Total Dissolved Solids	mg/L	CUSUM	7079	6200	5724	Yes	4800	5174	Yes

Notes:

mg/L, milligrams per liter

s.u., standard units for pH

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

H: Analyzed outside of holding time

Table 36: MW-16-6 (U) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**14-Oct-19**			**8-Apr-20**		
Boron, Total	mg/L	CUSUM	6.9	5.2	4.6	Yes	4.8	4.6	Yes
Calcium, Total	mg/L	CUSUM	634	530	518	Yes	540	518	Yes
Chloride	mg/L	CUSUM	54	45	42	Yes	35 H	40	Yes
Fluoride	mg/L	NP-PL	0.10	< 0.10 U	---	Yes	< 0.10 U	---	Yes
pH, Field-Measured	s.u.	CUSUM	5.55, 5.92	5.94	5.73, 5.89	No - Potential Exceedance	5.78	5.73, 5.90	Yes - Prior Result Was a False Positive
Sulfate	mg/L	CUSUM	4913	3900	3590	Yes	3400	3590	Yes
Total Dissolved Solids	mg/L	CUSUM	6277	6400	6939	No - Verified Exceedance	6000	7184	No - Previously Verified SSI

Notes:

mg/L, milligrams per liter

s.u., standard units for pH

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

H: Analyzed outside of holding time

U: Not detected at the shown reporting limit

Table 37: MW-16-7 (U) Comparative Statistics - Q2 2020 Detection Monitoring

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**15-Oct-19**			**8-Apr-20**		
Boron, Total	mg/L	NP-PL	0.11	< 0.10 U	---	Yes	< 0.10 U	---	Yes
Calcium, Total	mg/L	CUSUM	472	310	350	Yes	320	350	Yes
Chloride	mg/L	CUSUM	99	77	78	Yes	61	78	Yes
Fluoride	mg/L	NP-PL	0.12	< 0.10 U	---	Yes	< 0.10 U	---	Yes
pH, Field-Measured	s.u.	CUSUM	6.61, 7.18	6.98	6.90, 6.91	Yes	6.96	6.90, 6.90	Yes
Sulfate	mg/L	CUSUM	3167	2400	2429	Yes	2100	2429	Yes
Total Dissolved Solids	mg/L	CUSUM	4717	4000	4004	Yes	4200	4022	Yes

Notes:

mg/L, milligrams per liter
s.u., standard units for pH
NP-PL: Non-Parametric Prediction Limit
CUSUM: Parametric Shewhart-CUSUM Control Chart
U: Not detected at the shown reporting limit

Table 38: MW-10 (D) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**15-Oct-19**			**8-Apr-20**		
Boron, Total	mg/L	CUSUM	3.7	6.4	6.0	No - Potential Exceedance	4.6	8.0	No - Verified SSI
Calcium, Total	mg/L	CUSUM	387	200	256	Yes	260	256	Yes
Chloride	mg/L	CUSUM	26	17	17	Yes	11 H	17	Yes
Fluoride	mg/L	CUSUM	0.29	0.47	0.45	No - Potential Exceedance	0.37	0.59	No - Verified SSI
pH, Field-Measured	s.u.	CUSUM	6.57, 7.10	7.49	6.84, 7.42	No - Potential Exceedance	7.54	6.84, 8.06	No - Verified SSI
Sulfate	mg/L	NP-PL	1470	1300	---	Yes	1500	---	No - Potential Exceedance
Total Dissolved Solids	mg/L	CUSUM	3495	2400	2222	Yes	2800	2482	Yes

Notes:
mg/L, milligrams per liter
s.u., standard units for pH
CUSUM: Parametric Shewhart-CUSUM Control Chart
H: Analyzed outside of holding time

Table 39: MW-16-0 (D) Comparative Statistics

Appendix III Analytes	Units	Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result 14-Oct-19	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result 8-Apr-20	CUSUM Value	Within Compliance?
Boron, Total	mg/L	CUSUM	10.1	15.0	14.3	No - Potential Exceedance	9.7	9.0	Yes - Prior Result Was a False Positive
Calcium, Total	mg/L	CUSUM	581	450	412	Yes	290	412	Yes
Chloride	mg/L	CUSUM	47	24	36	Yes	11 H	36	Yes
Fluoride	mg/L	CUSUM	0.31	0.19	0.21	Yes	0.18	0.21	Yes
pH, Field-Measured	s.u.	CUSUM	6.89, 7.62	7.28	7.25, 7.29	Yes	7.40	7.25, 7.35	Yes
Sulfate	mg/L	CUSUM	3290	2700	2528	Yes	1600	2516	Yes
Total Dissolved Solids	mg/L	CUSUM	4616	4400	4303	Yes	2700	4184	Yes

Notes:

mg/L, milligrams per liter
s.u., standard units for pH
CUSUM: Parametric Shewhart-CUSUM Control Chart
H: Analyzed outside of holding time

Table 40: MW-16-1 (D) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**15-Oct-19**			**8-Apr-20**		
Boron, Total	mg/L	CUSUM	21	12	18	Yes	16	22	No - Potential Exceedance
Calcium, Total	mg/L	CUSUM	757	410	561	Yes	460	561	Yes
Chloride	mg/L	CUSUM	342	64	254	Yes - Prior Result Was a False Positive	120	254	Yes
Fluoride	mg/L	CUSUM	0.59	0.77	0.69	No - Potential Exceedance	0.57	0.49	Yes - Prior Result Was a False Positive
pH, Field-Measured	s.u.	CUSUM	6.92, 7.34	7.6	7.13, 7.55	No - Potential Exceedance	7.43	7.13, 7.80	No - Verified SSI
Sulfate	mg/L	CUSUM	3996	2400	2992	Yes - Prior Result Was a False Positive	3500	3464	Yes
Total Dissolved Solids	mg/L	CUSUM	6615	3900	5058	Yes	5700	5985	Yes

Notes:

mg/L, milligrams per liter
s.u., standard units for pH
CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 41: MW-72 (U) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**15-Oct-19**			**9-Apr-20**		
Boron, Total	mg/L	CUSUM	0.21	0.15	0.13	Yes	0.16	0.15	Yes
Calcium, Total	mg/L	CUSUM	1048	690	798.8	Yes	720	799	Yes
Chloride	mg/L	CUSUM	35	33	42	No - Verified SSI	27 H	40	No - Previously Verified SSI
Fluoride	mg/L	CUSUM	0.34	0.17	0.22	Yes	0.17	0.22	Yes
pH, Field-Measured	s.u.	CUSUM	6.48, 6.99	6.77	6.74, 6.74	Yes	6.72	6.74, 6.74	Yes
Sulfate	mg/L	CUSUM	3914	3100	3088	Yes	2800	3088	Yes
Total Dissolved Solids	mg/L	CUSUM	5824	5000	5067	Yes	4900	5067	Yes

Notes:

mg/L, milligrams per liter

s.u., standard units for pH

CUSUM: Parametric Shewhart-CUSUM Control Chart

H: Analyzed outside of holding time

Table 42: MW-42 (U) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**16-Oct-19**			**9-Apr-20**		
Boron, Total	mg/L	CUSUM	2.19	0.98	1.03	Yes	0.79	1.03	Yes
Calcium, Total	mg/L	CUSUM	346	220	244	Yes	300	275	Yes
Chloride	mg/L	CUSUM	28	22	23	Yes - Prior Result Was a False Positive	24 H	26	Yes
Fluoride	mg/L	CUSUM	0.42	0.27	0.30	Yes	0.21	0.30	Yes
pH, Field-Measured	s.u.	CUSUM	6.95, 7.65	7.31	7.30, 7.30	Yes	7.35	7.30, 7.30	Yes
Sulfate	mg/L	CUSUM	2177	1100	1414	Yes	1400	1414	Yes
Total Dissolved Solids	mg/L	CUSUM	3179	2200	2412	Yes	2500	2412	Yes

Notes:

mg/L, milligrams per liter

s.u., standard units for pH

CUSUM: Parametric Shewhart-CUSUM Control Chart

H: Analyzed outside of holding time

Table 43: MW-16-2 (D) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**21-Oct-19**			**9-Apr-20**		
Boron, Total	mg/L	CUSUM	14.4	10.0	10.0	Yes	9.7	10.0	Yes
Calcium, Total	mg/L	CUSUM	608	390	415	Yes	440	415	Yes
Chloride	mg/L	CUSUM	223	190	178	Yes	180	174	Yes
Fluoride	mg/L	CUSUM	1.26	0.55	0.60	Yes	0.52	0.60	Yes
pH, Field-Measured	s.u.	CUSUM	6.83, 7.43	7.16	7.13, 7.13	Yes	7.20	7.13, 7.13	Yes
Sulfate	mg/L	CUSUM	3255	2200	2315	Yes	2400	2315	Yes
Total Dissolved Solids	mg/L	CUSUM	4616	4200	4002	Yes	4200	4179	Yes

Notes:

mg/L, milligrams per liter
s.u., standard units for pH
CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 44: MW-16-3 (D) Comparative Statistics

		Statistical Method	**Statistical Limit**	**Q4 2019 Detection Monitoring Result**	**CUSUM Value**	**Within Compliance?**	**Q2 2020 Detection Monitoring Result**	**CUSUM Value**	**Within Compliance?**
Appendix III Analytes	**Units**			**21-Oct-19**			**9-Apr-20**		
Boron, Total	mg/L	CUSUM	27	19	18	Yes	19	18	Yes
Calcium, Total	mg/L	CUSUM	616	400	431	Yes	410	431	Yes
Chloride	mg/L	CUSUM	944	600	605.5	Yes	580	606	Yes
Fluoride	mg/L	CUSUM	2.2	1.3	1.5	Yes	1.3	1.5	Yes
pH, Field-Measured	s.u.	CUSUM	6.90, 7.24	7.14	7.07, 7.07	Yes	7.14	7.07, 7.13	Yes
Sulfate	mg/L	CUSUM	7782	5200	5137	Yes	5200	5137	Yes
Total Dissolved Solids	mg/L	CUSUM	12488	9200	9118	Yes	8000	9118	Yes

Notes:

mg/L, milligrams per liter

s.u., standard units for pH

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 45: MW-16-4 (D) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**16-Oct-19**			**9-Apr-20**		
Boron, Total	mg/L	CUSUM	1.13	0.53	0.57	Yes	0.54	0.57	Yes
Calcium, Total	mg/L	CUSUM	667	360	417	Yes	310	417	Yes
Chloride	mg/L	CUSUM	51 [1]	36	35	Yes	24 H	35	Yes
Fluoride	mg/L	CUSUM	0.43	0.27	0.32	Yes	0.27	0.32	Yes
pH, Field-Measured	s.u.	CUSUM	6.34, 7.38	6.89	6.86, 6.86	Yes	6.96	6.86, 6.86	Yes
Sulfate	mg/L	CUSUM	4104	3900	3713	Yes	2700	3310	Yes
Total Dissolved Solids	mg/L	CUSUM	6282 [1]	5400	4897	Yes	3900	4883	Yes

Notes:

mg/L, milligrams per liter

s.u., standard units for pH

CUSUM: Parametric Shewhart-CUSUM Control Chart

H: Analyzed outside of holding time

1. Statistical Limits for Chloride and TDS are deseasonalized, and may vary slightly from event to event based on the deseasonalized values.

Table 46: MW-15 (D) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**16-Oct-19**			**9-Apr-20**		
Boron, Total	mg/L	CUSUM	35	27	27	Yes	27	27	Yes
Calcium, Total	mg/L	CUSUM	557	420	444	Yes	400	444	Yes
Chloride	mg/L	CUSUM	384 [1]	260	279.4	Yes	220	281	Yes
Fluoride	mg/L	CUSUM	0.78	0.44	0.58	Yes	0.44	0.58	Yes
pH, Field-Measured	s.u.	CUSUM	6.74, 7.39	7.08	7.06, 7.06	Yes	7.23	7.06, 7.15	Yes
Sulfate	mg/L	CUSUM	4872	3800	3888	Yes	3600	3888	Yes
Total Dissolved Solids	mg/L	CUSUM	8191	4900	6164	Yes	6300	6164	Yes

Notes:

mg/L, milligrams per liter

s.u., standard units for pH

CUSUM: Parametric Shewhart-CUSUM Control Chart

1. Statistical Limit for Chloride is deseasonalized, and may vary slightly from event to event based on the deseasonalized values.

Table 47: MW-16-5 (D) Comparative Statistics

		Statistical Method	Statistical Limit	Q4 2019 Detection Monitoring Result	CUSUM Value	Within Compliance?	Q2 2020 Detection Monitoring Result	CUSUM Value	Within Compliance?
Appendix III Analytes	**Units**			**16-Oct-19**			**9-Apr-20**		
Boron, Total	mg/L	CUSUM	24	12	14	Yes	11	14	Yes
Calcium, Total	mg/L	CUSUM	551	340	344	Yes	320	344	Yes
Chloride	mg/L	CUSUM	195	120	130	Yes	91	130	Yes
Fluoride	mg/L	CUSUM	1.14	0.71	0.84	Yes	0.72	0.85	Yes
pH, Field-Measured	s.u.	CUSUM	6.80, 7.53	7.25	7.16, 7.16	Yes	7.28	7.16, 7.19	Yes
Sulfate	mg/L	CUSUM	3809	2500	2241	Yes	2000	2241	Yes
Total Dissolved Solids	mg/L	CUSUM	4365	4000	3814	Yes	3500	3622	Yes

Notes:

mg/L, milligrams per liter

s.u., standard units for pH

CUSUM: Parametric Shewhart-CUSUM Control Chart

Figures

LEGEND

- ⌖ UPGRADIENT MONITORING WELL
- ⌖ DOWNGRADIENT MONITORING WELL - DRAINS POND SYSTEM
- ⌖ DOWNGRADIENT MONITORING WELL - UPSTREAM RAISE 91
- ⌖ DOWNGRADIENT MONITORING WELL - UPSTREAM RAISE 92
- ⌖ DOWNGRADIENT MONITORING WELL - SOUTHEAST 16
- ⟶ GENERAL DIRECTION OF GROUNDWATER FLOW
- — 1930 — POTENTIOMETRIC SURFACE CONTOURS (SEE NOTE 2)

NOTE(S)

1. GROUNDWATER ELEVATIONS SHOWN WERE MEASURED APRIL-MAY 2020.
2. POTENTIOMETRIC SURFACE CONTOURS WERE CREATED USING WATER LEVEL INFORMATION FROM THE APRIL-MAY 2020 GROUNDWATER ELEVATIONS SHOWN, AS WELL AS SURVEYED SURFACE WATER EXPRESSIONS, ADDITIONAL SITE WELLS, AND PIEZOMETERS NOT SHOWN. CONTOUR INTERVAL IS 5 FEET.
3. MONITORING WELL MW-72 GROUNDWATER LEVEL COULD NOT BE MEASURED DUE TO PRESENCE OF ICE AS INDICATED IN THE FIELD DATASHEET DATED APRIL 09, 2020.
4. ONLY A WATER LEVEL WAS MEASURED AT MW-DP2. SUFFICIENT VOLUME WAS NOT AVAILABLE TO SAMPLE.
5. AERIAL IMAGERY OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE IMAGERY PROGRAM, 2019.

N

0 300 600
1" = 300' FEET

Path: \\Denver\acad\GREAT RIVER ENERGY\COAL CREEK\99_PROJECTS\19136224\Facility Water Quality\ | File Name: Figure 1_AprilMay 2020 MW Network.dwg

GOLDER

MONITORING WELL LOCATIONS AND APRIL 2020
GROUNDWATER CONDITIONS
GREAT RIVER ENERGY - COAL CREEK STATION

FIGURE 1

LEGEND

⊕	UPGRADIENT MONITORING WELL
⊕	DOWNGRADIENT MONITORING WELL - DRAINS POND SYSTEM
⊕	DOWNGRADIENT MONITORING WELL - UPSTREAM RAISE 91
⊕	DOWNGRADIENT MONITORING WELL - UPSTREAM RAISE 92
⊕	DOWNGRADIENT MONITORING WELL - SOUTHEAST 16
→	GENERAL DIRECTION OF GROUNDWATER FLOW
— 1930 —	POTENTIOMETRIC SURFACE CONTOURS (SEE NOTE 2)

NOTE(S)

1. GROUNDWATER ELEVATIONS SHOWN WERE MEASURED OCTOBER-NOVEMBER 2020.
2. POTENTIOMETRIC SURFACE CONTOURS WERE CREATED USING WATER LEVEL INFORMATION FROM THE OCTOBER-NOVEMBER 2020 GROUNDWATER ELEVATIONS SHOWN, AS WELL AS SURVEYED SURFACE WATER EXPRESSIONS, ADDITIONAL SITE WELLS, AND PIEZOMETERS NOT SHOWN. CONTOUR INTERVAL IS 5 FEET.
3. AT MW-DP2, SUFFICIENT VOLUME WAS NOT AVAILABLE TO MEASURE A WATER LEVEL OR TO SAMPLE.
4. AERIAL IMAGERY OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE IMAGERY PROGRAM, 2019.

N

0 300 600
1" = 300' FEET

GOLDER

MONITORING WELL LOCATIONS AND OCTOBER 2020 GROUNDWATER CONDITIONS
GREAT RIVER ENERGY - COAL CREEK STATION

FIGURE 2

Path: \\Denver\acad\GREAT RIVER ENERGY\COAL CREEK\99_PROJECTS\19136224\Facility Water Quality\ | File Name: Figure 2_OctNov 2020 MW Network.dwg

APPENDIX A

Alternative Source Demonstration - Q4 2019

REPORT

Alternative Source Demonstration for Chloride in Monitoring Well MW-49

Great River Energy - Coal Creek Station

Submitted to:

Great River Energy
Coal Creek Station
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Submitted by:

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19136224

May 13, 2020

Table of Contents

TABLES

FIGURES

1.0 INTRODUCTION

On behalf of Great River Energy (GRE), Golder Associates Inc. (Golder) performed a statistical evaluation of groundwater monitoring results from the fourth quarter (Q4) 2019 groundwater detection monitoring event at Coal Creek Station's Upstream Raise 91 coal combustion residual (CCR) surface impoundment. The statistical evaluation was performed as described in the Coal Combustion Residuals Groundwater Statistical Method Certification for Coal Creek Station, Revision 1 (Golder 2019b), in accordance with applicable provisions of 40 Code of Federal Regulations (CFR) Part 257, "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule" (CCR rule), as amended.

Statistical analyses of the Appendix III detection monitoring data for chloride in groundwater at the downgradient monitoring well MW-49 indicated a potential exceedance of the statistical limit based on the parametric Shewhart-CUSUM (Cumulative Summation) control chart analysis of the second quarter (Q2) 2019 sampling results. This potential exceedance was subsequently verified as evidence of a statistically significant increase (SSI) following the Q4 2019 detection monitoring sampling event. Although determination of a verified SSI generally indicates that the groundwater monitoring program should transition from detection monitoring to assessment monitoring, 40 CFR Part 257.94(e)(2) allows the owner or operator (i.e., GRE) 90 days from the date of determining a verified SSI (February 13, 2020) to demonstrate a source other than the regulated CCR facility caused the SSI or that the SSI was a result of an error in sampling, analysis, or statistical evaluation or natural variability in groundwater quality that was not fully captured during the baseline data collection.

Golder's review of the hydrological and geologic conditions at the site and the sampling and analytical procedures indicates the SSI is not an indication of impacts from the CCR unit. To assess potential chloride sources, including the statistical analysis and the natural variability of chloride concentrations in groundwater, a desktop study of previously collected CCR-impacted water from the facility, nearby surface water, and groundwater samples was conducted. Based upon this review and in accordance with provisions of the CCR Rule, Golder has prepared this Alternative Source Demonstration (ASD) for chloride at MW-49 and the Upstream Raise 91 CCR surface impoundment.

This ASD conforms to the requirements of 40 CFR Part 257.94(e)(2) and provides the basis for concluding that the verified SSI for chloride at MW-49 is not an indication of a release from Upstream Raise 91. The following sections provide a summary of Upstream Raise 91, sampling procedures and analytical methods, analytical and geochemical assessment results, and lines of evidence demonstrating an alternative source is responsible for the chloride SSI.

2.0 BACKGROUND

2.1 Site Background

GRE's Coal Creek Station (CCS) is a coal-fired electric generation facility located in McLean County, approximately 10 miles northwest of Washburn, North Dakota. CCRs are managed in composite-lined surface water impoundment cells and dry waste facilities regulated and permitted by the North Dakota Department of Environmental Quality (NDDEQ) in accordance with North Dakota Administrative Code (NDAC) Article 33-20, Solid Waste Management and Land Protection.

Coal Creek Station has four CCR facilities that are within the purview of the EPA CCR rule. This ASD only applies to the Upstream Raise 91 CCR surface impoundment. Upstream Raise 91 is located in the south-central portion of the plant site, east of the Coal Creek Station plant buildings (Figure 1).

2.2 Site Geology

Coal Creek Station and McLean County are situated at the eastern-most extent of the Williston Basin, a structural and sedimentary basin (USGS 1999). The region is characterized by the presence of glacial drift, reaching thicknesses of several hundred feet and overlying the Sentinel Butte Member, the source of commercially mined coal in the direct vicinity of Coal Creek Station (Falkirk 1979). The Sentinel Butte Member is the highest strata of the Paleocene Fort Union Formation, overlying the Tongue River, Ludlow, and Cannonball Members (USGS 1999). The Sentinel Butte Member is marked by drab-gray units, demarcating the separation from the lower Tongue River Member.

The site geology of CCS includes unconsolidated surficial deposits of the Coleharbor formation, consisting of stratified and unstratified glacial drift. The near-surface materials are silty clay and sandy clay till with interbedded lenses (CPA/UPA 1989).

2.3 Site Hydrogeology

Regional groundwater flow of the uppermost water-bearing unit in the vicinity of CCS is a subtle expression of the surface topography, which is influenced by the configuration of the eroded bedrock. Based on available groundwater elevation data, the shallow groundwater at the CCR facilities at Coal Creek Station generally follows surface topography, flowing east and north towards Lower Samuelson Slough and Sayler Slough. Available groundwater elevation data indicate that groundwater in the area of Upstream Raise 91 generally flows from the southwest to northeast, diagonally across the footprint of the facility, towards Lower Samuelson Slough.

Hydraulic conductivities in the area of Upstream Raise 91 range from 0.35 feet per day (ft/day) to 12.96 ft/day, with calculated groundwater flow rates during Q4 2019 ranging from 0.04 to 1.56 ft/day.

2.4 Groundwater Monitoring Network

The groundwater monitoring network for Upstream Raise 91 was developed with consideration for the size, disposal and operational history, anticipated flow direction, and location of adjoining facilities. Based on these factors, a monitoring well network consisting of two upgradient and three downgradient monitoring wells is used for monitoring the unit under the CCR rule.

The two upgradient monitoring wells (MW-75, MW-91-2) included in the groundwater monitoring network for Upstream Raise 91 are used to represent upgradient water quality flowing towards the unit from the west and south, including the potential for variability. The three downgradient wells (MW-49, MW-51, MW-91-1) are spaced along the northern edge of the facility. Upstream Raise 91 directly abuts Upstream Raise 92 on its eastern edge, preventing installation of monitoring wells along the eastern side of Upstream Raise 91 without jeopardizing the integrity of the liner system. The Upstream Raise 91 network wells are presented in Figure 1. Other monitoring locations used to support this ASD are also presented in Figure 1 and are discussed further in Section 5.0.

2.5 Groundwater Conditions

Between September 2015 and June 2017, GRE collected nine independent baseline groundwater samples from MW-75, MW-49, and MW-51, as required by 40 CFR Part 257.94, for use within the CCR rule monitoring program. Baseline samples were collected from MW-91-2 and MW-91-1 between January 2018 and October 2018, following installation of the wells in late 2017. Prior to installation of MW-91-2 and MW-91-1 and completion of the baseline monitoring at the wells, Upstream Raise 91 and Upstream Raise 92 were monitored jointly under a monitoring network consisting of the wells in both units (Golder 2019a). The results of the CCR baseline monitoring were used to develop appropriate statistical limits for each constituent at each monitoring well, based on site and parameter specific conditions (Golder 2019b). Following completion of the baseline monitoring events at each well, GRE began collecting groundwater samples on a semi-annual basis to support the detection monitoring program. Groundwater samples for detection monitoring are collected at each upgradient and downgradient monitoring well and analyzed for 40 CFR Part 257 Appendix III constituents. During the detection monitoring program, groundwater analysis results are compared to the calculated statistical limits to determine whether groundwater quality remains consistent or if changes are noted.

Chloride concentrations in groundwater at MW-49 during the baseline monitoring period ranged between 59.2 and 67.1 milligrams per liter (mg/L) in the nine baseline samples collected as part of the CCR rule monitoring program. The Shewhart-CUSUM statistical limit for the well-constituent pair was set at 73.9 mg/L.

Following collection of the baseline monitoring events, GRE began collecting groundwater samples on a semiannual basis in October 2017 to support the detection monitoring program. Groundwater samples for detection monitoring were collected at wells within the monitoring well network and analyzed for 40 CFR Part 257 Appendix III constituents. During the detection monitoring program, results from groundwater analysis are compared to the statistical limits calculated from the baseline monitoring results to determine whether groundwater quality remains consistent, or if changes in groundwater quality are a result of statistically significant increases (SSIs) stemming from the monitored unit.

The Q2 2019 detection monitoring event reported a chloride concentration of 70.0 mg/L at MW-49, with a calculated CUSUM value of 77.4 mg/L, exceeding the statistical limit. Verification resampling was conducted during the Q4 2019 detection monitoring event, confirming the SSI for chloride at MW-49 with a chloride concentration of 71.0 mg/L and a calculated CUSUM value of 83.8 mg/L.

2.6 Sampling and Laboratory Testing Procedures

As part of the ASD, a review was conducted of the sampling and laboratory testing procedures used throughout baseline monitoring and detection monitoring to date, along with the collected results. A review of the statistical assessment methods and associated results found the procedures followed during baseline and detection monitoring to be consistent with the stated procedures listed in the published Groundwater Statistical Methods Certification (Golder 2019b). Calculated limits were found to be consistent with the chosen statistical procedures and recommended methodology found within the Unified Guidance (USEPA 2009).

In review of the analytical results a shift in the MW-49 chloride concentrations was noted between data collected prior to June 2018 and data collected after June 2018. This shift was evaluated with a Wilcoxon Rank-Sum test which showed statistical significance at the 95% confidence level (Figure 2). The Wilcoxon Rank-Sum test determines if measurements from one population are significantly different than measurements from another population. This test is non-parametric, meaning that the data are not assumed to fit a specific distribution, such as a normal distribution.

Beginning in June 2018 (Q2 2018, the second semi-annual detection monitoring event), GRE switched sampling staff. The potential impacts of this change are evaluated in Section 3.0. Also beginning in June 2018 (Q2 2018, the second semi-annual detection monitoring event), GRE switched analytical laboratories from Minnesota Valley Testing Laboratory (Bismarck, North Dakota) to Eurofins TestAmerica (Denver Laboratory in Arvada, Colorado). Concurrent with the laboratory switch, differences were noted between the testing methodologies used for chloride by the two laboratories. An evaluation of the methods and their associated differences is discussed in Section 4.1.

3.0 POTENTIAL SAMPLING CAUSES

Between September 2015 and May 2018, sampling of the CCR rule wells and other wells and surface water sampling locations at Coal Creek Station was conducted by outside contractors from the Bismarck, North Dakota location of the Minnesota Valley Testing Laboratory (MVTL). Beginning with the samples collected in June 2018, sampling has been conducted in-house by GRE employees. Low-flow pumps and sampling methods have been used to collect groundwater samples throughout the monitoring program for the CCR rule, following manufacturer recommendations (Geotech 2015) and USEPA guidance (USEPA Region I 2017). Although using the same sampling methods, there is a potential for minor differences in sampling technique between sampling personnel. The timing of the change in sampling personnel coincides with both the June 2018 shift in chloride concentrations described in Section 2.5 and the change in laboratories noted in Section 2.6.

4.0 POTENTIAL LABORATORY SOURCES

4.1 Changes in Testing Methodology

Prior to June 2018, GRE contracted MVTL as their analytical testing laboratory for the monitoring program for the CCR rule. For analysis of chloride, MVTL used a variation of the SM4500-Cl- method (published variations of the method are labeled SM4500-Cl- A through SM4500-Cl- I; Standard Methods Online 2018). In the most recent sampling prior to the analytical laboratory switch, MVTL used method SM4500-Cl- E, Chloride by Automated Ferricyanide Method. Instrumentation for the method is an automated spectrophotometer, as the method is a colorimetric means of measuring chloride in water. All variations of SM4500-Cl are only applicable for testing chloride and are not indicated for use for other analytes.

Under typical use of the method, the applicable concentration range is 1 to 200 mg/L of chloride, which can be extended to higher and lower concentrations by dilution, adjustment of sample size, and other typical testing adjustments (USGS 2002a). The typical chloride reporting limit provided by MVTL was 1.0 mg/L. Although not reported within MVTL's laboratory information management system at the time of testing, dilutions to the sample results are likely to have occurred, given the range in chloride concentrations reported using the method between 2015 and 2018 (1.1 to 697 mg/L across all CCS samples collected as part of the monitoring program for the CCR rule).

Beginning with the June 2018 sampling events for the CCR rule groundwater monitoring program, GRE contracted Eurofins TestAmerica (TestAmerica) as their analytical testing laboratory. For analysis of chloride, TestAmerica has used method SW9056A, the Determination of Inorganic Anions by Ion Chromatography (USEPA 2007). Ion chromatography identifies and separates different ions based on their affinity to an ion exchanging resin which is packed in a flow-through column. The separated ions elute off the column at different times, characteristic to the ion size and charge, and are measured using an electrical conductivity meter, generating a series of peaks as the different ions leave the column (Figure 3). Relative to a baseline level of conductivity, the area of each peak is proportional to the ion's concentration in the sample. The peak area is compared to the peak areas generated by known concentrations in calibration standards to derive a sample concentration. In the case of method SW9056A, the specified analytical column (i.e., the ion exchanger), is required to be suitable for analyzing for chloride, fluoride, bromide, nitrate, nitrite, phosphate, and sulfate.

The typical chloride reporting limit provided by TestAmerica at the Denver Laboratory was 3.0 mg/L. Dilutions have varied across samples, ranging from 1x dilution factors (i.e., no dilution and a reporting limit of 3.0 mg/L) to 50x dilution factors (with a corresponding reporting limit of 150 mg/L). Due to the capacity of the method for testing multiple anions, indiscriminate dilution intended to account for high concentrations of one anion, particularly in accounting for samples with higher sulfate concentrations as found at CCS, can negatively impact outcomes for the other anions measured by the method, resulting in non-detect results with excessive dilutions. This aspect is particularly salient due to the base application of the method, as loading of the ion exchange column within the ion chromatograph should not exceed concentrations of approximately 500 parts per million (ppm; equivalent to 500 mg/L) of total anions within the sample when the sample to be tested is undiluted (USGS 2002b).

In comparing the methodologies used by the two laboratories, a few specific differences are apparent. First, the two methods analyze for chloride using fundamentally different mechanisms. Method SM4500-Cl^- E uses spectrophotometry, which measures how much a chemical of interest absorbs light by passing a light source through a sample. Differentiation of chemical compounds is based on the principle that each compound will absorb light over a specific range of wavelengths (Standard Methods Online 2018; USGS 2002a). Method SW9056A uses ion chromatography, quantifying the species of interest based on their affinity for an ion exchanger (USEPA 2007; USGS 2002b). Due to the difference in mechanisms between the methods, samples that are analyzed by the two methods would be anticipated to show slightly different results, even if tested portions are drawn from the same sample.

Second, larger differences between quantified results could be anticipated in samples with complex matrices, particularly those with large concentrations of other anions measured through the SW9056A methodology. Although the ion exchangers used within ion chromatography are specific to each method, the column specified by SW9056A is intended to account for the affinity of the complete list of analytes specified by the method in sequential order (USEPA 2007). In samples at CCS, concentrations of sulfate alone, as the final sequential anion within the method, often exceed the total anion loading of the methodology prior to dilution of samples. As the concentrations of chloride are less than those of sulfate within samples from CCS based on previously collected information and geochemical water-typing, masking of the intended analyte by other anions intended for quantification could skew results. Appropriate calibration across multiple concentration ranges is intended to prevent this issue. However, based on past included laboratory qualifiers and explanations within laboratory narratives, pinpointing a group of ranges across samples can prove difficult.

One further difference between the results from the two laboratories are the number of significant digits reported within sample results. Results for chloride using method SM4500-Cl^- E from MVTL were reported with 3 significant digits, while TestAmerica reports results for chloride using method SW9056A using only 2 significant digits. This difference in precision between the two laboratories may be subtle given the concentrations of chloride across samples, but could result in a difference in population medians, signifying a shift in concentrations with no cause from the facility. Similar differences are noted in the number of significant digits reported for boron, calcium, sulfate, and total dissolved solids between reporting from the two analytical laboratories.

4.2 Ion Chromatography

In addition to comparing differences between the chloride methods, Golder reviewed TestAmerica's SW9056A standard operating protocols and reviewed the ion chromatography data output data to look for practices that have the potential to bias chloride concentrations high.

The quality of ion chromatography measurements is dependent on consistently processing data in the conversion of peak area to concentration. For examples, the following aspects should be handled consistently:

- The time window used to calculate the area under a peak;
- The method for determining baseline conductivity; and
- The approach for dealing with minor peaks that elute from the column at the same time as an analyte of interest.

These data processing calculations are automatically performed by the instrument software and can result in minor differences between samples and standards. While TestAmerica checks ion chromatograph data to confirm that the instrument software is functioning consistently, there is a range of variability in the software data processing practices that is tolerated and the decision on whether to manually adjust the software-calculated concentrations by manually selecting peaks is the responsibility of TestAmerica personnel.

Golder's review of the TestAmerica ion chromatography data identified several data processing practices that have the potential to bias high chloride concentrations (Figure 4). These include:

- Using a longer integration time for samples than calibration standards;
- Selecting a lower baseline in samples relative to calibration standards; and
- Including minor shoulder peaks in sample chloride peaks when they were excluded from calibration standard chloride peaks.

These practices were implemented in the processing of the ion chromatographs for the MW-49 samples collected between 6/11/2018 and 10/16/2018 and have the potential to bias high the chloride concentrations by up to 4.2%. Golder discussed the data processing practices with TestAmerica after an internal review, and TestAmerica deemed the practices as within the range of acceptable variability and a revision to the originally reported values was not warranted (D. Bieniulis, personal communication, May 8, 2020). While up to a 4.2% difference is relatively small, this difference could account for part of the June 2018 shift in MW-49 chloride concentrations described in Section 2.5 and result in a false identification of an SSI.

5.0 POTENTIAL SITE CHLORIDE SOURCES

To assess the potential sources for a change in chloride concentrations at MW-49, Golder reviewed recent site changes upgradient of Upstream Raise 91, as well as previously collected data from the CCR rule program and other site monitoring data that are collected under other programs. The following sections summarize the supplemental assessment activities.

5.1 Site Changes and Potential Impacts

The following sections discuss site changes and potential impacts associated with those changes over the last 40 years. Site changes may have affected constituent concentrations entering the groundwater system or the hydrologic and hydrogeologic conditions (water balance) of the site.

5.1.1 Construction History and Liner System

Upstream Raise 91 was constructed on the historic footprint of the South Ash Pond, which was built in the late 1970s on a foundation of re-compacted site soils (glacial tills) and put into service in 1979. In 1981, the South Ash Pond was taken out of service to reconstruct the clay liner and was put back into service from 1982 until 1987, at which point CCR materials were removed and the geometry of the South Ash Pond footprint was modified. Monitoring wells MW-49, MW-51, and MW-75 were installed near Upstream Raise 91 in 1988 and chloride has been analyzed since that time on an approximately semi-annual basis as part of the NDDEQ monitoring program.

Chloride concentrations in MW-49 increased significantly shortly after monitoring began in the late 1980s due to likely impacts from the South Ash Pond. In 1993, Upstream Raise 91 was deepened and a new composite liner consisting of a 2-foot thick compacted clay liner underlying a 40-mil high-density polyethylene (HDPE) geomembrane was completed. Beginning in 1996, chloride concentrations started a downward trend, decreasing by approximately 50% over the next 10-year period (approximately from a high of 170 mg/L to 85 mg/L), likely a result of construction of the composite liner system. Overall, chloride concentrations decreased approximately 60% from 1996 to 2020 (approximately from a high of 170 mg/L to 70 mg/L).

5.1.2 Duck Pond and Drains Pond System Construction

Beginning in 2015, the drainages on the west and northwest sides of Upstream Raise 91 were modified to allow for construction of an expansion to the Drains Pond System. As a part of this construction, modifications to the existing drainage upgradient of Upstream Raise 91 were required and the composite-lined west and center cells of the Drains Pond System were constructed.

Historically, the Duck Pond area was a low-lying area west of Upstream Raise 91. The depth of water contained in this area was generally 12 feet (water surface elevation approximately 1911 feet) and the Duck Pond had a surface area of approximately three acres. As the water level increased, overflow passed through culvert piping to the north under what is now the center cell of the Drains Pond System. As part of the construction in 2015, the Duck Pond was dewatered, the area was graded, and culverts were installed to drain surface water south and east around the south side of Upstream Raise 91.

5.2 Data Sources

To determine if recent site changes upgradient of Upstream Raise 91 have impacted water quality in MW-49, the sampling locations and dates for groundwater, surface water and contact water results were reviewed for each potential source provided below (see Figure 1 for locations).

5.2.1 Upstream Raise 91

Data collected between September 2015 and March 2020[1] for the CCR rule monitoring program were considered in the evaluation. As part of the monitoring program, field personnel collected groundwater samples from the following monitoring wells:

- Upgradient to Upstream Raise 91: MW-75 and MW-91-2
- Downgradient from Upstream Raise 91: MW-49, MW-51, and MW-91-1

Additionally, results for a November 2018 sample of ash contact water collected from the Upstream Raise 91 sump (Sump-UR91) were available for the evaluation.

5.2.2 Drains Pond System (East Cell)

Data collected between September 2015 and March 2020 for the CCR rule monitoring program were considered in the evaluation. As part of the monitoring program, field personnel collected groundwater samples from the following monitoring wells:

- Upgradient to the Drains Pond System: MW-DP3 and MW-DP5
- Downgradient from the Drains Pond System: MW-DP1, MW-DP2, MW-DP2B, and MW-DP4

Additionally, results for 18 samples collected between 2014 and 2019 of ash contact water collected from the surface of the east cell of the Drains Pond System (Drains Pond, SW-DP101) were used in the evaluation.

---

[1] June 2019 samples from MW-91-1 and MW-91-2 not used because of a suspected quality control issue

5.2.3 Upgradient Plant Cooling Water

Groundwater potentially influenced by upgradient plant cooling water is monitored at the following locations:

- Upgradient to the powerplant: MW-96
- Downgradient from the Extended Basin: MW-62, MW-63, and MW-65
- EEG Wells: MW-17-1, MW-17-2, MW-17-3, MW-17-4, and MW-17-5 (these wells were installed to monitor a leak in the fuel line to the Emergency Engine Generator)

For the plant wells, results from samples collected between October 1988 and October 2019 were considered for this evaluation. The EEG wells were installed in the fourth quarter of 2017, and results included in this evaluation were for samples collected between January 2018 and October 2019.

Additionally, results for samples collected between October 1988 and June 2019 of surface water collected from the Extended Basin (SW-107) were used in the evaluation.

5.3 Evaluation of Potential Sources

Figure 5 displays a map of the locations and observed chloride concentrations (both October 2019 concentration and the range of chloride values observed in baseline and detection monitoring) for the monitoring wells and surface water sources described in Section 5.2. As shown in Figure 1, groundwater generally flows from the west to the east. To assist with the identification of potential chloride sources to MW-49, Figure 6 compares the ranges of chloride concentrations for the monitoring wells and surface water sources on the site with a box and whisker plot. Figure 7 displays a cross plot of the sulfate to chloride ratio versus the calcium to chloride ratio as a method of comparing different water qualities across the site. Piper plots were not employed due to inconsistently having the full suite of cations and anions analytical results for the different potential chloride sources at the site.

Several potential sources can contribute chloride to local groundwater at CCS, including outflows of plant cooling water from the Extended Basin, seepage from the Drains Pond System, and seepage from Upstream Raise 91. These three potential sources of chloride to groundwater are described in this section.

5.3.1 Upstream Raise 91

The chloride concentration measured in the sample from the Upstream Raise 91 sump (790 mg/L) does indicate that seepage (if occurring) from Upstream Raise 91 could increase the chloride concentrations in MW-49. The presence of the liner system at Upstream Raise 91 (a 2-foot thick compacted clay liner with a hydraulic conductivity of 1×10^{-7} cm/sec or less underlying a 40-mil HDPE geomembrane) reduces the likelihood of seepage to groundwater. Figure 7 indicates that contact water in the Upstream Raise 91 sump has lower calcium to chloride ratios and lower sulfate to chloride ratios than water observed at MW-49. If seepage from Upstream Raise 91 was impacting groundwater at MW-49 a shift in both of these ratios in the most recent samples from MW-49 towards those observed in the Upstream Raise 91 sump would be expected.

5.3.2 Drains Pond

Given the physical proximity of the east cell of the Drains Pond System (Drains Pond) to MW-49 and the elevated chloride concentrations observed in the surface water of the Drains Pond (125 to 827 mg/L), seepage (if occurring) from the Drains Pond could have the potential to elevate chloride concentrations at MW-49. The presence of the liner system at the Drains Pond (a 2-foot thick compacted clay liner with a hydraulic conductivity of 1×10^{-7} cm/sec or less underlying a 40-mil HDPE geomembrane) reduces the likelihood of seepage to groundwater. Contact water in the

Drains Pond has lower calcium to chloride ratios than water observed in MW-49 (Figure 7). If seepage from the Drains Pond was impacting groundwater at MW-49 a shift in the calcium to chloride ratios in the most recent samples from MW-49 towards those observed in the Drains Pond would be expected.

5.3.3 Upgradient Plant Cooling Water

To the west of Upstream Raise 91 and Coal Creek Station, water used for plant cooling is stored in the Extended Basin, which holds approximately 60 million gallons and is clay lined. This water originates from the Missouri River, but is cycled up to 15 times through the cooling towers. As the water is cycled, heat from the powerplant drives evaporation, which concentrates the constituents in the Extended Basin. Between 1988 and 2019, chloride concentrations in the Extended Basin ranged between 158 and 300 mg/L.

Nearby monitoring wells (MW-62, MW-63, and MW-65) located upgradient of the powerplant and immediately adjacent to the Extended Basin also have elevated chloride concentrations ranging from 8.0 to 290 mg/L indicating that water from the Extended Basin is impacting groundwater chloride concentrations. The elevated concentrations from the Extended Basin show considerable increase relative to MW-96, a background well for the plant that is side-gradient to the Extended Basin. Chloride concentrations at MW-96 range between 4.2 and 7.8 mg/L.

The water from the Extended Basin also appears to be impacting wells further downgradient. The concentrations observed along the flow path from the Extended Basin towards MW-49 include:

- The EEG wells located east of the Extended Basin have chloride concentrations ranging from between 58 and 130 mg/L.
- Well MW-DP5 downgradient from the plant and upgradient of the Drains Pond, has chloride concentrations between 66.0 and 84.8 mg/L. Well MW-DP3 also upgradient of the Drains Pond has chloride concentrations between 8.6 and 19.8 mg/L.
- Wells MW-91-2 and MW-75 upgradient of Upstream Raise 91 and side gradient to the Extended Basin have chloride concentrations between 1.1 and 16.8 mg/L.

Variations in screened lithology and preferential flow paths in the glacial till may explain why some wells downgradient of the Extended Basin show elevated chloride concentrations while other wells (MW-DP3, MW-91-2, and MW-75) have chloride concentrations more similar to MW-96.

Figure 7 demonstrates that surface waters from the Extended Basin may be influencing ion ratios in groundwater samples from monitoring wells upgradient of Upstream Raise 91, including MW-62, MW-63, MW-65, MW-17-2, and MW-17-5, and monitoring wells downgradient of Upstream Raise 91, including MW-49 and MW-91-1.

The recent removal of the Duck Pond and regrading of the area directly upgradient of the Drains Pond potentially altered the hydrological flow paths to MW-49 and increased the proportion of water with elevated chloride from the Extended Basin monitored at MW-49. In addition to the changing flow paths, the removal of the Duck Pond also eliminated infiltration of water from the Duck Pond to groundwater, which may have provided a dilution effect to groundwater concentrations upgradient of MW-49.

6.0 EVIDENCE OF AN ALTERNATIVE SOURCE

Based on the review of sampling sources, laboratory sources and potential alternate site sources of chloride presented in this report, primary lines of evidence and conclusions drawn from the evidence used to support this ASD are provided in Table 1.

Table 1: Primary and Supporting Lines of Evidence from ASD Analysis

Key Line of Evidence	Supporting Evidence	Description
Change in Field Personnel	Changed to site personnel from MVTL	Although using the same sampling methods, there is a potential for minor differences in sampling technique between sampling personnel. The timing of the change in sampling personnel coincides with the June 2018 shift in chloride concentrations.
Change in Laboratory and Methodology	Changed to TestAmerica from MVTL	The timing of the change in laboratory coincides with the June 2018 shift in chloride concentrations.
	Change from potentiometric method (SRM 4500-CL) to ion chromatography method (SRM 9056A)	Prior to June 2018, MVTL used method SM4500-Cl- E to measure chloride concentrations. Starting in June 2018, TestAmerica analyzed chloride concentrations by SW9056A. These methods have different mechanisms, detection limits, and matrix effects. The timing of the change in methodology coincides with the June 2018 shift in chloride concentrations.
Laboratory Artifact Biasing High Sample Concentrations	Ion chromatographs reflecting different data processing practices between some calibration standards and samples	Golder's review of the TestAmerica ion chromatography data identified several data processing practices (integration time length, baseline selection, and treatment of minor peaks) that have the potential to bias high chloride concentrations (Figure 4).
Groundwater Geochemistry	Relative ion abundances in groundwater differs from Upstream Raise 91 sump water and Drains Pond surface water	The water quality signature of groundwater samples collected from downgradient well MW-49 are not consistent with the signature of potential seepage from Upstream Raise 91. As presented in the Figure 7, differences in calcium-chloride and sulfate-chloride ratios are distinctly different between the ash-impacted waters and the downgradient groundwater samples, including from MW-49.

Key Line of Evidence	Supporting Evidence	Description
Local Sources of Chloride	Elevated chloride concentrations in the Extended Basin and other wells downgradient of the Extended Basin	Figure 6 suggests that chloride concentrations in the plant cooling water (Extended Basin) are impacting groundwater chloride concentrations in wells downgradient from the Extended Basin. Similarities in the ion ratios between water samples collected from MW-49 , the Extended Basin, and wells immediately downgradient of the Extended Basin (Figure 7) suggest that the Extended Basin may be a potential source for elevated chloride at MW-49.
	Hydrogeology	The removal of the Duck Pond in 2015 and regrading of the area directly upgradient of the Drains Pond potentially altered the hydrological flow paths, resulting in higher chloride concentrations at MW-49. This would be due to an increase in the proportion of groundwater potentially impacted by the Extended Basin and the removal of the more dilute water infiltrating from the Duck Pond.

7.0 CONCLUSION

In accordance with 40 CFR 257.95(g)(3), this ASD has been prepared in response to the identification of a verified SSI for chloride at monitoring well MW-49 following the Q4 2019 sampling event for Upstream Raise 91 at Coal Creek Station.

Based on review of historical analytical results and testing procedures, recent changes to chloride concentrations in groundwater at MW-49 are likely not a result of seepage from Upstream Raise 91 but can be attributed to laboratory artifacts and variability in the upgradient groundwater sources. Therefore, no further action (i.e., a transition to Assessment Monitoring) is warranted, and Upstream Raise 91 will remain in detection monitoring.

8.0 REFERENCES

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Signature Page

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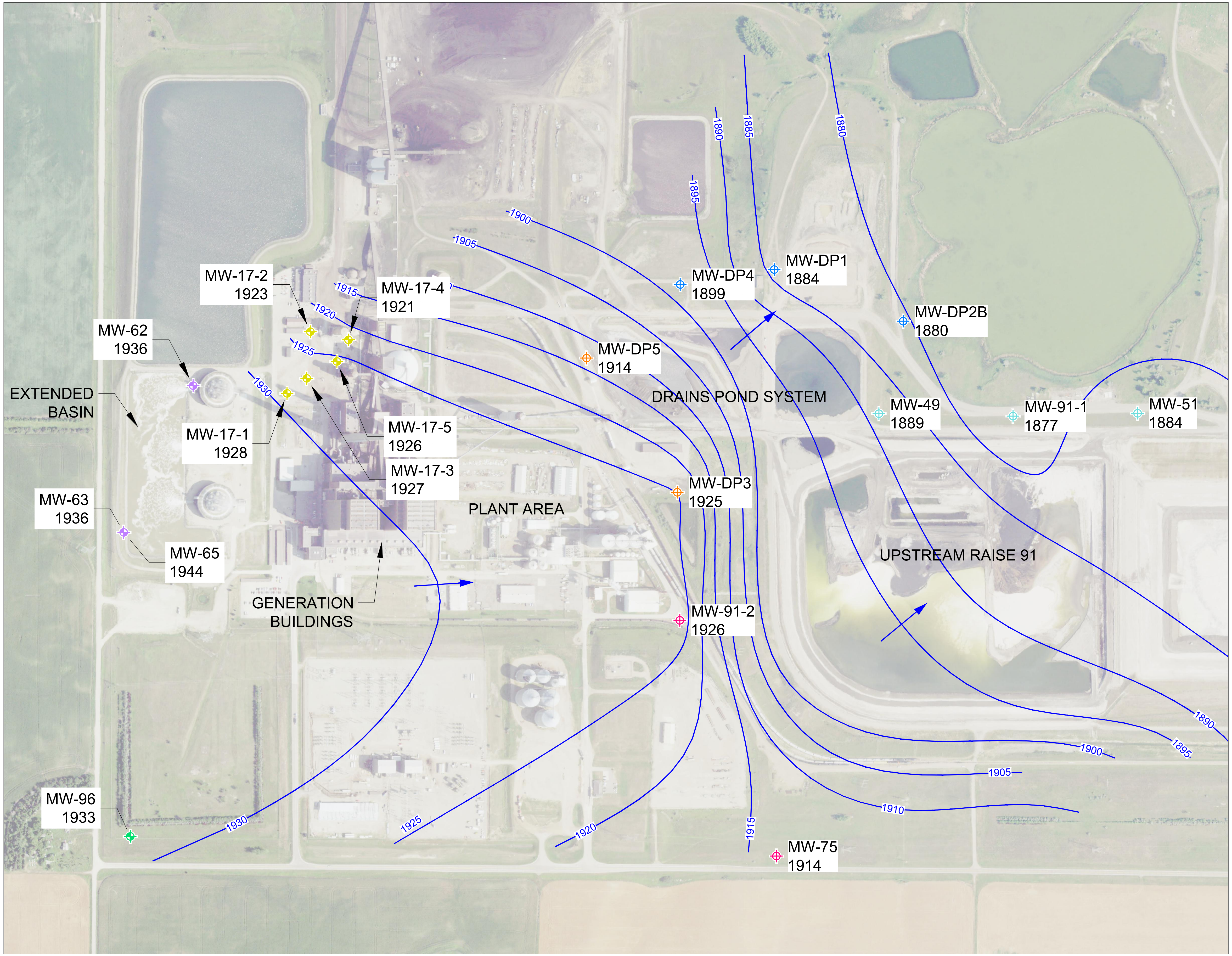
https://golderassociates.sharepoint.com/sites/120551/project files/6 deliverables/19136224c/reports/1-rpt_mw49-asd/1-rpt-0/19136224_asd-q42019_final_13may2020.docx

FIGURES

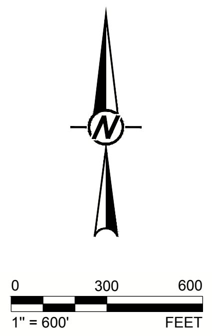


LEGEND

⌖ NDDEQ PLANT AREA UPGRADIENT WELL
⌖ NDDEQ PLANT AREA DOWNGRADIENT WELL
⌖ EEG PROGRAM WELL
⌖ DRAINS POND SYSTEM UPGRADIENT WELL
⌖ DRAINS POND SYSTEM DOWNGRADIENT WELL
⌖ UPSTREAM RAISE 91 UPGRADIENT WELL
⌖ UPSTREAM RAISE 91 DOWNGRADIENT WELL
→ GENERAL DIRECTION OF GROUNDWATER FLOW
— 1930 — POTENTIOMETRIC SURFACE CONTOURS

NOTE(S)

1. GROUNDWATER ELEVATIONS WERE MEASURED OCTOBER 2019, ELEVATION FEET ABOVE MEAN SEA LEVEL.
2. POTENTIOMETRIC SURFACE CONTOURS WERE CREATED FROM WATER LEVEL INFORMATION FROM THE OCTOBER 2019 GROUNDWATER ELEVATIONS SHOWN, AS WELL AS SURVEYED SURFACE WATER EXPRESSIONS, ADDITIONAL SITE WELLS, AND PIEZOMETERS NOT SHOWN. CONTOUR INTERVAL IS 5 FEET.
3. AERIAL IMAGERY OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE IMAGERY PROGRAM, 2018.



GOLDER

ALTERNATIVE SOURCE DEMONSTRATION
OCTOBER 2019 GROUNDWATER CONTOURS AND
SAMPLING LOCATIONS

FIGURE 1

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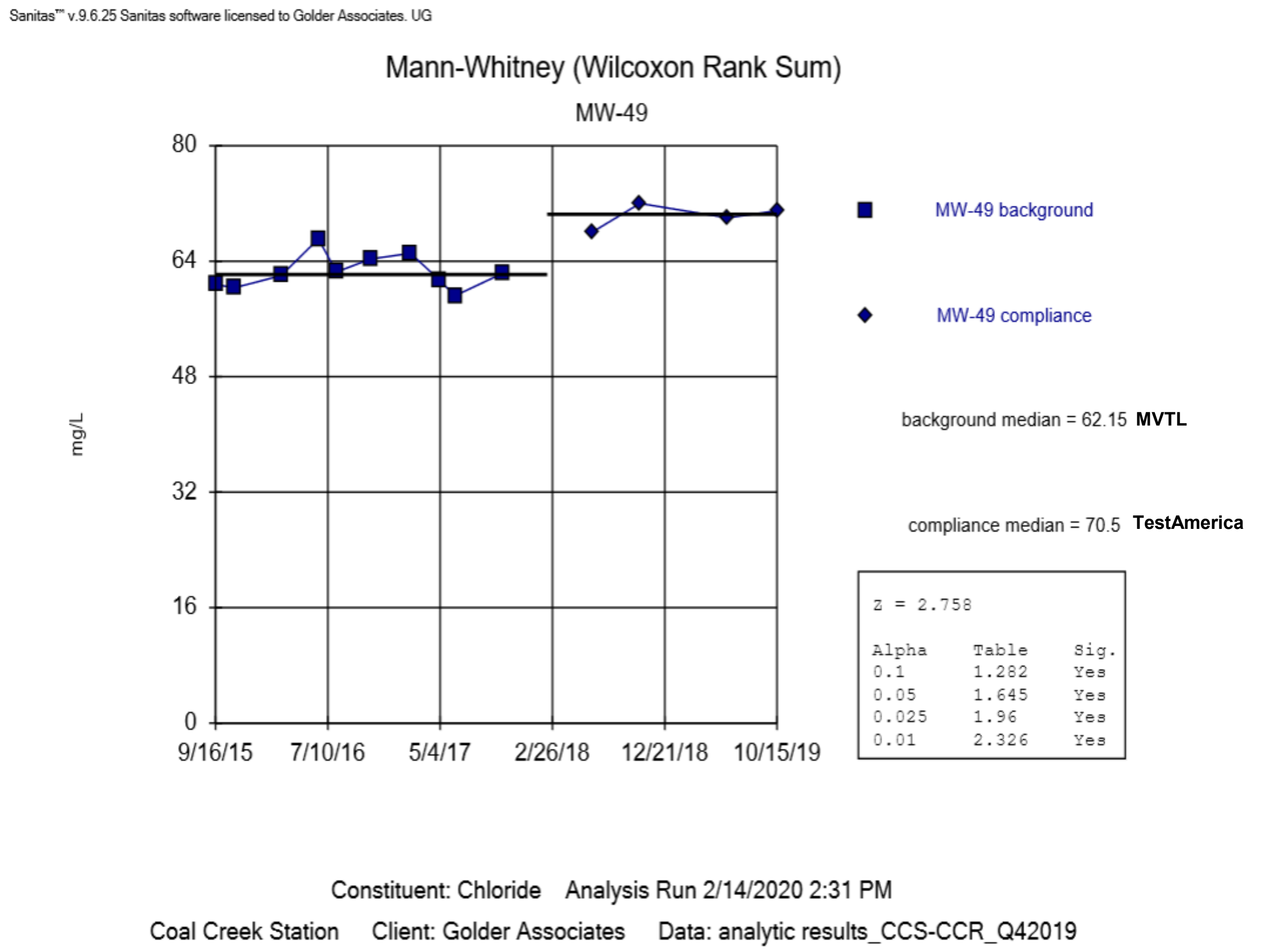

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Z = 2.758

Alpha     Table     Sig.
0.1       1.282     Yes
0.05      1.645     Yes
0.025     1.96      Yes
0.01      2.326     Yes
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CLIENT	PROJECT
Great River Energy Coal Creek Station	GRE CCS 2020 Consulting

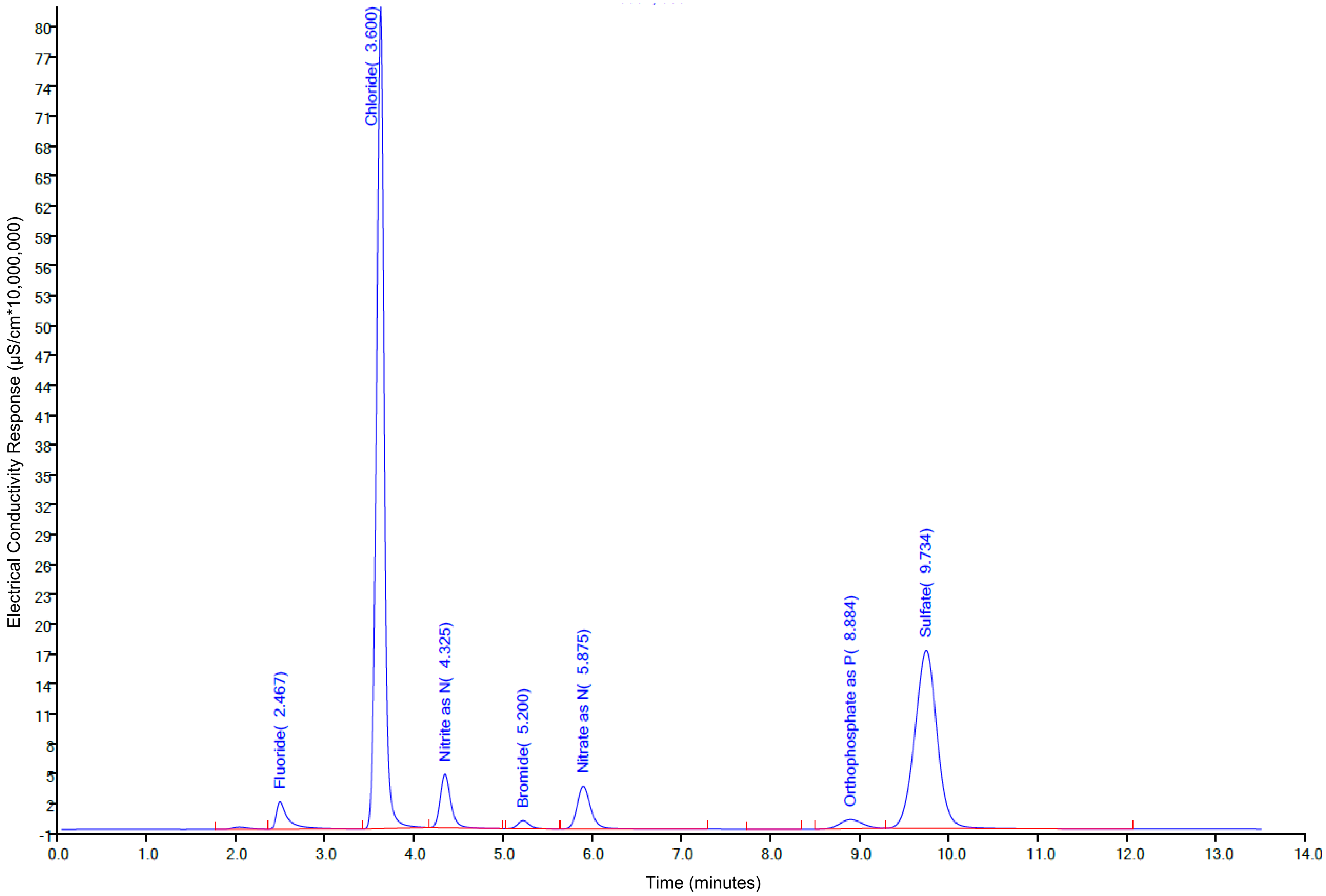
CONSULTANT

GOLDER

TITLE

Wilcoxon Rank-Sum Test for MW-49 Chloride Concentrations

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	A	2



CLIENT
Great River Energy Coal Creek Station

CONSULTANT
GOLDER

PROJECT
GRE CCS 2020 Consulting

TITLE
Example of Ion Chromatograph Data

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	A	3

1 in

Software Data Processing

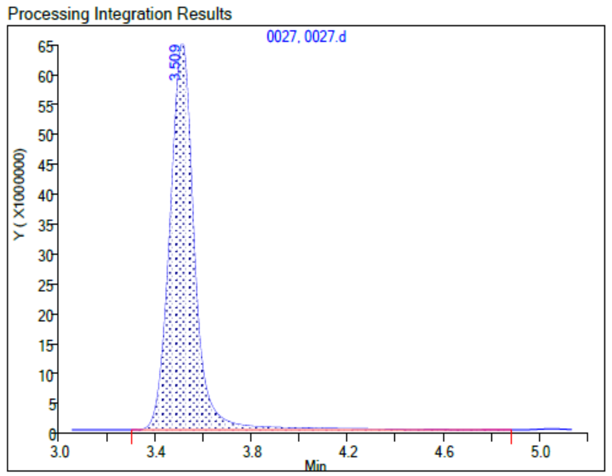
Manual Processing

Example #1:

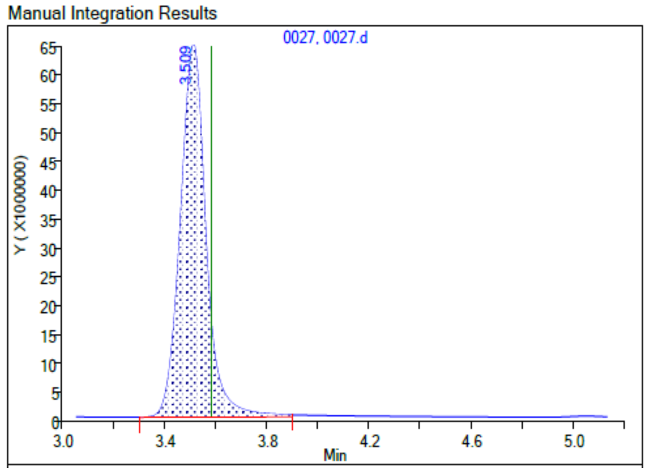
Shortened peak integration time to match calibration standards

Manual processing would decrease chloride concentration by 1.8%

RT: 3.51
Area: 457407359
Amount: 71.627674
Amount Units: ug/ml


Processing Integration Results

RT: 3.51
Area: 449145333
Amount: 70.344660
Amount Units: ug/ml

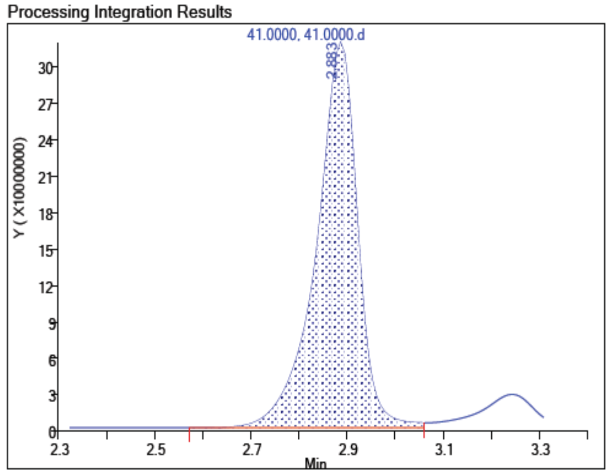

Manual Integration Results

Example #2:

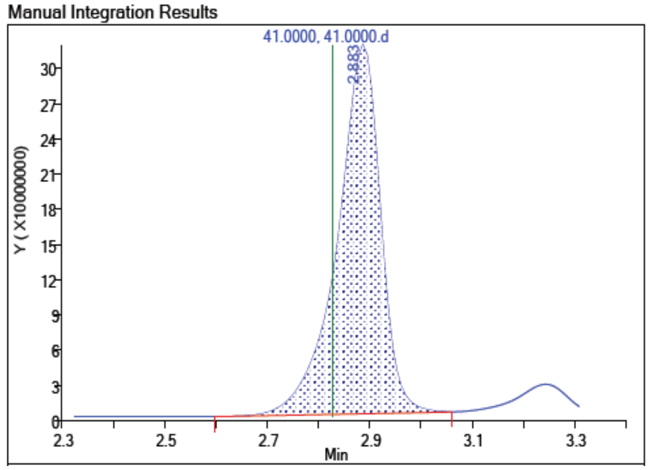
Right side of baseline brought up to minimum signal valley (not below valley), consistent with calibration standards

Manual Processing would decrease chloride concentration by 2.8%

RT: 2.88
Area: 1882027750
Amount: 107.4024
Amount Units: ug/ml


Processing Integration Results

RT: 2.88
Area: 1830626225
Amount: 104.4716
Amount Units: ug/ml

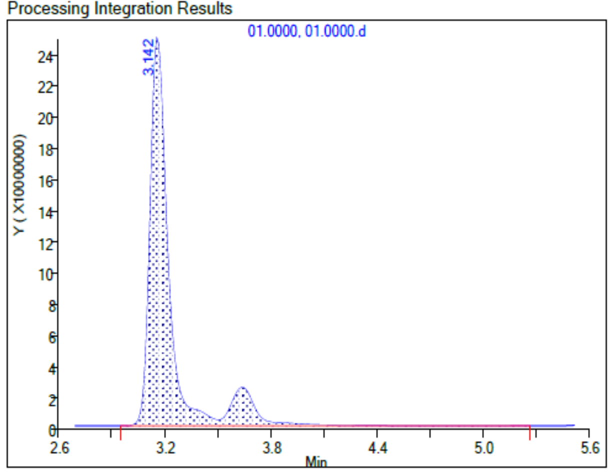

Manual Integration Results

Example #3:

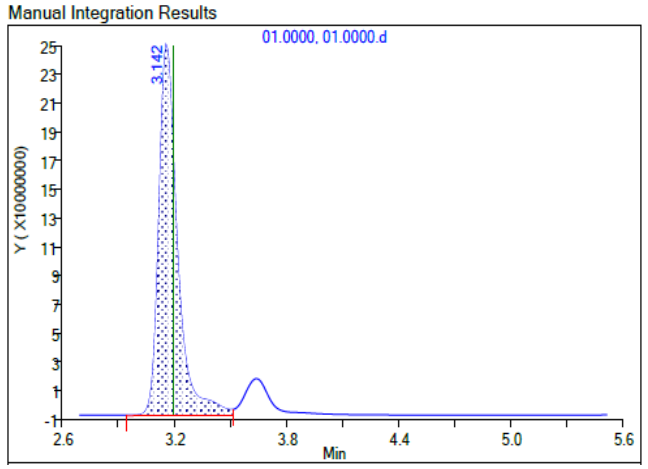
Minor peak to the right of chloride peak not included in area of chloride peak, consistent with calibration standards

Manual Processing would decrease chloride concentration by 4.2%

RT: 3.14
Area: 1753223086
Amount: 98.471277
Amount Units: ug/ml


Processing Integration Results

RT: 3.14
Area: 1683282689
Amount: 94.545083
Amount Units: ug/ml


Manual Integration Results

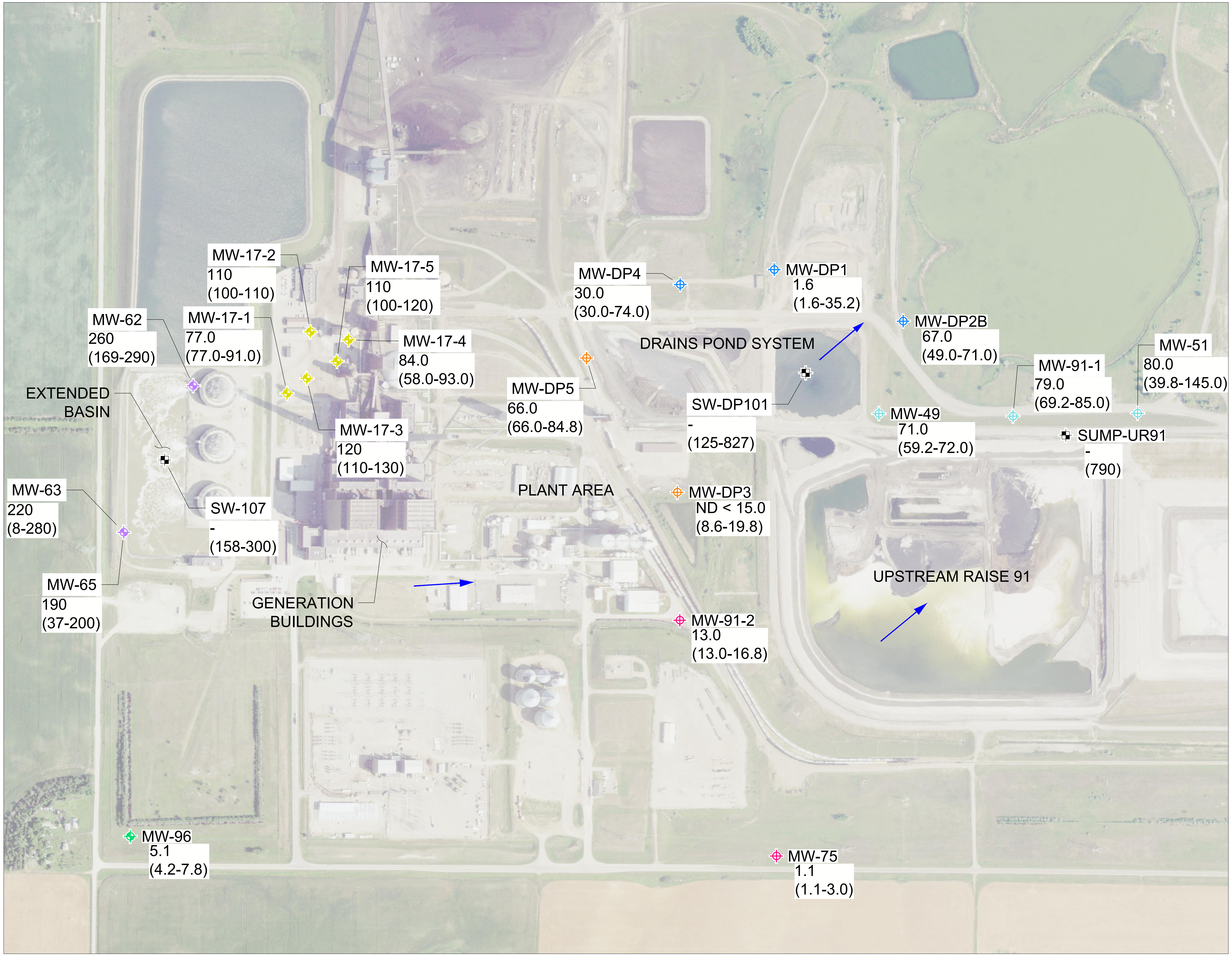
CLIENT
Great River Energy Coal Creek Station

PROJECT
GRE CCS 2020 Consulting

CONSULTANT
GOLDER

TITLE
Comparison of Ion Chromatograph Software Data Process versus Manual Adjustments

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	A	4

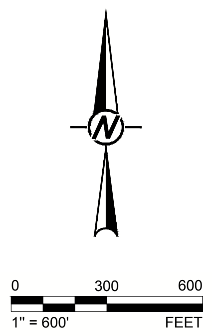


LEGEND

- ⌖ NDDEQ PLANT AREA UPGRADIENT WELL
- ⌖ NDDEQ PLANT AREA DOWNGRADIENT WELL
- ⌖ EEG PROGRAM WELL
- ⌖ DRAINS POND SYSTEM UPGRADIENT WELL
- ⌖ DRAINS POND SYSTEM DOWNGRADIENT WELL
- ⌖ UPSTREAM RAISE 91 UPGRADIENT WELL
- ⌖ UPSTREAM RAISE 91 DOWNGRADIENT WELL
- ▚ OTHER SAMPLING LOCATION
- → GENERAL DIRECTION OF GROUNDWATER FLOW
- 71.0 OCTOBER 2019 CHLORIDE CONCENTRATION (mg/L)
- (59.2-72.0) RANGE IN CHLORIDE CONCENTRATIONS, (mg/L)

NOTE(S)

1. AERIAL IMAGERY OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE IMAGERY PROGRAM, 2018.
2. SAMPLES FROM MW-DP5, MW-DP3, MW-DP2B, MW-DP1, MW-DP4, MW-91-2, MW-75, MW-49, MW-91-1, AND MW-51 WERE COLLECTED BETWEEN SEPTEMBER 2015 AND MARCH 2020. JUNE 2019 SAMPLES FROM MW-91-1 AND MW-91-2 WERE NOT USED BECAUSE OF SUSPECTED QUALITY CONTROL ISSUE.
3. SAMPLES FROM SW-DP101 WERE COLLECTED BETWEEN 2014 AND JUNE 2019. NO SAMPLE WAS COLLECTED FROM SW-DP101 IN OCTOBER 2019.
4. SAMPLE FROM SUMP-UR91 WAS COLLECTED FROM NOVEMBER 2018. THE RANGE SHOWN FOR SUMP-UR91 REPRESENTS THE SINGLE CHLORIDE SAMPLE COLLECTED FROM THE LOCATION. NO SAMPLE WAS COLLECTED FROM SUMP-UR91 IN OCTOBER 2019.
5. SAMPLES FROM MW-17-1, MW-17-2, MW-17-3, MW-17-4, AND MW-17-5 WERE COLLECTED BETWEEN JANUARY 2018 AND OCTOBER 2019.
6. SAMPLES FROM MW-96, MW-62, MW-63, AND MW-65 WERE COLLECTED BETWEEN OCTOBER 1988 AND OCTOBER 2019.
7. SAMPLES WERE COLLECTED FROM SW-107 BETWEEN OCTOBER 1988 AND JUNE 2019. NO SAMPLE WAS COLLECTED FROM SW-107 IN OCTOBER 2019.



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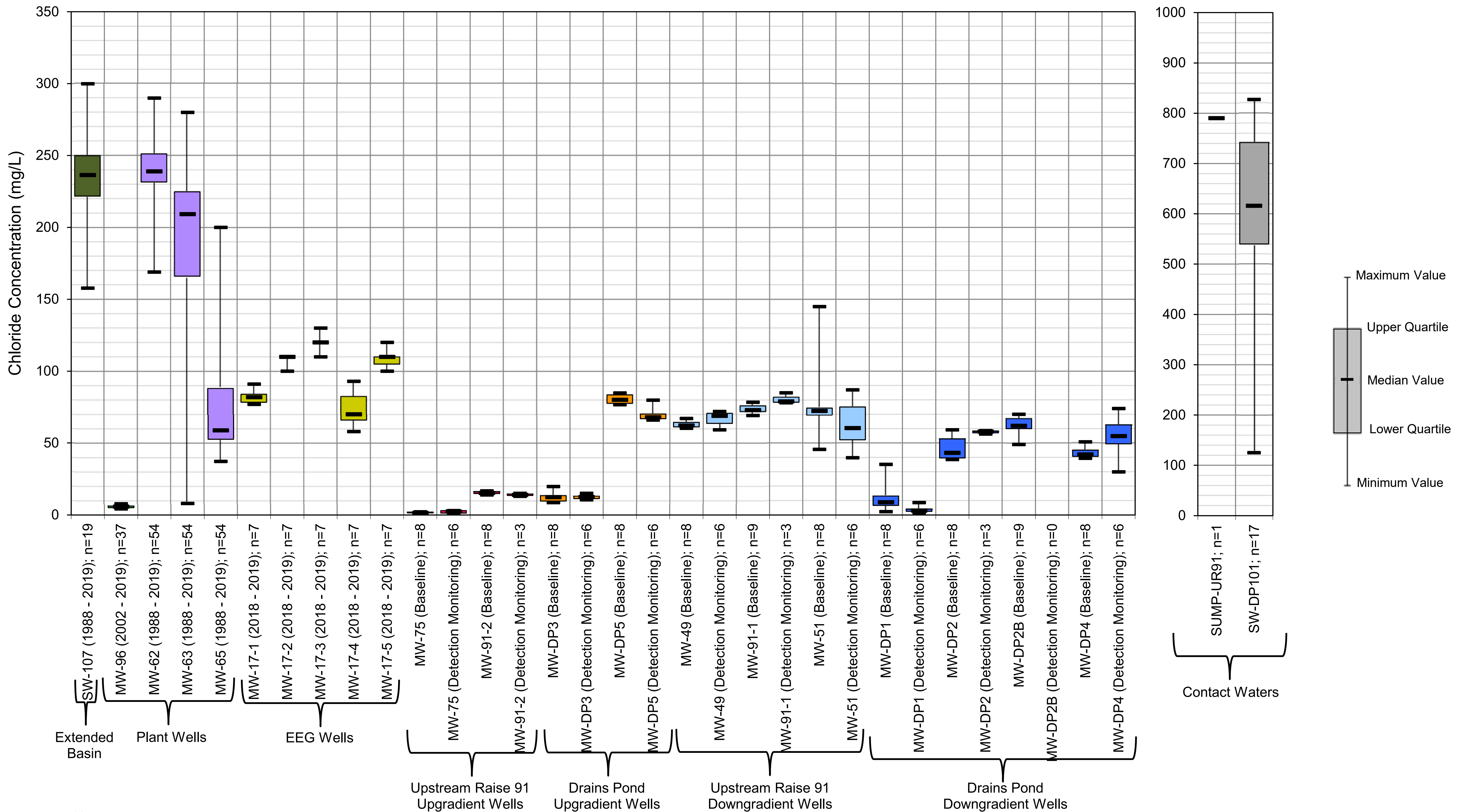
GOLDER

ALTERNATIVE SOURCE DEMONSTRATION
CHLORIDE CONCENTRATIONS

FIGURE 5



Notes:
Non-Detect replaced with the detection limit

June 2019 samples from MW-91-1 and MW-91-2 not used because of a suspected quality control issue.

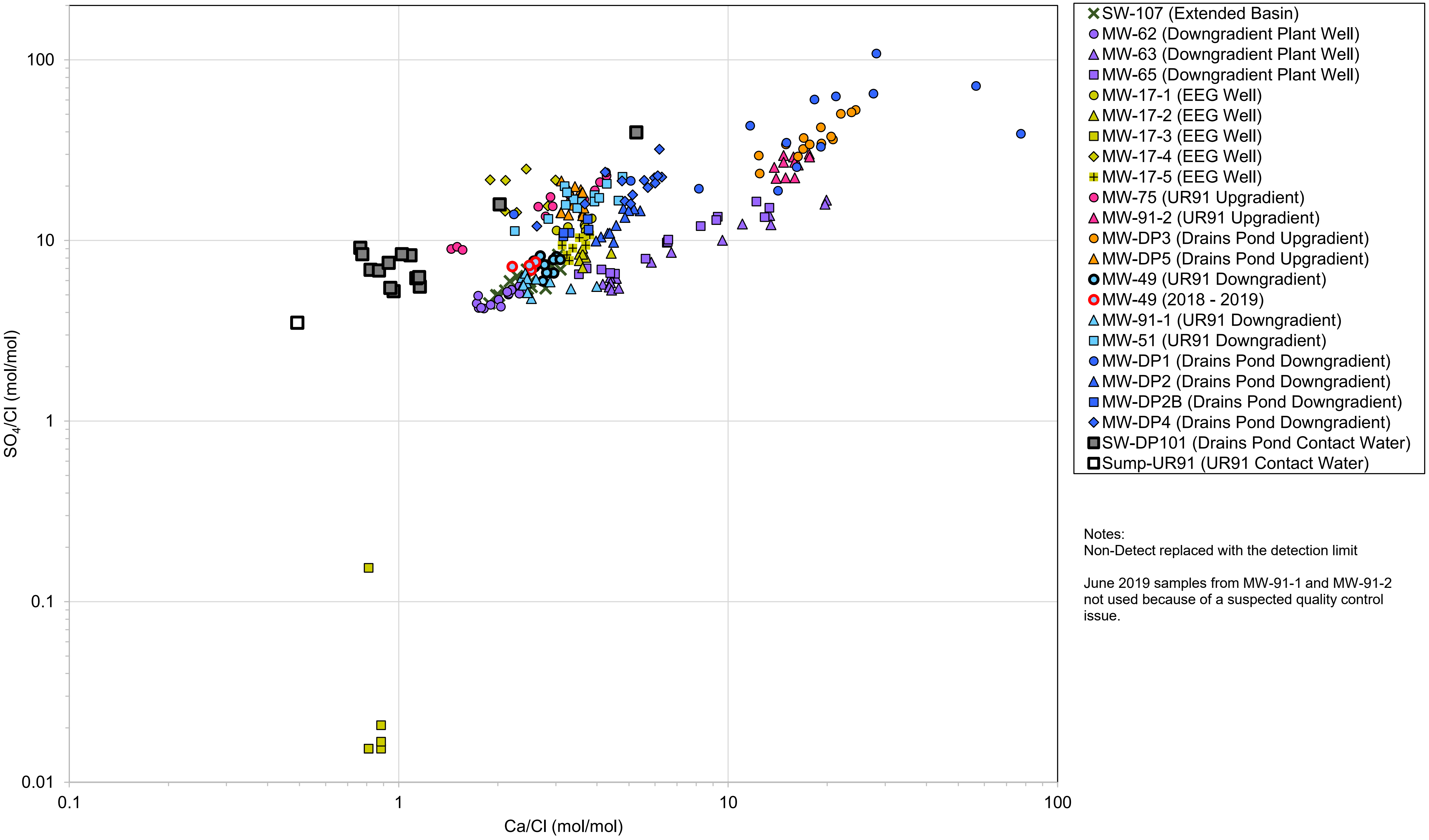
CLIENT	PROJECT
Great River Energy Coal Creek Station	Alternate Source Demonstration

CONSULTANT

GOLDER

TITLE
Box and Whisker Plot for Chloride

PROJECT NO.	PHASE	REV.	FIGURE
19136224	3	A	6



Notes:
Non-Detect replaced with the detection limit

June 2019 samples from MW-91-1 and MW-91-2
not used because of a suspected quality control
issue.

CLIENT
Great River Energy Coal Creek Station

PROJECT
GRE CCS 2020 Consulting

CONSULTANT
GOLDER

TITLE
Sulfate-Chloride versus Calcium-Chloride Ratio

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	A	7

APPENDIX B

Alternative Source Demonstrations - Q2 2020

REPORT

Alternative Source Demonstration for Fluoride in Monitoring Well MW-DP4

Great River Energy - Coal Creek Station

Submitted to:

Great River Energy

Coal Creek Station
2875 Third Street SW
Underwood, North Dakota 58576

Submitted by:

Golder Associates Inc.

7245 W Alaska Drive, Suite 200,
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+1 303 980-0540

19136224C-8-R-0

October 27, 2020

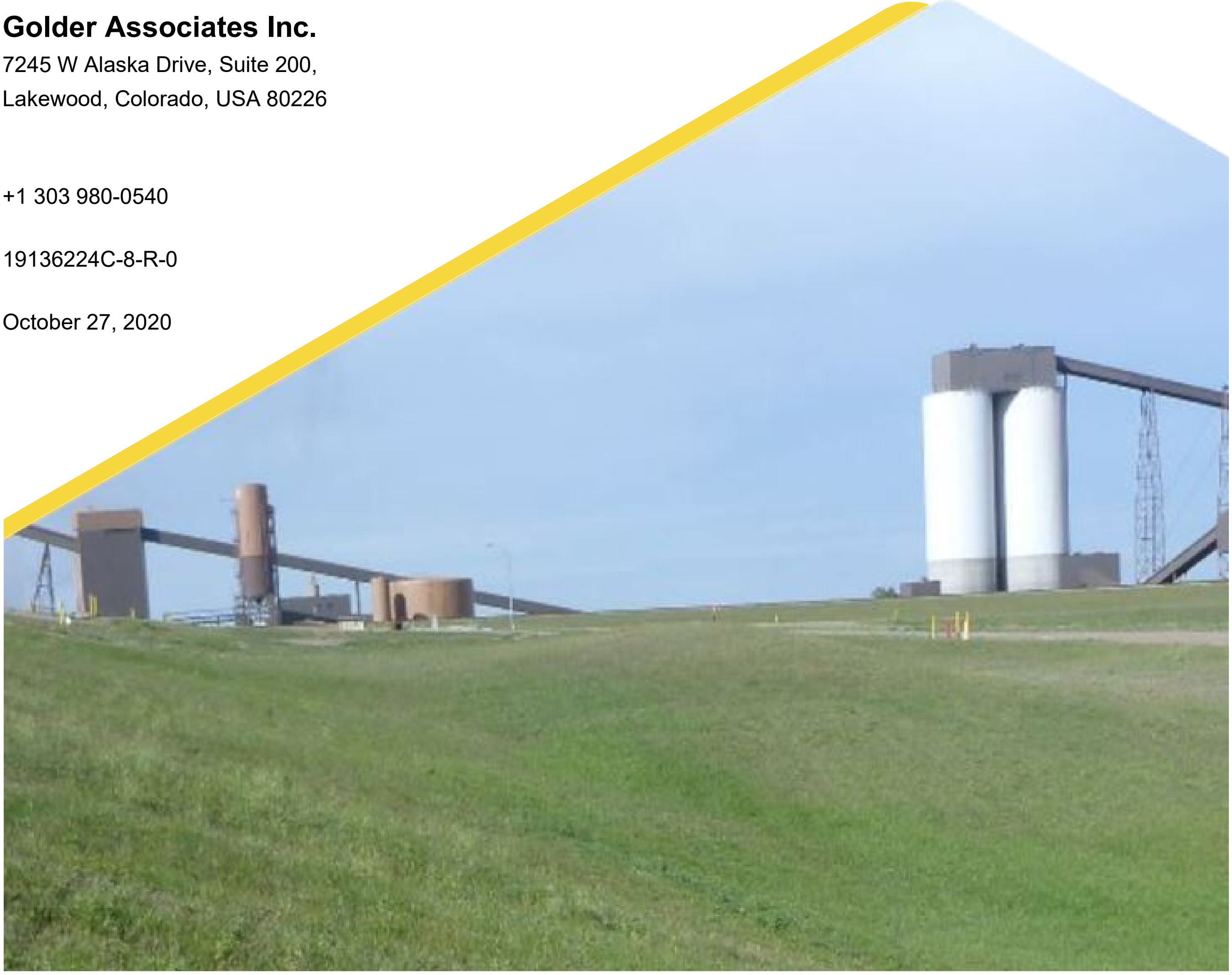

Table of Contents

TABLES

FIGURES

1.0 INTRODUCTION

On behalf of Great River Energy (GRE), Golder Associates Inc. (Golder) performed a statistical evaluation of groundwater monitoring results from the second quarter (Q2) 2020 groundwater detection monitoring event at Coal Creek Station's Drains Pond System coal combustion residual (CCR) surface impoundment. The statistical evaluation was performed as described in the Coal Combustion Residuals Groundwater Statistical Method Certification for Coal Creek Station, Revision 1 (Golder 2019a), in accordance with applicable provisions of 40 Code of Federal Regulations (CFR) Part 257, "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule" (CCR rule), as amended.

Statistical analyses of the Appendix III detection monitoring data for fluoride in groundwater at the downgradient monitoring well MW-DP4 indicated a potential exceedance of the statistical limit based on the parametric Shewhart-CUSUM (Cumulative Summation) control chart analysis of the fourth quarter (Q4) 2019 sampling results. This potential exceedance was subsequently verified as a statistically significant increase (SSI) following the Q2 2020 detection monitoring sampling event. Although determination of a verified SSI generally indicates that the groundwater monitoring program should transition from detection monitoring to assessment monitoring, 40 CFR Part 257.94(e)(2) allows the owner or operator (i.e., GRE) 90 days from the date of determining a verified SSI (July 29, 2020) to demonstrate a source other than the regulated CCR facility caused the SSI or that the SSI is an indication of an error in sampling, analysis, or statistical evaluation or natural variability in groundwater quality that was not fully captured during the baseline data collection period.

Golder's review of the hydrological and geologic conditions at the site indicates the fluoride SSI in MW-DP4 is not an indication of impacts from the CCR unit., A desktop study of previously collected CCR-impacted water from the facility, nearby surface water, and groundwater samples was conducted to assess potential fluoride sources. As a part of this work, potential error in the statistical analysis and the natural variability of fluoride concentrations in groundwater were evaluated. Based upon this review and in accordance with provisions of the CCR Rule, Golder has prepared this Alternative Source Demonstration (ASD) for fluoride at MW-DP4.

This ASD conforms to the requirements of 40 CFR Part 257.94(e)(2) and provides the basis for concluding that the verified SSI for fluoride at MW-DP4 is not an indication of a release from the Drains Pond System. The following sections provide a summary of the Drains Pond System, analytical and geochemical assessment results, and lines of evidence demonstrating an alternative source is responsible for the fluoride SSI at MW-DP4.

2.0 BACKGROUND

2.1 Site Background

GRE's Coal Creek Station (CCS) is a coal-fired electric generation facility located in McLean County, approximately 10 miles northwest of Washburn, North Dakota. CCRs are managed in composite-lined surface water impoundment cells and dry landfills regulated and permitted by the North Dakota Department of Environmental Quality (NDDEQ) in accordance with North Dakota Administrative Code (NDAC) Title 33.1, Article 33.1-20, Solid Waste Management and Land Protection.

CCS has four CCR facilities that are within the purview of the United States Environmental Protection Agency CCR rule. This ASD only applies to the Drains Pond System CCR surface impoundment. The Drains Pond System is located in the central portion of the plant site, east of the CCS plant buildings (Figure 1). The Drains Pond System is comprised of three cells: west, center, and east. Bottom ash, pulverizer rejects, and economizer ash are conveyed to the west cell where they are dewatered and hauled away to the other CCR facilities. Bottom ash, pulverizer rejects, and economizer ash transport water flows from the west cell to the center cell which acts as a clarifier facility and also receives minor amounts of sediment via the plant drains system. Water from the center cell flows to the east cell which is a non-CCR surface impoundment that is part of the plant process water storage inventory, acting as a clarifier for process water. Water from the east cell is recirculated back to the plant for reuse or is pumped to the onsite evaporation ponds or the permitted underground injection well.

2.2 Site Geology

CCS and McLean County are situated at the eastern-most extent of the Williston Basin, a structural and sedimentary basin (USGS 1999). The region is characterized by the presence of glacial drift, reaching thicknesses of several hundred feet and overlying the Sentinel Butte Member, the source of commercially mined coal in the direct vicinity of CCS (Falkirk 1979). The Sentinel Butte Member is the highest strata of the Paleocene Fort Union Formation, overlying the Tongue River, Ludlow, and Cannonball Members (USGS 1999). The Sentinel Butte Member is marked by drab-gray units, demarcating the separation from the lower Tongue River Member.

The site geology of CCS includes unconsolidated surficial deposits of the Coleharbor formation, consisting of stratified and unstratified glacial drift. The near-surface materials are silty clay and sandy clay till with interbedded lenses (CPA/UPA 1989).

2.3 Site Hydrogeology

Regional groundwater flow of the uppermost water-bearing unit in the vicinity of CCS is a subtle expression of the surface topography, which is influenced by the configuration of the eroded bedrock. Based on available groundwater elevation data, the shallow groundwater at the CCR facilities at CCS generally follows surface topography, flowing east and north towards Lower Samuelson Slough and Sayler Slough. Available groundwater elevation data indicate that groundwater in the area of the Drains Pond System generally flows from the southwest to the northeast, diagonally across the footprint of the facility, towards Lower Samuelson Slough.

Hydraulic conductivities in the area of the Drains Pond System range from 0.35 feet per day (ft/day) to 21.60 ft/day, with calculated groundwater flow rates during the Q2 2020 detection monitoring event ranging from 0.09 to 5.41 ft/day.

2.4 Groundwater Monitoring Network

The groundwater monitoring network for the Drains Pond System was developed for the size, disposal and operational history, anticipated flow direction, and location of adjacent facilities. Based on these factors, a monitoring well network consisting of two upgradient and four downgradient monitoring wells is used for monitoring the unit under the CCR rule.

The two upgradient monitoring wells (MW-DP3 and MW-DP5) included in the groundwater monitoring network for the Drains Pond System are used to represent upgradient water quality flowing towards the unit from the west and south (Golder 2019b). The four downgradient wells (MW-DP1, MW-DP2, MW DP2B, and MW-DP4) are positioned along the northern and eastern edges of the facility. Following the end of sample collection for the baseline monitoring period, MW-DP2 has had insufficient water to allow for routine sampling; therefore, MW-DP2B was installed in 2019 to provide further coverage for the monitored unit. The Drains Pond System network wells are presented in Figure 1. Other monitoring locations used to support this ASD are also presented in Figure 1 and are discussed further in Section 3.0.

Figure 2 displays a time-series plot of historical water levels in each monitoring well associated with the Drains Pond System. Water levels in upgradient monitoring wells MW-DP3 and MW-DP5 increased by approximately 2 to 5 feet between Q4 2018 and Q2 2020. A similar increase in water level was also observed in downgradient monitoring well MW-DP4 during the same period. The recent changes in water levels at upgradient and downgradient monitoring wells around the Drains Pond System and the timing of those changes suggest a change to groundwater flow conditions.

2.5 Groundwater Conditions

Between September 2015 and August 2017, GRE collected nine independent baseline groundwater samples from MW-DP3, MW-DP5, MW-DP1, MW-DP2, and MW-DP4, as required by 40 CFR 257.94, for use within the CCR rule monitoring program. Baseline samples were collected from MW-DP2B between June 2019 and March 2020, following installation of the well in 2019. The results of the CCR baseline monitoring were used to develop statistical limits for each constituent at each monitoring well, based on site conditions and parameter specific characteristics such as the data distribution and detection frequency (Golder 2019a).

Following completion of the baseline monitoring events at each well, GRE began collecting groundwater samples on a semi-annual basis to support the detection monitoring program. Groundwater samples for detection monitoring are collected at each upgradient and downgradient monitoring well and analyzed for 40 CFR Part 257 Appendix III constituents. During the detection monitoring program, groundwater analysis results are compared to the calculated statistical limits to determine whether groundwater quality remains consistent or if changes in groundwater quality are observed.

In accordance with the site Statistical Method Certification (Golder 2019a) and recommendations within the USEPA’s Unified Guidance (USEPA 2009), a baseline update was conducted for most well-constituent pairs within the Drains Pond System monitoring network prior to conducting comparative statistical analysis for the Q4 2019 detection monitoring event. As a result of the baseline update, results collected during the detection monitoring program were evaluated to determine if they were from the same statistical population as those collected during the initial baseline monitoring program.

Fluoride concentrations in groundwater at MW-DP4 during the initial baseline monitoring period ranged between 0.13 and 0.19 milligrams per liter (mg/L) in the nine baseline samples collected as part of the CCR rule monitoring program. Detection monitoring samples collected between October 2017 and June 2019 were incorporated into the updated baseline period, ranging between 0.11 and 0.18 mg/L. Of the four samples collected between October 2017 and June 2019, one result was excluded from the updated baseline data set, having been identified as an outlier. The result identified as an outlier was reported as a non-detect with an elevated reporting limit (ND < 0.5 mg/L). The Shewhart-CUSUM statistical limit for the well-constituent pair was set at 0.24 mg/L following the baseline update.

The Q4 2019 detection monitoring event reported a fluoride concentration of 0.25 mg/L at MW-DP4, with a calculated CUSUM value of 0.23 mg/L, exceeding the statistical limit. Verification resampling was conducted during the Q2 2020 detection monitoring event, confirming the SSI for fluoride at MW-DP4 with a fluoride concentration of 0.28 mg/L and a calculated CUSUM value of 0.34 mg/L.

3.0 POTENTIAL SITE FLUORIDE SOURCES

To assess the potential sources for a change in fluoride concentrations at MW-DP4, Golder reviewed recent site changes upgradient of the Drains Pond System, as well as previously collected data from the CCR rule program and other site monitoring data that are collected under other programs. The following sections summarize the supplemental assessment activities.

3.1 Site Changes and Potential sources

The following sections discuss site changes and potential impacts associated with those changes. Site changes may have affected constituent concentrations entering the groundwater system or the hydrologic and hydrogeologic conditions (water balance) of the site.

3.1.1 Duck Pond and Drains Pond System Construction

Beginning in 2015, the drainages on the south and southwest and sides of the Drains Pond System were modified to allow for construction of an expansion to the Drains Pond System. As a part of this construction, modifications to the existing drainage pathways adjacent to the footprints of the west and center cells of the Drains Pond System were required and the composite-lined west and center cells of the Drains Pond System were constructed.

Historically, the Duck Pond area was a low-lying area southwest of the east cell of the Drains Pond System (Figure 1). The depth of water contained in this area was generally 12 feet (water surface elevation approximately 1911 feet) and the Duck Pond had a surface area of approximately three acres. As the water level increased, overflow passed through culvert piping to the north under what is now the center cell of the Drains Pond System. As part of the construction in 2015, the Duck Pond was dewatered, the area was graded, and culverts were installed to drain surface water south and east around the south side of Upstream Raise 91.

The recent removal of the Duck Pond and regrading of the area upgradient of the Drains Pond System potentially altered the hydrological flow paths to MW-DP4. In addition to the changing flow paths, the removal of the Duck Pond also eliminated infiltration of water from the Duck Pond to groundwater, which may have provided a dilution effect on groundwater concentrations upgradient of MW-DP4.

3.1.2 Surface Water Drainage Ditch West of Drains Pond System

The west cell of the Drains Pond System is separated from a rail line to the west by a surface water drainage ditch. The rail cars using the line directly west of the Drains Pond System are primarily used to transport coal from CCS offsite and additional rail lines further to the west are primarily used to transport fly ash from CCS offsite for beneficial use. The haul road directly east of this surface water drainage ditch is used by GRE personnel to load bottom ash, pulverizer rejects, and economizer ash into trucks for disposal in the various CCR containment facilities.

The surface water drainage ditch mostly receives runoff due to precipitation from the rail line slope to the west and the embankment of the west cell of the Drains Pond System to the east. Since there is a potential for runoff into this surface water drainage ditch to contain contact water associated with either handling of coal or CCR during heavy rain events or snow melt, the ditch was originally designed to flow to the south and east, eventually draining into the center cell of the Drains Pond System. Due to operational constraints (pipeline alignments and haul routes), this drainage ditch no longer has the ability to passively drain into the Drains Pond System as described above. Therefore, water has been noted to accumulate in this drainage ditch occasionally. Therefore, stagnant water that previously would have readily flowed via the surface water drainage ditch toward the Drains Pond System may be infiltrating and impacting groundwater quality.

3.1.3 Plant Drains Pipe Corridor

Two “plant drains” pipelines run parallel to the main west-east haul road (Figure 1) and currently end approximately 100 feet to the southwest of MW-DP4. These pipelines consist of a 36-inch diameter “plant drain” concrete pipeline (bell and spigot joints) and a 14-inch diameter “chemical drain” fiberglass reinforced pipeline which have each been in service since plant commissioning (approximately 40 years). The 36-inch “plant drain” pipeline primarily carries flow collected from various floor drains around the industrial block, of which a major contribution to the flow is typically overflow from the bottom ash hoppers. The 14-inch “chemical drain” pipeline conveys water from the cooling water system (cooling water blowdown) and the chemistry laboratory. Cooling water blowdown is representative of the water contained in the Extended Basin and water from the chemistry laboratory includes water from the room sink and floor drains as well as demineralizer regen and reverse osmosis “clean in place” waste.

Construction in 2015 modified these pipelines so that they can passively drain into the center cell of the Drains Pond System via a new precast concrete manhole. Upstream of the new precast concrete manhole, the 36-inch “plant drain” pipeline was cleaned out using high-pressure water. During the cleanout process, a significant amount of sediment was removed; however, it was noted that a significant amount of sediment (likely cemented CCR particles) was difficult to remove and remained in place, making inspection of the physical state of this pipeline (i.e., joint condition, reinforced concrete pipeline wall condition, etc.) difficult.

Due to the low-pressure (gravity) operation and small diameters of these plant drains pipelines, they are difficult to evaluate for potential leaks. In addition, removing these pipelines from service is also difficult during both plant operation and outages. As a result, minimal maintenance has been performed during the life of these systems. Since these pipelines have been in operation for a significant amount of time, it is possible that they have been compromised or have deteriorated due to normal wear and tear over the course of the last 40 years. This could lead to leakage of the water being conveyed and result in changes to water quality adjacent to this piping.

3.2 Data Sources

To determine if recent site changes upgradient of the Drains Pond System have impacted water quality in MW-DP4, the sampling locations and dates for groundwater, surface water, and contact water results were reviewed for each potential source provided below.

3.2.1 Groundwater

Data collected between September 2015 and April 2020 for the CCR rule monitoring program were considered in the evaluation. As part of the monitoring program, field personnel collected groundwater samples from the following monitoring wells:

- Upgradient to the Drains Pond System: MW-DP3 and MW-DP5
- Upgradient to Upstream Raise 91: MW-75 and MW-91-2
- Downgradient from the Drains Pond System: MW-DP1, MW-DP2, MW-DP2B, and MW-DP4

3.2.2 Drains Pond System (East Cell)

Nineteen samples collected between Q3 2014 and Q2 2020 of ash contact water from the surface of the east cell of the Drains Pond System (SW-DP101) were used in the evaluation. Seventeen of these samples were analyzed for fluoride.

3.2.3 CCR Short Term Leach Testing

Short-term leach testing of the CCR materials by the synthetic precipitation leaching procedure (SPLP) was performed by EPA Method 1312 (EPA 2008). The SPLP simulates the interaction between a solid and meteoric water, which provides a screening-level estimate of ash effluent water quality.

CCR materials were collected by site personnel between 2012 and 2017. Details about the collection procedure are listed by material type below:

- Three bottom ash samples from Section 26 (a historic containment area for CCRs in a previously mined area) were collected in-situ at the facility in May 2017
- One bottom ash sample was collected from the Drains Pond System west cell in May 2017
- Two fly ash samples were collected from the fly ash silos (one sample was collected in November 2017 and one was collected in May 2017)
- Three coal rejects samples (combination of pulverizer rejects, economizer ash, and air jig rejects) were collected from Ash Pond 91 (also referred to as Upstream Raise 91) in June 2013
- One coal rejects sample was collected from Upstream Raise 91 in May 2017
- One Flue Gas Desulfurization (FGD) material sample was collected from the FGD material blowdown line at the scrubbers in May 2017

3.2.4 Upgradient Plant Cooling Water

Plant cooling water is contained in the Extended Basin, which is located on the western side of the property and upgradient of the CCS plant. Groundwater nearby and potentially influenced by the Extended Basin is monitored at the following locations:

- Upgradient to the powerplant: MW-96
- Downgradient from the Extended Basin: MW-62, MW-63, and MW-65
- EEG Wells: MW-17-1, MW-17-2, MW-17-3, MW-17-4, and MW-17-5 (these wells were installed to monitor a historic leak in the fuel line to the Emergency Engine Generator)

For the plant wells, results from samples collected between October 1988 and April 2020 were considered for this evaluation. The EEG wells were installed in the fourth quarter of 2017, and results included in this evaluation were for samples collected between January 2018 and May 2020.

Additionally, results for samples collected between October 1988 and April 2020 of surface water collected from the Extended Basin (SW-107) were used in the evaluation.

3.3 Evaluation of Potential Sources

As shown in Figure 1, groundwater generally flows from the southwest to the northeast. To assist with the identification of potential fluoride sources to MW-DP4, Figure 3 compares the ranges of fluoride concentrations for the monitoring wells and surface water sources on the site (as described in Section 3.1) with a box and whisker plot. Figure 4 displays a Piper diagram as a method of comparing water qualities between locations.

Several potential sources could contribute to changes in fluoride concentrations in groundwater at CCS, including infiltration of plant cooling water via the Extended Basin, infiltration of surface water collected in the surface water drainage ditches upstream of the Drains Pond System, leakage from the “plant drains” pipelines, and seepage from the Drains Pond System. These potential sources of fluoride are described below.

3.3.1 Drains Pond System

The fluoride concentrations measured in the samples from the east cell of the Drains Pond System (1.9 to 68 mg/L) are higher than sample collected from MW-DP4 and therefore indicates that seepage (if occurring) from the Drains Pond System could increase the fluoride concentrations in MW-DP4 (Figure 3). However, the presence of the liner systems described below for each cell of the Drains Pond System reduces the likelihood of seepage to groundwater.

The west cell of the Drains Pond System has a liner system consisting of (from bottom to top):

- 2 feet of compacted clay rich material with a hydraulic conductivity of $1\text{x}10^{-7}$ centimeters/second (cm/sec)
- 60-mil high density polyethylene (HDPE) geomembrane liner
- Geocomposite drainage layer
- Geosynthetic clay liner (GCL)
- 60-mil HDPE geomembrane liner

As indicated above, the west cell of the Drains Pond System was constructed as a double composite liner system with a drainage layer between the upper and lower composite liner systems. The double composite liner system is more protective of the environment since any water (i.e., leakage) passing through the upper geomembrane liner and GCL will be collected by the geocomposite drainage layer and is conveyed passively (via gravity pipelines) to the center cell of the Drains Pond System. Any small amount of water passing through the upper composite liner will quickly and passively drain away, resulting in minimal head on the lower composite liner. Liner leakage is directly proportional to the head on the liner; therefore, with no to minimal head on the lower liner, very little if any leakage is anticipated.

The center cell of the Drains Pond System has a liner system consisting of (from bottom to top):

- 2 feet of compacted clay rich material with a hydraulic conductivity of $1\text{x}10^{-7}$ cm/sec
- 60-mil HDPE geomembrane liner

The east cell of the Drains Pond System has a liner system consisting of (from bottom to top):

- 2 feet of compacted clay rich material with a hydraulic conductivity of $1\text{x}10^{-7}$ cm/sec
- 40-mil HDPE geomembrane liner

The relative proportion of major ion concentrations in groundwater samples and potential fluoride sources are depicted on a Piper diagram in Figure 4. The Piper diagram indicates that contact water in the Drains Pond System and CCR material SPLP leachates are calcium-sulfate and magnesium-sulfate dominant. Groundwater samples collected from MW-DP4 have a higher proportion of sodium, potassium, and bicarbonate than the contact water and CCR SPLP leachates. Additionally, the major ion chemistry has progressively shifted to a higher proportion of sodium relative to calcium and magnesium in the samples identified as SSIs. This shift indicates the water samples collected from MW-DP4 are progressing away from the ash contact water signature and Drains Pond System water samples (SW-DP101) on the Piper diagram. This same pattern is observed at MW- DP1. If seepage from the Drains Pond System was impacting groundwater at MW-DP4, the groundwater geochemistry would be expected to shift towards the major ion signature of ash contact waters and Drains Pond System water samples (SW-DP101) on the Piper diagram. Therefore, it is unlikely that water from the Drains Pond System is the source of the change in fluoride concentrations leading to the identification of the SSIs.

3.3.2 Upgradient Plant Cooling Water

To the west of the Drains Pond System and Coal Creek Station, water used for plant cooling is contained in the Extended Basin, which holds approximately 60 million gallons and is a clay lined facility. This water originates from the Missouri River, but is cycled up to 15 times through the cooling towers. As the water is cycled, heat from the powerplant drives evaporation, which concentrates the constituents in the Extended Basin. Between 1988 and 2020, fluoride concentrations in the Extended Basin ranged between 2.9 and 6.4 mg/L.

The pattern of recent groundwater changes at MW-DP4 illustrated on the Piper diagram (Figure 4) indicates water samples collected from MW-DP4 are progressing away from the Extended Basin chemical signature; therefore, it is unlikely that recent increases in fluoride concentrations are due to groundwater derived from the Extended Basin.

3.3.3 Other Potential Sources

Based on the Piper diagram (Figure 4), water contained in either the Drains Pond System or Extended Basin are unlikely to be potential sources of the fluoride SSI at MW-DP4. As mentioned in Section 2.4, water levels in upgradient and downgradient monitoring wells increased by approximately two to five feet between Q4 2018 and Q2 2020 (Figure 2). The recent changes in water levels at upgradient and downgradient monitoring wells around the Drains Pond System and the timing of those changes suggest a change in the hydrological regime. The following site changes and sources may have contributed to the increase in fluoride concentrations:

- The recent removal of the Duck Pond and regrading of the area directly upgradient of the Drains Pond System potentially altered the hydrological flow paths to MW-DP4. In addition to the changing flow paths, the removal of the Duck Pond also eliminated infiltration of water from the Duck Pond to groundwater. The infiltration may have provided a dilution effect on groundwater concentrations upgradient of MW-DP4. Elimination of this dilution source may have resulted in the increase in fluoride concentration that led to the identification of the SSI.
- The surface water drainage ditch west of Drains Pond System (Section 3.1.2) has intermittently contained precipitation and runoff water during times of excessive precipitation or snow melt. The stagnant water accumulating in this drainage ditch has historically not been removed prior to infiltration. While, no water samples have been collected to date, the location immediately upgradient of MW-DP4 suggests that localized infiltration from this ditch could influence groundwater concentrations.
- The two plant drains pipelines (Section 3.1.3) approximately 100 feet to the southwest of MW-DP4 are difficult to evaluate for potential leaks. These pipelines have been in operation for approximately 40 years; therefore, it is possible that they have been compromised or have deteriorated due to normal operation since installation. While, no water samples have been collected to date, the location upgradient of MW-DP4 suggests that if water leaked from the pipes it could infiltrate to groundwater and influence groundwater

concentrations at the well. Therefore, it is possible that leakage from the pipes has changed groundwater quality leading to the identification of the SSI at this well.

4.0 EVIDENCE OF AN ALTERNATIVE SOURCE

Based on the review of potential alternate site sources of fluoride presented in this report, primary lines of evidence and conclusions drawn from the evidence used to support this ASD are provided in Table 1.

In summary, we have concluded that the Drains Pond is not likely the cause of the SSI. Instead, variation in the background water quality related to recent changes in the site hydrology and/or potentially leaks in sub-surface piping likely caused a change in fluoride concentrations and identification of the SSIs at MW-DP4.

Table 1: Primary and Supporting Lines of Evidence from ASD Analysis

Key Line of Evidence	Supporting Evidence	Description
Hydrogeology	Groundwater elevations at monitoring wells around the Drains Pond System	Recent increases in water levels in upgradient and downgradient monitoring wells (2019 and 2020) indicate there may be changes in the hydrological flow regime surrounding Drains Ponds System and MW-DP4.
	Recent construction upgradient of MW-DP4 has the potential to alter the groundwater flow regime near MW-DP4	The draining of the Duck Pond to the southwest of MW-DP4 and the intermittent filling of the surface water drainage ditch west of the Drains Pond System have altered the locations of standing water upgradient of MW-DP4, potentially influencing where surface water may infiltrate and affecting the hydrological flow regime surrounding the Drains Pond System and MW-DP4. This change in the flow regime could influence fluoride concentrations observed in samples collected from MW-DP4 leading to identification of the SSIs.
Engineering Controls	Drains Pond System is lined	Each of the three cells of the Drains Pond System has a composite liner system, which decreases the likelihood of seepage from this facility. In addition, the west cell of the Drains Pond System has a double composite liner system with a drainage system between the liners. Observations of this drainage system have not indicated leakage through the upper composite liner system since operations began in late 2015.

Key Line of Evidence	Supporting Evidence	Description
Water Chemistry	Relative ion abundances in groundwater differ from Drains Pond System water	The water quality signature of groundwater samples collected from downgradient well MW-DP4 are not consistent with the signature of potential seepage from the Drains Pond System. As presented in Figure 4, the Piper diagram shows that groundwater from MW-DP4 is distinctly different from ash-impacted waters. This suggests that the Drains Pond System is not the cause of the change in fluoride concentrations.
	Geochemistry results from MW-DP4 are shifting away from Drains Pond System water	Major ion chemistry in MW-DP4 samples identified as SSIs has shifted to a higher proportion of sodium relative to calcium and magnesium and samples collected from MW-DP4 are progressing away from the ash contact water signature on the Piper diagram.

5.0 CONCLUSIONS

In accordance with §257.95(g)(3), this ASD has been prepared in response to the identification of a verified SSI for fluoride at monitoring well MW-DP4 following the Q2 2020 sampling event for the Drains Pond System at Coal Creek Station.

A review of historical analytical results indicates that the groundwater geochemistry at MW-DP4 is shifting so as to be less similar to Drains Pond System water or CCR contact water and thus the recent changes in fluoride are not expected to be from releases from the Drains Pond System. The increase in fluoride concentrations in groundwater at MW-DP4 likely reflects variability in upgradient groundwater sources and recent changes to site hydrogeology. Therefore, no further action (i.e., transition to Assessment Monitoring) is warranted, and the Coal Creek Station Drains Pond System will remain in detection monitoring.

6.0 REFERENCES

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Golder. 2019a. Coal Combustion Residuals Groundwater Statistical Method Certification, Revision 1, Great River Energy – Coal Creek Station, March 8, 2019.

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Signature Page

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https://golderassociates.sharepoint.com/sites/120551/project files/6 deliverables/19136224c/reports/8-r_asd_q2_mw_dp4/8-r-0/19136224c-8-r-0-asd_q2_mw_dp4_27oct20.docx

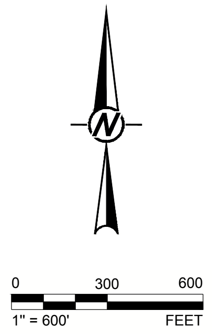
Figures

LEGEND

- NDDEQ PLANT AREA UPGRADIENT WELL
- NDDEQ PLANT AREA DOWNGRADIENT WELL
- EEG PROGRAM WELL
- DRAINS POND SYSTEM UPGRADIENT WELL
- DRAINS POND SYSTEM DOWNGRADIENT WELL
- UPSTREAM RAISE 91 UPGRADIENT WELL
- UPSTREAM RAISE 91 DOWNGRADIENT WELL
- → GENERAL DIRECTION OF GROUNDWATER FLOW
- —1930— POTENTIOMETRIC SURFACE CONTOURS
- — — DRAINS POND SYSTEM BOUNDARY
- — PLANT DRAINS PIPING (APPROXIMATE LOCATION)

NOTE(S)

1. GROUNDWATER ELEVATIONS WERE MEASURED APRIL-MAY 2020, ELEVATION FEET ABOVE MEAN SEA LEVEL.
2. POTENTIOMETRIC SURFACE CONTOURS WERE CREATED FROM WATER LEVEL INFORMATION FROM THE APRIL-MAY 2020 GROUNDWATER ELEVATIONS SHOWN, AS WELL AS SURVEYED SURFACE WATER EXPRESSIONS, ADDITIONAL SITE WELLS, AND PIEZOMETERS NOT SHOWN. CONTOUR INTERVAL IS 5 FEET.
3. AERIAL IMAGERY OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE IMAGERY PROGRAM, 2019.



CLIENT
GREAT RIVER ENERGY
COAL CREEK STATION

CONSULTANT
GOLDER

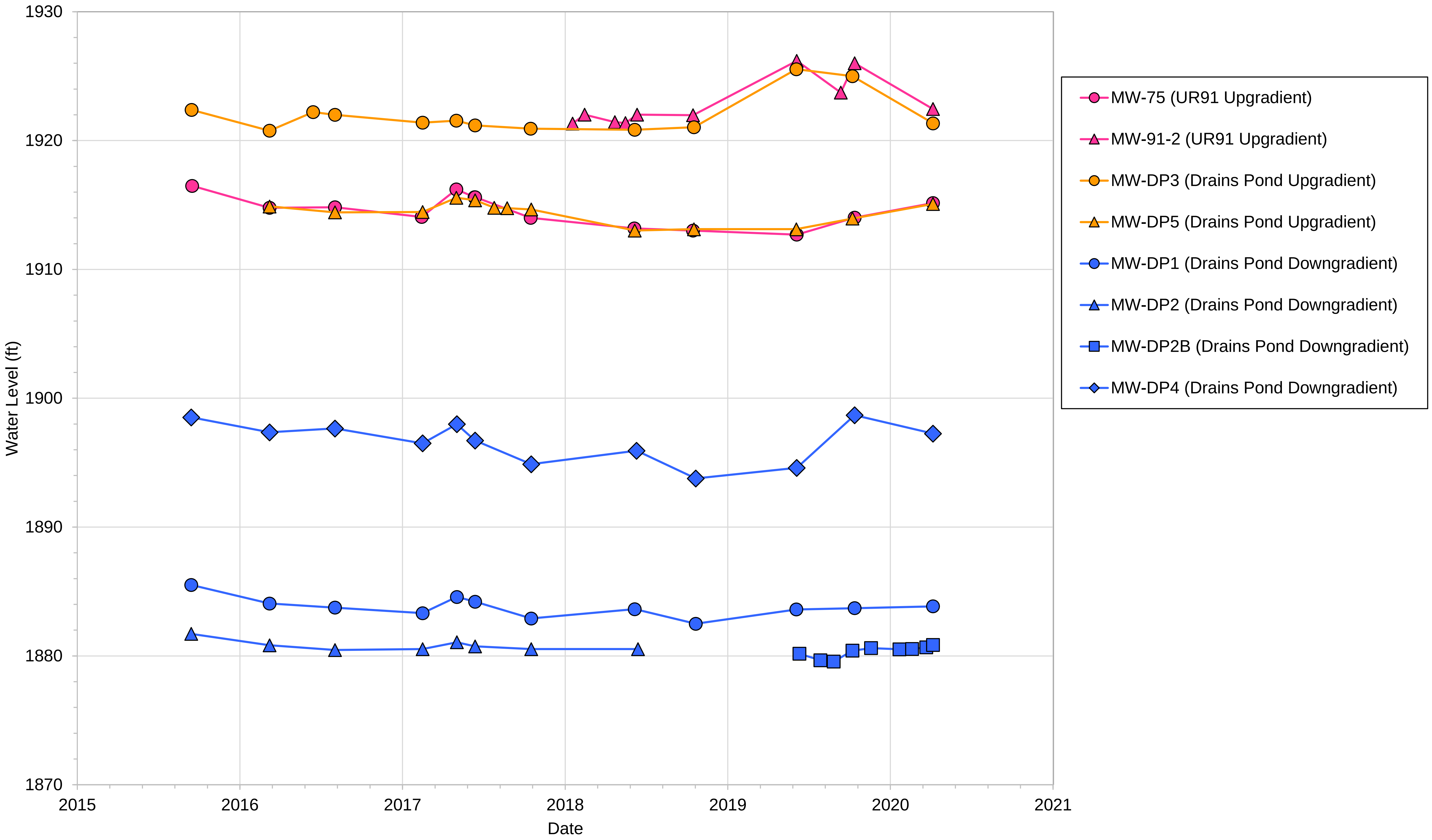
YYYY-MM-DD	2020-10-27
DESIGNED	DVS
PREPARED	DVS
REVIEWED	CCS
APPROVED	TJS

PROJECT
ALTERNATIVE SOURCE DEMONSTRATION

TITLE
APRIL - MAY 2020 GROUNDWATER CONTOURS AND SAMPLING LOCATIONS

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	0	1

PATH: https://golderassociates.sharepoint.com/sites/120551/Project Files/5 Technical Work/5 - Water Quality/ASD - Q2 2020 | FILE NAME: MW-DP4 Working Data.xlsx - version 91.0: 9/9/2020 11:29 AM



CLIENT
Great River Energy Coal Creek Station

PROJECT
Alternative Source Demonstration

CONSULTANT
GOLDER

TITLE
Time Series of Groundwater Elevations

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	0	2

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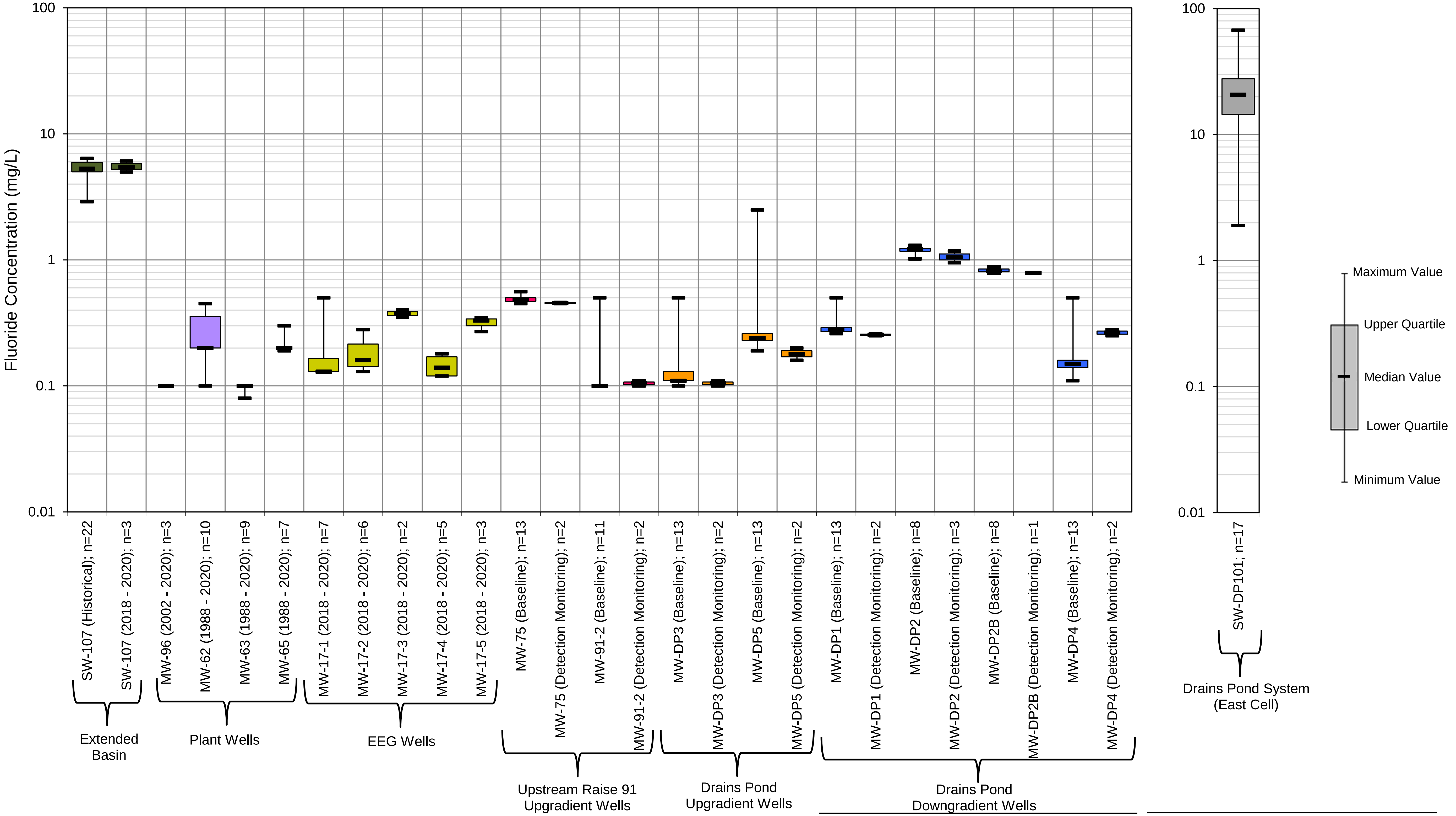
PATH: https://golderassociates.sharepoint.com/sites/120551/Project Files/5 Technical Work/5 - Water Quality/ASD - Q2 2020/MW-DP4 Fluoride ASD | FILE NAME: CCS_Box and Whisker_F.xlsm



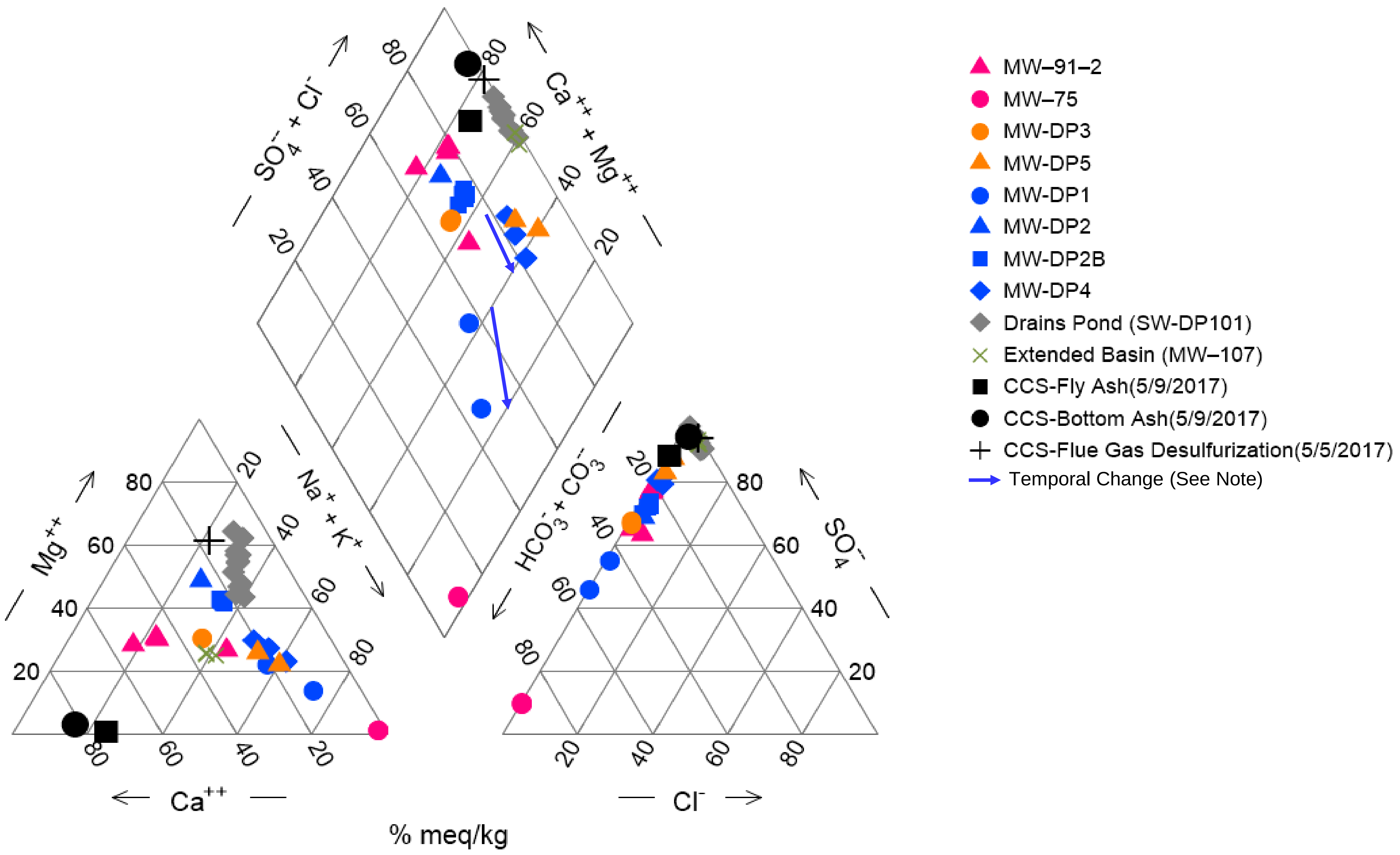
CLIENT
Great River Energy Coal Creek Station

PROJECT
Alternate Source Demonstration

CONSULTANT
GOLDER

TITLE
Box and Whisker Plot of Fluoride Concentrations

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	0	3



Note:
Arrows display the change in groundwater geochemistry at MW-DP4 and MW-DP1 with time. The arrows indicate that the most recent samples collected at MW-DP4 and MW-DP1 are less similar to Drains Pond water or CCR SPLP leachates, compared to earlier samples at these monitoring wells.

CLIENT
Great River Energy Coal Creek Station

PROJECT
Alternative Source Demonstration

CONSULTANT
GOLDER

TITLE
Piper Diagram

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	0	4

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REPORT

Alternative Source Demonstration for Chloride in Monitoring Well MW-49

Great River Energy - Coal Creek Station

Submitted to:

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19136224C-7-R-0

October 27, 2020

Table of Contents

TABLES

FIGURES

1.0 INTRODUCTION

On behalf of Great River Energy (GRE), Golder Associates Inc. (Golder) performed a statistical evaluation of groundwater monitoring results from the second quarter (Q2) 2020 groundwater detection monitoring event at Coal Creek Station's Upstream Raise 91 coal combustion residual (CCR) surface impoundment. The statistical evaluation was performed as described in the Coal Combustion Residuals Groundwater Statistical Method Certification for Coal Creek Station, Revision 1 (Golder 2019b), in accordance with applicable provisions of 40 Code of Federal Regulations (CFR) Part 257, "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule" (CCR rule), as amended.

Statistical analyses of the Appendix III detection monitoring data for chloride in groundwater at the downgradient monitoring well MW-49 indicated a potential exceedance of the statistical limit based on the parametric Shewhart-CUSUM (Cumulative Summation) control chart analysis of the Q2 2019 sampling results. This potential exceedance was subsequently verified as a statistically significant increase (SSI) following the fourth quarter (Q4) 2019 detection monitoring sampling event. The Q2 2020 detection monitoring result for chloride at MW-49 was also a verified SSI. Although determination of a verified SSI generally indicates that the groundwater monitoring program should transition from detection monitoring to assessment monitoring, 40 CFR Part 257.94(e)(2) allows the owner or operator (i.e., GRE) 90 days from the date of determining a verified SSI (July 29, 2020) to demonstrate a source other than the regulated CCR facility caused the SSI or that the SSI was a result of an error in sampling, analysis, or statistical evaluation or natural variability in groundwater quality that was not fully captured during the baseline data collection.

Golder's review of the hydrological and geologic conditions at the site and the sampling and analytical procedures indicates the SSI is not an indication of impacts from the CCR unit. A desktop study of previously collected CCR-impacted water from the facility, nearby surface water, and groundwater samples was conducted to assess potential chloride sources. As a part of this work, potential error in the statistical analysis, laboratory methods, and the natural variability of chloride concentrations in groundwater were evaluated. Based upon this review and in accordance with provisions of the CCR Rule, Golder has prepared this Alternative Source Demonstration (ASD) for chloride at MW-49 and the Upstream Raise 91 CCR surface impoundment. An ASD was initially developed following the Q4 2019 verified SSI (Golder 2020) and was reviewed for ongoing applicability and updated where necessary.

This ASD conforms to the requirements of 40 CFR Part 257.94(e)(2) and provides the basis for concluding that the verified SSI for chloride at MW-49 is not an indication of a release from Upstream Raise 91. The following sections provide a summary of Upstream Raise 91, sampling procedures and analytical methods, analytical and geochemical assessment results, and lines of evidence demonstrating an alternative source for the increased chloride concentrations at MW-49.

2.0 BACKGROUND

2.1 Site Background

GRE's Coal Creek Station (CCS) is a coal-fired electric generation facility located in McLean County, approximately 10 miles northwest of Washburn, North Dakota. CCRs are managed in composite-lined surface water impoundment cells and dry landfills regulated and permitted by the North Dakota Department of Environmental Quality (NDDEQ) in accordance with North Dakota Administrative Code (NDAC) Article 33-20, Solid Waste Management and Land Protection.

Coal Creek Station has four CCR facilities that are within the purview of the EPA CCR rule. This ASD only applies to the Upstream Raise 91 CCR surface impoundment. Upstream Raise 91 is located in the south-central portion of the plant site, east of the Coal Creek Station plant buildings (Figure 1).

2.2 Site Geology

Coal Creek Station and McLean County are situated at the eastern-most extent of the Williston Basin, a structural and sedimentary basin (USGS 1999). The region is characterized by the presence of glacial drift, reaching thicknesses of several hundred feet and overlying the Sentinel Butte Member, the source of commercially mined coal in the direct vicinity of Coal Creek Station (Falkirk 1979). The Sentinel Butte Member is the highest strata of the Paleocene Fort Union Formation, overlying the Tongue River, Ludlow, and Cannonball Members (USGS 1999). The Sentinel Butte Member is marked by drab-gray units, demarcating the separation from the lower Tongue River Member.

The site geology of CCS includes unconsolidated surficial deposits of the Coleharbor formation, consisting of stratified and unstratified glacial drift. The near-surface materials are silty clay and sandy clay till with interbedded lenses (CPA/UPA 1989).

2.3 Site Hydrogeology

Regional groundwater flow of the uppermost water-bearing unit in the vicinity of CCS is a subtle expression of the surface topography, which is influenced by the configuration of the eroded bedrock. Based on available groundwater elevation data, the shallow groundwater at the CCR facilities at Coal Creek Station generally follows surface topography, flowing east and north towards Lower Samuelson Slough and Sayler Slough. Available groundwater elevation data indicate that groundwater in the area of Upstream Raise 91 generally flows from the southwest to northeast, diagonally across the footprint of the facility, towards Lower Samuelson Slough.

Hydraulic conductivities in the area of Upstream Raise 91 range from 0.35 feet per day (ft/day) to 12.96 ft/day, with calculated groundwater flow rates during Q2 2020 ranging from 0.03 to 1.28 ft/day.

2.4 Groundwater Monitoring Network

The groundwater monitoring network for Upstream Raise 91 was developed with consideration for the size, disposal and operational history, anticipated flow direction, and location of adjoining facilities. Based on these factors, a monitoring well network consisting of two upgradient and three downgradient monitoring wells is used for monitoring the unit under the CCR rule.

The two upgradient monitoring wells (MW-75, MW-91-2) included in the groundwater monitoring network for Upstream Raise 91 are used to represent upgradient water quality flowing towards the unit from the west and south, including the potential for variability. The three downgradient wells (MW-49, MW-51, MW-91-1) are spaced along the northern edge of the facility. Upstream Raise 91 directly abuts Upstream Raise 92 on its eastern edge, preventing installation of monitoring wells along the eastern side of Upstream Raise 91 without jeopardizing the integrity of the liner system. The Upstream Raise 91 network wells are presented in Figure 1. Other monitoring locations used to support this ASD are also presented in Figure 1 and are discussed further in Section 5.0.

2.5 Groundwater Conditions

Between September 2015 and June 2017, GRE collected nine independent baseline groundwater samples from MW-75, MW-49, and MW-51, as required by 40 CFR Part 257.94, for use within the CCR rule monitoring program. Baseline samples were collected from MW-91-2 and MW-91-1 between January 2018 and

October 2018, following installation of the wells in late 2017. Prior to installation of MW-91-2 and MW-91-1 and completion of the baseline monitoring at the wells, Upstream Raise 91 and Upstream Raise 92 were monitored jointly under a monitoring network consisting of the wells near both units (Golder 2019a). The results of the CCR baseline monitoring were used to develop appropriate statistical limits for each constituent at each monitoring well, based on site and parameter specific conditions (Golder 2019b).

Following completion of the baseline monitoring events at each well, GRE began collecting groundwater samples on a semi-annual basis to support the detection monitoring program. Groundwater samples for detection monitoring are collected at each upgradient and downgradient monitoring well and analyzed for 40 CFR Part 257 Appendix III constituents. During the detection monitoring program, results from groundwater analysis are compared to the statistical limits calculated from the baseline monitoring results to determine whether groundwater quality remains consistent, or if changes in groundwater quality are observed.

Chloride concentrations in groundwater at MW-49 during the baseline monitoring period ranged between 59.2 and 67.1 milligrams per liter (mg/L) in the nine baseline samples collected as part of the CCR rule monitoring program. The Shewhart-CUSUM statistical limit for the well-constituent pair was set at 73.9 mg/L.

The Q2 2019 detection monitoring event reported a chloride concentration of 70.0 mg/L at MW-49, with a calculated CUSUM value of 77.4 mg/L, exceeding the statistical limit. Verification resampling was conducted during the Q4 2019 detection monitoring event, confirming the SSI for chloride at MW-49 with a chloride concentration of 71.0 mg/L and a calculated CUSUM value of 83.8 mg/L. The Q2 2020 chloride result at MW-49 was also a verified SSI (based on calculated CUSUM value) with a chloride concentration of 60.0 mg/L, which is in the range of baseline values, but the calculated CUSUM value of 85.3 mg/L was greater than the statistical limit.

2.6 Sampling and Laboratory Testing Procedures

As part of the ASD, a review was conducted of the sampling and laboratory testing procedures used throughout baseline monitoring and detection monitoring to date, along with the collected results. A review of the statistical assessment methods and associated results found the procedures followed during baseline and detection monitoring to be consistent with the stated procedures listed in the published Groundwater Statistical Methods Certification (Golder 2019b). Calculated limits were found to be consistent with the chosen statistical procedures and recommended methodology found within the Unified Guidance (USEPA 2009).

In review of the analytical results, a shift in the MW-49 chloride concentrations was noted between data collected prior to June 2018 and data collected after June 2018. This shift was evaluated with a Wilcoxon Rank-Sum test which showed statistical significance at the 95% confidence level (Figure 2). The Wilcoxon Rank-Sum test determines if measurements from one population are significantly different than measurements from another population. This test is non-parametric, meaning that the data are not assumed to fit a specific distribution, such as a normal distribution.

Beginning in June 2018 (Q2 2018, the second semi-annual detection monitoring event), GRE switched sampling staff. The potential impacts of this change are evaluated in Section 3.0. Also beginning in June 2018 (Q2 2018, the second semi-annual detection monitoring event), GRE switched analytical laboratories from Minnesota Valley Testing Laboratory (Bismarck, North Dakota) to Eurofins TestAmerica (Denver Laboratory in Arvada, Colorado). There are differences between the testing methodologies used for chloride by the two laboratories. An evaluation of the methods and their associated differences is discussed in Section 4.1.

3.0 POTENTIAL SAMPLING CAUSES

Between September 2015 and May 2018, sampling of the CCR rule wells and other wells and surface water sampling locations at Coal Creek Station was conducted by outside contractors from the Bismarck, North Dakota location of the Minnesota Valley Testing Laboratory (MVTL). Beginning with the samples collected in June 2018, sampling has been conducted in-house by GRE employees. Low-flow pumps and sampling methods have been used to collect groundwater samples throughout the monitoring program for the CCR rule, following manufacturer recommendations (Geotech 2015) and USEPA guidance (USEPA Region I 2017). Although using the same sampling methods, there is a potential for minor differences in sampling technique between sampling personnel. The timing of the change in sampling personnel coincides with both the June 2018 shift in chloride concentrations described in Section 2.5 and the change in laboratories noted in Section 2.6.

4.0 POTENTIAL LABORATORY SOURCES

4.1 Changes in Testing Methodology

Prior to June 2018, GRE contracted MVTL as their analytical testing laboratory for the monitoring program for the CCR rule. For analysis of chloride, MVTL used a variation of the SM4500-Cl- method (published variations of the method are labeled SM4500-Cl- A through SM4500-Cl- I; Standard Methods Online 2018). In the most recent sampling prior to the analytical laboratory switch, MVTL used method SM4500-Cl- E, Chloride by Automated Ferricyanide Method. Instrumentation for the method is an automated spectrophotometer, as the method is a colorimetric means of measuring chloride in water. All variations of SM4500-Cl are only applicable for testing chloride and are not indicated for use for other analytes.

Under typical use of the method, the applicable concentration range is 1 to 200 mg/L of chloride, which can be extended to higher and lower concentrations by dilution, adjustment of sample size, and other typical testing adjustments (USGS 2002a). The typical chloride reporting limit provided by MVTL was 1.0 mg/L. Although not reported within MVTL's laboratory information management system at the time of testing, dilutions to the sample results are likely to have occurred, given the range in chloride concentrations reported using the method between 2015 and 2018 (1.1 to 697 mg/L across all CCS samples collected as part of the monitoring program for the CCR rule).

Beginning with the June 2018 sampling events for the CCR rule groundwater monitoring program, GRE contracted Eurofins TestAmerica (TestAmerica) as their analytical testing laboratory. For analysis of chloride, TestAmerica has used method SW9056A, the Determination of Inorganic Anions by Ion Chromatography (USEPA 2007). Ion chromatography identifies and separates different ions based on their affinity to an ion exchanging resin which is packed in a flow-through column. The separated ions elute off the column at different times, characteristic to the ion size and charge, and are measured using an electrical conductivity meter, generating a series of peaks as the different ions leave the column (Figure 3). Relative to a baseline level of conductivity, the area of each peak is proportional to the ion's concentration in the sample. The peak area is compared to the peak areas generated by known concentrations in calibration standards to derive a sample concentration. In the case of method SW9056A, the specified analytical column (i.e., the ion exchanger), is required to be suitable for analyzing for chloride, fluoride, bromide, nitrate, nitrite, phosphate, and sulfate.

The typical chloride reporting limit provided by TestAmerica at the Denver Laboratory was 3.0 mg/L. Dilutions have varied across samples, ranging from 1x dilution factors (i.e., no dilution and a reporting limit of 3.0 mg/L) to 50x dilution factors (with a corresponding reporting limit of 150 mg/L). Due to the capacity of the method for testing multiple anions, indiscriminate dilution intended to account for high concentrations of one anion, particularly in accounting for samples with higher sulfate concentrations as found at CCS, can negatively impact outcomes for the other anions measured by the method, resulting in non-detect results with excessive dilutions. This aspect is particularly salient due to the base application of the method, as loading of the ion exchange column within the ion chromatograph should not exceed concentrations of approximately 500 parts per million ([ppm]; equivalent to 500 mg/L) of total anions within the sample when the sample to be tested is undiluted (USGS 2002b).

In comparing the methodologies used by the two laboratories, a few specific differences are apparent. First, the two methods analyze for chloride using fundamentally different mechanisms. Method SM4500-Cl- E uses spectrophotometry, which measures how much a chemical of interest absorbs light by passing a light source through a sample. Differentiation of chemical compounds is based on the principle that each compound will absorb light over a specific range of wavelengths (Standard Methods Online 2018; USGS 2002a). Method SW9056A uses ion chromatography, quantifying the species of interest based on their affinity for an ion exchanger (USEPA 2007; USGS 2002b). Due to the difference in mechanisms between the methods, samples that are analyzed by the two methods would be anticipated to show slightly different results, even if tested portions are drawn from the same sample.

Second, larger differences between quantified results could be anticipated in samples with complex matrices, particularly those with large concentrations of other anions measured through the SW9056A methodology. Although the ion exchangers used within ion chromatography are specific to each method, the column specified by SW9056A is intended to account for the affinity of the complete list of analytes specified by the method in sequential order (USEPA 2007). In samples at CCS, concentrations of sulfate alone, as the final sequential anion within the method, often exceed the total anion loading of the methodology prior to dilution of samples. As the concentrations of chloride are less than those of sulfate within samples from CCS based on previously collected information and geochemical water-typing, masking of the intended analyte by other anions intended for quantification could skew results. Appropriate calibration across multiple concentration ranges is intended to prevent this issue. However, based on past included laboratory qualifiers and explanations within laboratory narratives, pinpointing a group of ranges across samples can prove difficult.

One further difference between the results from the two laboratories are the number of significant digits reported within sample results. Results for chloride using method SM4500-Cl- E from MVTL were reported with three significant digits, while TestAmerica reports results for chloride using method SW9056A using only two significant digits. This difference in precision between the two laboratories may be subtle given the concentrations of chloride across samples, but could result in a difference in population medians, signifying a shift in concentrations with no cause from the facility. Similar differences are noted in the number of significant digits reported for boron, calcium, sulfate, and total dissolved solids between reporting from the two analytical laboratories.

4.2 Ion Chromatography

In addition to comparing differences between the chloride methods, Golder reviewed TestAmerica’s SW9056A standard operating protocols and reviewed the ion chromatography data output data to look for practices that have the potential to bias chloride concentrations high.

The quality of ion chromatography measurements is dependent on consistently processing data in the conversion of peak area to concentration. For example, the following aspects should be handled consistently:

- The time window used to calculate the area under a peak,

- The method for determining baseline conductivity,
- The approach for dealing with minor peaks that elute from the column at the same time as an analyte of interest.

These data processing calculations are automatically performed by the instrument software and can result in minor differences between samples and standards. While TestAmerica checks ion chromatograph data to confirm that the instrument software is functioning consistently, there is a range of variability in the software data processing practices that is tolerated and the decision on whether to manually adjust the software-calculated concentrations by manually selecting peaks is the responsibility of TestAmerica personnel.

Golder's review of the TestAmerica ion chromatography data identified several data processing practices that have the potential to bias high chloride concentrations (Figure 4). These include:

- Using a longer integration time for samples than calibration standards,
- Selecting a lower baseline in samples relative to calibration standards, and
- Including minor shoulder peaks in sample chloride peaks when they were excluded from calibration standard chloride peaks.

These practices were implemented in the processing of the ion chromatographs for the MW-49 samples collected between June 11, 2018 and October 15, 2019 and have the potential to bias high the chloride concentrations by up to 4.2%. Golder discussed the data processing practices with TestAmerica after an internal review, and TestAmerica deemed the practices as within the range of acceptable variability and a revision to the originally reported values was not warranted (D. Bieniulis, personal communication, May 8, 2020). While up to a 4.2% difference is relatively small, this difference could account for part of the June 2018 shift in MW-49 chloride concentrations described in Section 2.5 and result in identification of an SSI.

5.0 POTENTIAL SITE CHLORIDE SOURCES

To assess the potential sources for a change in chloride concentrations at MW-49, Golder reviewed recent site changes upgradient of Upstream Raise 91, as well as previously collected data from the CCR rule program and other site monitoring data that are collected under other programs. The following sections summarize the supplemental assessment activities.

5.1 Site Changes and Potential Impacts

The following sections discuss site changes and potential impacts associated with those changes over the last 40 years. Site changes may have affected constituent concentrations entering the groundwater system or the hydrologic and hydrogeologic conditions (water balance) of the site.

5.1.1 Construction History and Liner System

Upstream Raise 91 was constructed on the historic footprint of the South Ash Pond, which was built in the late 1970s on a foundation of re-compacted site soils (glacial tills) and put into service in 1979. In 1981, the South Ash Pond was taken out of service to reconstruct the clay liner and was put back into service from 1982 until 1987, at which point CCR materials were removed and the geometry of the South Ash Pond footprint was modified. Monitoring wells MW-49, MW-51, and MW-75 were installed near Upstream Raise 91 in 1988 and chloride has been analyzed since that time on an approximately semi-annual basis as part of the NDDEQ monitoring program.

Chloride concentrations in MW-49 increased significantly shortly after monitoring began in the late 1980s due to likely impacts from the South Ash Pond. In 1993, Upstream Raise 91 was deepened and a new composite liner consisting of a 2-foot thick compacted clay liner underlying a 40-mil high-density polyethylene (HDPE) geomembrane was completed. Beginning in 1996, chloride concentrations started a downward trend, decreasing by approximately 50% over the next 10-year period (approximately from a high of 170 mg/L to 85 mg/L), likely a result of construction of the composite liner system. Overall, chloride concentrations decreased approximately 60% from 1996 to 2020 (from a high of approximately 170 mg/L to 70 mg/L).

5.1.2 Duck Pond and Drains Pond System Construction

Beginning in 2015, the drainages on the west and northwest sides of Upstream Raise 91 were modified to allow for construction of an expansion to the Drains Pond System. As a part of this construction, modifications to the existing drainage upgradient of Upstream Raise 91 were required and the composite-lined west and center cells of the Drains Pond System were constructed.

Historically, the Duck Pond area was a low-lying area west of Upstream Raise 91. The depth of water contained in this area was generally 12 feet (water surface elevation approximately 1911 feet) and the Duck Pond had a surface area of approximately three acres. As the water level increased, overflow passed through culvert piping to the north under what is now the center cell of the Drains Pond System. As part of the construction in 2015, the Duck Pond was dewatered, the area was graded, and culverts were installed to drain surface water south and east around the south side of Upstream Raise 91.

5.2 Data Sources

To determine if recent site changes upgradient of Upstream Raise 91 have impacted water quality in MW-49, the sampling locations and dates for groundwater, surface water, and contact water results were reviewed for each potential source provided below (see Figure 1 for locations).

5.2.1 Upstream Raise 91

Data collected between September 2015 and April 2020[1] for the CCR rule monitoring program were considered in the evaluation. As part of the monitoring program, field personnel collected groundwater samples from the following monitoring wells:

- Upgradient to Upstream Raise 91: MW-75 and MW-91-2
- Downgradient from Upstream Raise 91: MW-49, MW-51, and MW-91-1

Additionally, results for a November 2018 sample of ash contact water collected from the Upstream Raise 91 sump (Sump-UR91) were available for the evaluation.

5.2.2 Drains Pond System

Data collected between September 2015 and April 2020 for the CCR rule monitoring program were considered in the evaluation. As part of the monitoring program, field personnel collected groundwater samples from the following monitoring wells:

- Upgradient to the Drains Pond System: MW-DP3 and MW-DP5

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[1] June 2019 samples from MW-91-1 and MW-91-2 not used because of a suspected quality control issue

- Downgradient from the Drains Pond System: MW-DP1, MW-DP2, MW-DP2B, and MW-DP4

Additionally, results for 18 samples collected between 2014 and 2019 of ash contact water collected from the surface of the east cell of the Drains Pond System (Drains Pond, SW-DP101) were used in the evaluation.

5.2.3 Upgradient Plant Cooling Water

Groundwater potentially influenced by upgradient plant cooling water is monitored at the following locations:

- Upgradient to the powerplant: MW-96
- Downgradient from the Extended Basin: MW-62, MW-63, and MW-65
- EEG Wells: MW-17-1, MW-17-2, MW-17-3, MW-17-4, and MW-17-5 (these wells were installed to monitor a historical leak in the fuel line to the Emergency Engine Generator)

For the plant wells, results from samples collected between October 1988 and April 2020 were considered for this evaluation. The EEG wells were installed in the fourth quarter of 2017, and results included in this evaluation were for samples collected between January 2018 and May 2020.

Additionally, results for samples collected between October 1988 and April 2020 of surface water collected from the Extended Basin (SW-107) were used in the evaluation.

5.3 Evaluation of Potential Sources

Figure 5 displays a map of the locations and observed chloride concentrations (both October 2019 concentration and the range of chloride values observed in baseline and detection monitoring) for the monitoring wells and surface water sources described in Section 5.2. As shown in Figure 1, groundwater generally flows from the southwest to the northeast. To assist with the identification of potential chloride sources to MW-49, Figure 6 compares the ranges of chloride concentrations for the monitoring wells and surface water sources on the site with a box and whisker plot. Figure 7 displays a scatter plot of the sulfate to chloride ratio versus the calcium to chloride ratio as a method of comparing water qualities across the site. Piper plots were not utilized due to the lack of consistently having the full suite of cations and anions for the different potential chloride sources at the site.

Several potential sources can influence chloride concentrations in groundwater at CCS, including infiltration of plant cooling water via the Extended Basin, seepage from the Drains Pond System, and seepage from Upstream Raise 91. These three potential sources of chloride are described below. The data suggests that the increase in chloride concentration at MW-49 chloride is due to a change in the hydrological flow regime caused by the 2015 removal of the Duck Pond. This change likely increased the proportion of water with elevated chloride from the Extended Basin, affecting chloride concentrations at MW-49 that resulted in the SSIs.

5.3.1 Upstream Raise 91

The chloride concentration measured in the sample from the Upstream Raise 91 sump (790 mg/L) is higher than groundwater concentrations and indicates that seepage (if occurring) from Upstream Raise 91 could increase the chloride concentrations in MW-49. The presence of the liner system at Upstream Raise 91 (a 2-foot thick compacted clay liner with a hydraulic conductivity of 1×10^{-7} centimeters/second or less underlying a 40-mil HDPE geomembrane) reduces the likelihood of seepage to groundwater. Figure 7 indicates that contact water in the Upstream Raise 91 sump has lower calcium to chloride ratios and lower sulfate to chloride ratios than water observed at MW-49. If seepage from Upstream Raise 91 was impacting groundwater at MW-49, a shift in both of these ratios in samples identified as SSIs from MW-49 (Q4 2018 through Q2 2020) towards those observed from the Upstream Raise 91 sump would be expected. A shift towards the Upstream Raise 91 sump signature was not observed on Figure 7 for the samples identified as SSIs.

5.3.2 Drains Pond System

Given the physical proximity of the east cell of the Drains Pond System to MW-49 and the elevated chloride concentrations observed in the surface water of the east cell of the Drains Pond System (125 to 827 mg/L), seepage (if occurring) from the east cell of the Drains Pond System could have the potential to elevate chloride concentrations at MW-49. The presence of the liner system of the east cell of the Drains Pond System (a 2-foot thick compacted clay liner with a hydraulic conductivity of $1x10^{-7}$ centimeters/second or less underlying a 40-mil HDPE geomembrane) reduces the likelihood of seepage to groundwater. Contact water in the east cell of the Drains Pond System has lower calcium to chloride ratios than water observed in MW-49 (Figure 7). If seepage from the Drains Pond System was impacting groundwater at MW-49 a shift in the calcium to chloride ratios in the samples identified as SSIs from MW-49 (Q4 2018 through Q2 2020) towards those observed from the east cell of the Drains Pond System would be expected. A shift towards the Drains Pond System signature was not observed on Figure 7 for the samples identified as SSIs.

5.3.3 Upgradient Plant Cooling Water

To the west of Upstream Raise 91 and Coal Creek Station, water used for plant cooling is contained in the Extended Basin, which holds approximately 60 million gallons and is clay lined. The Extended Basin water originates from the Missouri River, but is cycled up to 15 times through the cooling towers. As the water is cycled, heat from the powerplant drives evaporation, which concentrates the constituents in the Extended Basin. Between 1988 and 2019, chloride concentrations in the Extended Basin ranged between 158 and 300 mg/L.

Nearby monitoring wells (MW-62, MW-63, and MW-65) located upgradient of the powerplant and immediately adjacent to the Extended Basin also have elevated chloride concentrations ranging from 8.0 to 290 mg/L indicating that water from the Extended Basin is impacting groundwater chloride concentrations. The elevated concentrations from the Extended Basin show considerable increase relative to MW-96, a background well for the plant that is side-gradient to the Extended Basin. Chloride concentrations at MW-96 range between 4.2 and 7.8 mg/L.

The water from the Extended Basin also appears to be impacting wells further downgradient. The concentrations observed along the flow path from the Extended Basin towards MW-49 include:

- The EEG wells located east of the Extended Basin have chloride concentrations ranging between 58 and 130 mg/L.
- Well MW-DP5 downgradient from the plant and upgradient of the Drains Pond System, has chloride concentrations ranging between 66.0 and 84.8 mg/L. Well MW-DP3 also upgradient of the Drains Pond has chloride concentrations ranging between 8.6 and 19.8 mg/L.
- Wells MW-91-2 and MW-75 upgradient of Upstream Raise 91 and side gradient to the Extended Basin have chloride concentrations between 1.1 and 16.8 mg/L.

Variations in screened lithology and preferential flow paths in the glacial till may explain why some wells downgradient of the Extended Basin show elevated chloride concentrations while other wells (MW-DP3, MW 91-2, and MW-75) have chloride concentrations more similar to MW-96.

Figure 7 demonstrates that surface waters from the Extended Basin may be influencing ion ratios in groundwater samples from monitoring wells upgradient of Upstream Raise 91, including MW-62, MW-63, MW-65, MW-17-2, and MW-17-5, and monitoring wells downgradient of Upstream Raise 91, including MW-49 and MW-91-1.

The recent removal of the Duck Pond and regrading of the area directly upgradient of the Drains Pond System potentially altered the hydrological flow paths to MW-49 and increased the proportion of water with elevated chloride from the Extended Basin relative to other groundwater sources monitored at MW-49. In addition to the changing flow paths, the removal of the Duck Pond also eliminated infiltration of water from the Duck Pond to groundwater, which may have provided a dilution effect on groundwater concentrations upgradient of MW-49.

6.0 EVIDENCE OF AN ALTERNATIVE SOURCE

Primary lines of evidence and conclusions drawn from the evidence used to support this ASD are provided in Table 1. In summary, the chloride SSI in MW-49 is not likely and indication of a release from Upstream Raise 91. Instead the change in chloride concentration is potentially a reflection of sampling and laboratory changes and/or changes in the groundwater flow regime related to the removal of the Duck pond that have increased the proportion of water with elevated chloride from the Extended Basin relative to other groundwater sources monitored at MW-49.

Table 1: Primary and Supporting Lines of Evidence from ASD Analysis

Key Line of Evidence	Supporting Evidence	Description
Change in Field Personnel	Changed to site personnel from MVTL	Although using the same sampling methods, there is a potential for minor differences in sampling technique between sampling personnel. The timing of the change in sampling personnel coincides with the June 2018 shift in chloride concentrations.
Change in Laboratory and Methodology	Changed to TestAmerica from MVTL	The timing of the change in laboratory coincides with the June 2018 shift in chloride concentrations.
	Change from potentiometric method (SRM 4500-CL) to ion chromatography method (SRM 9056A)	Prior to June 2018, MVTL used method SM4500-Cl- E to measure chloride concentrations. Starting in June 2018, TestAmerica analyzed chloride concentrations by SW9056A. These methods have different mechanisms, detection limits, and matrix effects. The timing of the change in methodology coincides with the June 2018 shift in chloride concentrations.
Laboratory Artifact Biasing High Sample Concentrations	Ion chromatographs reflecting different data processing practices between some calibration standards and samples	Golder's review of the TestAmerica ion chromatography data identified several data processing practices (integration time length, baseline selection, and treatment of minor peaks) that have the potential to bias high chloride concentrations (Figure 4).

Key Line of Evidence	Supporting Evidence	Description
Groundwater Geochemistry	Relative ion abundances in groundwater differs from Upstream Raise 91 sump water and surface water collected from the east cell of the Drains Pond system	The water quality signature of groundwater samples collected from downgradient well MW-49 are not consistent with the signature of potential seepage from Upstream Raise 91. As presented in the Figure 7, differences in calcium-chloride and sulfate-chloride ratios are distinctly different between the ash-impacted waters and the downgradient groundwater samples, including from MW-49.
Local Sources of Chloride	Elevated chloride concentrations in the Extended Basin and other wells downgradient of the Extended Basin	Figure 6 suggests that chloride concentrations in the plant cooling water (Extended Basin) are impacting groundwater chloride concentrations in wells downgradient from the Extended Basin. Similarities in the ion ratios between water samples collected from MW-49, the Extended Basin, and wells immediately downgradient of the Extended Basin (Figure 7) suggest that the Extended Basin may be a potential source of elevated chloride at MW-49.
	Hydrogeology	The removal of the Duck Pond in 2015 and regrading of the area directly upgradient of the Drains Pond System potentially altered the hydrological flow paths, resulting in higher chloride concentrations at MW-49. This would be due to an increase in the proportion of groundwater potentially impacted by the Extended Basin and the removal of the more dilute water infiltrating from the Duck Pond.

7.0 CONCLUSION

In accordance with 40 CFR 257.95(g)(3), this ASD has been prepared in response to the identification of a verified SSI for chloride at monitoring well MW-49 following the Q2 2020 sampling event for Upstream Raise 91 at Coal Creek Station.

Based on review of historical analytical results and testing procedures, recent changes to chloride concentrations in groundwater at MW-49 are likely not a result of seepage from Upstream Raise 91. There are two potential alternative sources, laboratory and sampling artifacts and variability in the upgradient groundwater sources. Therefore, no further action (i.e., a transition to Assessment Monitoring) is warranted, and Upstream Raise 91 will remain in detection monitoring.

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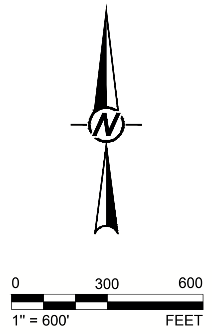
Figures

LEGEND

⌖	NDDEQ PLANT AREA UPGRADIENT WELL
⌖	NDDEQ PLANT AREA DOWNGRADIENT WELL
⌖	EEG PROGRAM WELL
⌖	DRAINS POND SYSTEM UPGRADIENT WELL
⌖	DRAINS POND SYSTEM DOWNGRADIENT WELL
⌖	UPSTREAM RAISE 91 UPGRADIENT WELL
⌖	UPSTREAM RAISE 91 DOWNGRADIENT WELL
→	GENERAL DIRECTION OF GROUNDWATER FLOW
— 1930 —	POTENTIOMETRIC SURFACE CONTOURS
— — —	UPSTREAM RAISE 91 BOUNDARY

NOTE(S)

1. GROUNDWATER ELEVATIONS WERE MEASURED APRIL-MAY 2020, ELEVATION FEET ABOVE MEAN SEA LEVEL.
2. POTENTIOMETRIC SURFACE CONTOURS WERE CREATED FROM WATER LEVEL INFORMATION FROM THE APRIL-MAY 2020 GROUNDWATER ELEVATIONS SHOWN, AS WELL AS SURVEYED SURFACE WATER EXPRESSIONS, ADDITIONAL SITE WELLS, AND PIEZOMETERS NOT SHOWN. CONTOUR INTERVAL IS 5 FEET.
3. AERIAL IMAGERY OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE IMAGERY PROGRAM, 2019.



CLIENT
GREAT RIVER ENERGY
COAL CREEK STATION

PROJECT
ALTERNATIVE SOURCE DEMONSTRATION

CONSULTANT

GOLDER

YYYY-MM-DD	2020-10-27
DESIGNED	DVS
PREPARED	DVS
REVIEWED	CCS
APPROVED	TJS

TITLE
APRIL - MAY 2020 GROUNDWATER CONTOURS AND SAMPLING LOCATIONS

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	0	1

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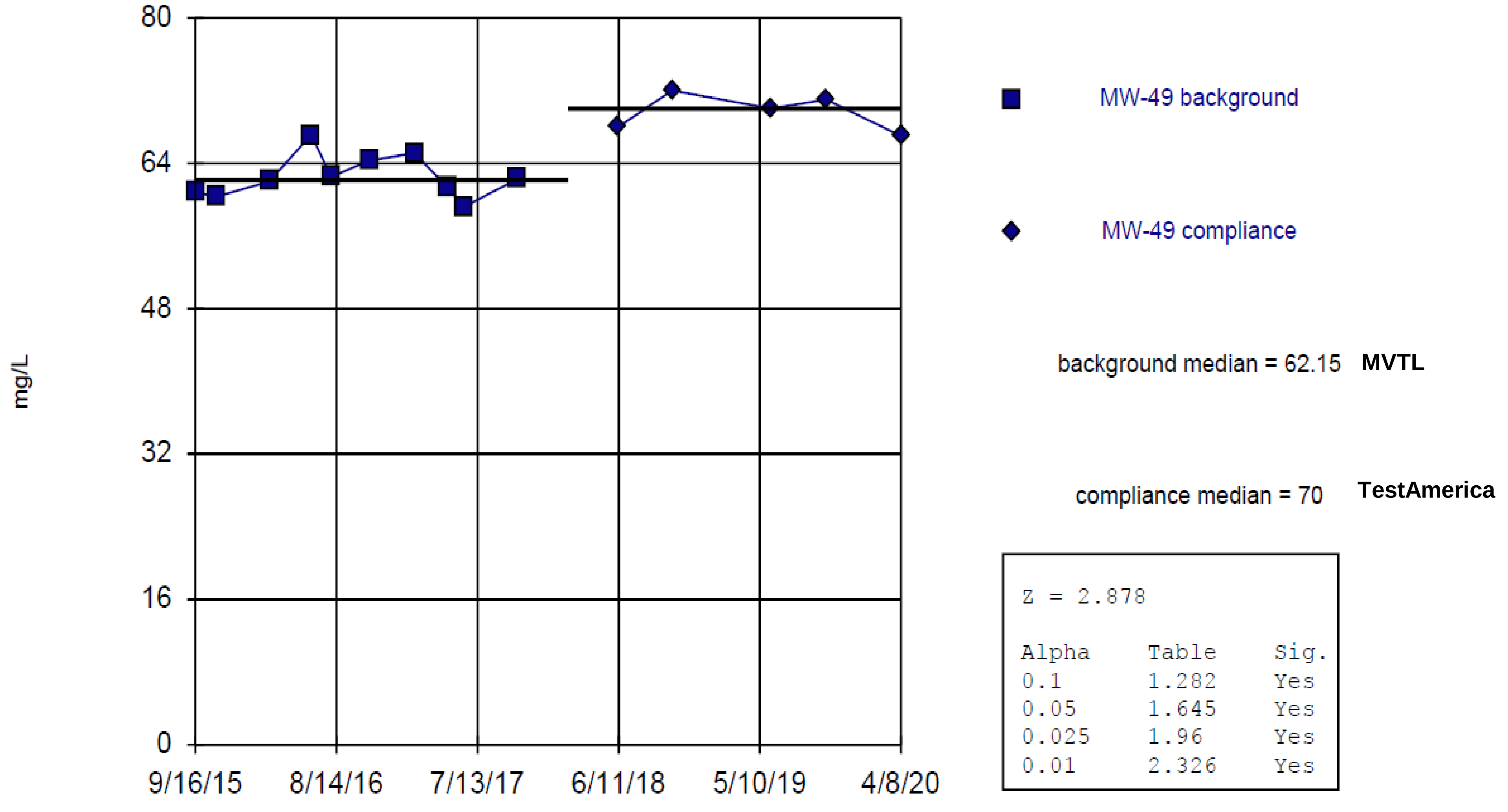
Sanitas™ v.9.6.26 Sanitas software licensed to Golder Associates. UG

Mann-Whitney (Wilcoxon Rank Sum)

MW-49



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0.05      1.645     Yes
0.025     1.96      Yes
0.01      2.326     Yes
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Constituent: Chloride   Analysis Run 9/28/2020 2:55 PM

Coal Creek Station   Client: Golder Associates   Data: analytic results_CCS-CCR_Q22020

CLIENT
Great River Energy Coal Creek Station

PROJECT
Alternate Source Demonstration

CONSULTANT
GOLDER

TITLE
Wilcoxon Rank-Sum Test for MW-49 Chloride Concentrations

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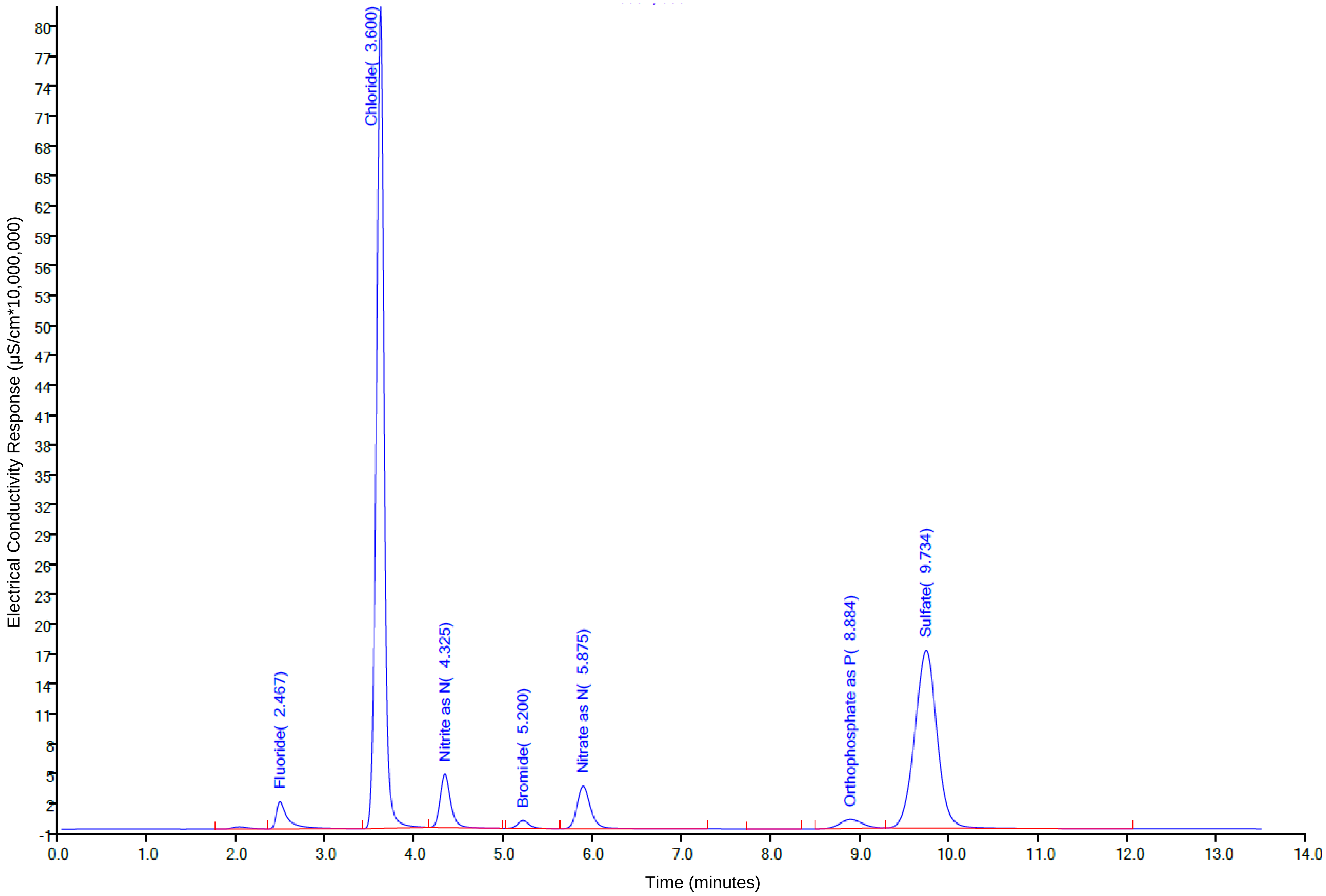


CLIENT
Great River Energy Coal Creek Station

PROJECT
Alternate Source Demonstration

CONSULTANT
GOLDER

TITLE
Example of Ion Chromatograph Data

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	0	3

Software Data Processing

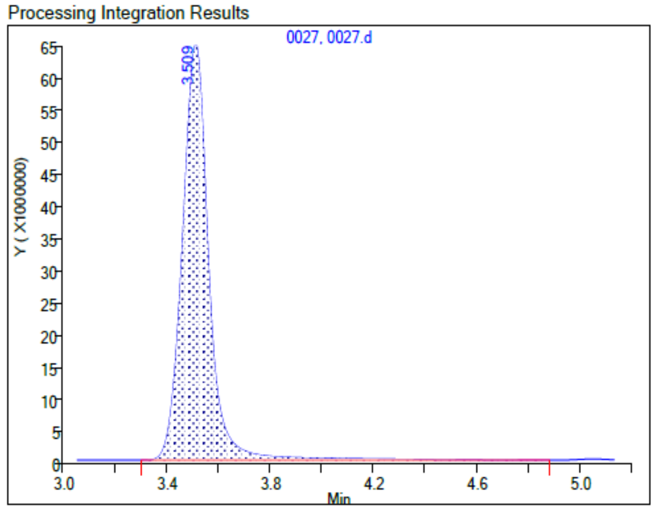
Manual Processing

Example #1:

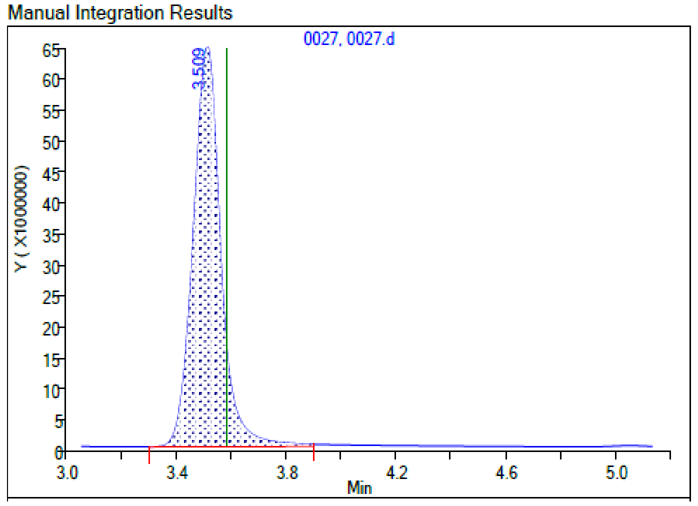
Shortened peak integration time to match calibration standards

Manual processing would decrease chloride concentration by 1.8%

RT: 3.51
Area: 457407359
Amount: 71.627674
Amount Units: ug/ml


Processing Integration Results

RT: 3.51
Area: 449145333
Amount: 70.344660
Amount Units: ug/ml

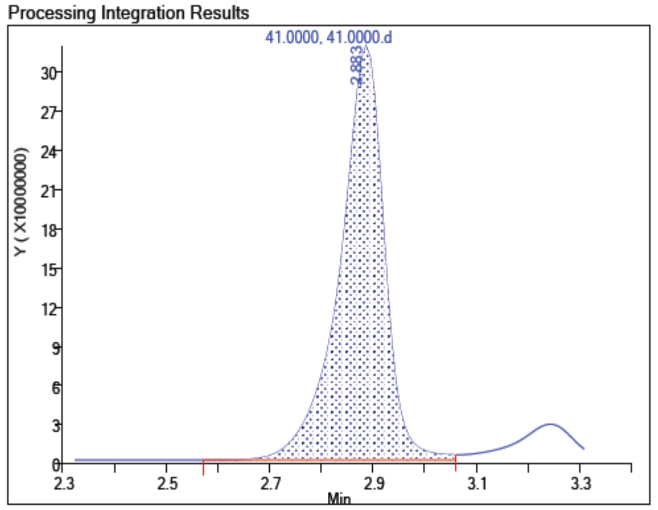

Manual Integration Results

Example #2:

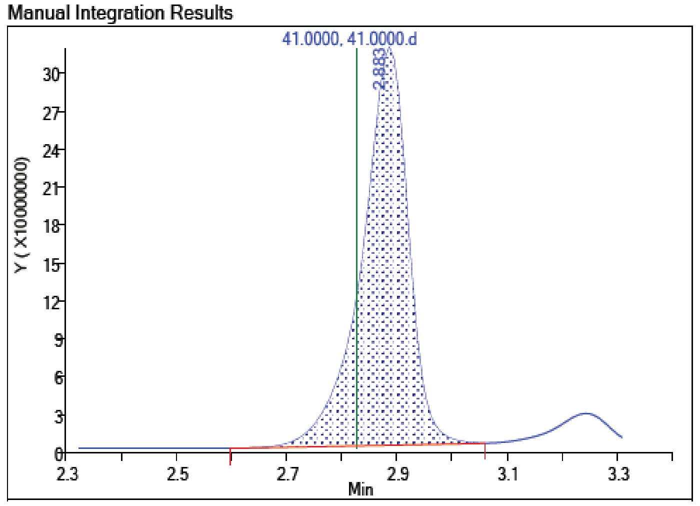
Right side of baseline brought up to minimum signal valley (not below valley), consistent with calibration standards

Manual Processing would decrease chloride concentration by 2.8%

RT: 2.88
Area: 1882027750
Amount: 107.4024
Amount Units: ug/ml


Processing Integration Results

RT: 2.88
Area: 1830626225
Amount: 104.4716
Amount Units: ug/ml

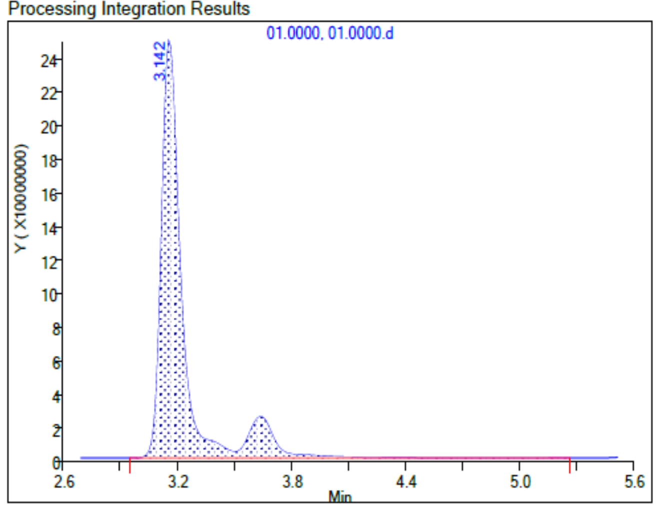

Manual Integration Results

Example #3:

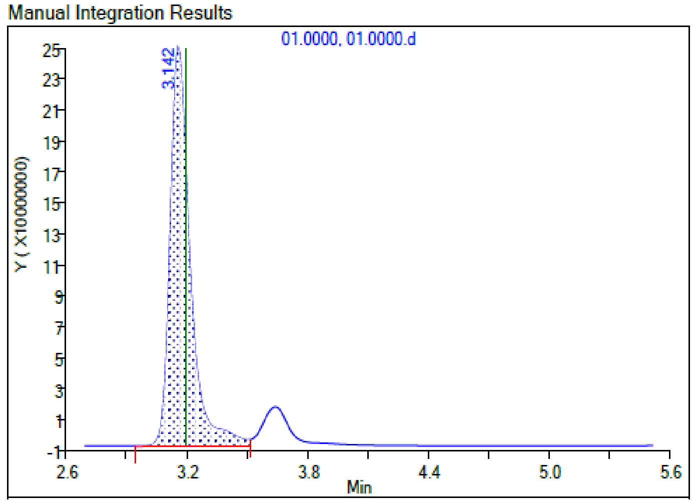
Minor peak to the right of chloride peak not included in area of chloride peak, consistent with calibration standards

Manual Processing would decrease chloride concentration by 4.2%

RT: 3.14
Area: 1753223086
Amount: 98.471277
Amount Units: ug/ml


Processing Integration Results

RT: 3.14
Area: 1683282689
Amount: 94.545083
Amount Units: ug/ml


Manual Integration Results

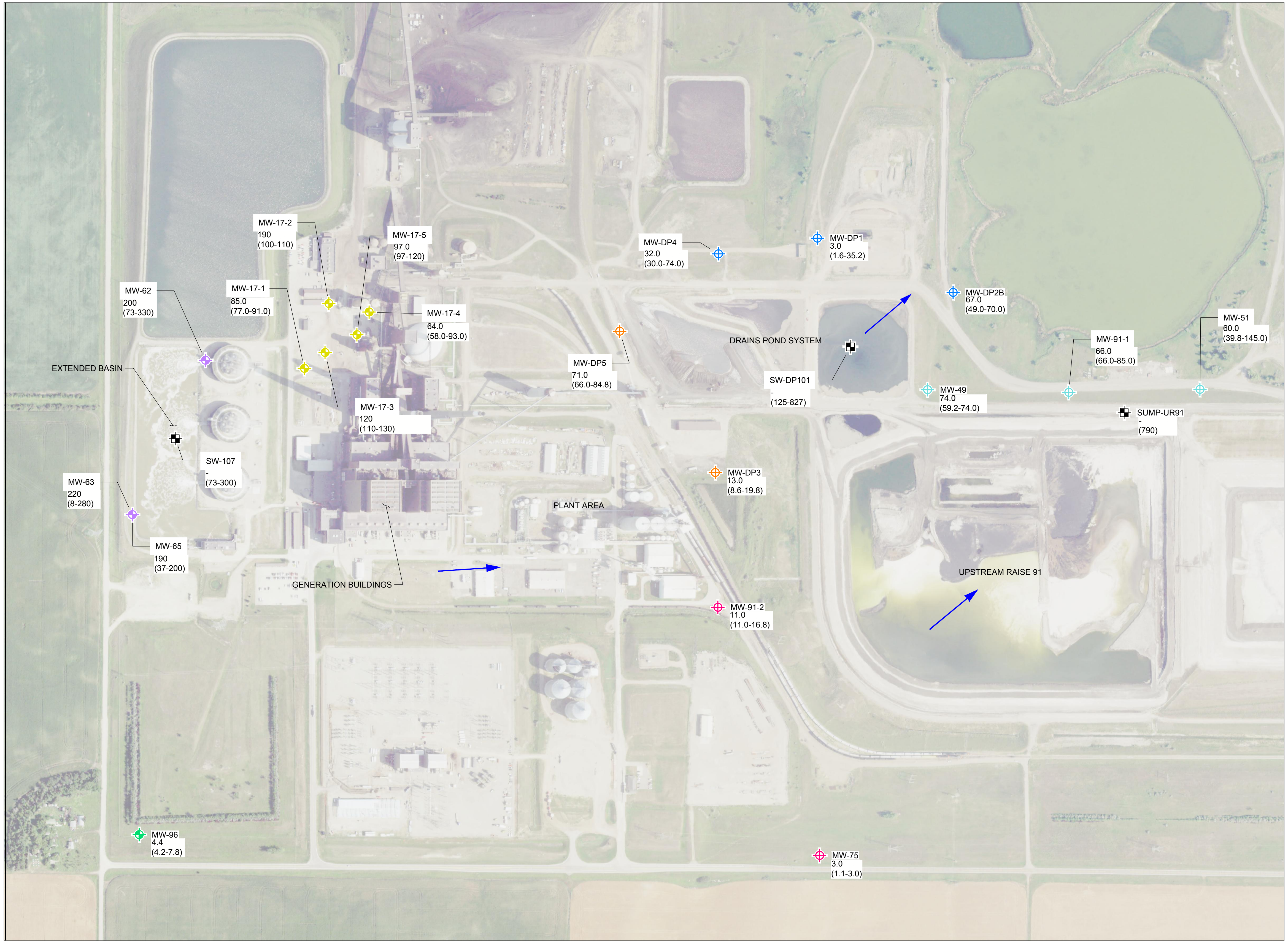
CLIENT
Great River Energy Coal Creek Station

PROJECT
Alternate Source Demonstration

CONSULTANT
GOLDER

TITLE
Comparison of Ion Chromatograph Software Data Process versus Manual Adjustments

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	0	4

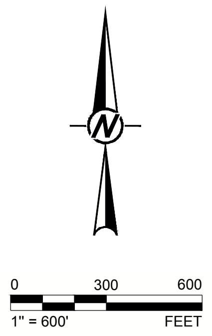


LEGEND

⊕	NDDEQ PLANT AREA UPGRADIENT WELL
⊕	NDDEQ PLANT AREA DOWNGRADIENT WELL
⊕	EEG PROGRAM WELL
⊕	DRAINS POND SYSTEM UPGRADIENT WELL
⊕	DRAINS POND SYSTEM DOWNGRADIENT WELL
⊕	UPSTREAM RAISE 91 UPGRADIENT WELL
⊕	UPSTREAM RAISE 91 DOWNGRADIENT WELL
▣	OTHER SAMPLING LOCATION
→	GENERAL DIRECTION OF GROUNDWATER FLOW
71.0	APRIL-MAY 2020 CHLORIDE CONCENTRATION (mg/L)
(59.2-72.0)	RANGE IN CHLORIDE CONCENTRATIONS, (mg/L)

NOTE(S)

1. AERIAL IMAGERY OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE IMAGERY PROGRAM, 2018.
2. SAMPLES FROM MW-DP5, MW-DP3, MW-DP2B, MW-DP1, MW-DP4, MW-91-2, MW-75, MW-49, MW-91-1, AND MW-51 WERE COLLECTED BETWEEN SEPTEMBER 2015 AND APRIL 2020. JUNE 2019 SAMPLES FROM MW-91-1 AND MW-91-2 WERE NOT USED BECAUSE OF SUSPECTED QUALITY CONTROL ISSUE.
3. SAMPLES FROM SW-DP101 WERE COLLECTED BETWEEN 2014 AND APRIL 2020.
4. SAMPLE FROM SUMP-UR91 WAS COLLECTED FROM NOVEMBER 2018. THE RANGE SHOWN FOR SUMP-UR91 REPRESENTS THE SINGLE CHLORIDE SAMPLE COLLECTED FROM THE LOCATION.
5. SAMPLES FROM MW-17-1, MW-17-2, MW-17-3, MW-17-4, AND MW-17-5 WERE COLLECTED BETWEEN JANUARY 2018 AND MAY 2020.
6. SAMPLES FROM MW-96, MW-62, MW-63, AND MW-65 WERE COLLECTED BETWEEN OCTOBER 1988 AND APRIL 2020.
7. SAMPLES WERE COLLECTED FROM SW-107 BETWEEN OCTOBER 1988 AND APRIL 2020.



CLIENT
GREAT RIVER ENERGY
COAL CREEK STATION

PROJECT
ALTERNATIVE SOURCE DEMONSTRATION

CONSULTANT

GOLDER

YYYY-MM-DD	2020-10-27
DESIGNED	DVS
PREPARED	DVS
REVIEWED	CCS
APPROVED	TJS

TITLE
CHLORIDE CONCENTRATIONS

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	0	5

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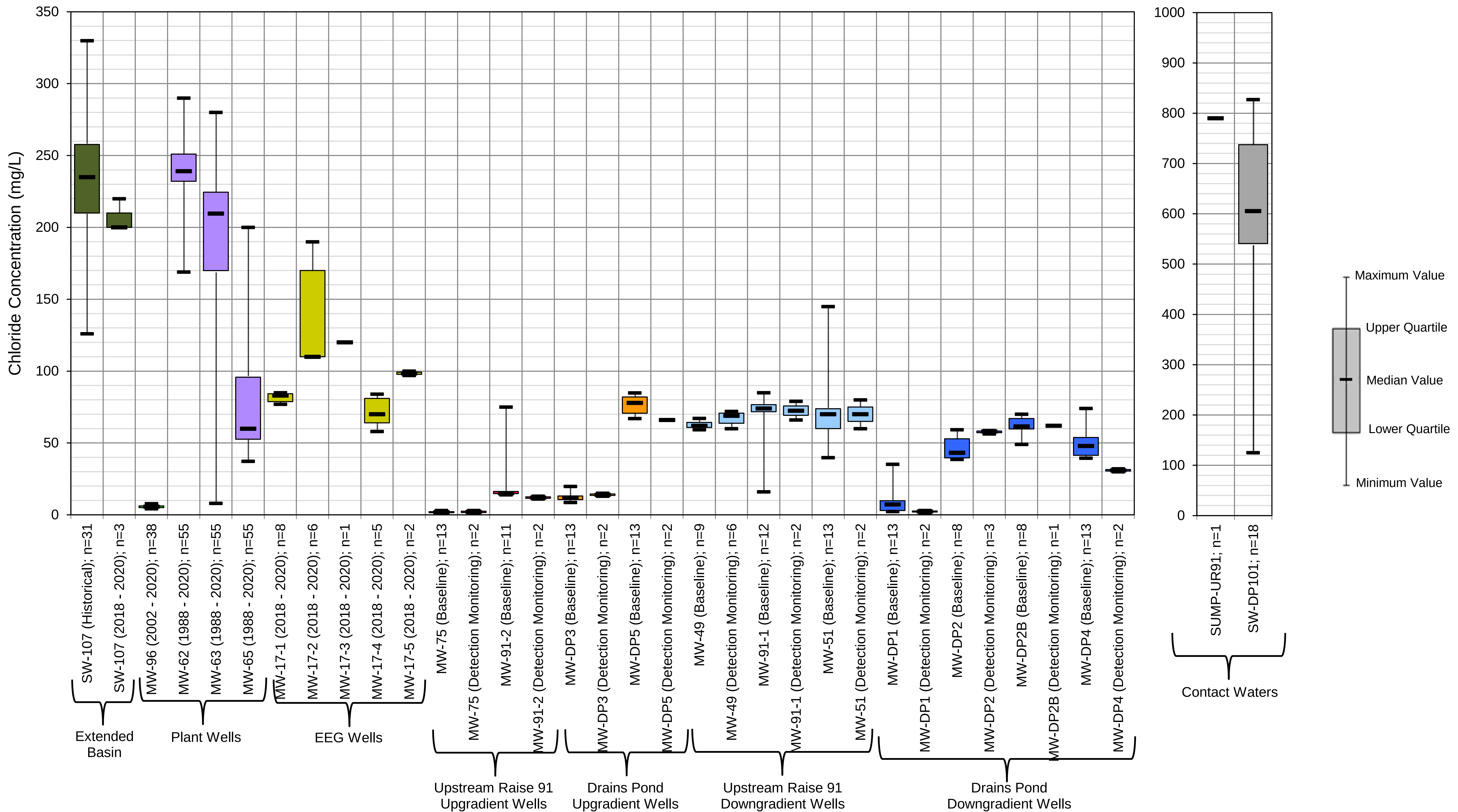

Notes:
Non-Detect replaced with the detection limit

June 2019 samples from MW-91-1 and MW-91-2 not used because of a suspected quality control issue.

CLIENT
Great River Energy Coal Creek Station

PROJECT
Alternate Source Demonstration

CONSULTANT
GOLDER

TITLE
Box and Whisker Plot for Chloride

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	0	6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
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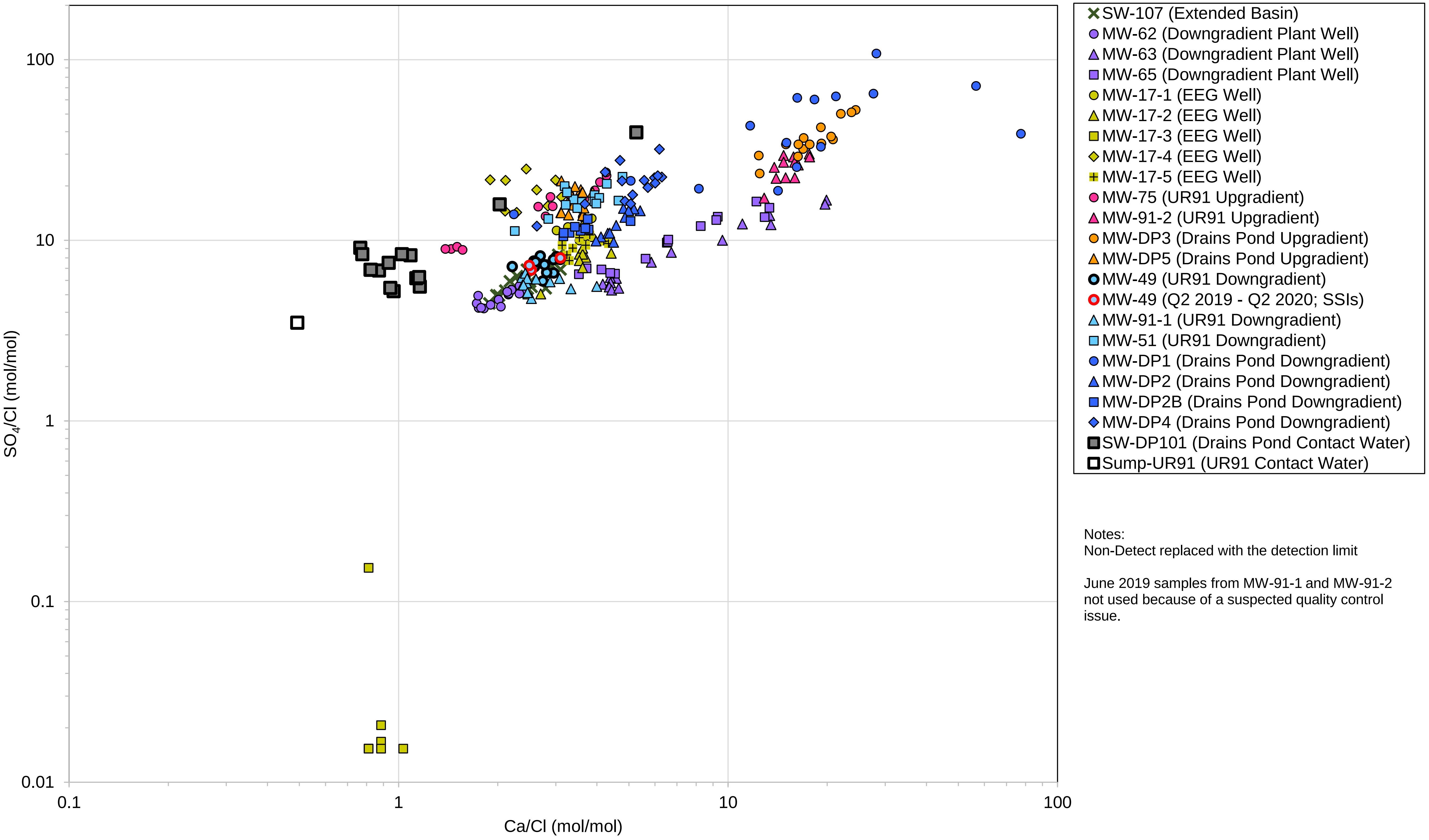

Notes:
Non-Detect replaced with the detection limit

June 2019 samples from MW-91-1 and MW-91-2 not used because of a suspected quality control issue.

CLIENT
Great River Energy Coal Creek Station

PROJECT
Alternate Source Demonstration

CONSULTANT
GOLDER

TITLE
Sulfate-Chloride versus Calcium-Chloride Ratio

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	0	7

REPORT

Alternative Source Demonstration for Monitoring Wells MW-10 and MW-16-1

Great River Energy - Coal Creek Station

Submitted to:

Great River Energy

Coal Creek Station
2875 Third Street SW
Underwood, North Dakota 58576

Submitted by:

Golder Associates Inc.

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19136224C-9-R-0

October 27, 2020

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

On behalf of Great River Energy (GRE), Golder Associates Inc. (Golder) performed a statistical evaluation of groundwater monitoring results from the second quarter (Q2) 2020 groundwater detection monitoring event at Coal Creek Station's Upstream Raise 92 coal combustion residual (CCR) surface impoundment. The statistical evaluation was performed as described in the Coal Combustion Residuals Groundwater Statistical Method Certification for Coal Creek Station, Revision 1 (Golder 2019a), in accordance with applicable provisions of 40 Code of Federal Regulations (CFR) Part 257, "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule" (CCR rule), as amended.

Statistical analyses of the Appendix III detection monitoring data indicated potential exceedances of the statistical limits based on the parametric Shewhart-CUSUM (Cumulative Summation) control chart analysis for the following parameters and monitoring wells in the fourth quarter (Q4) 2019 sampling results:

- Fluoride in samples collected from monitoring well MW-10
- Boron in samples collected from monitoring well MW-10
- Field pH in samples collected from monitoring well MW-10
- Field pH in samples collected from monitoring well MW-16-1

These potential exceedances were subsequently verified as statistically significant increases (SSIs) following the Q2 2020 detection monitoring sampling event. Although determination of a verified SSI generally indicates that the groundwater monitoring program should transition from detection monitoring to assessment monitoring, 40 CFR Part 257.94(e)(2) allows the owner or operator (i.e., GRE) 90 days from the date of determining a verified SSI (July 29, 2020) to demonstrate a source other than the regulated CCR facility caused the SSI or that the SSI was a result of an error in sampling, analysis, or statistical evaluation or natural variability in groundwater quality that was not fully captured during the baseline data collection period.

Golder's review of the hydrological and geologic conditions at the site indicates the SSI is likely an indication of a temporary impact due to a stormwater runoff event. As described below, the response to this runoff event was conducted as outlined in 40 CFR 257.83(b)(5). A desktop study of previously collected CCR-impacted water from the facility, nearby surface water, and groundwater samples was conducted to assess potential fluoride, boron and field pH sources. As a part of this work, potential error in the statistical analysis and the natural variability of concentrations in groundwater were evaluated. CCR-impacted water from the facility is broken into three categories for this demonstration. Contact water is defined as stormwater that comes into contact with CCR materials, porewater is defined as water collected from piezometers screened within the CCR deposition zone of the facility, and sump water is defined as water collected from the sumps overlying the composite liner system of the facility. Sump water and porewater samples have extended contact times with CCR materials while contact water has limited contact time with CCR materials. Based upon this review and in accordance with provisions of the CCR Rule, Golder has prepared this Alternative Source Demonstration (ASD) for monitoring wells MW-10 and MW-16-1 at Upstream Raise 92.

This ASD conforms to the requirements of 40 CFR Part 257.94(e)(2) and provides the basis for concluding that the verified SSIs at MW-10 and MW-16-1 are not an indication of seepage release from Upstream Raise 92. The following sections provide a summary of the CCR facilities, a storm event in September 2019, analytical and geochemical assessment results, and lines of evidence demonstrating stormwater that contacted CCR materials (contact water) is likely responsible for the SSIs at MW-10 and MW-16-1.

2.0 BACKGROUND

2.1 Site Background

GRE's Coal Creek Station (CCS) is a coal-fired electric generation facility located in McLean County, approximately 10 miles northwest of Washburn, North Dakota. CCRs are managed in composite-lined surface water impoundment cells and dry landfills regulated and permitted by the North Dakota Department of Environmental Quality (NDDEQ) in accordance with North Dakota Administrative Code (NDAC) Title 33.1, Article 33.1-20, Solid Waste Management and Land Protection.

CCS has four CCR facilities that are within the purview of the United States Environmental Protection Agency CCR rule. This ASD applies to the Upstream Raise 92 CCR surface impoundment. Upstream Raise 92 is located in the south-central portion of the plant site, east of the CCS plant buildings (Figure 1).

2.2 Site Geology

CCS and McLean County are situated at the eastern-most extent of the Williston Basin, a structural and sedimentary basin (USGS 1999). The region is characterized by the presence of glacial drift, reaching thicknesses of several hundred feet and overlying the Sentinel Butte Member, the source of commercially mined coal in the direct vicinity of CCS (Falkirk 1979). The Sentinel Butte Member is the highest strata of the Paleocene Fort Union Formation, overlying the Tongue River, Ludlow, and Cannonball Members (USGS 1999). The Sentinel Butte Member is marked by drab-gray units, demarcating the separation from the lower Tongue River Member.

The site geology of CCS includes unconsolidated surficial deposits of the Coleharbor formation, consisting of stratified and unstratified glacial drift. The near-surface materials are silty clay and sandy clay till with interbedded lenses (CPA/UPA 1989).

2.3 Site Hydrogeology

Regional groundwater flow of the uppermost water-bearing unit in the vicinity of CCS is a subtle expression of the surface topography, which is influenced by the configuration of the eroded bedrock. Based on available groundwater elevation data, the shallow groundwater at the CCR facilities at CCS generally follows surface topography, flowing east and north towards Lower Samuelson Slough and Sayler Slough. Available groundwater elevation data indicate that groundwater in the area of Upstream Raise 92 generally flows from the southwest to the northeast, diagonally across the footprint of the facility.

Hydraulic conductivities in the area of the Upstream Raise 92 range from 0.35 feet per day (ft/day) to 12.96 ft/day, with calculated groundwater flow rates during the Q2 2020 detection monitoring event ranging from 0.04 to 1.56 ft/day.

2.4 Groundwater Monitoring Network

The groundwater monitoring network for Upstream Raise 92 was developed with consideration for the size, disposal and operational history, anticipated flow direction, and location of adjoining facilities (Golder 2019b). Based on these factors, the Upstream Raise 92 monitoring well network consists of two upgradient and three downgradient monitoring wells used for monitoring the unit under the CCR rule.

The two upgradient monitoring wells (MW-16-6, MW-16-7) included in the groundwater monitoring network for Upstream Raise 92 are used to represent upgradient water flowing towards the unit from the west and south. The three downgradient wells (MW-10, MW-16-0, MW-16-1) are spaced along the north side of the facility. Upstream Raise 92 directly abuts Southeast Section 16 on its eastern edge, preventing installation of monitoring wells along the eastern side of Upstream Raise 92 without jeopardizing the integrity of the liner system. The Upstream Raise 92 monitoring network wells are presented in Figure 1. Other monitoring locations used to support this ASD are also presented in Figure 1.

2.5 Groundwater Conditions

Between September 2015 and June 2017, GRE collected nine independent baseline groundwater samples from MW-16-6, MW-16-7, MW-10, MW-16-0, and MW-16-1, as required by 40 CFR Part 257.94, for use within the CCR rule monitoring program. The results of the CCR baseline monitoring were used to develop statistical limits for each constituent at each monitoring well, based on site conditions and parameter specific characteristics such as the data distribution and detection frequency (Golder 2019a).

Following completion of the baseline monitoring events at each well, GRE began collecting groundwater samples on a semi-annual basis to support the detection monitoring program. Groundwater samples for detection monitoring are collected at each upgradient and downgradient monitoring well and analyzed for 40 CFR Part 257 Appendix III constituents. During the detection monitoring program, results from groundwater analysis are compared to the statistical limits to determine whether groundwater quality remains consistent, or if changes in groundwater quality are observed.

In accordance with the site Statistical Method Certification (Golder 2019a) and recommendations within the USEPA’s Unified Guidance (USEPA 2009), a baseline update was conducted for most well-constituent pairs within the Upstream Raise 92 monitoring network prior to conducting comparative statistical analysis for the Q4 2019 detection monitoring event. As a result of the baseline update, results collected during the detection monitoring program were evaluated to determine if they were from the same statistical population as those collected during the initial baseline monitoring program.

Figure 2 displays a time-series plot of historical water levels in each monitoring well. Water levels in both upgradient and downgradient wells increased between the Q2 2019 and Q4 2019 sampling events. Most of the groundwater levels remained elevated above older levels during the Q2 2020 sampling event.

2.5.1 Boron at MW-10

Boron concentrations in groundwater at MW-10 during the initial baseline monitoring period ranged between 1.8 and 3.0 milligrams per liter (mg/L) in the nine baseline samples collected as part of the CCR rule monitoring program. The boron concentrations of detection monitoring samples collected between October 2017 and June 2019 that were incorporated into the updated baseline period ranged between 2.0 and 2.8 mg/L. The Shewhart-CUSUM statistical limit for the well-constituent pair was set at 3.7 mg/L following the baseline update.

The Q4 2019 detection monitoring event reported a boron concentration of 6.4 mg/L at MW-10, with a calculated CUSUM value of 6.0 mg/L, exceeding the statistical limit. Verification resampling was conducted during the Q2 2020 detection monitoring event, confirming the SSI for boron at MW-10 with a boron concentration of 4.6 mg/L and a calculated CUSUM value of 8.0 mg/L.

2.5.2 Fluoride at MW-10

Fluoride concentrations in groundwater at MW-10 during the initial baseline monitoring period ranged between 0.19 and 0.23 mg/L in the nine baseline samples collected as part of the CCR rule monitoring program. The fluoride concentration of detection monitoring samples collected between October 2017 and June 2019 that were incorporated into the updated baseline period ranged between 0.17 and non-detect with a detection limit of 0.50 mg/L. The Shewhart-CUSUM statistical limit for the well-constituent pair was set at 0.29 mg/L following the baseline update.

The Q4 2019 detection monitoring event reported a fluoride concentration of 0.47 mg/L at MW-10, with a calculated CUSUM value of 0.45 mg/L, exceeding the statistical limit. Verification resampling was conducted during the Q2 2020 detection monitoring event, confirming the SSI for fluoride at MW-10 with a fluoride concentration of 0.37 mg/L and a calculated CUSUM value of 0.59 mg/L.

2.5.3 Field pH at MW-10

Field pH in groundwater at MW-10 during the initial baseline monitoring period ranged between 6.72 and 6.95 standard units (SU) in the nine baseline samples collected as part of the CCR rule monitoring program. Detection monitoring samples collected between October 2017 and June 2019 that were incorporated into the updated baseline period had field pH values between 6.81 and 6.92 SU. The Shewhart-CUSUM upper statistical limit for the well-constituent pair was set at 7.10 SU following the baseline update.

The Q4 2019 detection monitoring event reported a pH value of 7.49 SU at MW-10, with a calculated CUSUM value of 7.42 SU, exceeding the statistical limit. Verification resampling was conducted during the Q2 2020 detection monitoring event, confirming the SSI for field pH at MW-10 with a field pH of 7.54 SU and a calculated CUSUM value of 8.06 SU.

2.5.4 Field pH at MW-16-1

Field pH in groundwater at MW-16-1 during the initial baseline monitoring period ranged between 7.06 and 7.21 SU in the nine baseline samples collected as part of the CCR rule monitoring program. Detection monitoring samples collected between October 2017 and June 2019 that were incorporated into the updated baseline period had field pH values between 7.13 and 7.16 SU. The Shewhart-CUSUM upper statistical limit for the well-constituent pair was set at 7.34 SU following the baseline update.

The Q4 2019 detection monitoring event reported a pH value of 7.60 SU at MW-16-1, with a calculated CUSUM value of 7.55 SU, exceeding the statistical limit. Verification resampling was conducted during the Q2 2020 detection monitoring event, confirming the SSI for field pH at MW-16-1 with a field pH of 7.43 SU and a calculated CUSUM value of 7.80 SU.

3.0 POTENTIAL SITE FLUORIDE, BORON, AND FIELD PH SOURCES

To assess the potential sources for a change in fluoride, boron, and pH concentrations at MW-10 and pH concentrations at MW-16-1, Golder reviewed previously collected data and performed supplemental assessment activities. The following sections summarize the supplemental assessment activities.

3.1 Overview of September 20-21, 2019 Storm Event

Between Friday, September 20 and Saturday, September 21, 2019, a large thunderstorm system affected central North Dakota. The National Weather Service described the storm event in the following excerpt (NWS 2019):

> *"A large mid to upper level low pressure system moved across North Dakota on September 20th through September 21st, 2019. This low pressure system led to excessive rain across much of central North Dakota, as the atmosphere featured anomalously high moisture with a low level jet impinging on a stationary frontal boundary. These ingredients created a perfect scenario for thunderstorm training, which generally occurred in a line extending from Morton through Burleigh, Kidder, Stutsman, Sheridan, Wells, and Foster counties. The hardest hit areas were in portions of Sheridan and Wells counties, where some areas received over 7 inches of rain in less than 15 hours."*

Figure 3 shows a times series of monthly precipitation records from CCS between 2016 and 2020 and Turtle Lake, North Dakota (approximately 20 miles northeast of the Site) between 1993 and 2020. The contribution from the storm on September 20 - 21, 2019 made September 2019 the wettest month over the period of record (7.4 inches of rain at CCS and 8.7 inches of rain at Turtle Lake). The average rainfall for September at Turtle Lake between 1993 and 2018 is 1.3 inches.

Three days after the storm event (September 24, 2019), a registered professional engineer (PE) from Golder was on Site performing the annual PE inspection of Upstream Raise 91 and Upstream Raise 92 per USEPA Regulation 40 CFR 257.83(b) requirements. In the annual PE inspection reports (Golder 2020a and Golder 2020b), the Golder representatives noted the following:

- Standing water in the drainage ditches around Upstream Raise 91 and Upstream Raise 92
- Erosion of the fly ash cover along the inside of the ramp on the north side of Upstream Raise 92

Given the observed erosion, precipitation falling on the north side of Upstream Raise 92 (including a haul road ramp) likely contributed to significant runoff from exposed CCR slopes. Contact water was designed to flow from the inside of this ramp into a perimeter ditch at the toe of the CCR slope that is within the composite-lined footprint of the CCR surface impoundment. However, due to significant haul traffic over the course of several years and "rounding off" of the haul ramp and road near the toe of the facility, contact water appears to have had an opportunity to flow off of the lined footprint, especially in the case of a significant rain event (Figure 4). Although not directly observed, contact water is suspected to have flowed down the upper ramp and onto the lower ramp and lower perimeter berm slopes. Standing water was observed in the ditch near the lower ramp of Upstream Raise 92 that is meant to collect and route non-contact water from grass-covered slopes of the perimeter berm of the CCR surface impoundment.

Based on these observations, GRE personnel reviewed the contact water runoff controls for this area of Upstream Raise 92 and developed a plan to repair and improve contact water controls. Beginning in May 2020, once weather conditions allowed, these contact water controls were implemented to prevent contact water runoff during future storm events. The repairs are outlined in the Corrective Measures Report (Golder 2020c) in Appendix A. The response to this event outlined in the Corrective Measures Report was consistent with the requirements of 40 CFR 257.83(b)(5) which states, "If a deficiency or release is identified during an inspection, the owner or operator must remedy the deficiency or release as soon as feasible and prepare documentation detailing the corrective measures taken."

Monitoring wells MW-10 and MW-16-1 are in low areas in close proximity to the north lower ramp of Upstream Raise 92 and the contact water flowing off of the facility is likely to have accumulated in the area around these wells.

3.2 Data Sources Used in Alternative Source Review

To evaluate potential site sources of fluoride, boron, and field pH near Upstream Raise 91 and Upstream Raise 92, Golder reviewed the following groundwater, surface water, and CCR-impacted water results (see Figure 1 and Figure 4 for locations).

3.2.1 Groundwater Monitoring Data

Data collected between September 2015 and April 2020 for the CCR rule monitoring program were considered in the evaluation. As part of the monitoring program, field personnel collected groundwater samples from the following monitoring wells:

- Upgradient to Upstream Raise 92: MW-16-6 and MW-16-7
- Downgradient to Upstream Raise 92: MW-10, MW-16-0, and MW-16-1
- Downgradient to Upstream Raise 91: MW-51 (the eastern-most downgradient monitoring well of Upstream Raise 91 that is within the surface water drainage ditch at the toe of the perimeter berm slope at the border between Upstream Raise 91 and Upstream Raise 92)

3.2.2 CCR-Impacted Waters

Sump water and porewater collected from Upstream Raise 92 was used to characterize waters in extended contact with CCR materials and includes the following:

- Upstream Raise 92 north sump (Sump-N-AP92)
- Porewater from piezometers (PZ-1, PZ-11, and PZ-13) screened within the deposited CCR

While MW-10 and MW-16-1 are downgradient wells for Upstream Raise 92 , sump water from other CCR storage facilities was also included to increase the sample size and capture potential variability in sump water and porewater samples, especially given the drainage and process water systems between Upstream Raise 91 and the Drains Pond System are connected to Upstream Raise 92 via piping:

- Upstream Raise 91 sump (Sump-UR91)
- Southwest 16 sump (Sump-NW-SW16)

3.2.3 Short Term Leach Testing of CCR Materials

Short-term leach testing of the CCR materials by the synthetic precipitation leaching procedure (SPLP) was performed by EPA Method 1312 (EPA 2008). The SPLP simulates the interaction between a solid and meteoric water, which provides a screening-level estimate of ash effluent water quality.

CCR materials were collected by site personnel between 2012 and 2017. Details about the collection procedure are listed by material type below:

- Three bottom ash samples from Section 26 (a historic containment area for CCRs in a previously mined area) were collected in-situ at the facility in May 2017

- One bottom ash sample was collected from the Drains Pond System west cell in May 2017
- Two fly ash samples were collected from the fly ash silos (One sample was collected in November 2017 and one was collected in May 2017)
- Three coal rejects samples were collected from Ash Pond 91(also referred to as Upstream Raise 91) in June 2013
- One coal rejects sample was collected from Upstream Raise 91 in May 2017
- One Flue Gas Desulfurization (FGD) material sample was collected from the FGD material blowdown line at the scrubbers in May 2017

3.2.4 Ditch on the North Side of Upstream Raise 92

As part of the investigation of Upstream Raise 92 (Golder 2020c), standing water was observed in the ditch near the lower ramp of Upstream Raise 92. A water sample was collected from this drainage ditch located on the north side of Upstream Raise 92 (Ditch_N_UR92, see Figure 4), herein referred to as ditch water. This water likely represents contact water runoff from Upstream Raise 92.

3.3 Evaluation of Potential Sources of Boron, Fluoride, and Field pH

The relative proportion of major ion concentrations in groundwater samples and potential sources are depicted on a Piper diagram in Figure 5. This Piper diagram compares water quality results from groundwater, sump water, CCR material SPLP leachates, and Upstream Raise 92 ditch water to evaluate potential sources of boron, fluoride, and field pH. The results from the more recent groundwater sampling events are marked with solid blue symbols to distinguish between older and more recent samples. Figure 6 presents a scatter plot of the sulfate to chloride ratio versus the boron to chloride ratio as an additional method to compare site sources. The data suggests the SSIs identified for samples collected from MW-10 and MW-16-1 can be primarily attributed to a contact water runoff event associated with a significant rain event in September 2019.

3.3.1 Contact Water Runoff Event from Upstream Raise 92

Based on the magnitude of the September 2019 storm event and site observations of the CCR slopes and haul road ramp on the north side of Upstream Raise 92 after this event, contact water runoff from Upstream Raise 92 was evaluated as a potential source for the changing boron and fluoride concentrations and field pH values at the downgradient monitoring wells.

The conceptual model for contact water runoff impacting the shallow groundwater wells assumes that:

1) Due to failure of the contact water controls during a significant precipitation event, contact water flowing down existing CCR slopes and the upper haul road ramp on the north side of Upstream Raise 92 was able to bypass the controls, flow off the composite lined footprint along the north side of Upstream Raise 92, and pond near the downgradient monitoring wells.
2) This ponded contact water then partially infiltrated into the shallow groundwater monitored by the downgradient wells, resulting in a change in water quality monitored during the Q4 2019 and Q2 2020 sampling events.

3) Because of the transient nature of this event, it is expected that water quality in the downgradient wells would shift towards contact water quality immediately after the event, and then would shift back towards historical water quality after the event.

Boron and fluoride concentrations and pH values in samples collected from ditch water (water that has been in short-term contact with CCR and expected to be similar to the water that was released during the storm event), MW-10, and MW-16-1 are presented in Table 1. Concentrations are generally higher in samples collected from ditch water than the monitoring wells, indicating that contact water runoff from Upstream Raise 92 could be responsible for elevated boron and fluoride concentrations and field pH values observed in recent samples collected from MW-10 and MW-16-1.

Table 1: Summary of Select Concentrations in Potential Contact Water Runoff and Downgradient Wells

Analyte	Units	Ditch water (Ditch_N_UR92) (10/24/2019)	MW-10 (Baseline and Detection Monitoring)	MW-16-1 (Baseline and Detection Monitoring)
pH	SU	8.1 (Lab)	6.81 – 7.54 (Field)	7.13 – 7.60 (Field)
Boron	mg/L	12.0	1.8 – 6.4	5.3 – 16.8
Fluoride	mg/L	0.26	0.17 – 0.47	0.16 – 0.77

Notes:
SU: standard units
Lab: pH measure in laboratory
Field: pH measure in the field
mg/L: milligrams per liter

SPLP testing was also used to assess the water quality expected from short-term interactions of water with CCR. As concentrations observed in SPLP leachates are partly a function of the liquid to solid ratio of the test conducted, results should not be directly compared to Site waters. Instead, Piper diagrams and ion ratios allow for comparisons of relative concentrations of Site waters to SPLP leachates.

The relative proportion of major ion concentrations in groundwater samples and potential boron, fluoride, and field pH sources are depicted on a Piper diagram in Figure 5. The Piper diagram indicates that the Q4 2019 groundwater samples from MW-10 shifted towards a more sulfate dominant signature, and closer to the CCR SPLP leachates and ditch water (Ditch_N_UR92) sample (surrogates for contact water) on the plot. The major ion signature of the Q2 2020 groundwater sample shifted back towards the historical (May 2017 – June 2019) signature, suggesting the groundwater quality change was temporary and transient. Major ions were not analyzed in the Q4 2019 sample from MW-16-1; however, a shift towards CCR SPLP leachates and the ditch water sample (surrogates for contact water) is observed for the Q2 2020 sample. As discussed in Section 2.5, the boron, fluoride, and field pH concentrations in Q2 2020 groundwater samples generally shifted back towards the range of baseline measurements, with the exception of field pH in MW-10, which remained similar to the Q4 2019 value.

The shifting of groundwater quality toward a potential source and then back toward the historical chemical signature is consistent with what would be expected if a stormwater runoff event temporarily influenced groundwater concentrations. If contact water flowed down existing CCR slopes and the haul road ramp on the north side of Upstream Raise 92 and ponded near the downgradient monitoring wells, the water is likely to have partially infiltrated into groundwater and influenced concentrations in nearby wells. After the storm and short-term contact water runoff infiltration event, the water quality signature of samples collected from a given downgradient well would return closer to the historical signature as the "plug" of infiltrated contact water migrates downgradient. A similar shift towards the CCR SPLP and ditch water sample signature in Q4 2019 samples and then back towards the historical signature in Q2 2020, was also observed for Q2 2020 samples collected from nearby wells MW-51 and MW-16-0, which are also located so as to have seen potential contact water runoff from the north haul road ramp at Upstream Raise 92. The widespread observation of water quality changes in the area likely affected by contact water runoff on the north side of Upstream Raise 92 suggests a temporary change in groundwater quality due to ponding and infiltration of contact water.

A return towards the historical chemical signature would not be expected if an ongoing source, such as seepage from the CCR facility, caused the initial change in the major ion signature. Furthermore, if seepage from a CCR facility was impacting groundwater at MW-10 or MW-16-1, the groundwater geochemistry would be expected to shift towards the major ion signature of sump samples on the Piper diagram, which is not observed.

Figure 6 presents an ion ratio plot to further highlight differences between estimated contact water chemistry (based on CCR material SPLPs and ditch water) and facility seepage chemistry (based on sump water and porewater samples). Sump water and porewater samples have extended contact times with CCR materials and have higher chloride to sulfate and chloride to boron ratios relative to groundwater samples, CCR material SPLP leachates and ditch water. The groundwater samples collected in Q4 2019 from MW-10 and MW-16-1 appear to be impacted by a water source with higher concentrations of sulfate and boron relative to chloride (shifting to the upper-right), indicating impacts likely due to contact water runoff. Similar to observations from the Piper diagram, the groundwater samples collected in Q2 2020 from MW-10 and MW-16-1 shift back towards their historical chemical signatures, indicating that the "plug" of infiltrated contact water is migrating downgradient. These same temporal patterns are observed in MW-51 and MW-16-0, which are nearby to MW-10 and MW-16-1 and likely experienced the same temporary impacts from contact water runoff.

3.3.2 Seepage from Upstream Raise 92

Seepage from Upstream Raise 92 has the potential to impact downgradient monitoring wells experiencing SSIs. The range of boron and fluoride concentrations, and pH values in samples collected from sumps and piezometers (porewater), and MW-10, and MW-16-1 are presented in Table 2. Sump water and piezometer water (porewater) concentrations and pH values are elevated above groundwater concentrations and pH values in samples collected from MW-10 and MW-16-1. Therefore, seepage, if occurring, could increase concentrations at MW-10 and MW-16-1. However, as discussed in Section 3.3.1, the ion ratios presented in Figure 6 show that the Q4 2019 groundwater samples at MW-10 and MW-16-1 shifted away from the sump water and porewater signatures, making leakage from Upstream Raise 92 an unlikely source for the observed changes in boron, fluoride, and field pH.

The presence of the composite liner systems at Upstream Raise 92 reduces the likelihood of seepage. The composite liner on the east side of Upstream Raise 92 includes a 2-foot thick compacted clay liner with a hydraulic conductivity of 1×10^{-7} centimeters/second (cm/sec) or less underlying a 40-mil high density polyethylene (HDPE) geomembrane. The composite liner on the west side of Upstream Raise 92 includes a 1-foot thick compacted clay liner with a hydraulic conductivity of 1×10^{-7} cm/sec or less underlying a 60-mil linear-low density polyethylene (LLDPE) geomembrane.

Table 2: Summary of Select Concentrations in Sumps and Piezometers and Downgradient Wells

Analyte	Units	Sumps and Piezometers Samples Upstream Raise 91, Upstream Raise 92, and Southwest 16 (2018 – 2019)	MW-10 (Baseline and Detection Monitoring)	MW-16-1 (Baseline and Detection Monitoring)
pH	SU	7.5 – 10.5 (Lab)	6.81 – 7.54 (Field)	7.13 – 7.60 (Field)
Boron	mg/L	3.7 - 50	1.8 – 6.4	5.3 – 16.8
Fluoride	mg/L	0.18 - 70	0.17 – 0.47	0.16 – 0.77

4.0 EVIDENCE OF AN ALTERATIVE SOURCE

Primary lines of evidence and conclusions drawn from the evidence used to support this ASD are provided in Table 3. In summary, the SSIs identified for samples collected from MW-10 and MW-16-1 were not an indication of seepage from the CCR unit and can be primarily attributed to a contact water runoff event associated with a significant rain event in September 2019.

Table 3: Primary and Supporting Lines of Evidence from ASD Analysis

Key Line of Evidence	Supporting Evidence	Description
Hydrogeology	Groundwater elevations at monitoring wells around Upstream Raise 92	Q4 2019 increases in water levels downgradient monitoring wells indicate a change in the hydrological regime downgradient of Upstream Raise 92, potentially reflecting the infiltration of contact water runoff from the upper CCR slopes and the north Upstream Raise 92 haul road ramp.
Engineering Controls	Upstream Raise 92 has a composite liner system	Upstream Raise 92 has composite liner systems consisting of compacted clay liner with a hydraulic conductivity of 1x10-7 cm/sec or less underlying a geomembrane, which decreases the likelihood of seepage from the facility.

Key Line of Evidence	Supporting Evidence	Description
Water Geochemistry	Relative ion abundances in groundwater differs from CCR facility porewater and sump water samples	The water quality signature of groundwater samples collected from downgradient wells MW-10 and MW-16-1 are not consistent with the signature of potential seepage from Upstream Raise 92, which is shown in two different ways on Figure 5 (Piper diagram) and Figure 6 (ion ratio plot). Groundwater chemistry results from MW-10 and MW-16-1 in Q4 2019 shift towards contact water (SPLP leachates and ditch water consistent with contact water runoff from the surface of the facility). In Q2 2020 samples, the groundwater from MW-10 and MW-16-1 shifted back towards their historical chemical signature, indicating a short-term impact, from infiltration of contact water runoff.

5.0 CONCLUSIONS

In accordance with 40 CFR 257.95(g)(3), this ASD has been prepared in response to the identification of verified SSIs for boron, fluoride, and field pH at monitoring well MW-10 and field pH at monitoring well MW-16-1 following the Q2 2020 sampling event for Upstream Raise 92 at Coal Creek Station.

Based on review of site analytical results, recent changes to boron, fluoride, and field pH concentrations in groundwater downgradient of Upstream Raise 92 are likely not a result of leakage from a CCR facility but instead can be attributed to a contact water runoff event associated with a significant rain event in September 2019. As a result, GRE performed the actions outlined in the Corrective Measures Report (Golder 2020c) to prevent runoff from CCR slopes or the Upstream Raise 92 north haul road ramp from migrating off the composite-lined facility footprint during future storm events. Therefore, no further action (i.e., a transition to Assessment Monitoring) is warranted, and Upstream Raise 92 will remain in detection monitoring.

6.0 REFERENCES

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Signature Page

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https://golderassociates.sharepoint.com/sites/120551/project files/6 deliverables/19136224c/reports/9-r_asd_q2_ur92/9-r-0/19136224c-9-r-0-asd_q2_ur92_27oct20.docx

Figures

LEGEND

⊕	UPGRADIENT MONITORING WELL
⊕	DOWNGRADIENT MONITORING WELL - DRAINS POND SYSTEM
⊕	DOWNGRADIENT MONITORING WELL - UPSTREAM RAISE 91
⊕	DOWNGRADIENT MONITORING WELL - UPSTREAM RAISE 92
△	SAMPLED PIEZOMETER - UPSTREAM RAISE 92
⊕	DOWNGRADIENT MONITORING WELL - SOUTHEAST 16
→	GENERAL DIRECTION OF GROUNDWATER FLOW
— 1915 —	POTENTIOMETRIC SURFACE CONTOURS (SEE NOTE 2)
— — —	UPSTREAM RAISE 92 BOUNDARY

NOTE(S)

1. GROUNDWATER ELEVATIONS SHOWN WERE MEASURED APRIL-MAY 2020.
2. POTENTIOMETRIC SURFACE CONTOURS WERE CREATED USING WATER LEVEL INFORMATION FROM THE APRIL-MAY 2020 GROUNDWATER ELEVATIONS SHOWN, AS WELL AS SURVEYED SURFACE WATER EXPRESSIONS, ADDITIONAL SITE WELLS, AND PIEZOMETERS NOT SHOWN. CONTOUR INTERVAL IS 5 FEET.
3. MONITORING WELL MW-72 GROUNDWATER LEVEL COULD NOT BE MEASURED DUE TO PRESENCE OF ICE AS INDICATED IN THE FIELD DATASHEET DATED APRIL 09, 2020.
4. AERIAL IMAGERY OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE IMAGERY PROGRAM, 2019.

CLIENT
GREAT RIVER ENERGY
COAL CREEK STATION

PROJECT
ALTERNATIVE SOURCE DEMONSTRATION

CONSULTANT
GOLDER

YYYY-MM-DD	2020-10-27
DESIGNED	DVS
PREPARED	DVS
REVIEWED	CCS
APPROVED	TJS

TITLE
APRIL-MAY 2020 GROUNDWATER CONTOURS AND SAMPLING LOCATIONS

PROJECT NO.	PHASE	REV.	FIGURE
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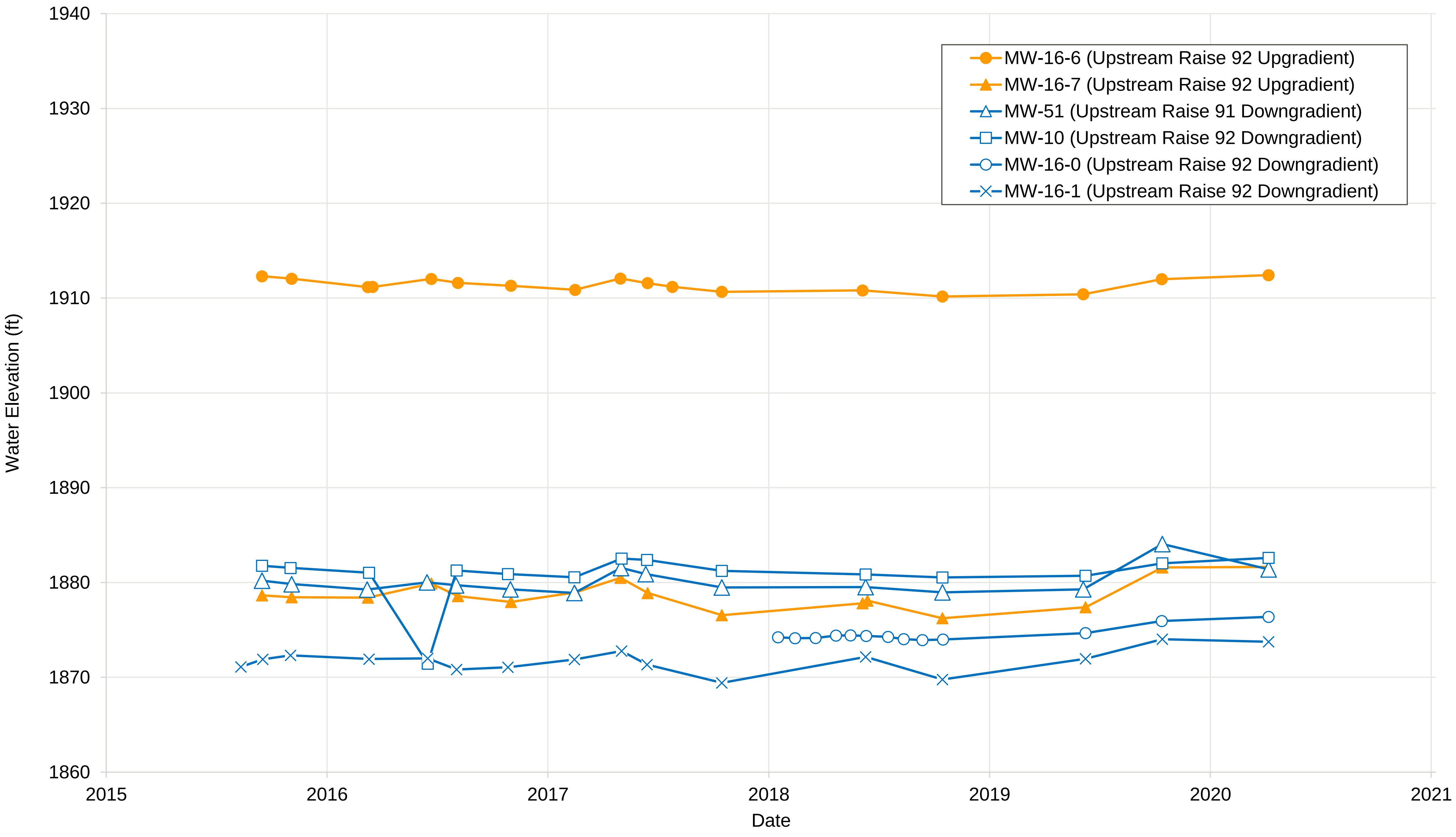

CLIENT
Great River Energy Coal Creek Station

PROJECT
Alternative Source Demonstration

CONSULTANT
GOLDER

TITLE
Time Series of Groundwater Elevations in Network Wells

PROJECT NO.	PHASE	REV.	FIGURE
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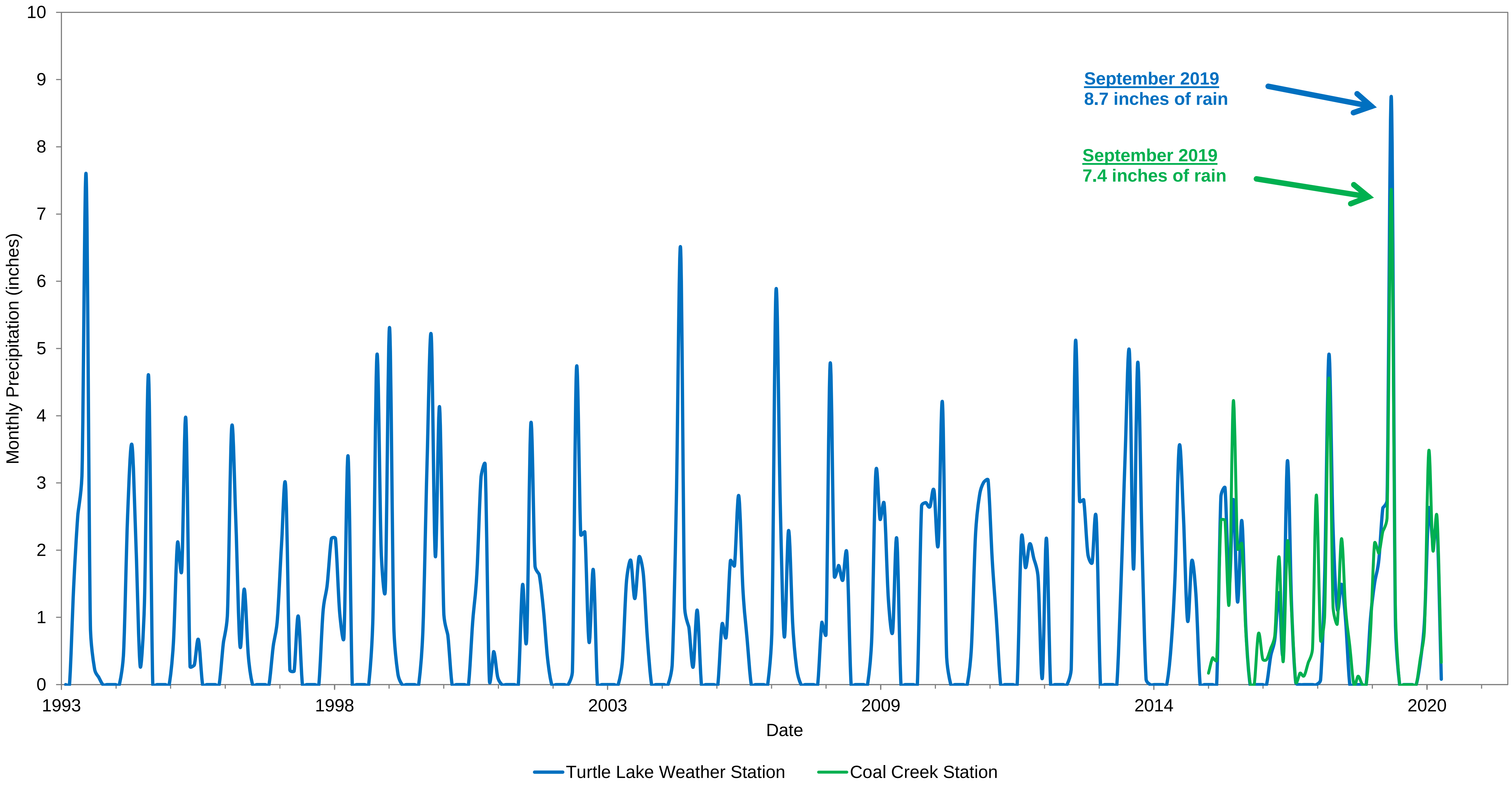

Note: Turtle Lake Weather Station is located approximately 20 miles northwest of Coal Creek Station.

CLIENT
Great River Energy Coal Creek Station

PROJECT
Alternative Source Demonstration

CONSULTANT
GOLDER

TITLE
Time Series of Monthly Precipitation at CCS and Turtle Lake, ND Weather Stations

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	0	3

LEGEND

⌖	DOWNGRADIENT MONITORING WELL - UPSTREAM RAISE 91
⌖	DOWNGRADIENT MONITORING WELL - UPSTREAM RAISE 92
⌖	OTHER SAMPLING LOCATION
→	DESIGNED CONTACT WATER FLOW PATH
→	SUSPECTED CONTACT WATER RUNOFF

NOTE(S)

1. AERIAL IMAGERY OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE IMAGERY PROGRAM, 2019.

CLIENT
GREAT RIVER ENERGY
COAL CREEK STATION

PROJECT
ALTERNATIVE SOURCE DEMONSTRATION

CONSULTANT
GOLDER

YYYY-MM-DD	2020-10-27
DESIGNED	DVS
PREPARED	DVS
REVIEWED	CCS
APPROVED	TJS

TITLE
UPSTREAM RAISE 92 NORTH RAMP

PROJECT NO.	PHASE	REV.	FIGURE
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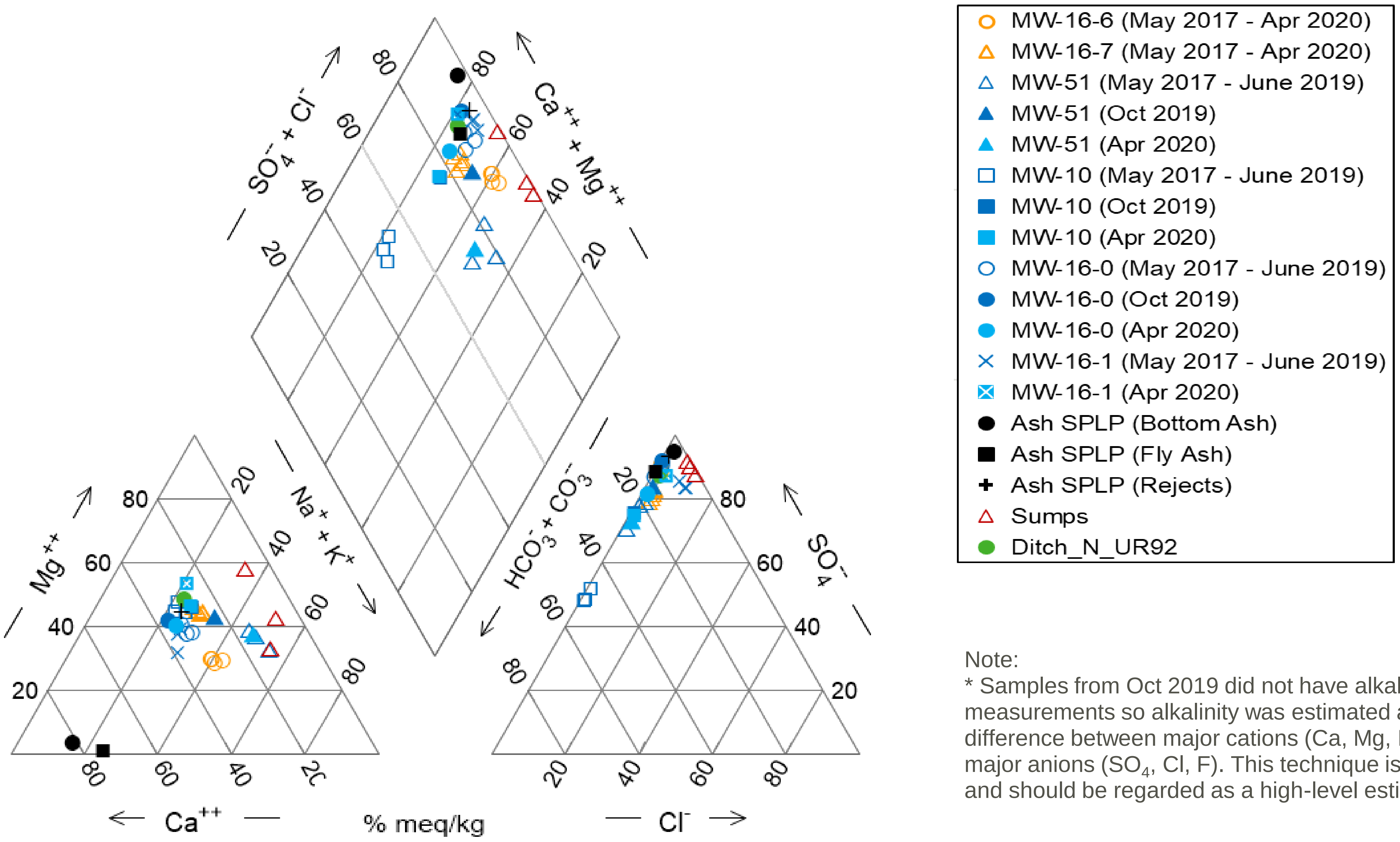

Note:
* Samples from Oct 2019 did not have alkalinity measurements so alkalinity was estimated as the difference between major cations (Ca, Mg, Na, K) and major anions (SO_4, Cl, F). This technique is less percise and should be regarded as a high-level estimate.

CLIENT
Great River Energy Coal Creek Station

PROJECT
Alternative Source Demonstration

CONSULTANT
GOLDER

TITLE
Piper Diagram

PROJECT NO.	PHASE	REV.	FIGURE
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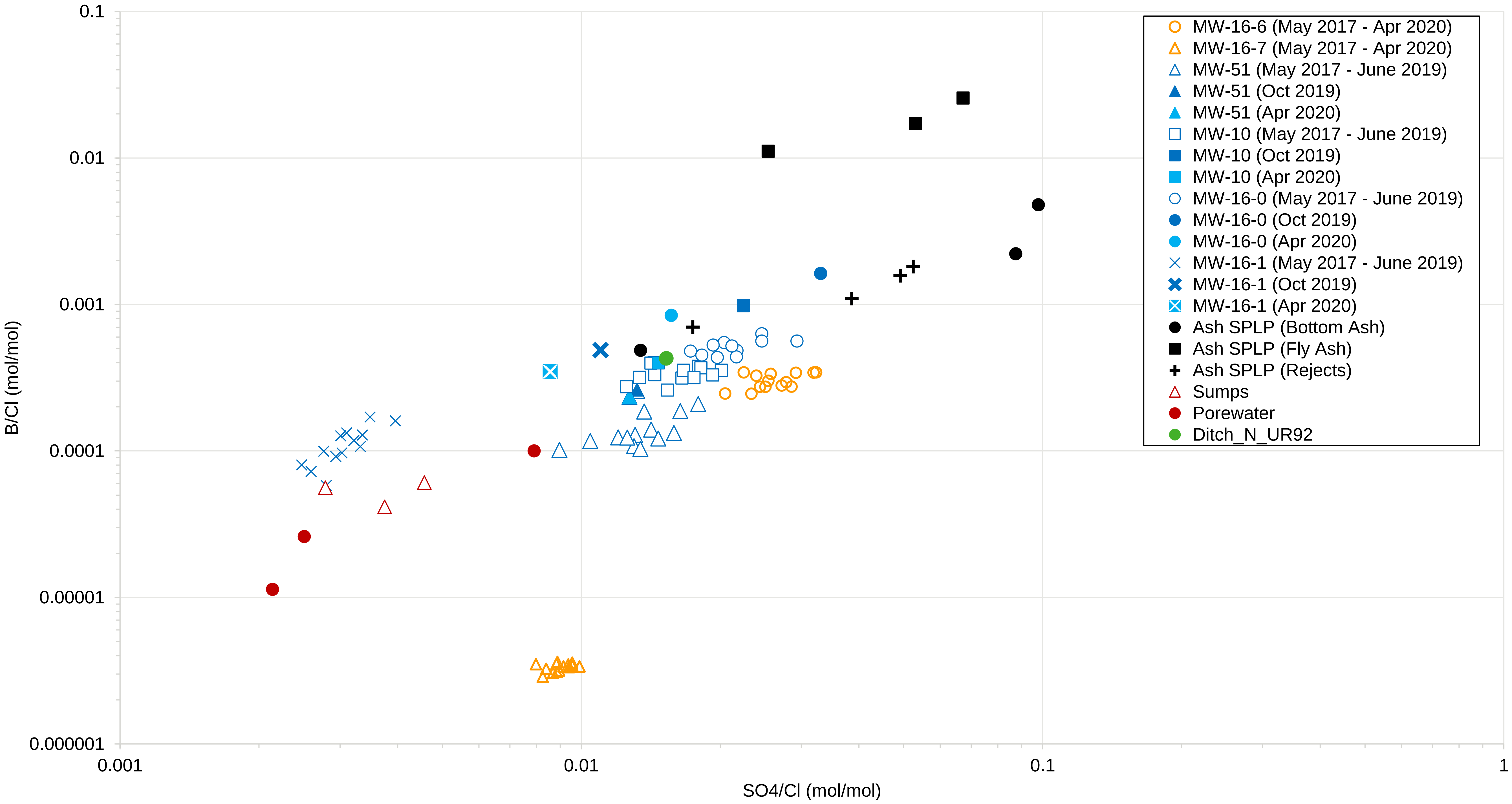

CLIENT
Great River Energy Coal Creek Station

PROJECT
Alternative Source Demonstration

CONSULTANT
GOLDER

TITLE
Boron to Chloride versus Sulfate to Chloride Ratio Plot

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	0	6

APPENDIX A

Corrective Measures Report
Upstream Raise 92

REPORT

Corrective Measures Report

Coal Creek Station - Upstream Raise 92 CCR Surface Impoundment

Submitted to:

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Submitted by:

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19136224C-10-R-0

October 27, 2020

Table of Contents

FIGURES

APPENDICES

1.0 INTRODUCTION

Golder Associates Inc. (Golder) has prepared this report to document corrective measures implemented at the Upstream Raise 92 Coal Combustion Residual (CCR) Surface Impoundment (Upstream Raise 92) at Great River Energy's (GRE) Coal Creek Station (CCS). Corrective measures were implemented in response to a potential non-groundwater release of contact water (release of stormwater coming in contact with CCR) along the north side of Upstream Raise 92. This report has been prepared in accordance with the Environmental Protection Agency's (EPA's) CCR Rule, 40 CFR Part 257.83(b)(5) which states, "If a deficiency or release is identified during an inspection, the owner or operator must remedy the deficiency or release as soon as feasible and prepare documentation detailing the corrective measures taken."

2.0 BACKGROUND

GRE's Coal Creek Station (CCS) is a coal-fired electric generation facility located in McLean County, approximately 10 miles northwest of Washburn, North Dakota. CCRs are managed in composite-lined surface water impoundment cells and dry landfills regulated and permitted by the North Dakota Department of Environmental Quality (NDDEQ) in accordance with North Dakota Administrative Code (NDAC) Title 33.1, Article 33.1-20, Solid Waste Management and Land Protection.

2.1 Facility Location and Operation

CCS has four CCR facilities that are within the purview of the EPA CCR rule (Figure 1):

- Drains Pond System CCR Surface Impoundment (Drains Pond System) is located in the south-central portion of the plant site, northeast of the plant buildings.
- Upstream Raise 91 CCR Surface Impoundment (Upstream Raise 91) is located in the south-central portion of the plant site, east of the plant buildings.
- Upstream Raise 92 CCR Surface Impoundment (Upstream Raise 92) is located in the southeast portion of the plant site, between Upstream Raise 91 and Southeast Section 16 CCR Landfill.
- Southeast Section 16 CCR Landfill (Southeast 16) is located in the southeast portion of the plant site, east of Upstream Raise 92.

Upstream Raise 92 is located in Section 16, Township 145N, Range 82W and covers approximately 110 acres (Figure 1). The facility is used as a combined dewatering and storage facility for coal combustion residuals (CCR) including fly ash, bottom ash, economizer ash, and flue gas desulfurization (FGD) material. FGD material and hydraulic conveyance water enter the middle of the Upstream Raise 92 CCR surface impoundment through a high-density polyethylene (HDPE) pipe from the plant. Bottom ash, economizer ash and fly ash are hauled to the facility using heavy construction equipment, such as Caterpillar 777 haul trucks. Two haul ramps are used to access the facility as shown on Figure 1: a haul ramp up the north side of Upstream Raise 92 and a haul ramp up the east and south sides of the facility. Upstream Raise 92 is approximately 300 feet south of Lower Samuelson Slough and 100 feet north of the rail lines. Upstream Raise 91 is adjacent to and west of Upstream Raise 92 and Southeast 16 is adjacent to and east of Upstream Raise 92.

2.2 Downstream Slopes

The downstream slopes are divided into two sections (Figure 2), the soil embankment below the perimeter access/haul roads (surrounding the composite lined footprint), and the Upstream Raise 92 CCR slopes and soil-covered slopes above the perimeter access/haul roads (within the composite lined footprint).

The Upstream Raise 92 soil embankments are protected from erosion and deterioration by the establishment of a vegetative cover consisting of native grasses. The vegetative cover is inspected weekly for erosion, signs of seepage, animal burrows, sloughing, and woody vegetation that could affect the performance of the embankments.

Upstream Raise 92 CCR slopes have areas with no soil cover, temporary soil cover, and final soil cover. The areas with no soil cover (including haul ramps) are protected from erosion and deterioration by a hardened fly ash surface. The fly ash slopes are inspected weekly for erosion, cracking, signs of seepage, and sloughing that could affect the performance of the slopes.

Final cover has been constructed over the south CCR slopes of Upstream Raise 92 concurrently with deposition of CCR materials. The north side of Upstream Raise 92 has received temporary cover over portions of the slopes to limit erosion of the fly ash slopes and to promote vegetative growth as a means of dust control. Slopes with temporary or final soil cover are protected from erosion and deterioration by the establishment of a vegetative cover consisting of native grasses. The vegetative cover is inspected weekly for erosion, signs of seepage, animal burrows, sloughing, and woody vegetation that could affect the performance of the embankments.

2.3 Contact Water Management Plan

A run-on and runoff control plan has been prepared for Upstream Raise 92 in accordance with 40 CFR Part 257.81(b)(1) (Golder 2016). This plan addresses runoff of contact water and includes controls to prevent runoff from the active portion of the CCR unit from a 24-hour, 25-year storm event. Contact water is directed using berms, channels, ditches, and culverts contained within the lined footprint of the facilities. Contact water on the north side of Upstream Raise 92 is designed to be controlled as follows (see Appendix A for a basin layout figure from the run-on and runoff control plan):

- Contact water to the west of the upper haul ramp is allowed to sheet flow down the slopes to the north perimeter ditch where it either infiltrates into the bottom ash material or is directed west towards the Upstream Raise 91 CCR Surface Impoundment.
- Contact water above the upper haul ramp is collected in a drainage ditch along the west side of the haul ramp by sloping the haul ramp to the west. This ditch flows down the upper haul ramp and discharges west into the north perimeter ditch.
- Contact water below the upper haul ramp is allowed to sheet flow down the slopes to a lower contact water control channel and is directed east to the Southeast 16 contact water management area.

2.4 Evidence of Contact Water Release

A release of contact water on the north side of Upstream Raise 92 is suspected to have occurred in September 2019. This release was largely driven by large precipitation events during the month of September, and degradation of the contact water controls along the north side of Upstream Raise 92.

Figure 3 shows a times series of monthly precipitation records from CCS between 2016 and 2020 and Turtle Lake, ND (approximately 20 miles northeast of the Site) between 1993 and 2020. September 2019 was the wettest month over the period of record (7.4 inches of rain at CCS and 8.7 inches of rain at Turtle Lake). The average rainfall for September at Turtle Lake between 1993 and 2018 is 1.3 inches. This wet September was driven by several large storm events. The largest event measured at CCS in September 2019 (2.1 inches) was from a thunderstorm system which affected central North Dakota between Friday, September 20 and Saturday, September 21, 2019.

Three days after the storm event (September 24, 2019), a registered professional engineer (PE) from Golder was on Site performing the annual PE inspection of Upstream Raise 92 and the surrounding CCR facilities at CCS per USEPA Regulation 40 CFR 257.83(b) requirements. In the annual PE inspection reports (Golder 2020a and Golder 2020b), the Golder representatives noted the following (also see Figure 4):

- Standing water in the drainage ditches around Upstream Raise 91 and Upstream Raise 92
- Erosion of the fly ash cover along the inside of the ramp on the north side of Upstream Raise 92.

Photographs from the September 2019 annual PE inspection are included in Appendix B.

As discussed above, contact water above the haul ramp was designed to be collected in a drainage ditch along the west side of the haul ramp by sloping the haul ramp to the west. This haul ramp ditch was designed to route contact water down the upper haul ramp and discharge it west into the north perimeter ditch.

However, due to significant haul traffic over the course of several years and “rounding off” of the upper haul ramp and road near the toe of the upper haul ramp, and due to eroded fly ash (from recent storm events) filling in the transition from the upper haul ramp ditch to the north perimeter ditch, contact water appears to have had an opportunity to flow off of the lined footprint, especially in the case of a significant rain event. Although not directly observed, contact water is suspected to have flowed down the upper haul ramp and onto the lower haul ramp and lower perimeter berm slopes. Standing water was observed in the drainage ditch outside the lined footprint of the unit near the lower haul ramp of Upstream Raise 92. This ditch is meant to collect and route non-contact water from grass-covered slopes of the perimeter berm of the CCR surface impoundment. Following this potential release, corrective measures were evaluated, and a remedy was selected and implemented.

3.0 CORRECTIVE MEASURES

Golder evaluated possible pathways for contact water to have been released under the current facility configuration. The following sections describe designs associated with addressing the contact water release and construction of these remedial measures.

3.1 Design of Corrective Measures

Based on observations from the September 2019 annual PE inspections and observations from GRE site personnel, the run-off controls for this area of Upstream Raise 92 were reviewed and a plan was developed over the 2019/2020 winter months (when earthworks construction is not feasible due to frozen ground conditions) to repair and install contact water controls. Grading plans were developed to route contact water so that runoff due to precipitation remains within the lined boundaries of regulated CCR facilities (see Appendix C). The following summarizes design elements associated with the corrective measures (also see Figure 5):

- Three-foot contact water containment berms were constructed along the north side of the perimeter access/haul roads on the north side of Upstream Raise 91 and Upstream Raise 92.
- The perimeter access/haul roads were graded so that precipitation falling on these roads flows toward the contact water containment ditches within the lined facility footprints.
- The haul road ramp on the north side of Upstream Raise 92 was raised between 2 and 3 feet to direct water into contact water containment ditches rather than allowing for this water to flow north down the lower soil embankments below the perimeter access/haul road.
- A contact water containment berm was constructed north of Upstream Raise 92 to direct water east of the north haul road ramp into a contact water containment drainage channel that directs water toward the composite-lined Southeast 16 landfill contact water containment area.
- Topsoil was applied to the exterior-facing slopes of Upstream Raise 92 described above and these areas were seeded to promote vegetative growth.

3.2 Construction of Corrective Measures

GRE began construction of the contact water controls described above as soon as weather allowed in the spring of 2020 (April/May). Further description of the steps taken to implement corrective measures is included below.

- April 2020:
  - Design of the contact water controls at the north ramp of Upstream Raise 92 were finalized with input from GRE operations personnel.
  - GRE evaluated three borrow areas for soil resources required to construct the containment berms associated with the contact water controls.
- May-June 2020:
  - GRE operations personnel constructed containment berms and haul road modifications to more effectively direct contact water per the plans as discussed in Section 2.3.
  - Topsoil was applied to re-graded areas and GRE seeded and these areas were seeded to promote vegetative growth.
- July-August 2020:
  - GRE operations personnel constructed 3-foot contact water containment berms along the north side of the perimeter access/haul roads on the north side of Upstream Raise 91 and Upstream Raise 92.
  - GRE re-graded the perimeter access/haul roads so that precipitation falling on these roads flows toward the contact water containment ditches within the lined facility footprints.

Significant construction of contact water controls at the north ramp of Upstream Raise 92 was completed in June of 2020, while additional construction activities were completed by August of 2020. Photographs documenting these construction activities were taken in July 2020 and October 2020 and are included in Appendix B.

Following completion of the contact water controls near the upper haul ramp, a large storm event occurred (2.4-inch event June 29-30, 2020) and GRE personnel were able to observe the contact water controls in operation. No water was observed leaving the lined footprint of the unit. Water was observed flowing down the upper haul ramp ditch and then either flowing to the left into the north perimeter ditch toward Upstream Raise 91, or to the right and through the haul road-ramp intersection swale prior to proceeding down the new contact water containment channel and into the lower existing drainage channel that routes water to the Southeast 16 contact water management area.

In October 2020, a registered PE from Golder was on Site performing the annual PE inspection of Upstream Raise 92 and the surrounding CCR facilities at CCS. The Golder representative observed the contact water controls and noted:

- Contact water containment berms on the north side of the Upstream Raise 91 and Upstream Raise 92 perimeter/access haul roads preventing contact water runoff from the facilities.
- Grading along the perimeter/access haul road and upper haul ramp to direct contact water coming from the upper haul ramp to either the north perimeter ditch on the west side of Upstream Raise 92 or the existing lower drainage channel on the east side of Upstream Raise 92.
- Erosion of the invert of the contact water containment berm routing water from the haul road and ramp east to the existing drainage channel to Southeast 16. This erosion suggests contact water runoff has been captured with this new contact water containment berm and routed as designed. Golder discussed the erosion with GRE personnel and repairs to the new channel will be made to allow it to continue to perform as designed (GRE already began placing concrete rubble as erosion armoring at the start of this channel).

4.0 MONITORING OF THE CORRECTIVE ACTION

To assess the effectiveness of the corrective actions, two primary approaches will be employed. Following installation of the contact water controls at the facility, GRE personnel will perform visual observations of the area to evaluate the effectiveness of the controls and the resiliency of the controls to the storm event. Specifically, the controls will be observed for signs of contact water overtopping, pooling, or bypassing. If unintended run-off pathways are observed, controls will be modified as needed to mitigate runoff and prevent impacts.

5.0 CONCLUSIONS

Based on observations made by GRE and Golder personnel, a contact water release on the north side of Upstream Raise 92 is suspected to have occurred in September of 2019, likely driven by large precipitation events during the month of September and degradation of the contact water controls in this area. In accordance with the EPA's CCR Rule, 40 CFR Part 257.83(b)(5) which states, "If a deficiency or release is identified during an inspection, the owner or operator must remedy the deficiency or release as soon as feasible and prepare documentation detailing the corrective measures taken," GRE took the following steps after identifying the suspected release:

- Developed construction plans to repair and install contact water controls on the north side of Upstream Raise 92 in the vicinity of the haul ramp.
- Constructed the designed contact water controls as soon as site conditions allowed, including new contact water containment berms and grading of haul road and haul ramp to divert contact water to the desired management locations.
- Documented the implemented corrective measures with this report.

As a result of these actions, new contact water control features were designed and constructed in the area to limit the opportunity for similar events in the future. Continued monitoring of the newly installed contact water control features coupled with ongoing surface water and groundwater monitoring at nearby locations will continue to determine the efficacy of corrective measures.

6.0 REFERENCES

Eugene A. Hickok & Associates. 1986. Evaluation of Pond Bottom Conditions Southwest and West Portions of the East Ash Pond: Coal Creek Station, Prepared for Cooperative Power Association. July 1986.

Foth & Van Dyke. 1988. *Liner Evaluation South Ash Pond and East Ash Pond*, Prepared for Cooperative Power Association and United Power Association. March 1988.

Golder Associates Inc. 2016. Run-On and Run-Off Control System Plan – Upstream Raise CCR Surface Impoundment (Upstream Raise 92) – Coal Creek Station. October 2016.

Golder Associates Inc. 2020a. Annual Inspection, Coal Creek Station – Upstream Raise 92 CCR Surface Impoundment. January 2020.

Golder Associates Inc. 2020b. Annual Inspection, Coal Creek Station – Upstream Raise 91 CCR Surface Impoundment. January 2020.

Signature Page

Golder Associates Inc.

REGISTERED PROFESSIONAL ENGINEER
TODD J. STONG
PE-6144
DATE 10/27/2020
NORTH DAKOTA

Craig Schuettpelz, PE
Senior Engineer

Todd Stong, PE
Senior Consultant and Associate

ELH/TJS/mb

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https://golderassociates.sharepoint.com/sites/120551/project files/6 deliverables/19136224c/reports/10-r_correctivemeasure/10-r-0/19136224c-10-r-0-corrective_measures_ur92_27oct20.docx

Figures

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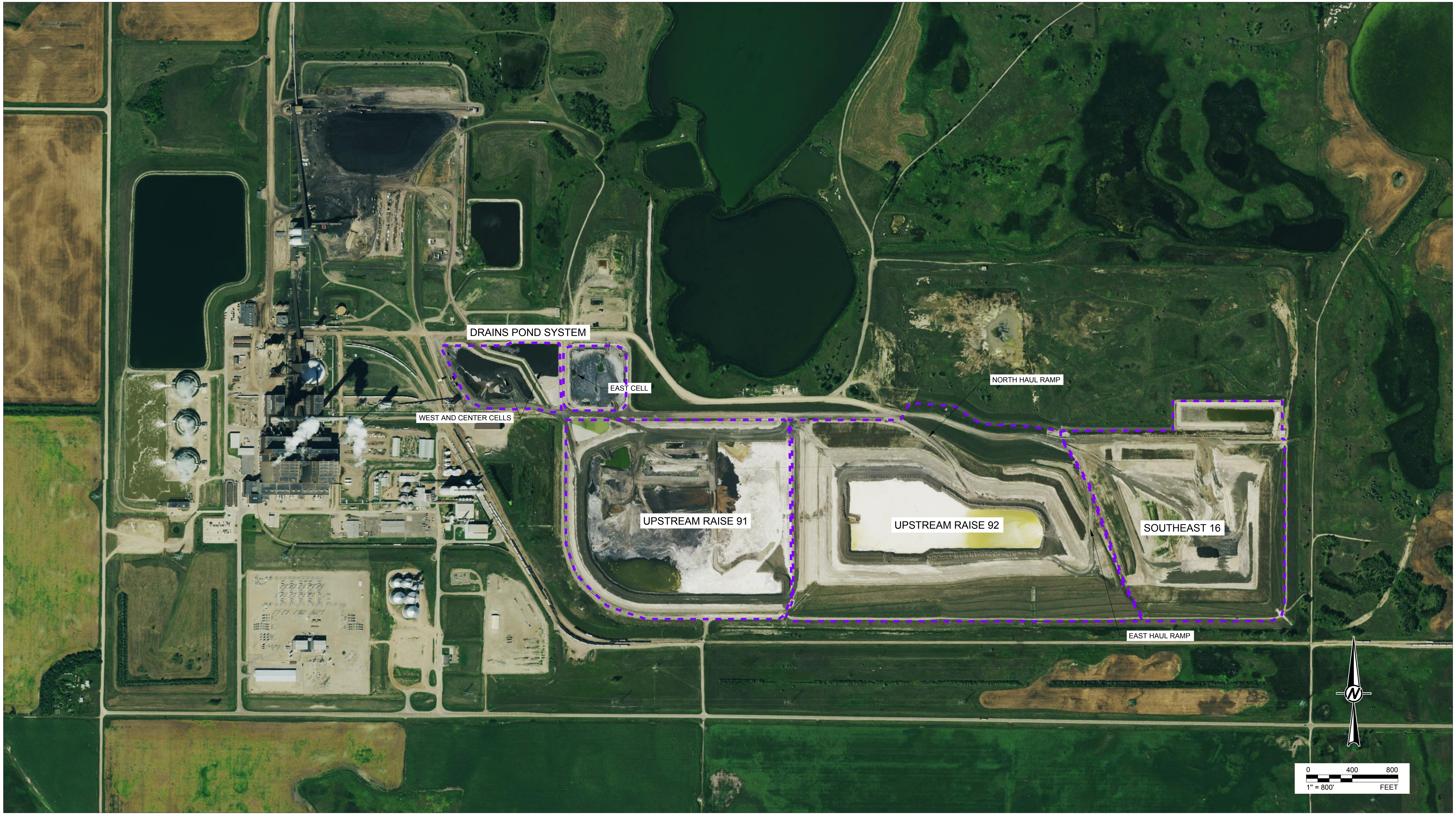

LEGEND

▬ ▬ ▬ EXSTING CCR FACILITIES

REFERENCE(S)

1. AERIAL IMAGERY FROM THE UNITED STATES DEPARTMENT OF AGRICULTURE NATIONAL AGRICULTURE IMAGERY PROGRAM, TAKEN 2019.

CLIENT
GREAT RIVER ENERGY - COAL CREEK STATION
2875 THIRD STREET SOUTHWEST
UNDERWOOD, NORTH DAKOTA

CONSULTANT

GOLDER

YYYY-MM-DD	2020-10-27
DESIGNED	CCS
PREPARED	CCS
REVIEWED	TJS
APPROVED	TJS

PROJECT
UPSTREAM RAISE 92 CCR SURFACE IMPOUNDMENT
CORRECTIVE MEASURES

TITLE
EXISTING CCR FACILITIES

PROJECT NO.	REV.	FIGURE
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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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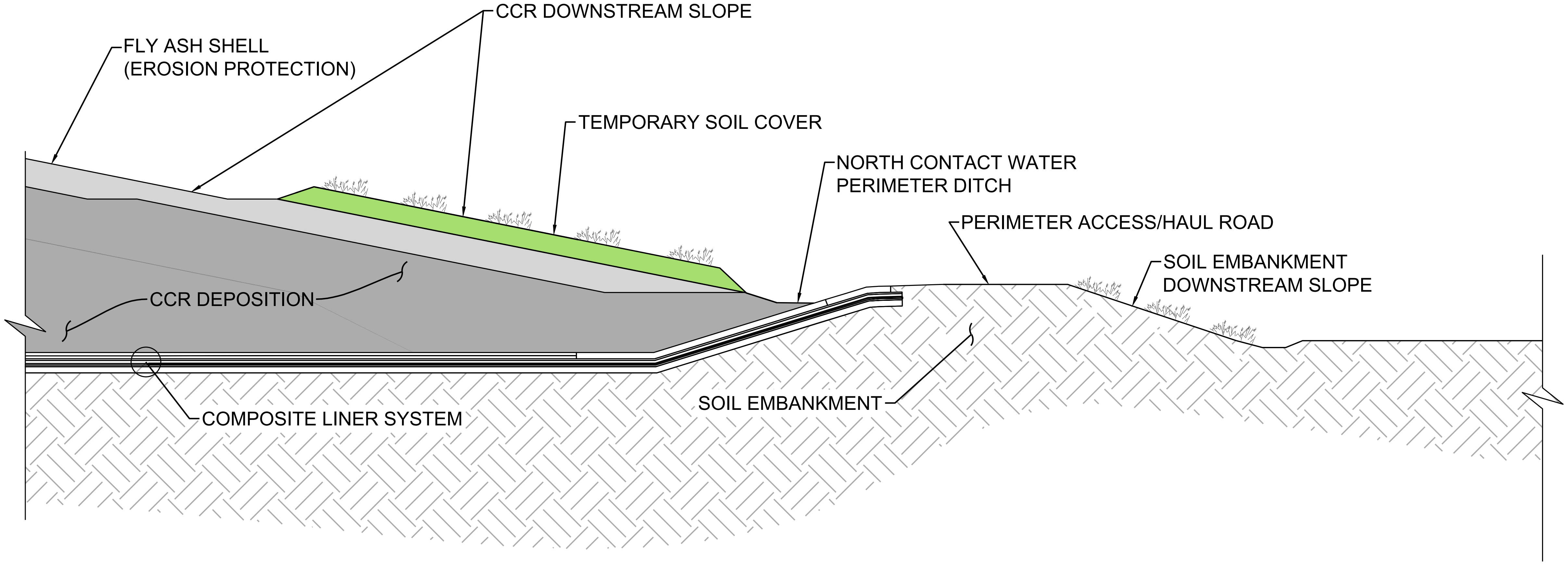

NOTES
1. FIGURE IS NOT TO SCALE.

CLIENT GREAT RIVER ENERGY - COAL CREEK STATION 2875 THIRD STREET SOUTHWEST UNDERWOOD, NORTH DAKOTA	PROJECT UPSTREAM RAISE 92 CCR SURFACE IMPOUNDMENT CORRECTIVE MEASURES

CONSULTANT

GOLDER

YYYY-MM-DD	2020-10-27
DESIGNED	CCS
PREPARED	CCS
REVIEWED	TJS
APPROVED	TJS

TITLE
UPSTREAM RAISE 92 NORTH DOWNSTREAM SLOPE PROFILE

PROJECT NO.	REV.	FIGURE
19136224c	0	2

Path: \\Denver\acad\GREAT RIVER ENERGY\COAL CREEK\99_PROJECTS\19136224\UR92 CORRECTIVE MEASURES\ | File Name: 19136224c - Corrective Measures_FIGURE 2.dwg | Last Edited By: cschuettpelz Date: 2020-10-27 Time:12:30:44 PM | Printed By: CSchuettpelz Date: 2020-10-27 Time:1:25:22 PM

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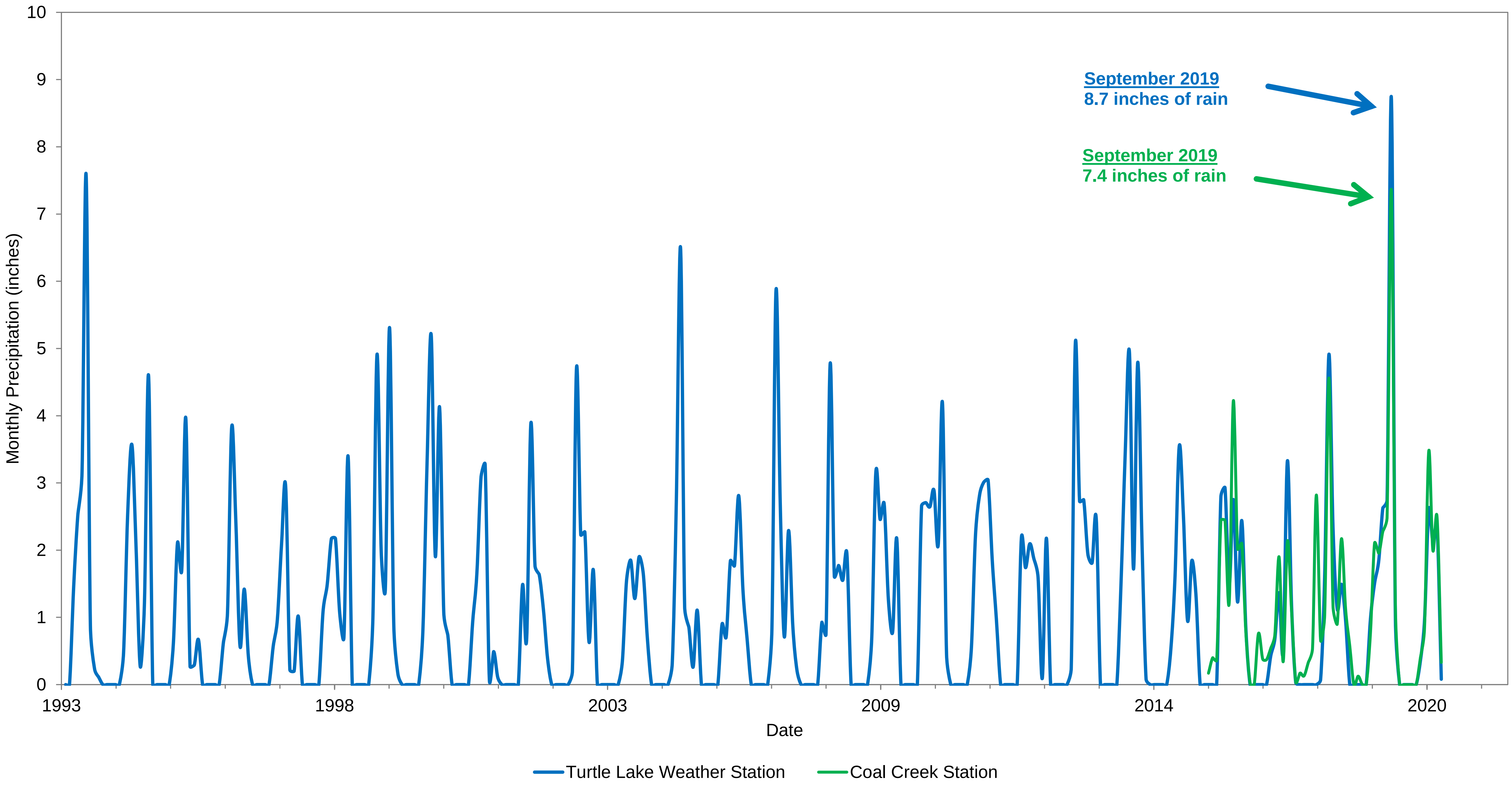

September 2019
8.7 inches of rain

September 2019
7.4 inches of rain

Note: Turtle Lake Weather Station is located approximately 20 miles northwest of Coal Creek Station.

CLIENT
Great River Energy Coal Creek Station

CONSULTANT
GOLDER

PROJECT
Upstream Raise 92 CCR Surface Impoundment Corrective Measures

TITLE
Time Series of Monthly Precipitation at CCS and Turtle Lake, ND Weather Stations

PROJECT NO.	PHASE	REV.	FIGURE
19136224C	3	0	3

NOTES/REFERENCES

1. AERIAL IMAGE IS FROM THE UNITED STATES DEPARTMENT OF AGRICULTURE NATIONAL AGRICULTURE IMAGE PROGRAM, ACQUIRED IN 2019.
2. TOPOGRAPHY IS APPROXIMATE AND PROVIDED FOR ILLUSTRATION ONLY.

CLIENT
GREAT RIVER ENERGY - COAL CREEK STATION
2875 THIRD STREET SOUTHWEST
UNDERWOOD, NORTH DAKOTA

CONSULTANT
GOLDER

YYYY-MM-DD	2020-10-26
DESIGNED	CCS
PREPARED	CAJ
REVIEWED	CCS
APPROVED	TJS

PROJECT
UPSTREAM RAISE 92 CCR SURFACE IMPOUNDMENT
CORRECTIVE MEASURES

TITLE
EVIDENCE OF CONTACT WATER RELEASE

PROJECT NO.	REV.	FIGURE
19136224c	0	4

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NOTES/REFERENCES

1. DETAILED INSET AERIAL IMAGE PROVIDED BY GRE, ACQUIRED JUNE 2020.
2. AERIAL IMAGE OTHER THAN THAT IN NOTE 1 IS FROM THE UNITED STATES DEPARTMENT OF AGRICULTURE NATIONAL AGRICULTURE IMAGE PROGRAM, ACQUIRED IN 2019.
3. TOPOGRAPHY IS APPROXIMATE AND PROVIDED FOR ILLUSTRATION ONLY.

CLIENT
GREAT RIVER ENERGY - COAL CREEK STATION
2875 THIRD STREET SOUTHWEST
UNDERWOOD, NORTH DAKOTA

CONSULTANT
GOLDER

YYYY-MM-DD	2020-10-26
DESIGNED	CCS
PREPARED	CAJ
REVIEWED	CCS
APPROVED	TJS

PROJECT
UPSTREAM RAISE 92 CCR SURFACE IMPOUNDMENT
CORRECTIVE MEASURES

TITLE
CONTACT WATER CONTOLS CORRECTIVE MEASURES

PROJECT NO.	REV.	FIGURE
19136224c	0	5

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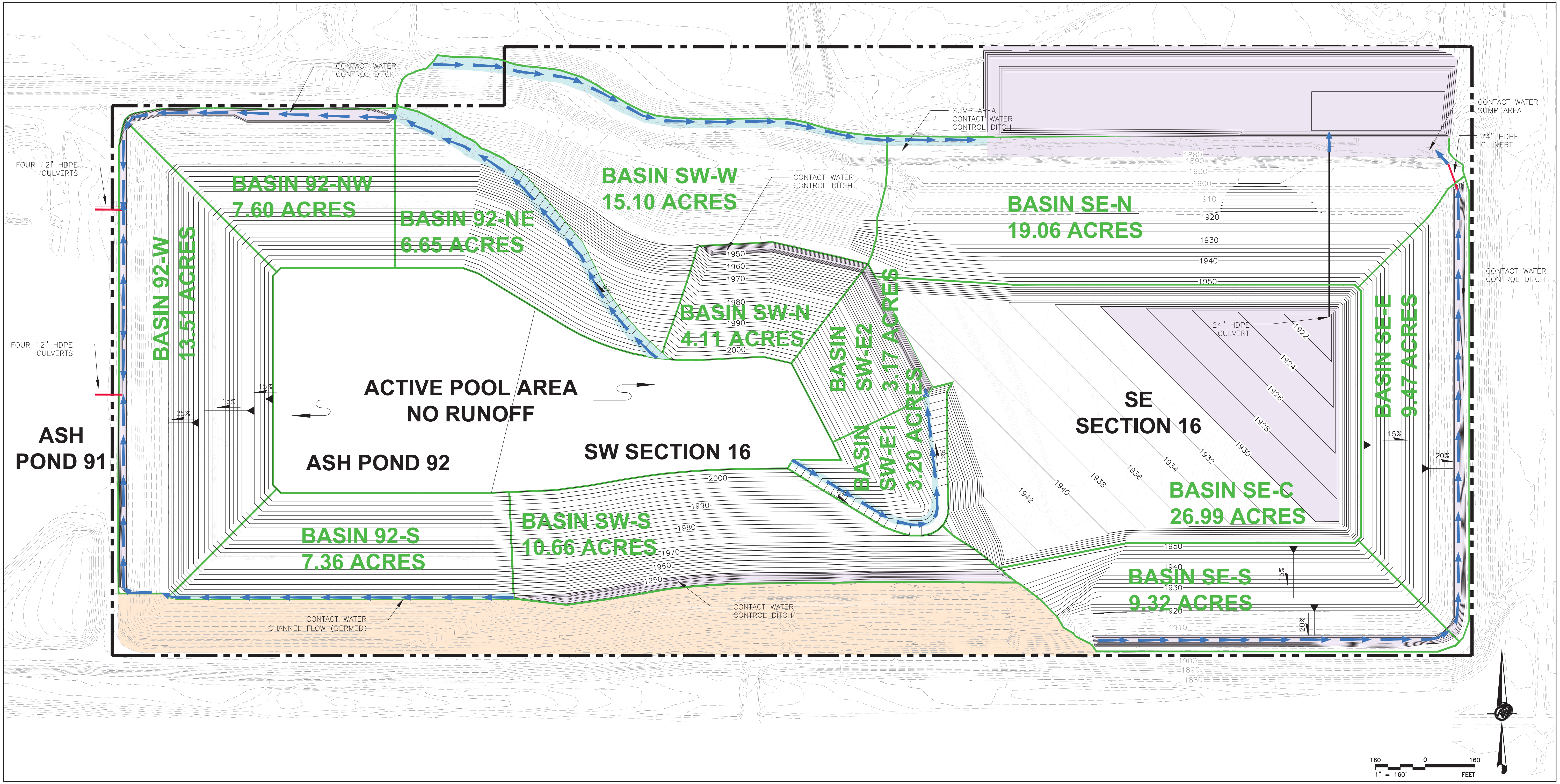
1 in
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

APPENDIX A

Figure 1 - Contact Water Basin Layout A (from the Upstream Raise CCR Surface Impoundment Run-On and Run-Off Control System Plan, October 2016)



LEGEND

1880	EXISTING GROUND TOPOGRAPHY	🟪	CONTACT WATER CONTROL DITCH
1980	PROPOSED TOP OF COVER	→ →	CONTACT WATER CONTROL CHANNEL
🟩	BASIN DELINEATION	🟧	TEMPORARY/FINAL COVER PLACED
▬ ▪ ▪ ▬	PERMITTED LIMIT OF CCP PLACEMENT (PERMIT MODIFICATION ISSUED 09/24/03)		
🟥	CULVERTS		

GREAT RIVER ENERGY
COAL CREEK STATION
UNDERWOOD, NORTH DAKOTA

CONTACT WATER BASIN LAYOUT A

FIGURE 1

Golder Associates

PROJECT No. 113-81519

FILE No. 11381519_ContactWater FINAL.dwg

Drawing File: J:\11JOBS\113-81519 GRE\URVE Permit Modification_Appendix C\9-Contact Water\Contact Water Part A\ 11381519_ContactWater FINAL.dwg | Layout: CONTACT WATER A | Modified: Oct 26, 2012 09:04 LSeabury | Plotted: 11/28/12 12:26pm CSchuettpelz

APPENDIX B

Corrective Measures Report Photographs

Upstream Raise 92 Contact Water Release

Photograph 1 (September 2019)
Erosion of the fly ash cover along the inside of the ramp on the north side of Upstream Raise 92 (1 of 2). (DSCF0414.JPG)

Photograph 2 (September 2019)
Erosion of the fly ash cover along the inside of the ramp on the north side of Upstream Raise 92 (2 of 2). (DSCF0416.JPG)

Upstream Raise 92 Contact Water Release

Photograph 3 (September 2019)
Standing water in the lower drainage ditch near the lower ramp of Upstream Raise 92 (meant to collect and control surface water). (DSCF0422.JPG)

Photograph 4 (September 2019)
CCR and contact water collected in the perimeter ditch of Upstream Raise 92 (shortly after September 2019 storm event). (IMGP6905.JPG)

Upstream Raise 92 Contact Water Release

Photograph 5 (July 2020)
Upstream Raise 92 upper north ramp transition to haul road. (DSCF1163.JPG)

Photograph 6 (July 2020)
Contact water containment berm at bottom of Upstream Raise 92 north ramp. (DSCF1169.JPG)

Upstream Raise 92 Contact Water Release

Photograph 7 (July 2020)
Drainage channel that directs water toward the composite-lined Southeast 16 landfill contact water containment area. (DSCF1170.JPG)

Photograph 8 (July 2020)
Recently seeded exterior-facing slope. (DSCF1173.JPG)

Upstream Raise 92 Contact Water Release

Photograph 9 (October 2020)
Contact water containment berm on north side of Upstream Raise 92 haul road. (IMGP7454.jpg)

Photograph 10 (October 2020)
Upstream Raise 92 upper north ramp. (IMGP7456.jpg)

Upstream Raise 92 Contact Water Release

Photograph 11 (October 2020)
North perimeter ditch for contact water containment (and containment berm in background). (IMGP7459.jpg)

Photograph 12 (October 2020)
Swale in Upstream Raise 92 north haul road to direct contact water from ramp west to north perimeter ditch or west to contact water containment berm channel. (IMGP7460.jpg)

Upstream Raise 92 Contact Water Release

Photograph 13 (October 2020)
Contact water containment berm on the north side of the haul road and across from the upper north ramp. (IMGP7461.jpg)

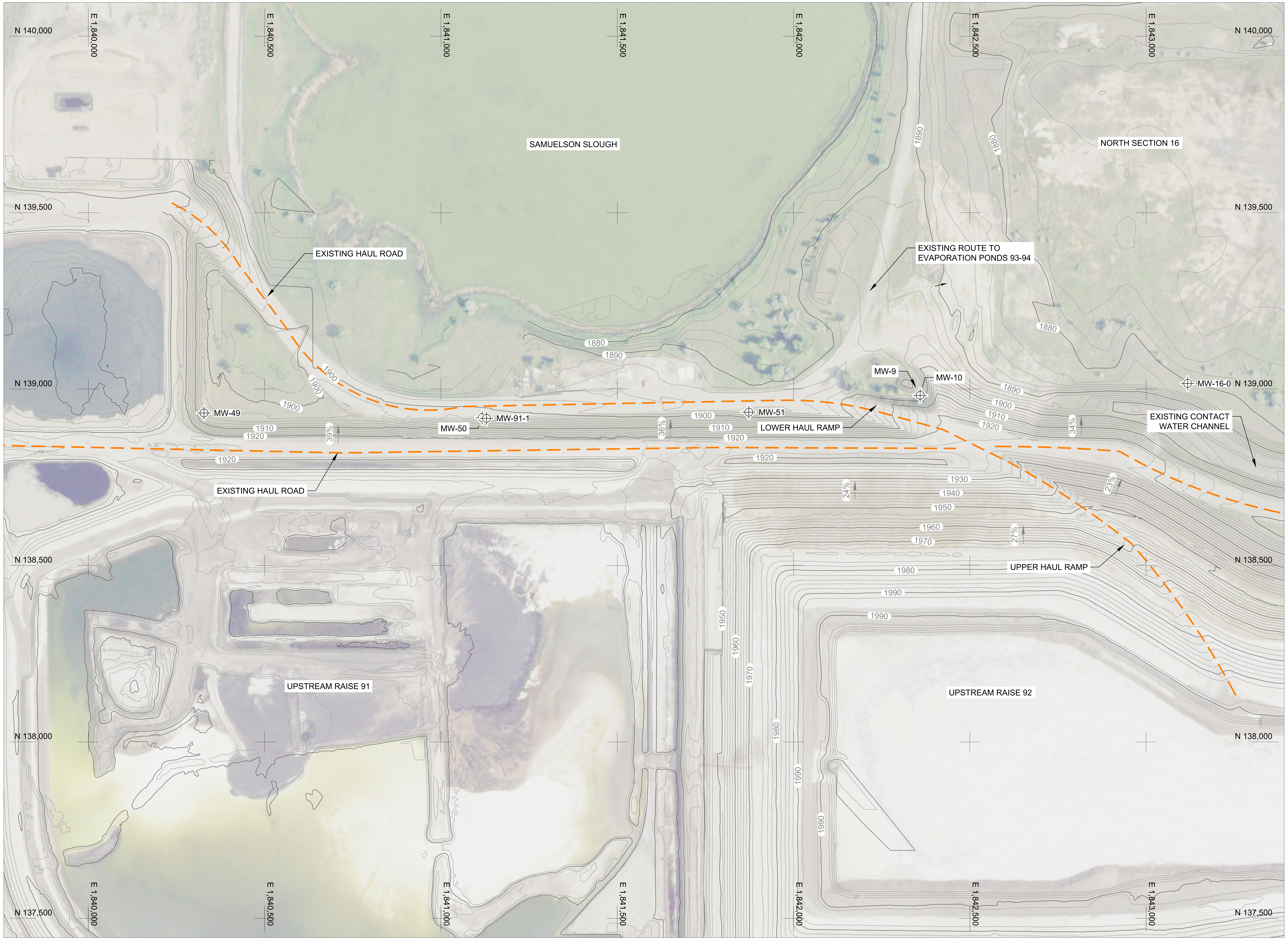
Photograph 14 (October 2020)
Contact water containment berm channel routing water towards existing controls. (IMGP7465.jpg)

Upstream Raise 92 Contact Water Release

Photograph 15 (October 2020) **Vegetation growth on work area. (IMGP7464.jpg)**

APPENDIX C

Upstream Raise 91-92 Haul Road Improvements – Safety Berm and Contact Water Containment (Rev. B May 2020)



LEGEND

1900	EXISTING TOPOGRAPHY (REFERENCE 3)
⌖ MW-16-0	EXISTING MONITORING WELL
— — —	EXISTING HAUL ROUTE

NOTE(S)

1. EXISTING TOPOGRAPHY CONTOUR INTERVAL IS 2 FEET.

REFERENCE(S)

1. AERIAL IMAGERY TAKEN IN 2018 (OBTAINED FROM THE USDA NATIONAL AGRICULTURAL IMAGERY PROGRAM).
2. COORDINATE SYSTEM: PLANT SPECIFIC COORDINATE SPACE.
3. EXISTING TOPOGRAPHY COMPILED FROM SURVEYS TAKEN BETWEEN 2017 AND 2018.

MATERIAL QUANTITIES

QUANTITIES SUMMARY

AREA		MATERIAL TYPE	QUANTITY (CY)
UPSTREAM RAISE 91 HAUL ROAD	SAFETY AND CONTACT WATER BERM	GENERAL SOIL FILL	800
	INTERIOR ADD-ON	ASH	1,500
	TOPSOIL	TOPSOIL	90
UPSTREAM RAISE 92 HAUL ROAD	SAFETY AND CONTACT WATER BERM	GENERAL SOIL FILL	600
	INTERIOR ADD-ON	ASH	450
	TOPSOIL	TOPSOIL	120
UPSTREAM RAISE 92 HAUL RAMP INTERSECTION		ROAD FILL (GRE DISCRETION)	1,150
UPSTREAM RAISE 92 LOWER HAUL RAMP	SAFETY AND CONTACT WATER CONTAINMENT BERM	GENERAL SOIL FILL	6,400
	TOPSOIL	TOPSOIL	560

N

0 150 300

1" = 150' FEET

CLIENT

GREAT RIVER ENERGY - COAL CREEK STATION
2875 THIRD STREET SOUTHWEST
UNDERWOOD, NORTH DAKOTA

CONSULTANT

GOLDER

YYYY-MM-DD	2020-05-13
DESIGNED	KAC
PREPARED	KAC
REVIEWED	CCS
APPROVED	TJS

PROJECT

UPSTREAM RAISE 91-92 HAUL ROAD IMPROVEMENTS
SAFETY BERM AND CONTACT WATER CONTAINMENT

TITLE

SITE OVERVIEW

PROJECT NO.	REV.	DRAWING
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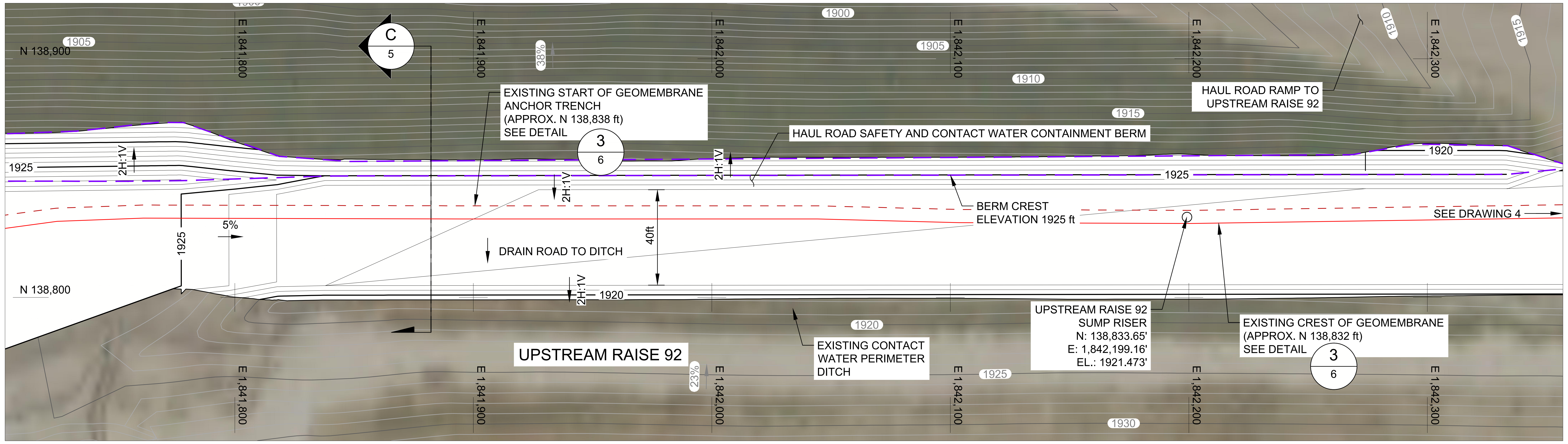

LEGEND

1985	EXISTING TOPOGRAPHY (REFERENCE 3)
1925	PROPOSED TOPOGRAPHY
━	EXISTING CREST OF GEOMEMBRANE (APPROXIMATE)
– – –	EXISTING START OF GEOMEMBRANE ANCHOR TRENCH (APPROXIMATE)
⌖ MW-49	MONITORING WELL
– – –	AREA TO RECEIVE TOPSOIL

NOTE(S)

1. TOPOGRAPHY CONTOUR INTERVAL IS 1 FOOT.

REFERENCE(S)

1. AERIAL IMAGERY TAKEN IN 2018 (OBTAINED FROM THE USDA NATIONAL AGRICULTURAL IMAGERY PROGRAM).
2. COORDINATE SYSTEM: PLANT SPECIFIC COORDINATE SPACE.
3. EXISTING TOPOGRAPHY COMPILED FROM SURVEYS TAKEN BETWEEN 2017 AND 2018.

0 30 60
1" = 30' FEET

CLIENT
GREAT RIVER ENERGY - COAL CREEK STATION
2875 THIRD STREET SOUTHWEST
UNDERWOOD, NORTH DAKOTA

CONSULTANT

GOLDER

YYYY-MM-DD	2020-05-13
DESIGNED	KAC
PREPARED	KAC
REVIEWED	CCS
APPROVED	TJS

PROJECT
UPSTREAM RAISE 91-92 HAUL ROAD IMPROVEMENTS
SAFETY BERM AND CONTACT WATER CONTAINMENT

TITLE
HAUL ROAD SAFETY AND CONTACT WATER CONTAINMENT BERM

PROJECT NO.	REV.	DRAWING
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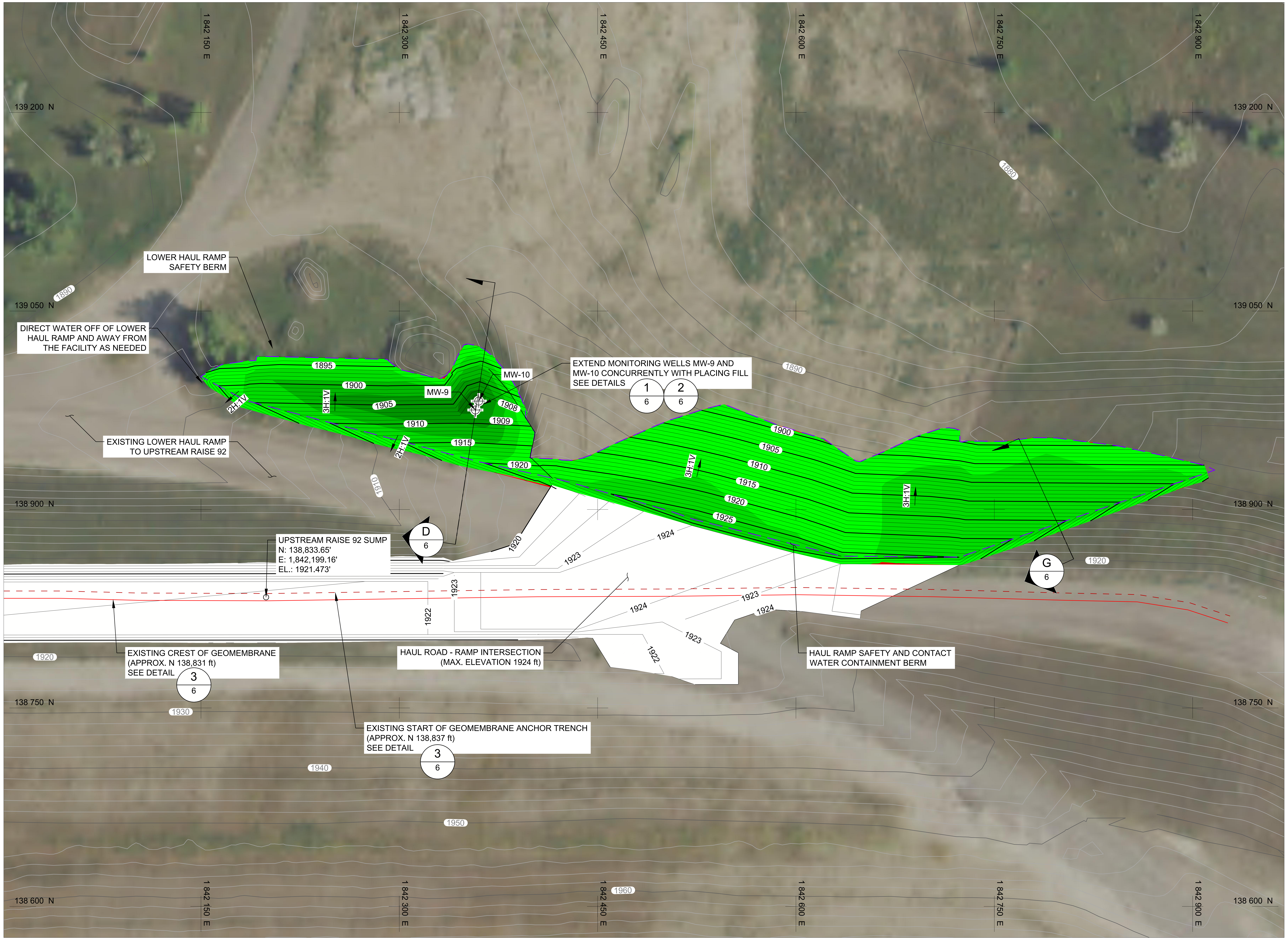

LEGEND

1970	EXISTING TOPOGRAPHY (REFERENCE 3)
1900	PROPOSED GRADES
⌖	MONITORING WELL
——	EXISTING CREST OF GEOMEMBRANE (APPROXIMATE)
– – –	EXISTING START OF GEOMEMBRANE ANCHOR TRENCH (APPROXIMATE)
— —	AREA TO RECEIVE TOPSOIL

NOTE(S)

1. EXISTING TOPOGRAPHY CONTOUR INTERVAL IS 2 FEET.
2. PROPOSED TOPOGRAPHY CONTOUR INTERVAL IS 1 FOOT.
3. SAFETY AND CONTACT WATER CONTAINMENT BERMS AND DOWNSTREAM GRADING SHALL BE CONSTRUCTED USING SOIL BACKFILL THAT IS COMPACTED AS MUCH AS PRACTICAL BY GRE USING AVAILABLE EQUIPMENT.
4. COAL COMBUSTION RESIDUALS SHALL NOT BE USED IN CONSTRUCTION OF THE PROPOSED SAFETY AND CONTACT WATER CONTAINMENT BERM AND DOWNSTREAM GRADING.

REFERENCE(S)

1. AERIAL IMAGERY TAKEN IN 2018 (OBTAINED FROM THE USDA NATIONAL AERIAL IMAGERY PROGRAM).
2. COORDINATE SYSTEM: PLANT SPECIFIC COORDINATE SPACE.
3. EXISTING TOPOGRAPHY COMPILED FROM SURVEYS TAKEN BETWEEN 2017 AND 2018.

CUT/FILL ISOPACH LEGEND

VOLUME CUT/FILL ISOPACH

RANGE	MIN. EL.	MAX. EL.	COLOR
1	-3.0	0.0	🟥
2	0.0	3.0	🟩
3	3.0	6.0	🟩
4	6.0	9.0	🟩
5	9.0	12.0	🟩
6	12.0	15.0	🟩

1. THE QUANTITY OF SOIL FILL TO BE PLACED AS SHOWN IS APPROXIMATELY 6,400 CUBIC YARDS.

N

0 40 80
1" = 40' FEET

CLIENT
GREAT RIVER ENERGY - COAL CREEK STATION
2875 THIRD STREET SOUTHWEST
UNDERWOOD, NORTH DAKOTA

CONSULTANT
GOLDER

YYYY-MM-DD	2020-05-13
DESIGNED	KAC
PREPARED	KAC
REVIEWED	CCS
APPROVED	TJS

PROJECT
UPSTREAM RAISE 91-92 HAUL ROAD IMPROVEMENTS
SAFETY BERM AND CONTACT WATER CONTAINMENT

TITLE
PROPOSED SAFETY BERM AND CONTACT WATER CONTAINMENT

PROJECT NO.	REV.	DRAWING
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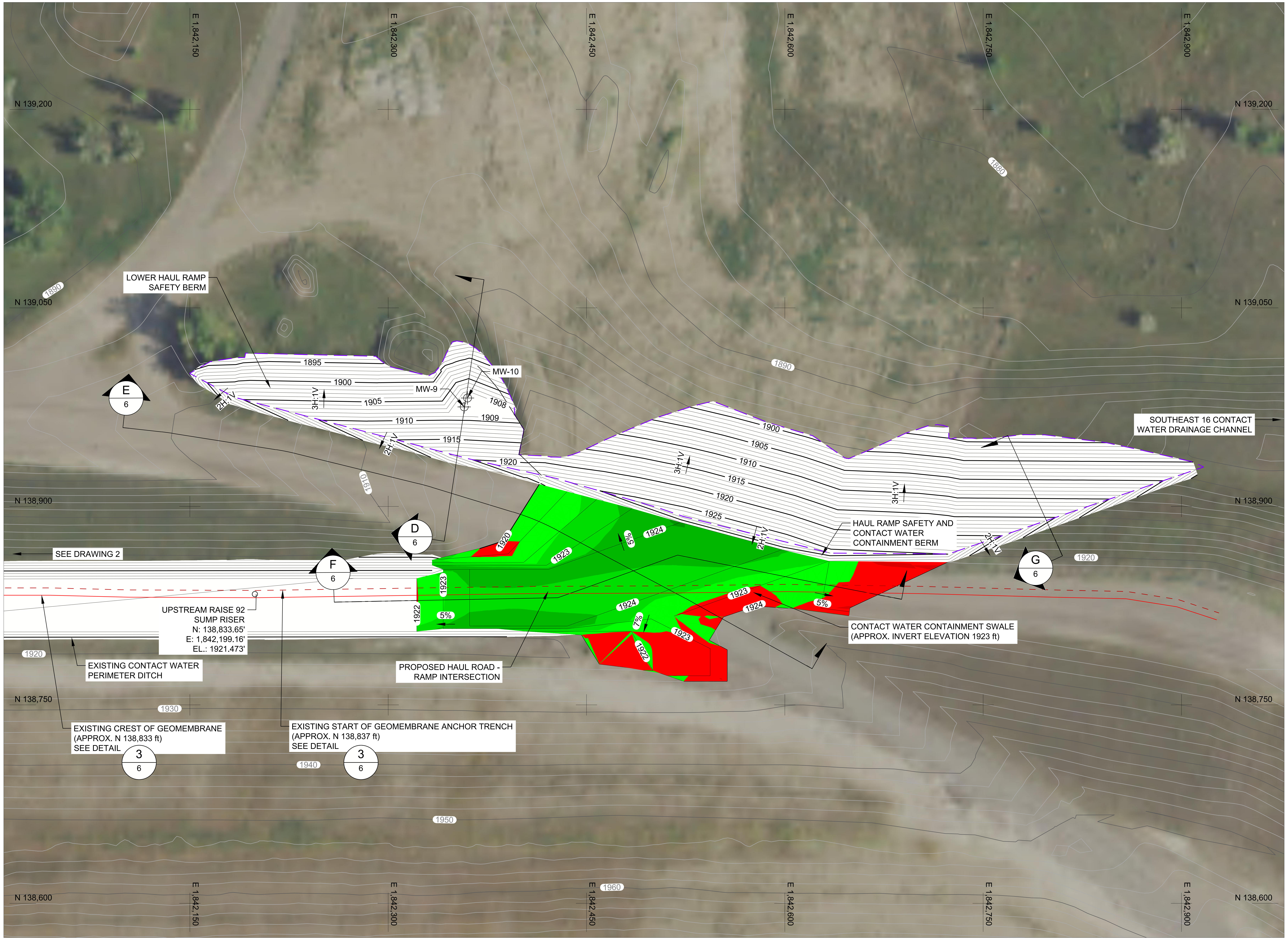


LEGEND

— 1970 —	EXISTING TOPOGRAPHY (REFERENCE 3)
— 1910 —	PROPOSED GRADES
⌖	MONITORING WELL
——	EXISTING CREST OF GEOMEMBRANE (APPROXIMATE)
— — —	EXISTING START OF GEOMEMBRANE ANCHOR TRENCH (APPROXIMATE)
— — —	AREA TO RECEIVE TOPSOIL

NOTE(S)

1. EXISTING TOPOGRAPHY CONTOUR INTERVAL IS 2 FEET.
2. PROPOSED TOPOGRAPHY CONTOUR INTERVAL IS 1 FOOT.
3. GREAT RIVER ENERGY IS RESPONSIBLE FOR USING SITE EXPERIENCE WHEN CHOOSING MATERIALS FOR CONSTRUCTION OF THE ROAD, INCLUDING WHETHER SUBCUT OF THE EXISTING ROAD MATERIAL IS REQUIRED AND COMPACTION REQUIREMENTS.

REFERENCE(S)

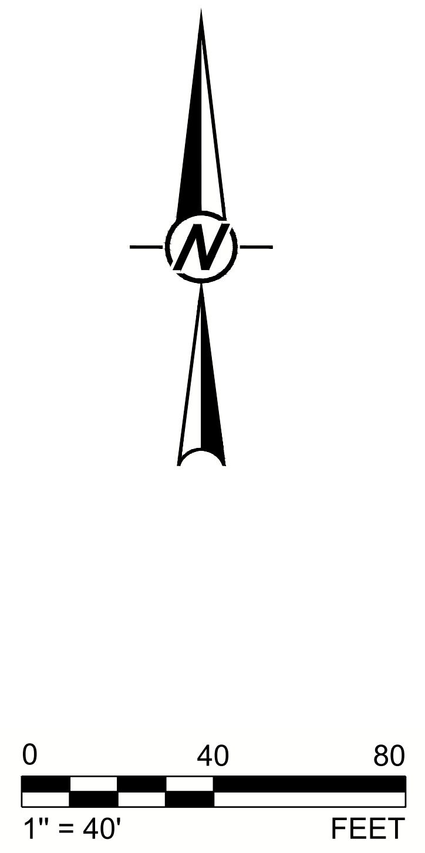
1. AERIAL IMAGERY TAKEN IN 2018 (OBTAINED FROM THE USDA NATIONAL AERIAL IMAGERY PROGRAM).
2. COORDINATE SYSTEM: PLANT SPECIFIC COORDINATE SPACE.
3. EXISTING TOPOGRAPHY COMPILED FROM SURVEYS TAKEN BETWEEN 2017 AND 2018.

CUT/FILL ISOPACH LEGEND

VOLUME CUT/FILL ISOPACH

RANGE	MIN. EL.	MAX. EL.	COLOR
1	-2.0	-1.0	🟥
2	-1.0	0.0	🟥
3	0.0	1.0	🟩
4	1.0	2.0	🟩
5	2.0	3.0	🟩
6	3.0	4.0	🟩

1. THE QUANTITY OF ROAD FILL TO BE PLACED AS SHOWN IS APPROXIMATELY 1,150 CUBIC YARDS.



CLIENT
GREAT RIVER ENERGY - COAL CREEK STATION
2875 THIRD STREET SOUTHWEST
UNDERWOOD, NORTH DAKOTA

CONSULTANT

GOLDER

YYYY-MM-DD	2020-05-13
DESIGNED	KAC
PREPARED	KAC
REVIEWED	CCS
APPROVED	TJS

PROJECT
UPSTREAM RAISE 91-92 HAUL ROAD IMPROVEMENTS
SAFETY BERM AND CONTACT WATER CONTAINMENT

TITLE
PROPOSED RAMP INTERSECTION

PROJECT NO.	REV.	DRAWING
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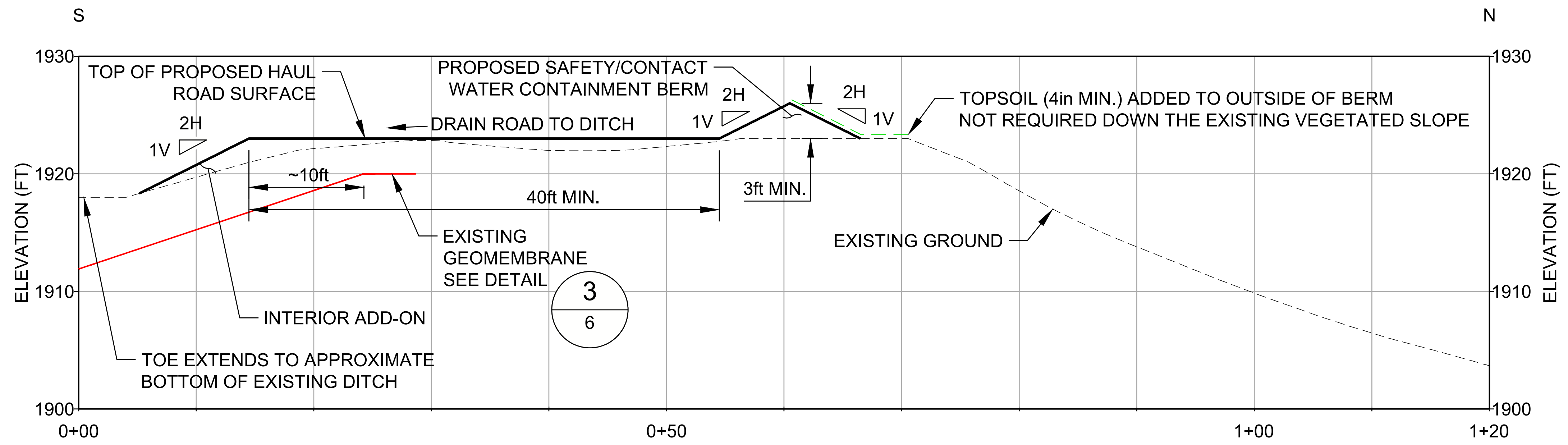
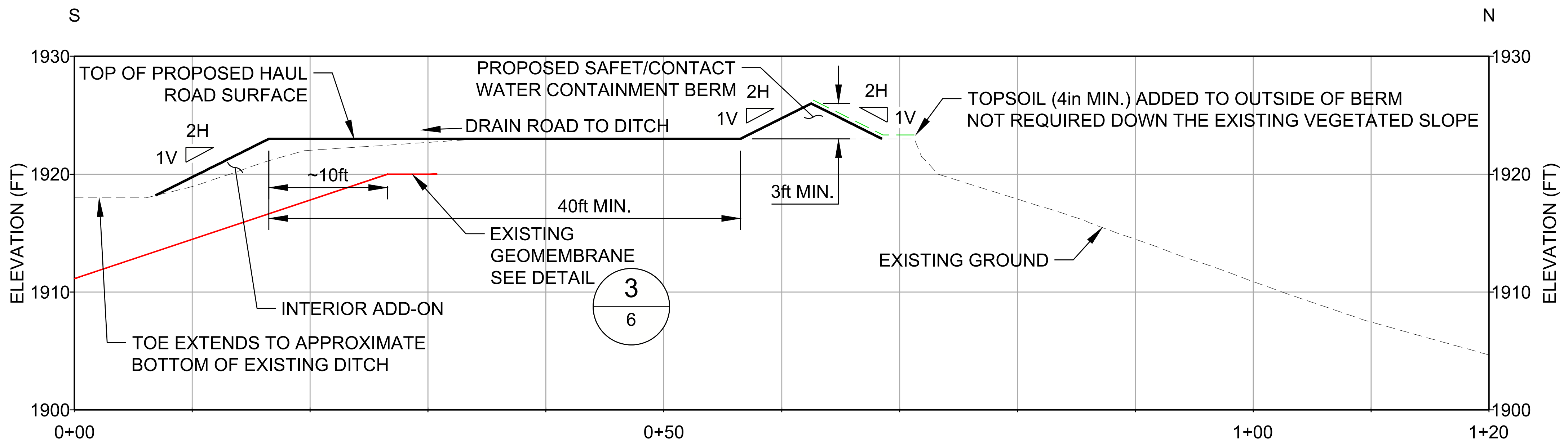
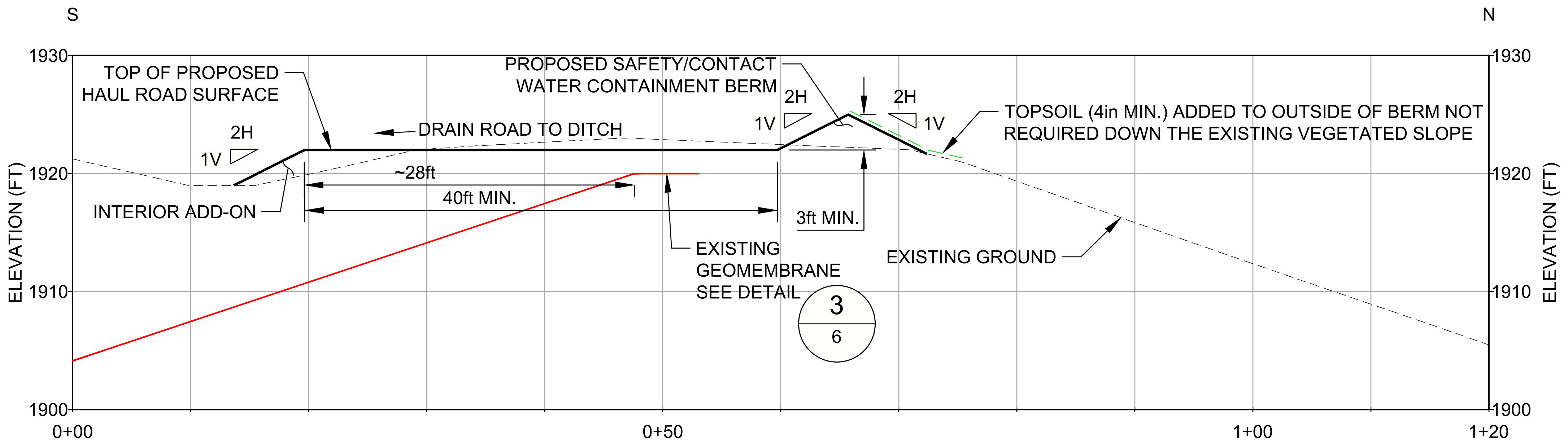


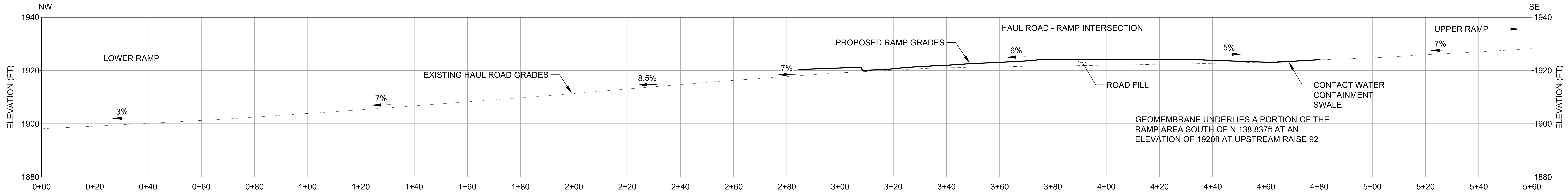
SCALE 1:10 **A** PROPOSED HAUL ROAD SAFETY BERM CROSS SECTION (WEST)
VERT. SCALE 1:1 5



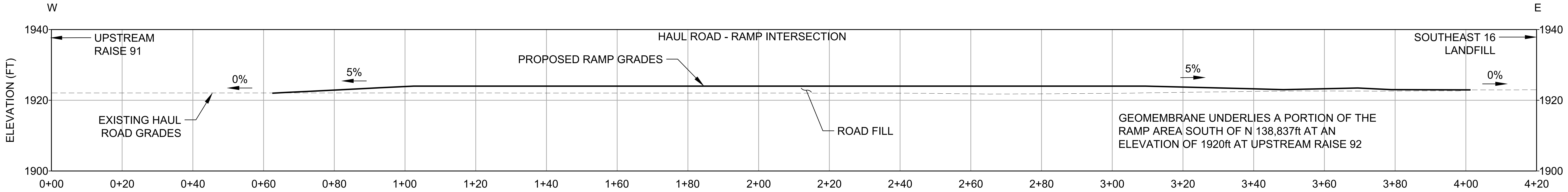
SCALE 1:10 **B** PROPOSED HAUL ROAD SAFETY BERM CROSS SECTION (CENTER)
VERT. SCALE 1:1 5



SCALE 1:10 **C** HAUL ROAD SAFETY BERM CROSS SECTION (EAST)
VERT. SCALE 1:1 5



SCALE 1:20 **E** LOWER HAUL RAMP TO UPPER HAUL RAMP CROSS SECTION
VERT. SCALE 1:1 5



SCALE 1:20 **F** HAUL RAMP INTERSECTION GRADES CROSS SECTION
VERT. SCALE 1:1 5

LEGEND

- - - - EXISTING GRADES
━━━━ PROPOSED GRADES
- - - - TOPSOIL GRADES
──── TOP OF GEOMEMBRANE LINER (APPROXIMATE)

CLIENT
GREAT RIVER ENERGY - COAL CREEK STATION
2875 THIRD STREET SOUTHWEST
UNDERWOOD, NORTH DAKOTA

CONSULTANT
GOLDER

YYYY-MM-DD	2020-05-13
DESIGNED	KAC
PREPARED	KAC
REVIEWED	CCS
APPROVED	TJS

PROJECT
UPSTREAM RAISE 91-92 HAUL ROAD IMPROVEMENTS
SAFETY BERM AND CONTACT WATER CONTAINMENT

TITLE
SECTIONS AND DETAILS 1

PROJECT NO.	REV.	DRAWING
19136224	B	5

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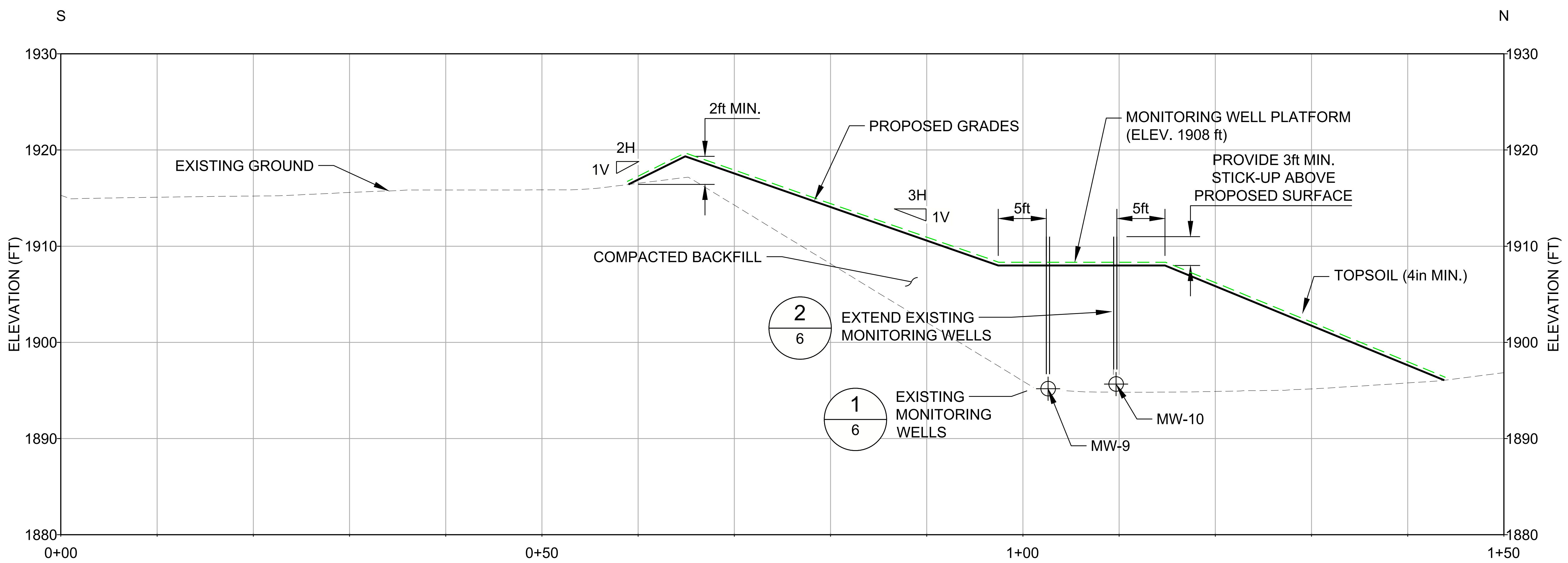
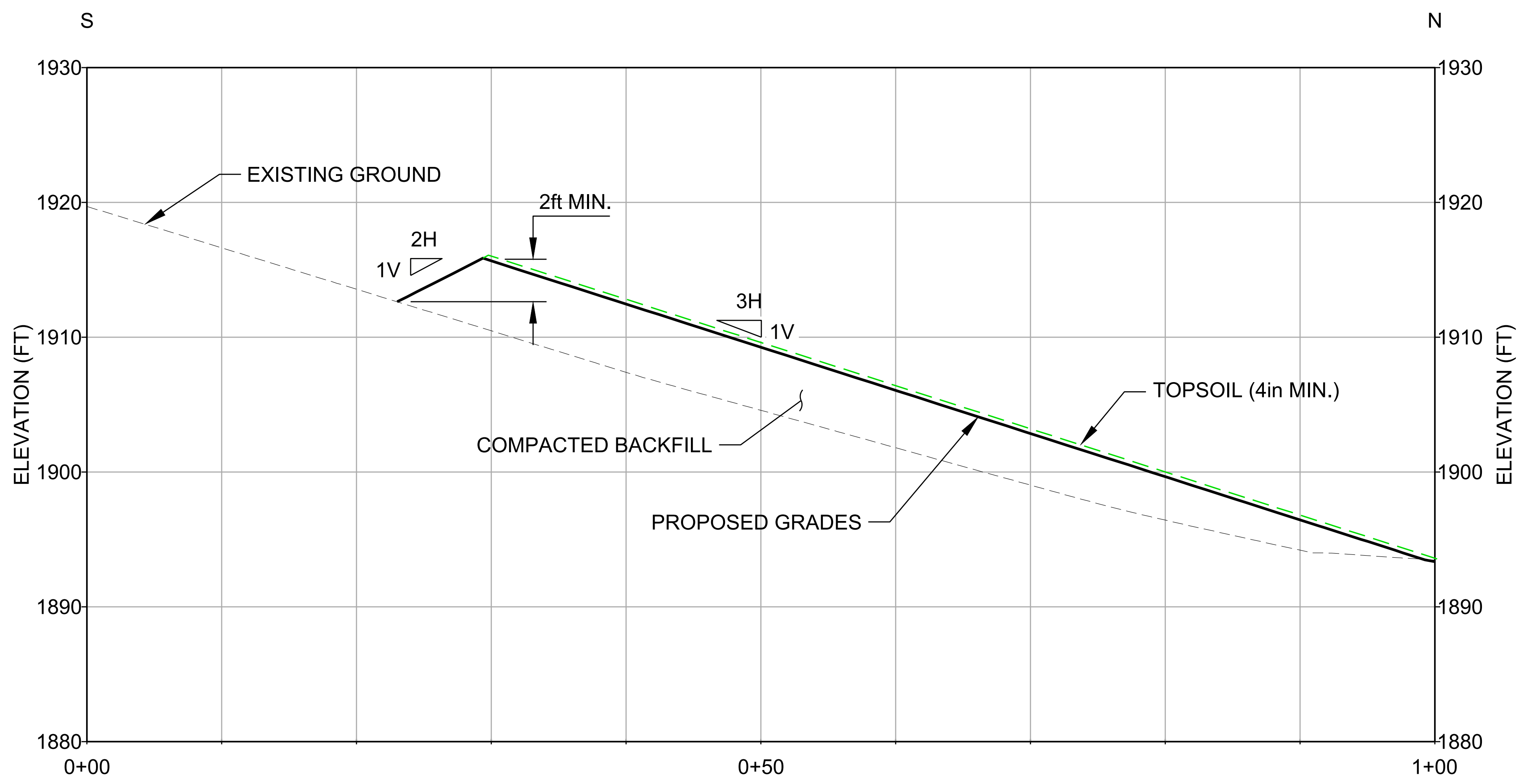


SCALE 1:10
VERT. SCALE 1:1

D / 6 PROPOSED LOWER RAMP GRADES CROSS SECTION

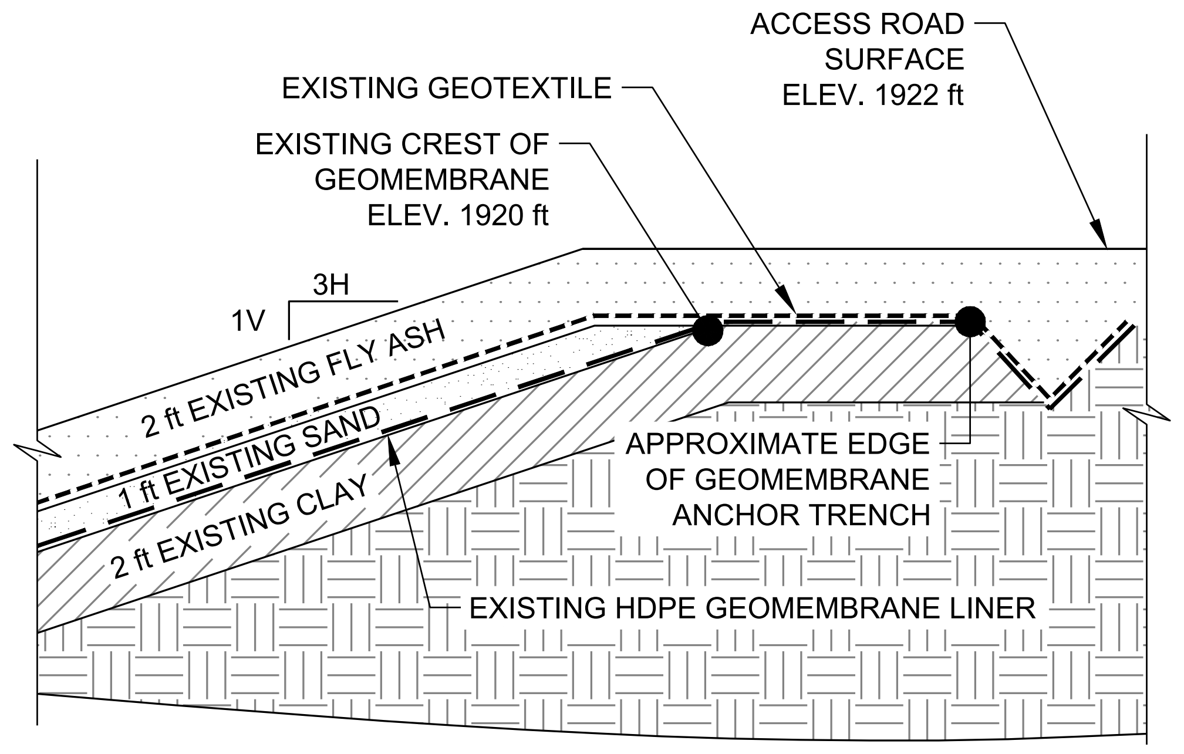


SCALE 1:10
VERT. SCALE 1:1

G / 6 PROPOSED CONTACT WATER CONTAINMENT GRADES CROSS SECTION

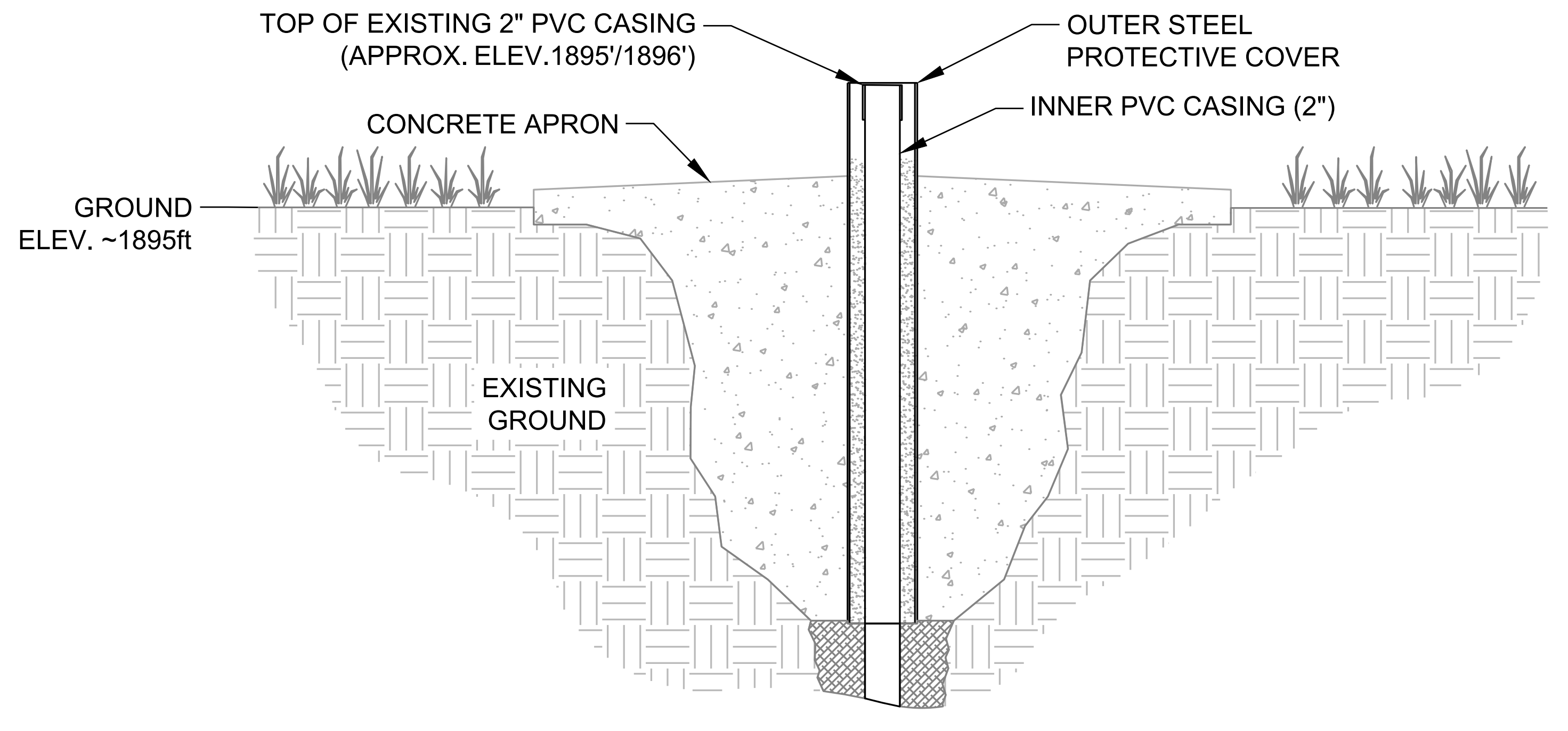
LEGEND

┄	EXISTING GRADES
─	PROPOSED GRADES
┄	TOPSOIL GRADES



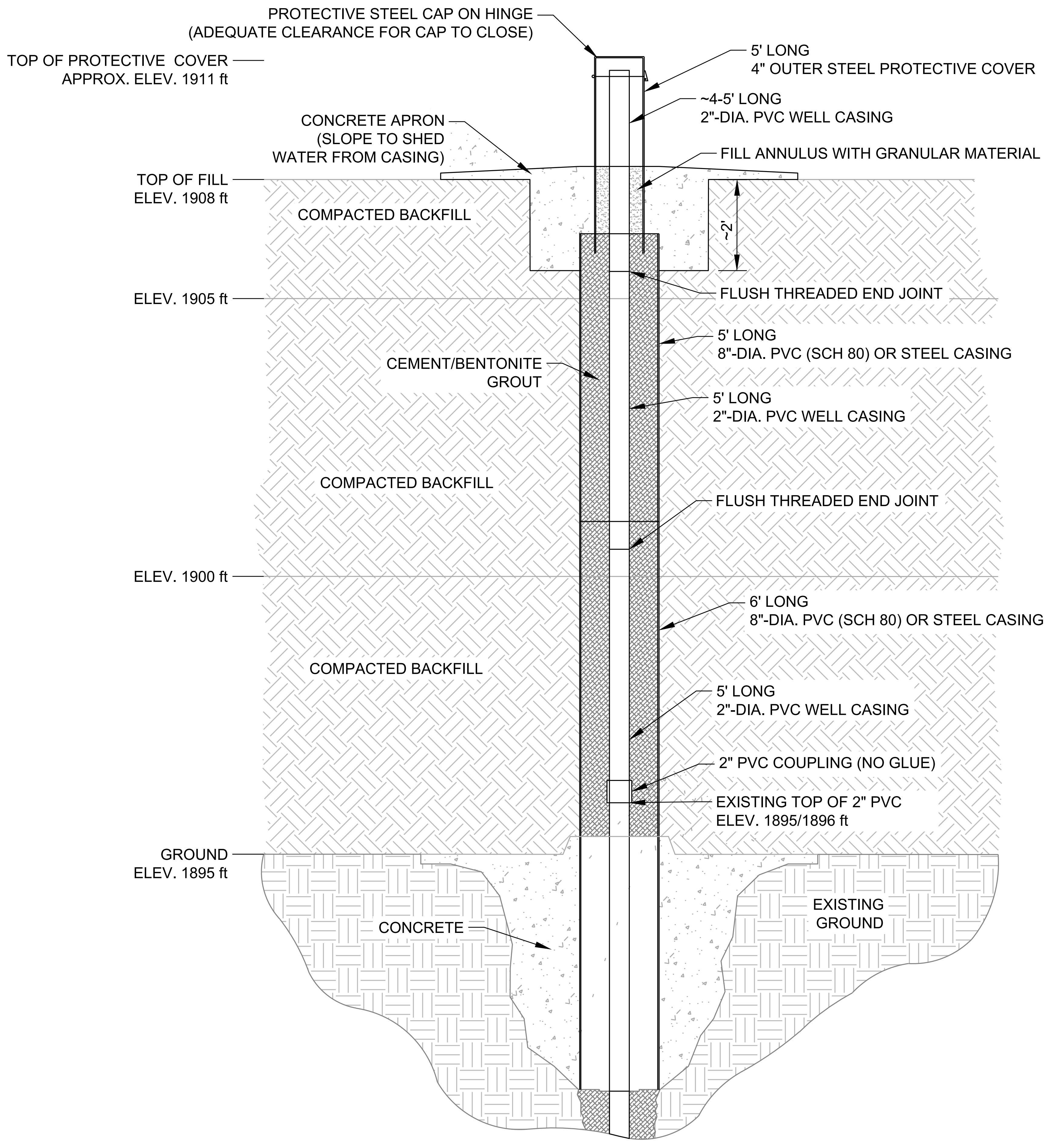
SCALE N.T.S.

3 / 6 EXISTING LINER DETAIL



SCALE N.T.S.

1 / 6 EXISTING MONITORING WELL DETAIL



SCALE N.T.S.

2 / 6 MONITORING WELL EXTENSION FINAL DETAIL

CLIENT
GREAT RIVER ENERGY - COAL CREEK STATION
2875 THIRD STREET SOUTHWEST
UNDERWOOD, NORTH DAKOTA

CONSULTANT

GOLDER

YYYY-MM-DD	2020-05-13
DESIGNED	KAC
PREPARED	KAC
REVIEWED	CCS
APPROVED	TJS

PROJECT
UPSTREAM RAISE 91-92 HAUL ROAD IMPROVEMENTS
SAFETY BERM AND CONTACT WATER CONTAINMENT

TITLE
SECTIONS AND DETAILS 2

PROJECT NO.	REV.	DRAWING
19136224	B	6

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LEGEND

1910	EXISTING TOPOGRAPHY (REFERENCE 3)
1890	PROPOSED BORROW GRADES - APPROXIMATE (GRADE TO DRAIN AS INDICATED)
⌖ MW-16-0	EXISTING MONITORING WELL
—	POTENTIAL BORROW AREAS

NOTE(S)

1. EXISTING TOPOGRAPHY CONTOUR INTERVAL IS 2 FEET.
2. GRADE TO DRAIN BORROW AREAS AS SHOWN. DO NOT LEAVE FINAL BORROW AREA GRADES STEEPER THAN 10%.
3. BORROW AREAS SHALL BE SEEDED UPON COMPLETION OF THE WORK. TOPSOIL CAN BE APPLIED AT THE DISCRETION OF GRE PERSONNEL.

REFERENCE(S)

1. AERIAL IMAGERY TAKEN IN 2018 (OBTAINED FROM THE USDA NATIONAL AGRICULTURAL IMAGERY PROGRAM).
2. COORDINATE SYSTEM: PLANT SPECIFIC COORDINATE SPACE.
3. EXISTING TOPOGRAPHY COMPILED FROM SURVEYS TAKEN BETWEEN 2017 AND 2018.

N

0 150 300
1" = 150' FEET

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GREAT RIVER ENERGY - COAL CREEK STATION
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UNDERWOOD, NORTH DAKOTA

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PROJECT
UPSTREAM RAISE 91-92 HAUL ROAD IMPROVEMENTS
SAFETY BERM AND CONTACT WATER CONTAINMENT

TITLE
POTENTIAL BORROW AREAS

PROJECT NO.	REV.	DRAWING
19136224	B	7

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