



REPORT

Annual Coal Combustion Residuals Groundwater Monitoring and Corrective Action Report - 2020

Nebraska Public Power District, Gerald Gentleman Station

Submitted to:

Nebraska Public Power District

Gerald Gentleman Station, 6089 South Highway 25, Sutherland, Nebraska 69165

Submitted by:

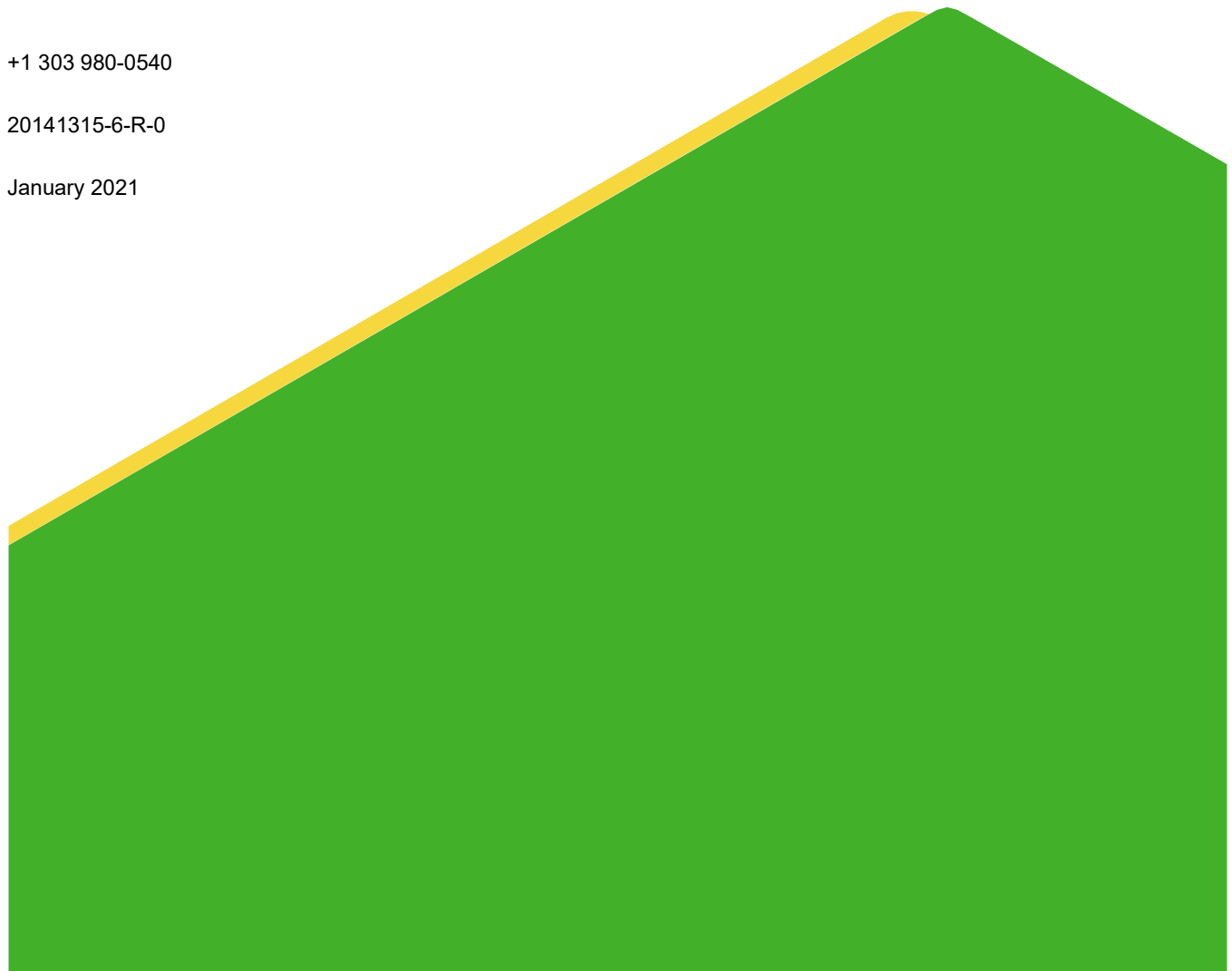
Golder Associates Inc.

7245 W Alaska Drive, Suite 200, Lakewood, Colorado, USA 80226

+1 303 980-0540

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Executive Summary

This report presents the results from groundwater monitoring that occurred at Nebraska Public Power District's Gerald Gentleman Station 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 facility entered 2020 under a detection monitoring program and remains in detection monitoring based on the results of sampling and analysis events conducted in the second and fourth quarters of 2020 (Q2 and Q4).

For the Q2 2020 sampling event, a potential exceedance was identified for sulfate at APMW-5 (an upgradient location). No other items of statistical significance were identified during the Q2 2020 sampling event.

During the Q4 2020 sampling event, no potential exceedances were identified. The potential exceedance for sulfate at APMW-5 identified during the Q2 2020 sampling event was determined to be a false-positive through confirmative re-sampling. No other items of statistical significance were identified during the Q4 2020 sampling event.

As described in the Groundwater Monitoring System Certification (Golder 2017a) and the Groundwater Monitoring Statistical Methods Certification (Golder 2017b), the groundwater monitoring and analytical procedures meet the general requirements of the Coal Combustion Residuals (CCR) rule, and modifications to the monitoring network and sampling program are not recommended at this time.

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Figure 1: June 2020 Groundwater Contours

Figure 2: November/December 2020 Groundwater Contours

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APPENDIX A

Alternate Source Demonstration - Q4 2019 Detection Monitoring Event

1.0 INTRODUCTION

Golder Associates Inc. (Golder) has prepared this report describing the 2020 groundwater sampling and comparative statistical analysis for Nebraska Public Power District's (NPPD's) Gerald Gentleman Station (GGS) in Sutherland, Nebraska. This report was written to meet the requirements of the federal Coal Combustion Residuals (CCR) rule's sections on groundwater monitoring and corrective action, 40 CFR 257.90 to 257.98.

1.1 Facility Information

GGS is located approximately 5 miles south of Sutherland, Nebraska, and 1.2 miles south of Sutherland Reservoir. The ash disposal facility at GGS is situated in the NW ¼, NE ½, Section 30 of Township 13 N, Range 33 W, in Lincoln County, Nebraska. NPPD began operating GGS in 1979 as a coal-fired electrical generation facility. GGS is both owned and operated by NPPD. The plant, with a generation capacity of 1,365 megawatts (MW) of power, uses a low-sulfur coal from Wyoming's Powder River Basin. The active CCR landfill at the site contains fly ash and bottom ash.

1.2 Purpose

The federal CCR rule established specific requirements for reporting of groundwater monitoring and corrective actions in 40 CFR 257.90. Per part (e) of §257.90, no later than January 31, 2018, and annually thereafter, owners or operators of CCR units must prepare an annual groundwater monitoring and corrective action report.

2.0 GROUNDWATER MONITORING NETWORK PROGRAM STATUS

The groundwater monitoring network for the active CCR landfill at GGS consists of 14 monitoring wells, as shown in Figure 1 and Figure 2. The four upgradient monitoring wells are APMW-5, APMW-15, APMW-16A, and APMW-17 and are indicated by the inclusion of "(U)" throughout the text. The 10 downgradient monitoring wells are APMW-4, APMW-6, APMW-8A, APMW-10, APMW-11, APMW-12, APMW-13, APMW-14, APMW-18, and APMW-19.

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 within the operating record and on NPPD's publicly accessible CCR website (Golder 2020).
- An ASD was conducted and completed in April 2020 for the verified statistically significant increases (SSIs) for calcium and sulfate at APMW-19 identified in Quarter 4 (Q4) 2019, with an alternative source identified.
- A baseline update was conducted for data collected through Q4 2019.
- Detection monitoring samples were collected in June and November/December 2020 and analyzed for the Appendix III constituent list associated with the CCR rule for the program wells.
- A new field meter was acquired by NPPD and used for collection of field parameters beginning with the samples collected in Q4 2020. Beginning in Q4 2020, NPPD began collecting field parameters using a QED MP25T field meter. Prior to Q4 2020, NPPD used a QED MP20 field meter. The switch in field instrumentation was initiated to allow for collection of additional field parameters in support of other sampling efforts at GGS.
- Comparative statistical analysis was completed for the second quarter (Q2) 2020 and Q4 2020 detection monitoring events, collected in June and November/December 2020, respectively.

2.2 Installation and Decommissioning of Monitoring Wells

No monitoring wells associated with the ash disposal facility groundwater quality monitoring network were installed or decommissioned at GGS in 2020.

2.3 Problems and Resolutions

No problems were encountered in 2020 that required resolutions.

2.4 Proposed Key Activities for 2021

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

- Detection monitoring sampling events and associated comparative statistical analysis are planned to occur in Q2 and Q4 2021.

3.0 GROUNDWATER MONITORING ANALYTICAL PROGRAM STATUS

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

3.1 Samples Collected

GGS staff collected monitoring samples from the four upgradient and ten downgradient monitoring wells on June 16 and 17, 2020 and November 30 and December 1, 2020. Specific dates for each sample are provided on Tables 1 through 14.

3.1.1 Groundwater Elevation and Flow Rate

Groundwater elevations were measured in each well during each sampling event prior to purging. Elevation measurements can be found in Tables 1 through 14 for each location. Groundwater elevations and interpolated groundwater contours are shown in Figure 1 for the June 2020 (Q2 2020) detection monitoring sampling event. Groundwater elevations and interpolated groundwater contours are shown on Figure 2 for the November/December 2020 (Q4 2020) detection monitoring sampling event.

The groundwater flow rate across the 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, estimated from slug testing results from system wells, in ft/day
- i is the hydraulic gradient, calculated based on groundwater elevations for each monitoring event, in feet per foot (ft/ft)
- n_e is the effective porosity, estimated to be 0.25 for site soils

Hydraulic conductivity values at the site range from 0.14 to 19 ft/day, based on slug test data reported in Design and Construction of a Groundwater Monitoring Network, Final Report, issued in September 1991 by Woodward-Clyde Consultants. According to the 1991 report, a hydraulic conductivity value of 0.14 ft/day represents the Ogallala Formation silts. Values of 16 and 19 ft/day were reported for Ogallala Formation sands. Both 0.14 and 19 ft/day have been used to estimate a range of hydraulic conductivities. The effective porosity estimate above is based on typical values for sands and silts, as presented in Applied Hydrogeology (Fetter 1994).

Based on the range of site values for hydraulic conductivity, the estimated effective porosity, and calculated hydraulic gradient based on water level readings, the average groundwater flow rate for June 2020 was estimated between 3.4×10^{-4} ft/day and 6.4×10^{-2} ft/day. The average groundwater flow rate for November/December 2020 was estimated between 3.2×10^{-4} ft/day and 7.4×10^{-2} ft/day.

3.2 Monitoring Data (Analytical Results)

Analytical results for the CCR rule Appendix III detection monitoring events in June 2020 and November/December 2020 are shown in Table 1 through Table 14.

3.3 Statistical Baseline Update

Prior to comparative statistical analysis for the Q2 2020 detection monitoring event, the baseline (or background) period for each well-constituent pair within the program was reviewed. Baseline periods for most program wells were previously established prior to conducting comparative statistical analysis for the first detection monitoring sampling event conducted in November 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 five samples collected between November 2017 and November 2019 were reviewed for the potential to update the statistical baseline periods.

The steps taken for updating the statistical baseline reflect those used for initial establishment of baseline, as described in the Groundwater Monitoring Statistical Methods Certification (Golder 2017a), available on NPPD's publicly accessible CCR website. The baseline period for a specific well-constituent pair was not reviewed for the potential to be updated if either an unresolved potential exceedance or a verified SSI was identified for that well-constituent pair that had not been resolved with an alternative source demonstration. 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 alternative source demonstration 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, to better reflect the full range of variability within the background data.

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 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 by the Groundwater Monitoring Statistical Methods Certification (Golder 2017a). By setting baseline periods, baseline limits have been updated and are shown on Table 15 through Table 28. If a dataset was found to have statistical seasonality, the dataset was deseasonalized for updating the statistical limit.

Certain well-constituent pairs were not 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 (APMW-4 and APMW-5)
- Identification of statistically significant decreasing trends in the proposed baseline periods (calcium at APMW-17, original statistical limit retained)

3.4 Comparative Statistical Analysis

The comparative statistical analysis is summarized below with the results presented in Table 15 through Table 28. A description of the steps taken for the comparative statistical analysis is summarized below with the results presented in Table 15 through Table 28.

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 (NP-PL), the comparative statistical analysis consists of a comparison of detection monitoring results collected during the period of interest to the statistical limit calculated from the baseline data collection period. For well-constituent 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 compliance. For well-constituent pairs with decreasing trends identified for the baseline period, a Sen's Slope tests was used to assess the compliance results. Additional information on the methods for the comparative statistical analysis can be found in the Groundwater Monitoring Statistical Methods Certification (Golder 2017a).

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

- **Elevated CUSUM** – is defined as 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 for field-measured pH, the CUSUM value may also be below the lower Shewhart-CUSUM limit established by the baseline statistical analysis.
- **Potential Exceedance** – 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 re-sampling will determine if the potential exceedance is a false-positive or a verified SSI. Non-detect results that exceed either the Shewhart-CUSUM limit or the non-parametric statistical limit are not considered potential exceedances.
- **False-positive** – 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.

Results of the statistical analysis for the Q2 2020 and Q4 2020 detection monitoring events are shown on Table 15 through Table 28. For reporting purposes, compliance samples with non-detect results are shown at the practical quantitation limit (PQL) on Table 15 through Table 28.

3.4.1 Potential Exceedances

A potential exceedance was identified for sulfate at APMW-5 (upgradient) during the Q2 2020 sampling event. Confirmatory sampling occurred during the Q4 2020 sampling event, with results discussed below.

No potential exceedances were identified during the Q4 2020 detection monitoring event.

3.4.2 False-Positives

No potential exceedances were identified during the Q4 2019 detection monitoring event. As such, no false-positives were identified during the Q2 2020 detection monitoring sampling event.

The potential exceedance identified for sulfate at APMW-5 (upgradient) during the Q2 2020 sampling event was determined to be a false-positive through confirmatory re-sampling conducted during the Q4 2020 sampling event. No other false-positives were identified.

3.4.3 Verified SSIs

No potential exceedances were identified during the Q4 2019 detection monitoring event. As such, no verified SSIs were found during the Q2 2020 detection monitoring sampling event.

Similarly, as no potential exceedances were identified during the Q2 2020 detection monitoring event, no verified SSIs were found during the Q4 2020 detection monitoring sampling event.

3.4.4 Trending Data

Statistical limits were unable to be established for sulfate at APMW-15 and chloride at APMW-4 due to statistically significant trends throughout the proposed baseline period. The following approaches have been used to assess the statistical significance of these constituents:

- APMW-15 (Upgradient), Sulfate: As an upgradient location, the facility was determined not to be the source of the increasing sulfate trend at APMW-15. For comparative statistics, an alternative trend test, namely that described by EPRI (2015), was used. Both the complete data set and the most recent eight points were analyzed with Sen's Slope trend test to determine if the data continue to show a statistically significant trend. Both data sets were found to exhibit a statistically significant trend. Linear trend lines were then made for both the baseline data and the complete data set, including the most recent data from Q2 2020 and Q4 2020, following both the Q2 2020 and Q4 2020 detection monitoring sampling events. The regression residuals for the linear trend lines were tested for normalcy and shown to be normal or transform-normal. The slopes of the two lines were then compared. Per guidance provided by the Electric Power Research Institute (EPRI 2015), as the trend line for each of the complete data sets (both the complete data asset through Q2 2020 and the complete data set through Q4 2020) had a lower slope than that of the baseline data set, the Q2 2020 and Q4 2020 detection monitoring points are not considered statistically significant. Data for this well-constituent pair will continue to be reassessed following collection of further data to determine if the trend continues or if non-trending baseline period can be established.
- APMW-4, Chloride: A baseline statistical limit was unable to originally be established for chloride at APMW-4 due to a statistically significant trend within the proposed baseline period. Upon review of the data set with inclusion of the Q2 2020 data, the data set no longer displays a statistically significant trend. A baseline period and CUSUM statistical limit were established with data through Q2 2020 prior to conducting comparative statistical analysis for the Q4 2020 event. No items of statistical significance were identified for Q4 2020 for chloride at APMW-4.

3.5 Program Transitions

Beginning in Q4 2017, the groundwater monitoring program at GGS transitioned from the baseline period to detection monitoring. During the baseline period, eight independent samples from each well 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), with the previously noted exceptions of APMW-4 and APMW-5 (U) due to lack of precipitation (Golder 2018).

3.5.1 Detection Monitoring

Samples for the detection monitoring program are collected on a semi-annual basis, beginning with the sample collected in November 2017. NPPD plans to collect semi-annual samples for the detection monitoring program in Q2 and Q4 2021.

3.5.2 Alternative Source Demonstrations

Resulting from the verified SSIs for calcium and sulfate at APMW-19 in Q4 2019, NPPD pursued an ASD. As specified in 40 CFR 257.94, NPPD had 90 days to complete the ASD following completion of comparative statistics or establish an assessment monitoring program. The successful ASD was completed on April 22, 2020 and is included as Appendix A. As a result of the successful ASD outcome, NPPD remains in detection monitoring.

3.5.3 Assessment Monitoring

The current groundwater monitoring program at GGS is not in assessment monitoring. Assessment monitoring has not been triggered as described in 40 CFR 257.95.

3.5.4 Corrective Measures and Assessment

The current groundwater monitoring program at GGS does not indicate the need for corrective measures. An assessment of corrective measures, as described in 40 CFR 257.96, has not been required. No ASDs for Appendix IV parameters have been made. No corrective actions are required at this time.

4.0 RECOMMENDATIONS AND CLOSING

This report presents the results from the Q2 2020 and Q4 2020 detection monitoring events of the CCR program and the associated comparative statistical analysis, along with the successful ASD for calcium and sulfate at APMW-19 during Q4 2019. The groundwater monitoring and analytical procedures implemented at GGS meet the requirements of the CCR rule and are consistent with the approach described in the Groundwater Monitoring System Certification (Golder 2017b) and the Groundwater Monitoring Statistical Methods Certification (Golder 2017a). Modifications to the monitoring network and sampling program are not recommended at this time. Comparative statistics and the ASD presented within this report support remaining in detection monitoring, and do not trigger assessment monitoring nor an assessment of corrective measures.

Signature Page

Golder Associates Inc.



Erin L. Hunter, PhD, PE

Senior Project Engineer



Jacob J. Sauer, PE

Associate and Senior Engineer

ELH/JJS/rrm

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5.0 REFERENCES

- Electric Power Research Institute (EPRI). 2015. Groundwater Monitoring Guidance for the Coal Combustion Residuals Rule – 2015 Technical Report, November 2015.
- Fetter, Charles Willard. 1994. Applied Hydrogeology, 3rd Edition. Prentice-Hall.
- Golder. 2017a. Groundwater Monitoring Statistical Methods Certification, Gerald Gentleman Station Ash Disposal Facility. Golder Associates Inc. October 10, 2017.
- Golder. 2017b. Coal Combustion Residuals Landfill Groundwater Monitoring System Certification, Gerald Gentleman Station, Sutherland, Nebraska. Golder Associates Inc. October 10, 2017.
- Golder. 2018. Annual Groundwater Report – 2017, Nebraska Public Power District – Gerald Gentleman Station. Golder Associates Inc. January 24, 2018.
- Golder. 2019a. Annual Groundwater Report – 2018, Nebraska Public Power District – Gerald Gentleman Station. Golder Associates Inc. Published January 25, 2019. Tables Revised March 7, 2019.
- Golder. 2019b. Alternative Source Demonstration, Nebraska Public Power District – Gerald Gentleman Station. Golder Associates Inc. Published April 19, 2019.
- Golder. 2019c. Alternative Source Demonstration, Nebraska Public Power District – Gerald Gentleman Station. Golder Associates Inc. Published December 25, 2019.
- Golder. 2020a. Annual Coal Combustion Residuals Groundwater Monitoring and Corrective Action Report – 2019, Nebraska Public Power District, Gerald Gentleman Station. Golder Associates Inc. Published January 25, 2020.
- Golder. 2020b. Alternate Source Demonstrations, Nebraska Public Power District. Golder Associates Inc. Published April 22, 2020.
- USEPA (United States Environmental Protection Agency). 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. Office of Resource Conservation and Recovery, EPA-R-09-007. March 2009.
- USEPA. 2015. Code of Federal Regulations Title 40 Part 257: Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities. April 17, 2015.
- Woodward-Clyde Consultants. 1991. Design and Construction of a Groundwater Monitoring Network, Final Report. September 1991.

Tables

Table 1. Data Summary Table - APMW-5 (Upgradient)

Analytes		6/16/2020	11/30/2020
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	< 0.100	< 0.100
Calcium, Total	mg/L	73.5	38.4
Chloride	mg/L	33.6	< 5.00
Fluoride	mg/L	< 0.500	< 0.500
pH, Field	pH units	7.36	8.02
pH	pH units	7.8	7.9
Sulfate	mg/L	52.2	21.8
Total Dissolved Solids	mg/L	392	216
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

ft amsl, feet above mean sea level

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 2. Data Summary Table - APMW-15 (Upgradient)

Analytes		6/16/2020	11/30/2020
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	0.146	< 0.100
Calcium, Total	mg/L	102	82.3
Chloride	mg/L	29.7	27.3
Fluoride	mg/L	< 0.500	< 0.500
pH, Field	pH units	7.2	7.6
pH	pH units	7.6	7.6
Sulfate	mg/L	155	115
Total Dissolved Solids	mg/L	600	518
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors constituents found in Appendix III.

Analytes		6/16/2020	11/30/2020
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	0.186	0.131
Calcium, Total	mg/L	110	106
Chloride	mg/L	27.7	50
Fluoride	mg/L	< 0.500	< 0.500
pH, Field	pH units	6.67	7.45
pH	pH units	7.5	7.5
Sulfate	mg/L	160	190
Total Dissolved Solids	mg/L	624	638
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 4. Data Summary Table - APMW-17 (Upgradient)

Analytes		6/16/2020	11/30/2020
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	0.102	< 0.100
Calcium, Total	mg/L	105	96.6
Chloride	mg/L	21.1	31
Fluoride	mg/L	< 0.500	< 0.500
pH, Field	pH units	6.99	7.5
pH	pH units	7.5	7.5
Sulfate	mg/L	112	120
Total Dissolved Solids	mg/L	504	516
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 5. Data Summary Table - APMW-4

Analytes		6/16/2020	11/30/2020
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	< 0.100	< 0.100
Calcium, Total	mg/L	55.8	44.7
Chloride	mg/L	36.3	44.8
Fluoride	mg/L	< 0.500	< 0.500
pH, Field	pH units	7.4	8
pH	pH units	7.8	7.8
Sulfate	mg/L	25.3	27.3
Total Dissolved Solids	mg/L	230	316
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 6. Data Summary Table - APMW-6

Analytes		6/16/2020	11/30/2020
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	< 0.100	< 0.100
Calcium, Total	mg/L	53.1	45.8
Chloride	mg/L	16.1	17.9
Fluoride	mg/L	< 0.500	< 0.500
pH, Field	pH units	7.33	7.82
pH	pH units	7.8	7.7
Sulfate	mg/L	26.3	27.3
Total Dissolved Solids	mg/L	250	276
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 7. Data Summary Table - APMW-8A

Analytes		6/16/2020	12/1/2020
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	< 0.100	< 0.100
Calcium, Total	mg/L	94.3	88.2
Chloride	mg/L	84.6	104
Fluoride	mg/L	< 0.500	< 0.500
pH, Field	pH units	7.13	7.56
pH	pH units	7.6	7.6
Sulfate	mg/L	69.6	81.8
Total Dissolved Solids	mg/L	452	546
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 8. Data Summary Table - APMW-10

Analytes		6/16/2020	12/1/2020
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	< 0.100	< 0.100
Calcium, Total	mg/L	68.4	55.9
Chloride	mg/L	26.9	26
Fluoride	mg/L	< 0.500	< 0.500
pH, Field	pH units	7.34	7.76
pH	pH units	7.7	7.6
Sulfate	mg/L	52.2	48.3
Total Dissolved Solids	mg/L	354	332
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 9. Data Summary Table - APMW-11

Analytes		6/16/2020	12/1/2020
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	< 0.100	< 0.100
Calcium, Total	mg/L	94.7	83.8
Chloride	mg/L	89.6	123
Fluoride	mg/L	< 0.500	< 0.500
pH, Field	pH units	7.21	7.55
pH	pH units	7.5	8.2
Sulfate	mg/L	44.5	38.2
Total Dissolved Solids	mg/L	436	520
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 10. Data Summary Table - APMW-12

Analytes		6/17/2020	12/1/2020
	Units	Detection Monitoring ¹	
Water Elevation	ft amsl		
Appendix III			
Boron, Total	mg/L	0.281	0.19
Calcium, Total	mg/L	156	131
Chloride	mg/L	147	161
Fluoride	mg/L	< 0.500	< 0.500
pH, Field	pH units	6.89	7.24
pH	pH units	7.3	7.4
Sulfate	mg/L	294	290
Total Dissolved Solids	mg/L	916	1080
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 11. Data Summary Table - APMW-13

Analytes		6/17/2020	12/1/2020
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	0.3	0.206
Calcium, Total	mg/L	145	126
Chloride	mg/L	118	123
Fluoride	mg/L	< 0.500	< 0.500
pH, Field	pH units	6.98	7.29
pH	pH units	7.3	7.4
Sulfate	mg/L	266	274
Total Dissolved Solids	mg/L	884	956
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 12. Data Summary Table - APMW-14

Analytes		6/17/2020	12/1/2020
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	0.28	0.199
Calcium, Total	mg/L	149	128
Chloride	mg/L	124	135
Fluoride	mg/L	< 0.500	< 0.500
pH, Field	pH units	7.04	7.33
pH	pH units	7.4	7.4
Sulfate	mg/L	206	201
Total Dissolved Solids	mg/L	824	878
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 13. Data Summary Table - APMW-18

Analytes		6/16/2020	11/30/2020
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	< 0.100	< 0.100
Calcium, Total	mg/L	87	68.5
Chloride	mg/L	91.3	94.3
Fluoride	mg/L	< 0.500	< 0.500
pH, Field	pH units	7.34	7.63
pH	pH units	7.7	7.9
Sulfate	mg/L	33.2	28.8
Total Dissolved Solids	mg/L	400	426
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 14. Data Summary Table - APMW-19

Analytes		6/16/2020	11/30/2020
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	0.107	< 0.100
Calcium, Total	mg/L	111	94.8
Chloride	mg/L	50.6	53.1
Fluoride	mg/L	< 0.500	< 0.500
pH, Field	pH units	7.1	7.58
pH	pH units	7.6	7.8
Sulfate	mg/L	166	134
Total Dissolved Solids	mg/L	586	590
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 15: Comparative Statistics - APMW-5 (Upgradient)

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Detection Monitoring Analytes	Units			6/16/2020			11/30/2020		
Boron, Total	mg/L	NP-PL	0.200	< 0.100	---	Yes	< 0.100	---	Yes
Calcium, Total	mg/L	CUSUM	120.2	73.5	71.5	Yes	38.4	71.5	Yes
Chloride	mg/L	CUSUM	108.1	33.6	35.7	Yes	< 5.00	35.7	Yes
Fluoride	mg/L	CUSUM	1.785	< 0.500	0.727	Yes	< 0.500	0.727	Yes
pH, Field	pH units	NP-PL	7.23, 9.71	7.36	---	Yes	8.02	---	Yes
Sulfate	mg/L	CUSUM	76.9	52.2	79.1	No - Potential Exceedance	21.8	48.7	Yes - Prior Result was a False Positive
Total Dissolved Solids	mg/L	CUSUM	653	392	385.8	Yes	216	385.8	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 16: Comparative Statistics - APMW-15 (Upgradient)

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Detection Monitoring Analytes	Units			6/16/2020			11/30/2020		
Boron, Total	mg/L	NP-PL	0.200	0.146	---	Yes	< 0.100	---	Yes
Calcium, Total	mg/L	CUSUM	145.0	102.0	105.8	Yes	82.3	105.8	Yes
Chloride	mg/L	CUSUM	40.4	29.7	34.0	Yes	27.3	34.0	Yes
Fluoride	mg/L	NP-PL	0.716	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	6.24, 8.15	7.20	7.20, 7.20	Yes	7.60	7.20, 7.36	Yes
Sulfate	mg/L	Trend	NA	155	---	---	115	---	---
Total Dissolved Solids	mg/L	CUSUM	853	600	585	Yes	518	585	Yes

Notes:

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.

NA: No limit set due to increasing trend. Alternative statistical method used.

Table 17: Comparative Statistics - APMW-16A (Upgradient)

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Detection Monitoring Analytes	Units			6/16/2020			11/30/2020		
Boron, Total	mg/L	NP-PL	0.200	0.186	---	Yes	0.131	---	Yes
Calcium, Total ¹	mg/L	CUSUM	196	110	134	Yes	106	133	Yes
Chloride ¹	mg/L	CUSUM	148.8	27.7	57.0	Yes	50.0	56.0	Yes
Fluoride	mg/L	NP-PL	1.490	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	6.08, 8.00	6.67	6.91, 7.04	Yes	7.45	7.04, 7.21	Yes
Sulfate ¹	mg/L	CUSUM	271	160	194	Yes	190	193	Yes
Total Dissolved Solids ¹	mg/L	CUSUM	1113	624	717	Yes	638	714	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

1. Seasonality was detected in the baseline period. Statistical limits may vary slightly between monitoring events due to deseasonalization of the data or if seasonality is not identified in the full data set (i.e. the baseline period and any comparative points).

Table 18: Comparative Statistics - APMW-17 (Upgradient)

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Detection Monitoring Analytes	Units			6/16/2020			11/30/2020		
Boron, Total	mg/L	NP-PL	0.200	0.102	---	Yes	< 0.100	---	Yes
Calcium, Total	mg/L	CUSUM	183.8	105	140	Yes	96.6	140	Yes
Chloride	mg/L	CUSUM	59.0	21.1	42.5	Yes	31.0	42.5	Yes
Fluoride	mg/L	NP-PL	1.070	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	5.99, 7.88	6.99	7.12, 7.12	Yes	7.50	7.12, 7.30	Yes
Sulfate	mg/L	CUSUM	225	112	142	Yes	120	142	Yes
Total Dissolved Solids	mg/L	CUSUM	927	504	589	Yes	516	589	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 19: Comparative Statistics - APMW-4

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Detection Monitoring Analytes	Units			6/16/2020			11/30/2020		
Boron, Total	mg/L	NP-PL	0.200	< 0.100	---	Yes	< 0.100	---	Yes
Calcium, Total	mg/L	CUSUM	64.3	55.8	55.1	Yes	44.7	55.1	Yes
Chloride ¹	mg/L	CUSUM	51.36	36.3	---	---	44.8	41.9	Yes
Fluoride	mg/L	NP-PL	0.569	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	6.21, 9.02	7.40	7.62, 7.62	Yes	8.00	7.62, 7.69	Yes
Sulfate	mg/L	CUSUM	40.5	25.3	28.0	Yes	27.3	28.0	Yes
Total Dissolved Solids	mg/L	CUSUM	428	230	306	Yes	316	306	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

1. Statistical limit was established on data without a statistically significant trend collected through Q2 2020. Prior to Q2 2020, the data displayed a statistically significant increasing trend.

Table 20: Comparative Statistics - APMW-6

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Detection Monitoring Analytes	Units			6/16/2020			11/30/2020		
Boron, Total	mg/L	NP-PL	0.200	< 0.100	---	Yes	< 0.100	---	Yes
Calcium, Total	mg/L	CUSUM	65.7	53.1	52.4	Yes	45.8	52.4	Yes
Chloride	mg/L	CUSUM	20.4	16.1	13.6	Yes	17.9	18.7	Yes
Fluoride	mg/L	NP-PL	0.713	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	6.24, 8.62	7.33	7.43, 7.43	Yes	7.82	7.43, 7.52	Yes
Sulfate	mg/L	CUSUM	38.4	26.3	28.1	Yes	27.3	28.1	Yes
Total Dissolved Solids	mg/L	CUSUM	414	250	291	Yes	276	291	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 21: Comparative Statistics - APMW-8A

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Detection Monitoring Analytes	Units			6/16/2020			12/1/2020		
Boron, Total	mg/L	NP-PL	0.200	< 0.100	---	Yes	< 0.100	---	Yes
Calcium, Total	mg/L	CUSUM	175.6	94.3	105.7	Yes	88.2	105.7	Yes
Chloride	mg/L	CUSUM	104.9	84.6	81.7	Yes	104.0	99.1	Yes
Fluoride	mg/L	NP-PL	13.700	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	5.86, 8.61	7.13	7.23, 7.23	Yes	7.56	7.23, 7.23	Yes
Sulfate	mg/L	CUSUM	244.9	69.6	90.5	Yes	81.8	90.5	Yes
Total Dissolved Solids	mg/L	CUSUM	850	452	536	Yes	546	536	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 22: Comparative Statistics - APMW-10

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Detection Monitoring Analytes	Units			6/16/2020			12/1/2020		
Boron, Total	mg/L	NP-PL	0.200	< 0.100	---	Yes	< 0.100	---	Yes
Calcium, Total	mg/L	CUSUM	78.3	68.4	64.5	Yes	55.9	62.5	Yes
Chloride	mg/L	CUSUM	63.8	26.9	38.1	Yes	26.0	38.1	Yes
Fluoride	mg/L	NP-PL	3.780	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	5.95, 8.89	7.34	7.42, 7.42	Yes	7.76	7.42, 7.42	Yes
Sulfate	mg/L	CUSUM	72.4	52.2	46.1	Yes	48.3	46.1	Yes
Total Dissolved Solids	mg/L	CUSUM	489	354	358	Yes	332	358	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 23: Comparative Statistics - APMW-11

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Detection Monitoring Analytes	Units			6/16/2020			12/1/2020		
Boron, Total	mg/L	NP-PL	0.200	< 0.100	---	Yes	< 0.100	---	Yes
Calcium, Total	mg/L	CUSUM	101.7	94.7	89.7	Yes	83.8	86.8	Yes
Chloride	mg/L	CUSUM	137.0	89.6	74.2	Yes	123.0	107.3	Yes
Fluoride	mg/L	NP-PL	6.960	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	6.89, 7.83	7.21	7.33, 7.36	Yes	7.55	7.36, 7.43	Yes
Sulfate	mg/L	CUSUM	75.0	44.5	34.3	Yes	38.2	34.3	Yes
Total Dissolved Solids	mg/L	CUSUM	622	436	438	Yes	520	474	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 24: Comparative Statistics - APMW-12

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Detection Monitoring Analytes	Units			6/17/2020			12/1/2020		
Boron, Total	mg/L	CUSUM	0.390	0.281	0.283	Yes	0.190	0.283	Yes
Calcium, Total	mg/L	CUSUM	203	156	166	Yes	131	166	Yes
Chloride	mg/L	CUSUM	272	147	163	Yes	161	163	Yes
Fluoride	mg/L	NP-PL	21.300	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	6.28, 7.66	6.89	6.97, 6.97	Yes	7.24	6.97, 7.09	Yes
Sulfate	mg/L	CUSUM	383	294	302	Yes	290	302	Yes
Total Dissolved Solids	mg/L	CUSUM	1602	916	1108	Yes	1080	1108	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 25: Comparative Statistics - APMW-13

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Detection Monitoring Analytes	Units			6/17/2020			12/1/2020		
Boron, Total	mg/L	CUSUM	0.449	0.300	0.314	Yes	0.206	0.314	Yes
Calcium, Total	mg/L	CUSUM	196	145	148	Yes	126	148	Yes
Chloride	mg/L	CUSUM	190	118	141	Yes	123	141	Yes
Fluoride	mg/L	NP-PL	8.250	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	6.05, 8.11	6.98	7.08, 7.08	Yes	7.29	7.08, 7.08	Yes
Sulfate	mg/L	CUSUM	362	266	264	Yes	274	264	Yes
Total Dissolved Solids	mg/L	CUSUM	1215	884	1026	Yes	956	1026	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 26: Comparative Statistics - APMW-14

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Detection Monitoring Analytes	Units			6/17/2020			12/1/2020		
Boron, Total	mg/L	CUSUM	0.382	0.280	0.261	Yes	0.199	0.261	Yes
Calcium, Total	mg/L	CUSUM	195	149	158	Yes	128	158	Yes
Chloride	mg/L	CUSUM	207	124	135	Yes	135	135	Yes
Fluoride	mg/L	NP-PL	19.200	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	6.03, 8.44	7.04	7.17, 7.17	Yes	7.33	7.17, 7.17	Yes
Sulfate	mg/L	CUSUM	272	206	217	Yes	201	217	Yes
Total Dissolved Solids	mg/L	CUSUM	1240	824	949	Yes	878	949	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 27: Comparative Statistics - APMW-18

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Detection Monitoring Analytes	Units			6/16/2020			11/30/2020		
Boron, Total	mg/L	NP-PL	0.200	< 0.100	---	Yes	< 0.100	---	Yes
Calcium, Total	mg/L	CUSUM	103.7	87.0	82.1	Yes	68.5	81.7	Yes
Chloride	mg/L	CUSUM	160.4	91.3	65.2	Yes	94.3	77.5	Yes
Fluoride	mg/L	NP-PL	1.740	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	5.99, 8.01	7.34	7.33, 7.33	Yes	7.63	7.33, 7.44	Yes
Sulfate	mg/L	CUSUM	147.7	33.2	38.3	Yes	28.8	38.3	Yes
Total Dissolved Solids	mg/L	CUSUM	638	400	401	Yes	426	401	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

January 2021

Table 28: Comparative Statistics - APMW-19

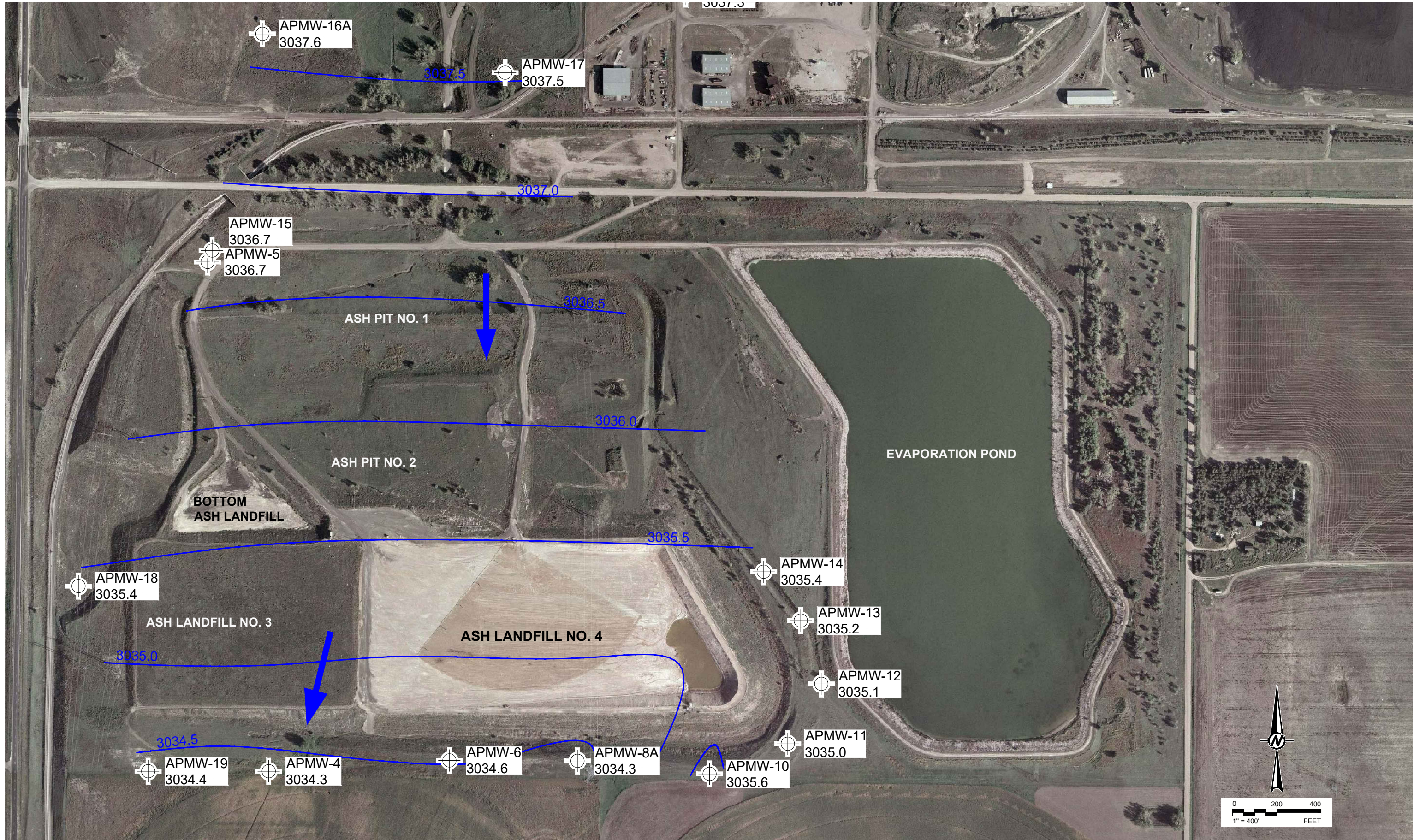
		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Detection Monitoring Analytes	Units			6/16/2020			11/30/2020		
Boron, Total	mg/L	NP-PL	0.200	0.107	---	Yes	< 0.100	---	Yes
Calcium, Total	mg/L	CUSUM	142.9	111.0	96.6	Yes	94.8	91.7	Yes
Chloride	mg/L	CUSUM	71.7	50.6	42.7	Yes	53.1	47.8	Yes
Fluoride	mg/L	NP-PL	0.665	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	6.25, 8.29	7.10	7.27, 7.27	Yes	7.58	7.27, 7.33	Yes
Sulfate	mg/L	CUSUM	191	166	139	Yes	134	162	Yes
Total Dissolved Solids	mg/L	CUSUM	645	586	542	Yes	590	620	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

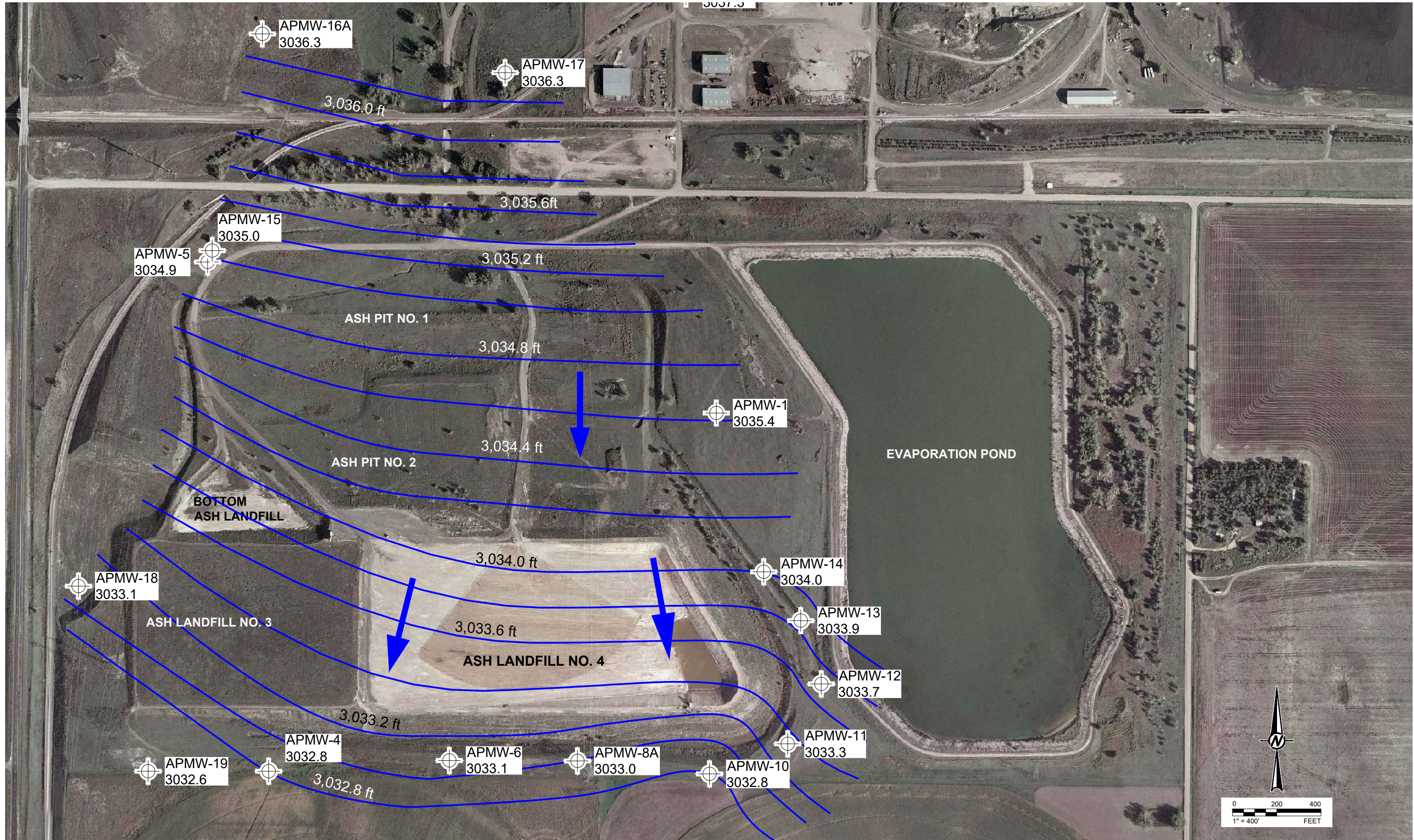
CUSUM: Parametric Shewhart-CUSUM Control Chart

Figures



NOTE
GROUNDWATER CONTOURS DEVELOPED FROM LEVELS MEASURED IN ACTIVE
MONITORING WELLS SHOWN.

NEBRASKA PUBLIC POWER DISTRICT
GERALD GENTLEMAN STATION
GROUNDWATER MONITORING WELL NETWORK
JUNE 2020 GROUNDWATER CONTOURS
FIGURE 1



NOTE
GROUNDWATER CONTOURS DEVELOPED FROM LEVELS MEASURED IN ACTIVE MONITORING WELLS SHOWN.

NEBRASKA PUBLIC POWER DISTRICT
GERALD GENTLEMAN STATION
GROUNDWATER MONITORING WELL NETWORK
NOVEMBER/DECEMBER 2020 GROUNDWATER CONTOURS
FIGURE 2

APPENDIX A

**Alternate Source Demonstration -
Q4 2019**



REPORT

Alternate Source Demonstration

Nebraska Public Power District

Submitted to:

Nebraska Public Power District

Gerald Gentleman Station, 6089 South Highway 25, Sutherland, Nebraska 69165

Submitted by:

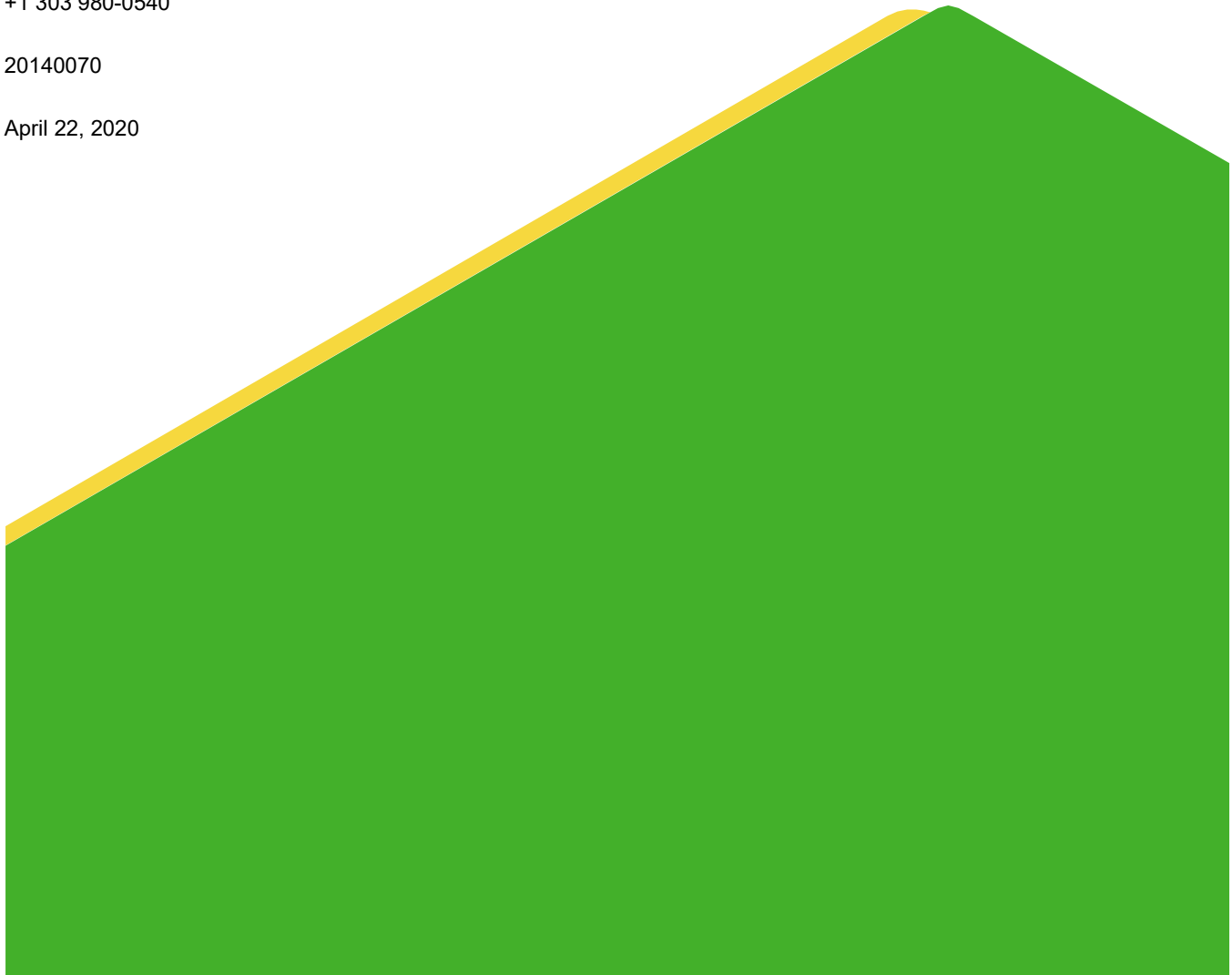
Golder Associates Inc.

7245 W Alaska Drive, Suite 200, Lakewood, Colorado, USA 80226

+1 303 980-0540

20140070

April 22, 2020



Distribution List

Nebraska Public Power District

Golder Associates, Inc.

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FIGURES

Figure 1: Site Map with Groundwater Contours- November 2019

Figure 2: Groundwater Monitoring Well Water Levels

Figure 3: Piper Diagram of Groundwater and Potential Calcium and Sulfate Sources

Figure 4: Box and Whisker Plot of Calcium Concentrations

Figure 5: Box and Whisker Plot of Sulfate Concentrations

Figure 6: Ternary Diagram of Groundwater and Potential Calcium and Sulfate Sources

Figure 7: Conceptual Site Model

APPENDICES

APPENDIX A

Historical Concentrations of Appendix III and Selected Appendix IV Analytes

1.0 INTRODUCTION

On behalf of Nebraska Public Power District (NPPD), Golder Associates Inc. (Golder) performed a statistical evaluation of groundwater quality from the fourth quarter groundwater detection monitoring event of 2019 (Q4 2019) at the Gerald Gentleman Station (GGS or Site) ash landfill (or CCR Unit), located at 6089 South Highway 25, Sutherland, Lincoln County, Nebraska (Figure 1). The statistical evaluation was performed 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 (CCR) from Electric Utilities; Final Rule” (CCR Final Rule), as amended, and corresponding regulations under Nebraska Administrative Code (NAC) Title 132, Chapter 7 (Integrated Solid Waste Management Regulations, Groundwater Monitoring and Remedial Action).

Statistical analyses of the Appendix III detection monitoring data for calcium and sulfate in groundwater at the downgradient monitoring well APMW-19 indicated a potential exceedance of the statistical limit based on the parametric Cumulative Sum analysis (CUSUM) in the Q2 2019 sampling results, which was subsequently verified as evidence of statistically-significant increases (SSIs) after the Q4 2019 event. Although determination of an SSI generally indicates that the groundwater monitoring program should transition from detection monitoring to assessment monitoring, 40 CFR §257.94(e)(2) allows the owner or operator (i.e., NPPD) 90 days from the date of determination (January 25, 2020) to demonstrate a source other than the CCR unit, or another condition, caused the potential SSIs for calcium and sulfate at APMW-19.

Golder’s review of the hydrological and geologic conditions at the Site indicated the potential for the SSIs to have resulted from a source other than the CCR unit. To assess potential calcium and sulfate sources and the natural variability of calcium and sulfate concentrations in groundwater, Golder reviewed analytical results of previously collected CCR-impacted water samples from the ash landfills, surface water from the Sutherland Reservoir, and groundwater samples. Based upon this assessment and in accordance with provisions of the CCR Final Rule, Golder prepared this Alternative Source Demonstration (ASD) for the CCR unit. This ASD includes an evaluation of geological, hydrogeological, and chemical information regarding ash, surface water, and groundwater obtained from surface waters and monitoring wells installed within and adjacent to the CCR Unit.

This ASD conforms to the requirements of 40 CFR §257.94(e)(2) and provides the basis for concluding that the apparent SSIs for calcium and sulfate in groundwater at APMW-19 are not a result of a release from the CCR Unit. The following sections provide a summary of the GGS CCR Unit, analytical and geochemical assessment results, a Conceptual Site Model, and lines of evidence demonstrating an alternative source is responsible for the calcium and sulfate SSIs in groundwater at APMW-19.

2.0 BACKGROUND

2.1 Description of Waste Disposal Area

The ash landfill at GGS is located southwest of the plant’s generation facility, in the northern one-half of Section 30, Township 13N, Range 33W. The ash disposal facility consists of Ash Landfill Nos. 1, 2, 3, and 4 and the bottom ash landfill. Ash Landfill Nos. 1 and 2 are closed, and Ash Landfill Nos. 3 and 4 are active (Figure 1). The bottom ash landfill was closed in October 2018.

Fly ash is currently disposed at Ash Landfill No. 4 and in the east cell of Ash Landfill No. 3. The liner design at Ash Landfill No. 4 consists of a 60-mil high density polyethylene (HDPE) geomembrane over compacted subgrade. Prior to geomembrane installation, the existing subgrade was scored to a depth of at least 6 inches and compacted to 95 percent of its maximum dry density (standard Proctor). Smooth HDPE geomembrane was placed on the bottom

of the ash landfill and textured HDPE geomembrane was placed on the side slopes. Construction quality assurance (CQA) for the geomembrane installation was performed by Golder Construction Services and completed on November 15, 1994. There is no leachate collection system (LCS) at Ash Landfill No. 4.

The original liner at Ash Landfill No. 3 consisted of 2 feet of soil compacted to 95 percent of the standard Proctor maximum dry density. The average permeability of the liner was 1.2×10^{-8} cm/sec. Ash Landfill No. 3 was previously closed in 1995 with 2.0 to 7.5 feet of soil cover. This cover was removed and the historically placed CCR was covered with a new liner in 2015. The new liner system at Ash Landfill No. 3 consists of a prepared subgrade overlain by a geosynthetic clay liner (GCL) and 60-mil linear low-density polyethylene (LLDPE) geomembrane. Ash Landfill No. 3 also has a 1-foot LCS sand layer that reports to two sumps. Construction of the new Ash Landfill No. 3 liner system was completed in November 2015.

To the east of the ash landfills, plant process water, such as boiler blowdown, is managed in a 50-acre evaporation pond, as shown in Figure 1. The bottom of the approximately 8 to 10 foot (ft) deep evaporation pond consists of re-compacted native soils.

2.2 Site Geology

The geologic sequence near the ash landfill was summarized by Woodward-Clyde in 1991. In the report, soil boring data from nine boreholes (APMW-1, APMW-2, APMW-3, APMW-4, APMW-5, EPMW-1, EPMW-2, EPMW-3, and EPMW-4) were used to characterize the Site geology. The geologic sequence, from top to bottom, was described as follows:

- 4 to 5 feet of topsoil and/or fill
- 20 to 35 feet of eolian silty sands
- 8 to 10 feet of silty clay paleosol at the top of the Ogallala Formation
- 25 to 35 feet of Ogallala Formation silts
- Approximately 50 feet of Ogallala Formation sands or Ogallala Formation silts and clays, to the bottoms of the boreholes

The topsoil layer consists of stiff, dark brown, low to medium plasticity silty clay directly overlying the eolian silts and sands. Thickness of topsoil ranges from 0 to 4 feet. The fill material consists of stiff, dark brown, low plasticity sandy silty clay with trace gravel and other debris. Fill thickness ranges from 0 to 5 feet.

The eolian silts and sands (Quaternary Period) consist of loose to medium dense, tan, very fine-grained, well-rounded, and well-sorted sandy silts and silty sands. The thickness of this unit ranges from 17 feet (APMW-5) to 34 feet (EPMW-2). Materials with a bimodal texture (two distinct grain sizes) are present in the lower part of this unit. The eolian silts and sands are interpreted as wind-blown dune sand deposits.

The Ogallala Formation (Tertiary Period) was encountered in each of the nine boreholes at a depth beginning at 16 to 38 feet bgs and extending to the bottom of the boreholes (109 to 133 feet bgs). The Ogallala Formation near the ash landfill may be separated into three general stratigraphic units:

- Upper silty clay paleosol unit
- Middle clayey or sandy silt unit
- Lower unit of either predominantly sand and gravel or an equivalent unit of predominantly silt and clay

The top of the Ogallala Formation is represented by a widespread paleosol (a previous soil horizon) that consists of a very stiff, reddish-brown to buff, low plasticity, silty clay to clayey silt with abundant calcareous nodules, calcareous matrix, and interbedded layers of caliche up to one foot thick. The thickness of the initial paleosol is about 8 to 10 feet, but the presence of interbedded caliche layers continues into the middle and lower Ogallala units.

The middle Ogallala Formation unit consists of a stiff to very stiff, buff-white to reddish-brown, low plasticity, clayey silt to sandy silt with abundant calcareous nodules, matrix, and caliche layers. Scattered occurrences of calcareously cemented siltstone layers from ½ to 1 foot thick are present in the lower part of this unit. The thickness of this middle unit ranges from about 25 to 35 feet. The clayey silts and sandy silts of this unit were possibly deposited as overbank or floodplain deposits in an alluvial depositional system.

There are two distinct lithofacies recognized in the lower Ogallala Formation unit. This unit is present for about 45 to 50 feet in the borings. One lithofacies consists of dense to very dense, reddish-brown, fine-grained silty sands grading into medium- and coarse-grained, poorly-graded sands with some fine gravels and some calcareously cemented sandstone beds (½ to 1 foot thick). This lithofacies was primarily encountered in borings on the northern side of the ash landfill (APMW-1, APMW-2, APMW-5, and EPMW-1).

The second lithofacies recognized in the lower unit consists of stiff to hard, reddish-brown, low plasticity clayey or sandy silts with some calcareously-cemented siltstone beds. This lithofacies was encountered in borings on the southern side of the ash landfill (APMW-3, APMW-4, EPMW-2, EPMW-3, and EPMW-4).

The lithologic differences and areal distribution of the two lower units suggest that the units were deposited in two separate facies of an alluvial system. The sand and gravel unit is possibly a series of longitudinal bars, channels, and channel-fill deposits, while the silt and clay unit is possibly a series of upper channel fills, overbank, or floodplain deposits (Woodward-Clyde 1991).

2.3 Site Hydrogeology

Based on observations made during logging of soil borings and findings of the Nebraska Water Survey Paper No. 70 (Goeke et al. 1992), the unsaturated geologic units underlying the ash landfill area consist of topsoil (0 to 4 feet thick), eolian silts and sands (15 to 25 feet thick), Ogallala Formation silts (40 to 50 feet thick), and Ogallala Formation sands and gravels (unsaturated portion of this unit is approximately 20 to 25 feet thick). Beneath these units lies 10 feet or more of saturated Ogallala Formation sands and gravels. Based on the Site observations, the thickness of the vadose zone ranges from approximately 90 to 100 ft.

The saturated geologic units underlying the ash landfill area consist of Ogallala Formation silts and sands that extend to the bottom of the aquifer. The Ogallala Formation is underlain by the White River Group, which is composed of the Brule and Chadron formations. The bedrock formations of the White River Group are not considered to be an important potential source of water, and therefore their surface is considered to form the base of the aquifer and is regarded as the lower drilling limit for irrigation wells in the agricultural region near the Site. Underlying the White River Group is the impermeable Pierre Shale (Goeke et al. 1992).

Available groundwater elevation data indicate that groundwater beneath GGS flows from north to south (Figure 1). The groundwater gradient is controlled by the Sutherland Reservoir, an approximately 3,200-acre open water body located 1.5 miles north of the ash landfill that is used as a source of condenser cooling water for GGS. Since groundwater level monitoring began in 1996, regular water level fluctuations have been observed in the monitoring wells located around the ash landfill. These fluctuations are attributed to seasonal trends in water consumption or recharge and precipitation patterns. In Figure 2, which shows a time-series plot of historical water

levels in each monitoring well, it is also apparent that long-term changes in water levels have occurred between 1996 and 2019. In general, water levels rose by approximately 1.5 feet between 1996 and 2000, before declining by between 9 to 10 feet between 2000 and 2009. The cause of the decline is not clear, but possible explanations include a regional response to the drought being experienced by parts of the western United States and/or a change in the amount of groundwater used for irrigation in the area around the Site. Between 2009 and 2019 water levels have continued to show seasonal variability, with seasonal maximums occurring in the spring and seasonal minimums occurring in the fall, but there is no apparent long-term increasing or decreasing trend.

2.4 Groundwater Monitoring Network

Design of the CCR Final Rule-compliant ash landfill monitoring program considered the size, disposal and operational history, anticipated groundwater flow direction, and saturated thickness of the uppermost aquifer. Based on these factors, a monitoring well network that consists of four background monitoring wells and ten downgradient monitoring wells was installed around the ash landfill. The monitoring wells are listed in Table 1 and presented in Figure 1.

Table 1: Monitoring Well Network

Location	Background Monitoring Wells	Downgradient Monitoring Wells
Ash Landfill	APMW-5, APMW-15, APMW-16A, APMW-17	APMW-4, APMW-6, APMW-8A, APMW-10, APMW-11, APMW-12, APMW-13, APMW-14, APMW-18, APMW-19

The four upgradient monitoring wells included in the groundwater monitoring program are used to represent the background groundwater quality, including its potential variability. The ten downgradient wells were installed along the western, southern, and eastern boundaries of the active ash landfill. The depths of the monitoring wells were selected such that the monitoring wells are screened in the Ogallala Formation to yield groundwater samples that are representative of water quality in the uppermost water-bearing zone.

2.5 Groundwater Conditions

Between December 2015 and June 2017, NPPD collected eight quarterly independent baseline groundwater samples from each of the background and downgradient monitoring wells listed in Table 1, as required by 40 CFR §257.94. The results of the baseline monitoring phase were used to develop appropriate and statistically valid baseline values for each constituent at each monitoring well (Golder 2017).

Following completion of the eight baseline monitoring events, NPPD started collecting groundwater samples on a semiannual basis in November 2017 to support the detection monitoring program. Groundwater samples for detection monitoring were collected at all four background and ten downgradient monitoring wells and analyzed for 40 CFR Part 257 Appendix III constituents. During the detection monitoring program, the results of groundwater analysis are compared to the calculated prediction limits to determine whether groundwater quality remains consistent, or if changes are considered statistically significant increases (SSI).

2.5.1 Calcium Concentrations

During the baseline monitoring period, calcium concentrations were variable in the upgradient and downgradient groundwater, as shown in Appendix A, Figure A2. Calcium concentrations in upgradient groundwater (based on 30 samples from four wells) ranged from 54.6 to 168 mg/L between December 2015 and June 2017.

Downgradient groundwater quality was also variable (based on 78 samples from 10 wells), with calcium concentrations ranging from 49.6 to 179 mg/L.

Calcium concentrations in groundwater at APMW-19 remained relatively steady compared to other downgradient wells during the baseline monitoring period, with values ranging between 54.9 and 90.9 mg/L in the eight samples collected. A concentration of 104.4 mg/L was calculated as the statistical limit for calcium at this monitoring well.

The Q2 2019 detection monitoring event reported a calcium concentration of 113 mg/L in groundwater at APMW-19 and the parametric CUSUM value (115.8 mg/L) exceeded the calculated statistical limit of 104.4 mg/L. Verification sampling was completed in November 2019 (i.e., Q4 2019) and although the sample result was below the statistical limit at 102 mg/L, a confirmed SSI for calcium at APMW-19 was identified based on the CUSUM value of 122.7 mg/L.

2.5.2 Sulfate Concentrations

Sulfate concentrations in the upgradient and downgradient groundwater are shown in Appendix A, Figure A7. Sulfate concentrations in upgradient groundwater (based on 30 samples from four wells) ranged from 32.4 to 237 mg/L between December 2015 and June 2017. Sulfate concentrations varied between 20.2 to 328 mg/L in downgradient groundwater wells (based on 78 samples from 10 wells).

Sulfate concentrations in groundwater at APMW-19 remained relatively steady compared to other downgradient wells during the baseline monitoring period, with values ranging between 38.1 and 86.6 mg/L in the eight samples collected. A concentration of 135.4 mg/L was calculated as the statistical limit for sulfate at this monitoring well.

The Q2 2019 detection monitoring event reported a sulfate concentration of 135.0 mg/L in groundwater at APMW-19 and the parametric CUSUM value exceeded the calculated statistical limit of 135.6 mg/L. Verification sampling was completed in Q4 2019 and although the results were below the statistical limit at 130.0 mg/L, a confirmed SSI for sulfate at APMW-19 was identified based on the CUSUM value of 199.2 mg/L.

2.6 Review of 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. Golder found that the analytical methodologies used were consistent with the stated objectives of the sampling program. No anomalies were found within the sampling and laboratory testing procedures and the collected results are considered valid.

Additionally, 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 Monitoring Statistical Methods Certification (Golder 2017). Calculated limits were found to be consistent with the chosen statistical procedures and recommended methodology found within the Unified Guidance (EPA 2009).

3.0 DATA SOURCES USED IN ALTERNATE SOURCE REVIEW

To assess groundwater downgradient of the GGS CCR facilities, Golder reviewed previously collected data and performed supplemental assessment activities. The following sections summarize the supplemental assessment activities.

3.1 Groundwater

3.1.1 Baseline Monitoring Data

As part of the baseline monitoring, NPPD GGS field personnel collected groundwater samples from the 14 GGS monitoring wells listed in Table 1. Between December 2015 and June 2017, quarterly samples were collected to establish background concentrations for Appendix III and Appendix IV constituents. After June 2017, groundwater samples were collected twice a year (Q2 and Q4) and analyzed for Appendix III constituents as part of the ongoing detection monitoring program at NPPD GGS.

For baseline monitoring groundwater samples collected in Q4 2019, an expanded analyte list was collected, including field parameters, major cations, major anions, and select dissolved metals (Section 3.5).

3.1.2 Supplemental Groundwater Samples

In February (Q1) 2019, an additional set of groundwater samples were collected from eight of the 14 wells listed in Table 1 (APMW-5, APMW-17, APMW-4, APMW-8A, APMW-18, APMW-19, APMW-12, and APMW-14) to support advanced geochemical modeling. These samples were analyzed for field parameters, major cations, major anions, and select dissolved metals.

3.2 Evaporation Pond

While collecting the supplemental groundwater samples in Q1 2019, a surface water sample was also collected from the Evaporation Pond. The sample was analyzed for the same suite of parameters as the groundwater: field parameters, major cations, major anions, and select dissolved metals.

3.3 Ash Impacted Water

To characterize the potential for the material in the ash landfill to release calcium and sulfate, NPPD GGS field personnel retrieved sump water from Ash Landfill No. 3 and pond water in direct contact with CCR materials in Ash Landfill No.4 on October 28th, 2019. The sample was analyzed for the same suite of parameters as the groundwater: field parameters, major cations, major anions, and select dissolved metals.

3.4 Surface Water

Surface water samples were collected from the Sutherland Reservoir and Sutherland Canal on October 28th, 2019, to access the source of regional groundwater at the Site. These samples were analyzed for the same suite of parameters as the groundwater: field parameters, major cations, major anions, and select dissolved metals.

3.5 Geochemical Methods

The geochemical analysis of groundwater and surface water samples included fluid parameters, major cations and anions, and dissolved metals. The methods selected for these analyses are summarized below.

Field Parameters: Parameters measured in the field using a handheld meter included pH, conductivity, and temperature. The pH of each sample was also measured in the laboratory.

Major Cations and Anions: Geochemical modeling of mineral solubility, metal attenuation and background contributions required analysis of major cations and anions because they affect and participate in sorption and mineral dissolution/precipitation reactions. Major anions included chloride, sulfate, and bicarbonate and major cations included calcium, magnesium, potassium, and sodium.

Metals: Metals analyses (i.e., Appendix III and IV) are important to understand the geochemical properties of groundwater. For groundwater, metals analysis allows for the delineation of a potential plume, and identification of background contributions from natural sources or off-site locations.

The laboratory analyzed the ash landfill water, groundwater, and surface water samples using the following methods:

- Alkalinity following Standard Method (SM) 2320B Alkalinity by Titration (2005)
- Chloride, fluoride, and sulfate following USEPA SW846 9056A Determination of Inorganic Anions by Ion Chromatography Revision 1 (February 2007)
- pH following SM 4500 H+ B (2017)
- Arsenic, boron, barium, calcium, magnesium, molybdenum, potassium, selenium, and sodium following USEPA SW-846 6020A (November 2004)
- Ammonia following USEPA 350.1 Determination of Ammonia Nitrogen by Automated Colorimetry, Revision 2 (August 1993)
- Total Kjeldahl nitrogen following USEPA 351.2 Determination of Total Kjeldahl Nitrogen by Semi-Automated Colorimetry, Revision 2 (August 1993)
- Total nitrate-nitrite nitrogen following USEPA 353.2 Determination of Nitrate-Nitrite Nitrogen by Automated Colorimetry, Revision 2 (August 1993)
- Fluoride following SM 4500-F-C (2017)
- Dissolved silica following SM4500-SiO₂-C Silica, Molybdosilicate Method (2017)

4.0 DATA EVALUATION

Historical concentrations of Appendix III analytes and selected Appendix IV analytes in groundwater at GGS, including analytes that are typically indicators of potential CCR seepage (e.g., arsenic, barium, molybdenum, and selenium), are presented in time series plots in Appendix A. The plots include the results of the supplemental samples that were collected in Q1 2019 to support the Q4 2018 ASD for fluoride at APMW-19 (Golder 2019). Sampling for the Appendix IV analytes concluded with the end of baseline monitoring in Q2 2017, which means there is a gap of six quarters in the data plots until the supplemental sampling results are shown in Q1 2019.

Figure 3 presents a Piper diagram with relative major ion chemistry for the monitoring well groundwater samples (Q1 2019 supplemental samples and Q4 2019 assessment monitoring samples), regional groundwater sources (Sutherland Reservoir, Sutherland Canal, and North and South Platte River), and coal ash impacted waters (Ash Landfill No. 3 sump water, Ash Landfill No. 4 surface pond water, fly ash SPLP leachate, and Evaporation Pond water). The groundwater at the upgradient monitoring wells was dominated by calcium and bicarbonate. Samples from the downgradient monitoring wells were also majority calcium and bicarbonate ions. The downgradient well APMW-12 was the only well where the major ion composition was dominated by calcium and sulfate. The Sutherland Reservoir and Canal water, along with the average North and South Platte River waters are generally dominated by calcium, sodium, bicarbonate and sulfate. The Ash Landfill No. 3 sump water sample was primarily sodium and bicarbonate, while the Ash Landfill No. 4 pond water was dominated by sodium and sulfate. The evaporation pond water also contained majority sodium and sulfate ions.

4.1 Potential Calcium and Sulfate Sources

Several potential sources, other than the active CCR units, can contribute calcium and sulfate to local groundwater at GGS, including outflows from the Sutherland Reservoir into regional groundwater, seepage from the Evaporation Pond, and seepage from historical deposits of fly ash that remain at GGS. These three potential sources of calcium to groundwater are described in this section.

4.1.1 Regional Groundwater from Sutherland Reservoir

As described in Section 2.3, the groundwater gradient in the area around the ash landfill shows groundwater flows from north to south, rather than from south to north in the direction of the Platte River. The groundwater flow direction appears to be based on both the groundwater recharge provided by the Sutherland Reservoir to the north of GGS and groundwater extraction by irrigation wells located south of GGS that are pumped seasonally and used to support local agriculture. The Sutherland Reservoir is fed by the Sutherland Canal, which delivers water from both the North and South Platte River for use as condenser cooling water at GGS.

4.1.1.1 Calcium

The USGS monitored South Platte River chemistry at Rosco, NE between 1975 and 2013 (USGS 2016a). The monitoring location at Rosco, NE is less than one mile downstream of where South Platte River water is diverted into the Sutherland Canal. Calcium concentrations in the South Platte River (n=59) ranged from 63 to 230 mg/L. The USGS also characterized North Platte River waters at Keystone, NE, immediately downstream of Lake Ogallala, where North Platte River water is diverted into the Sutherland Canal (USGS 2016b). The USGS measured calcium concentrations 26 times at Keystone, NE between 1972 and 2011, with values ranging from 50 to 67 mg/L.

Calcium concentrations of 47.5 and 48.9 mg/L were measured in Sutherland Reservoir and Sutherland Canal surface water samples collected by NPPD in October 2019, respectively (Section 3.2). Seven water samples were also collected from the center of the Sutherland Reservoir by the USGS between August 2005 and December 2006, with calcium concentrations ranging from 41.2 to 49.6 mg/L (USGS 2016c and USGS 2016d). These calcium concentrations were similar to the concentrations observed in the North Platte River and lower than concentrations in the South Platte River.

Given the difference in the calcium concentrations in North and South Platte River waters, potentially variable flow rates of the two sources into the Sutherland Reservoir could have caused historical variability in calcium concentrations within the Sutherland Reservoir and the groundwater underneath the Site. Higher proportions of South Platte River water within the Sutherland Reservoir could lead to a groundwater quality with a calcium concentration sufficiently high enough to cause the elevated calcium concentrations measured at the upgradient monitoring wells at the Site and the calcium concentrations measured at downgradient monitoring wells APMW-8A and APMW-19. While the elevated calcium concentrations at APMW-19 were only observed during detection monitoring (113 mg/L in Q2 2019 and 102 mg/L in Q4 2019, which triggered the SSI), elevated concentrations at APMW-8A (71.6 mg/L to 133 mg/L) were observed during the baseline and detection monitoring periods.

Evidence of shifts in Sutherland Reservoir chemistry are apparent in groundwater immediately surrounding the Sutherland Reservoir. Between September 2005 and May 2007, the USGS collected 14 shallow groundwater samples from 12 wells less than 1 mile from the perimeter Sutherland Reservoir (USGS 2016e). The calcium concentrations in the shallow groundwater ranged from 59.6 to 129 mg/L, which were similar to the concentrations in groundwater at the four GGS upgradient monitoring wells (APMW-5, APMW-15, APMW-16A, and APMW-17). On the Piper diagram (Figure 3), the shallow groundwater samples appear to be a mixture of water from the North Platte River, South Platte River, and groundwater similar to the downgradient monitoring wells (i.e. APMW-4, APMW-8A,

APMW-10, APMW-11, APMW-12, APMW-13, APMW-14, APMW-18, APMW-19), which suggest that multiple shifts in the source to the Sutherland Reservoir may have occurred over time.

Figure 4 displays a box and whisker plot of the calcium concentrations in groundwater at wells in the monitoring well network and possible calcium sources at or near the Site. The distribution of data shows a large variability in calcium concentrations in groundwater at the background monitoring wells (APMW-5, APMW-15, APMW-16A, and APMW-17). This variability may reflect calcium concentration fluctuations that have occurred over time in the Sutherland Reservoir. The Piper diagram (Figure 3) also shows that groundwater samples at two of the background wells (APMW-15 and APMW-16A) had major ion ratios similar to the Sutherland Reservoir, providing further evidence of a natural shift in groundwater geochemistry.

4.1.1.2 Sulfate

The USGS collected 60 sulfate samples from the South Platte River at Rosco, NE between 1975 and 2013 (USGS 2016a). Sulfate concentrations in the South Platte River ranged from 208 to 930 mg/L. The USGS collected 26 sulfate samples from the North Platte River at Keystone, NE between 1972 and 2011 (USGS 2016b). Sulfate concentrations in the North Platte River ranged from 150 to 230 mg/L.

The sulfate concentrations of the Sutherland Reservoir and Sutherland Canal samples collected by NPPD field staff in October 2019 were 172 and 164 mg/L, respectively (Section 3.2). The seven Sutherland Reservoir samples the USGS collected between August 2005 and December 2006 had sulfate concentrations that ranged from 194 to 220 mg/L (USGS 2016c and USGS 2016d). Similar to calcium, the sulfate concentrations in the Sutherland Reservoir and Sutherland Canal were similar to concentrations observed in the North Platte River and lower than concentrations observed in the South Platte River.

Sulfate concentrations in the North Platte River, South Platte River, and Sutherland Reservoir were sufficiently high enough to be regarded as a source of the elevated concentrations measured in groundwater at the upgradient monitoring wells at the Site and the elevated concentrations measured in downgradient groundwater at APMW-8a and APMW-19. While the elevated sulfate concentrations at APMW-19 were only observed during detection monitoring (135.6 mg/L in Q2 2019 and 130 mg/L in Q4 2019, which triggered the SSI), elevated concentrations at APMW-8A (23.2 mg/L to 145 mg/L) were observed during the baseline and detection monitoring periods. The groundwater samples collected by the USGS immediately around the Sutherland Reservoir (less than 1 mile) also support the hypothesis that the reservoir is the source of the elevated sulfate concentrations at the Site (USGS 2016). These 14 shallow groundwater samples had sulfate concentrations of between 191 and 296 mg/L, which is similar to the 32.4 to 237 mg/L sulfate concentration range measured in groundwater at the GGS upgradient monitoring wells (APMW-5, APMW-15, APMW-16A, and APMW-17) between December 2015 and June 2017.

Figure 5 displays a box and whisker plot of the sulfate concentrations from the GGS monitoring well network and samples of possible sulfate sources at the Site. The plot indicates that groundwater containing elevated sulfate concentrations has been traveling across the Site, including past the background monitoring wells, and has only recently started reaching downgradient monitoring wells.

4.1.2 Evaporation Pond

Although the evaporation pond is located to the east of APMW-19, and side-gradient in terms of groundwater flow (i.e., seepage from the evaporation pond would be unlikely to be detected at monitoring well APMW-19), evaporation pond water quality is described in this section as it contains water related to GGS plant operations.

Groundwater quality at the three downgradient monitoring wells located around the evaporation pond (i.e., APMW-12, APMW-13, and APMW-14) indicates that process water discharged from the GGS plant and stored in the evaporation pond has migrated to groundwater. Historical monitoring results show that elevated concentrations of boron (Figure A1), chloride (Figure A4), sulfate (Figure A9), and TDS (Figure A10), which are elements that are typically associated with CCR, were detected in groundwater at the three monitoring wells closest to the evaporation pond compared to the background monitoring wells.

Based on the slight differences in water quality between the groundwater at the monitoring wells APMW-12, APMW-13 and APMW-14 and the evaporation pond, mixing between the evaporation pond water and the upgradient groundwater likely occurs and groundwater at the monitoring wells is not entirely composed of seepage from the evaporation pond. This mixing reaction is supported by the Piper diagram in Figure 3, which shows samples from monitoring wells APMW-12 and APMW-14 plot on a mixing line between the evaporation pond and background groundwater end-member data points.

During the Q1 2019 sampling, the calcium concentration in the evaporation pond water was 111 mg/L and the sulfate concentration was 436 mg/L. Based on the similarities in water quality between the evaporation pond and adjacent groundwater monitoring wells, the evaporation pond is considered a potential source of calcium and sulfate to groundwater at GGS. However, it is unlikely the evaporation pond influenced groundwater quality at APMW-19, which is side gradient to groundwater flow underneath the evaporation pond (Figure 1).

4.1.3 Historical Ash Landfills

Historical deposits of fly ash present at GGS in historic soil-lined Ash Landfills Nos. 1 and 2 may release soluble constituents to groundwater as the seepage generated by infiltrating precipitation interacts with the ash. While it was not feasible to collect a sample of seepage from Ash Landfills Nos. 1 and 2 directly, ash-impacted waters collected from Ash Landfill No. 3 sump and Ash Landfill No. 4 pond (Section 3.1) had calcium concentrations of 10.7 and 86.9 mg/L, respectively, which are lower than the calcium concentrations that triggered the SSI. These results indicate that the ash is unlikely to be contributing calcium to the groundwater.

Sulfate concentrations in the ash-impacted waters from Ash Landfills Nos. 3 and 4 (Section 3.1) were 1,270 and 1,810 mg/L, respectively. At these concentrations, ash impacted seepage have the potential to increased sulfate concentrations in downgradient wells.

A ternary plot comparing sodium, calcium, and sulfate (Figure 6) reveals that ash impacted waters have higher relative sodium abundances and lower relative calcium abundance compared to the upgradient and downgradient groundwater. If infiltrating precipitation was leaching calcium and sulfate from the historical fly ash, the relative concentrations of sodium would increase considerably in the groundwater and would be similar to the ash impacted waters, but this elevated sodium signature was not observed in any of the samples collected from the downgradient groundwater monitoring wells.

4.1.4 Mineral Weathering

Another potential source of calcium and sulfate in the watershed is from the natural weathering of calcium bearing minerals and sulfur bearing minerals. McMahon et al. (2007) used a mass balance approach to study increases in calcium and sulfate concentrations along a groundwater flow path in Central Nebraska. They determined that the dissolution of calcite and oxidation of pyrite were the likely sources of calcium and sulfate increases in groundwater, respectively. These natural weathering products have the potential to raise concentrations to a small

degree, but the natural concentrations were relatively low compared to the concentrations in groundwater generated by the Sutherland Reservoir, particularly as demonstrated by comparing groundwater quality between the USGS shallow wells and the GGS upgradient wells.

5.0 EVIDENCE OF AN ALTERNATIVE SOURCE

Based on the testing results and list of potential alternate sources of calcium and sulfate presented in this report, primary lines of evidence and conclusions drawn from the evidence used to support this ASD are provided in Table 2.

Table 2: Primary Lines of Evidence and Supporting ASD Analysis

Key Line of Evidence	Supporting Evidence	Description
Primary CCR Indicators	Calcium concentrations in CCR impacted waters	Calcium concentrations in the sump water from Ash Landfill No. 3 and pond water from Ash Landfill No. 4 are lower than calcium concentrations that triggered the SSI at APMW-19 (Figure 4). An alternative source is required to elevate calcium in APMW-19.
	Boron concentrations in groundwater	Boron (Figure A1) is a primary CCR indicator based on high concentrations in sump water from Ash Landfill No. 3 (18.3 mg/L) and pond water from Ash Landfill No.4 (13.8 mg/L). All upgradient and downgradient CCR unit monitoring wells, with the exception of monitoring wells near the evaporation pond that may be influenced by process waters, have boron concentrations below the PQL (typically <0.2 mg/L).
	Sodium concentrations in CCR impacted waters	The relative abundance of sodium in CCR impacted waters would indicate that high sodium concentrations would also be expected in groundwater if calcium and sulfate were from CCR materials (Figure 6). Relative increases in sodium were not observed in monitoring wells at the Site, suggesting an alternative source of elevated calcium and sulfate in groundwater at APMW-19.
Groundwater Geochemistry	Relative ion abundances in groundwater differs from ash landfill water	As presented in the Piper plot (Figure 3), relative differences in major ion concentrations show a distinct dissimilarity between the ash-impacted sump and pond waters and the downgradient groundwater samples, including from APMW-19. The geochemical properties of the downgradient groundwater samples are not consistent with seepage from the CCR unit.
	Elevated and variable calcium and sulfate concentrations in background monitoring wells	Calcium and sulfate concentrations in groundwater at background monitoring wells APMW-5, APMW-16A, and APMW-17 were elevated compared to calcium and sulfate concentrations at monitoring well APMW-19 throughout the baseline monitoring period. Since the CCR unit cannot influence the calcium and sulfate groundwater concentrations in the upgradient wells, the only explanation is that there is an alternate source of calcium and sulfate present in groundwater across the Site.

Key Line of Evidence	Supporting Evidence	Description
Local Sources of Calcium and Sulfate	Hydrogeology	The North and South Platte Rivers, which are ultimately the source of groundwater recharge that occurs from the Sutherland Reservoir located approximately 1.5 miles north of the ash landfill, have calcium concentrations between 47.5 and 230 mg/L and sulfate concentrations between 150 and 930 mg/L. Samples from shallow wells near the Sutherland Reservoir and upgradient wells (Figures 4 and 5) indicate that groundwater with elevated calcium and sulfate is migrating south through the Site.
	Mineral weathering of calcium and sulfate bearing minerals	McMahon et al. (2007) found that small increases in calcium and sulfate concentrations along a groundwater flow path in Central Nebraska were due to calcite dissolution and pyrite oxidation, respectively.

6.0 CONCEPTUAL SITE MODEL

Golder developed a conceptual site model (CSM) that is presented graphically in Figure 7 to frame and support the ASD assessment approach. The CSM presents the GGS site layout, a summary of the geologic and hydrogeologic information, and a discussion of groundwater monitoring data, which together lays the groundwork for consideration and development of the ASD. Additionally, the CSM summarizes the findings of literature research that suggest certain naturally occurring groundwater conditions observed in Nebraska are present at the Site and may contribute to naturally elevated calcium and sulfate concentrations in groundwater around the ash landfill.

7.0 CONCLUSION

In accordance with §257.95(g)(3), this ASD has been prepared in response to the identification of SSIs for calcium and sulfate at monitoring well APMW-19 following the Q4 2019 sampling event for the ash landfill at Gerald Gentleman Station.

A review of historical analytical results indicates that the elevated calcium and sulfate concentrations in groundwater at APMW-19 were not the result of seepage from the ash landfill but can be attributed to naturally occurring calcium and sulfate in regional groundwater. Therefore, no further action (i.e., transition to Assessment Monitoring) is warranted, and the Gerald Gentleman Station ash landfill will remain in detection monitoring.

8.0 REFERENCES

- EPA. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. EPA 530-R-09-007, March.
- Goeke, J.W., J.M. Peckenpaugh, R.E. Cady, and J.T. Dugan. 1992. Hydrogeology of Parts of the Twin Platte and Middle Republican Natural Resources Districts, Southwestern Nebraska, Nebraska Water Survey Paper No. 70, Conservation and Survey Division, University of Nebraska-Lincoln, 89 pp.
- Golder Associates Inc. 2017. Coal Combustion Residuals Landfill Groundwater Monitoring System Certification, Nebraska Public Power District Gerald Gentlemen Station, Sutherland, Nebraska.

Golder Associates Inc. 2019. Alternate Source Demonstration, Nebraska Public Power District Gerald Gentlemen Station, Sutherland, Nebraska, April.

EPA. 2014. National Functional Guidelines for Inorganic Data Review. EPA 540-R-013-001, August.

McMahon PB, Böhlke JK, Carney CP. 2007. Vertical gradients in water chemistry and age in the northern High Plains aquifer, Nebraska, 2003. US Geological Survey.

U.S. Geological Survey (USGS), 2016a, National Water Information System data available on the World Wide Web (USGS Water Data for the Nation: USGS 06764880 South Platte River at Roscoe, Nebr.), accessed April 2020, at URL: https://nwis.waterdata.usgs.gov/nwis/qwdata/?site_no=06764880&agency_cd=USGS&.

USGS 2016b, National Water Information System data available on the World Wide Web (USGS Water Data for the Nation: USGS 06690500 North Platte River Near Keystone, Nebr.), accessed April 2020, at URL: https://nwis.waterdata.usgs.gov/nwis/qwdata/?site_no=06690500&agency_cd=USGS&.

USGS 2016c, National Water Information System data available on the World Wide Web (USGS Water Data for the Nation: USGS 410630101080202 Sutherland Reservoir Middle Deep), accessed April 2020, at URL: https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=410630101080202.

USGS 2016d, National Water Information System data available on the World Wide Web (USGS Water Data for the Nation: USGS 410630101080201 Sutherland Reservoir Middle Shallow), accessed April 2020, at URL: https://nwis.waterdata.usgs.gov/usa/nwis/qwdata/?site_no=410630101080201.

USGS 2016e, National Water Information System data available on the World Wide Web (USGS Water Data for the Nation: USGS-410711101060201, USGS-410606101061301, USGS-410529101062501, USGS-410542101053501, USGS-410438101055301, USGS-410452101055301, USGS-410522101075601, USGS-410508101091501, USGS-410456101091801, USGS-410530101093701, and USGS-410811101072501), accessed April 2020, at URL: <https://www.waterqualitydata.us/portal/#siteid=USGS-410711101060201&siteid=USGS-410606101061301&siteid=USGS-410529101062501&siteid=USGS-410542101053501&siteid=USGS-410438101055301&siteid=USGS-410452101055301&siteid=USGS-410522101075601&siteid=USGS-410508101091501&siteid=USGS-410456101091801&siteid=USGS-410530101093701&siteid=USGS-410811101072501&imeType=csv>.

Woodward-Clyde Consultants. 1991. Design and Construction of a Groundwater Monitoring Network, Final Report, Gerald Gentleman Station, Nebraska Public Power District, Sutherland, Nebraska, WCC Project No. 90MC176, Omaha, Nebraska, September.

Signature Page

Golder Associates Inc.



Jacob Sauer
Senior Engineer



Hugh Davies
Senior Geochemist



Gregory Lehn
Staff Geochemist

JS/HD/GL/cc

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Figures

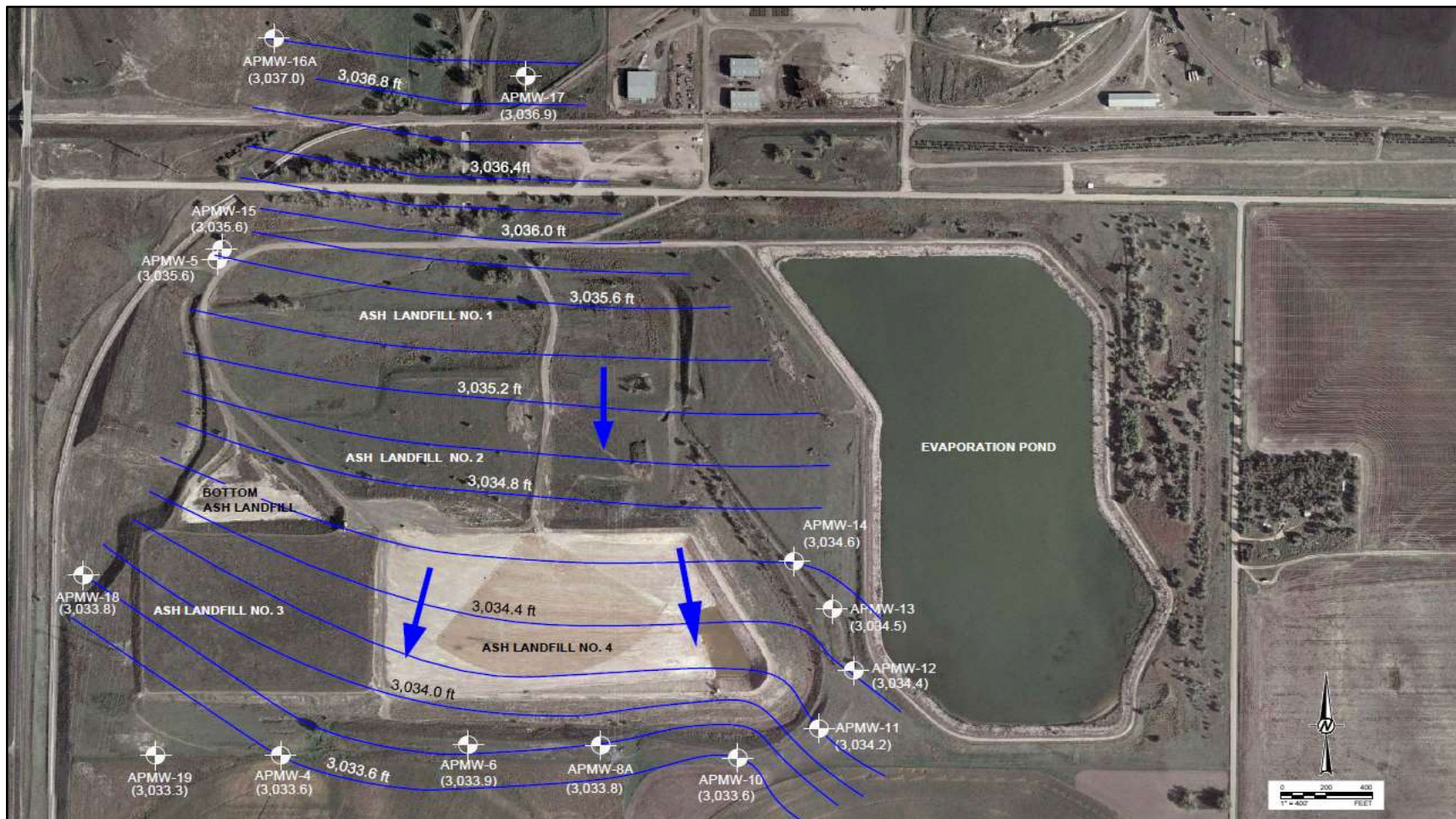


Figure 1
Site Map with Groundwater Contours- November 2019

Alternate Source Demonstration
 Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

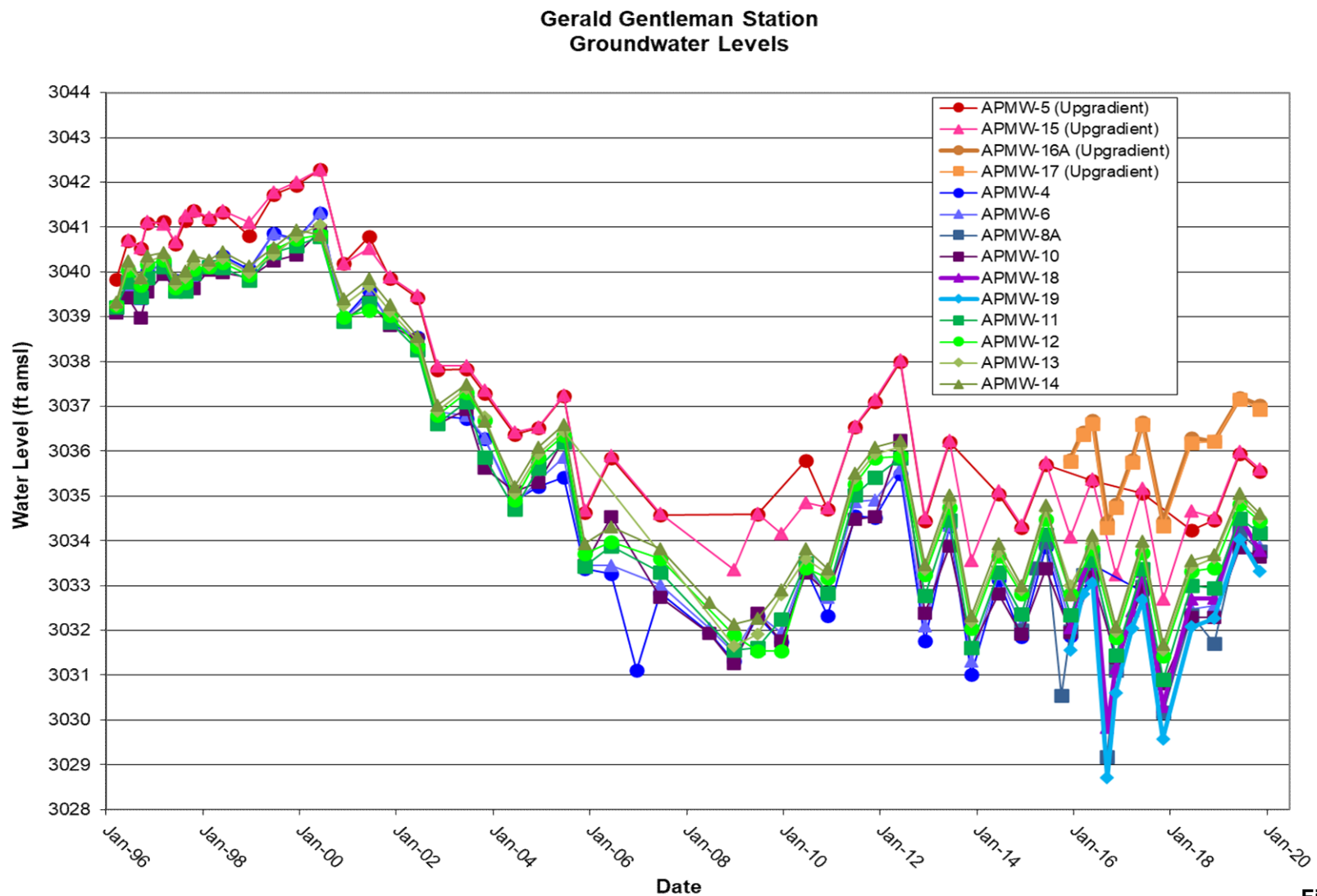
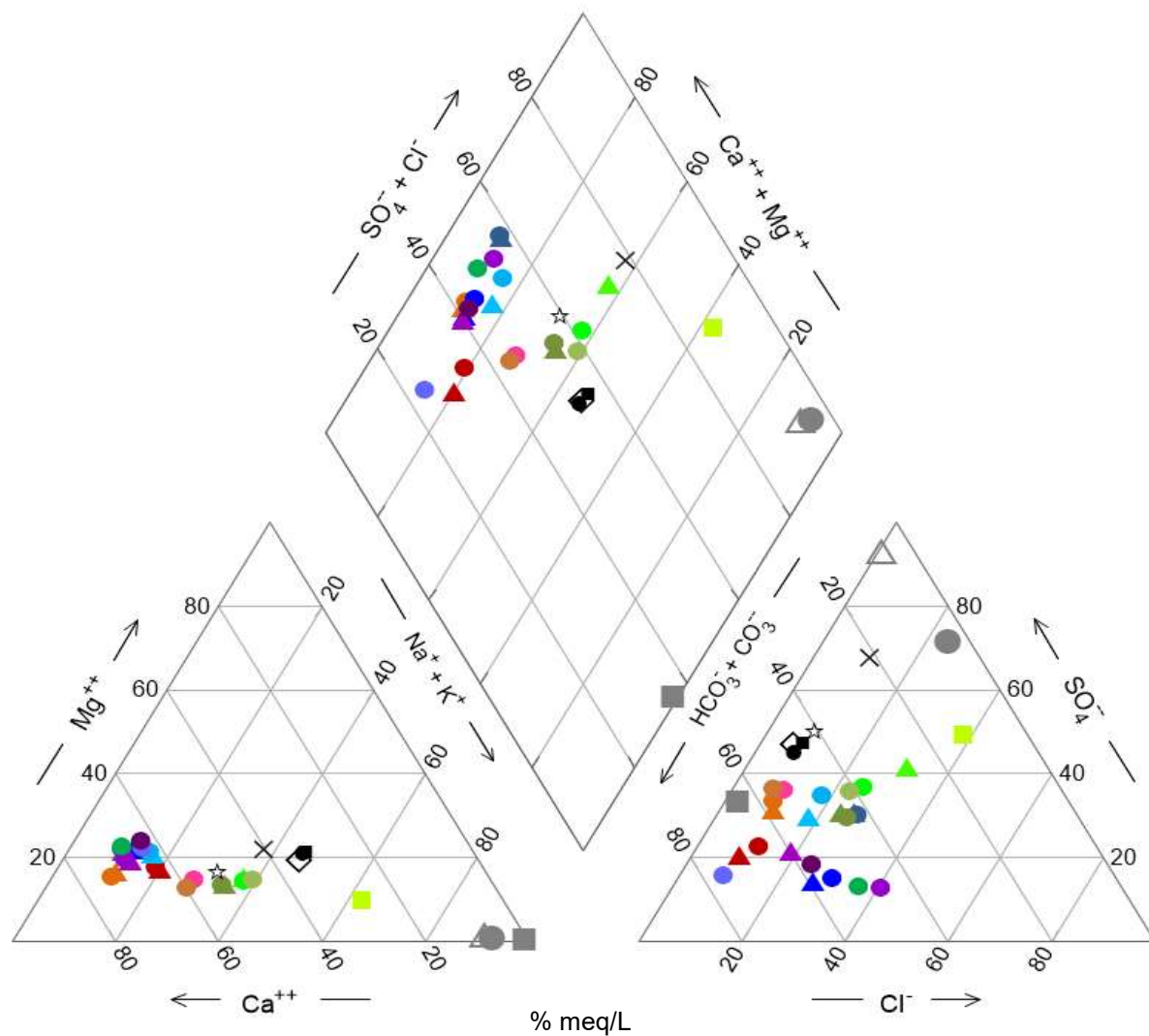


Figure 2
Groundwater Monitoring Well Water Levels

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates



- ▲ APMW-5 (Upgradient; Q1 2019)
- APMW-5 (Upgradient; Q4 2019)
- ▲ APMW-17 (Upgradient; Q1 2019)
- APMW-17 (Upgradient; Q4 2019)
- APMW-15 (Upgradient; Q4 2019)
- APMW-16A (Upgradient; Q4 2019)
- ▲ APMW-4 (Q1 2019)
- APMW-4 (Q4 2019)
- ▲ APMW-8A (Q1 2019)
- APMW-8A (Q4 2019)
- ▲ APMW-18 (Q1 2019)
- APMW-18 (Q4 2019)
- ▲ APMW-19 (Q1 2019)
- APMW-19 (Q4 2019)
- ▲ APMW-12 (Q1 2019)
- APMW-12 (Q4 2019)
- ▲ APMW-14 (Q1 2019)
- APMW-14 (Q4 2019)
- APMW-6 (Q4 2019)
- APMW-10 (Q4 2019)
- APMW-11 (Q4 2019)
- APMW-13 (Q4 2019)
- Evaporation Pond (Q1 2019)
- × South Platte River (Average)
- ◇ North Platte River (Average)
- Reservoir (Q4 2019)
- Canal (Q4 2019)
- Ash Pit 3 Sump (Q4 2019)
- Ash Pit 4 Pond (Q4 2019)
- △ SPLP leachate from fly ash
- ☆ USGS Wells near Sutherland R.

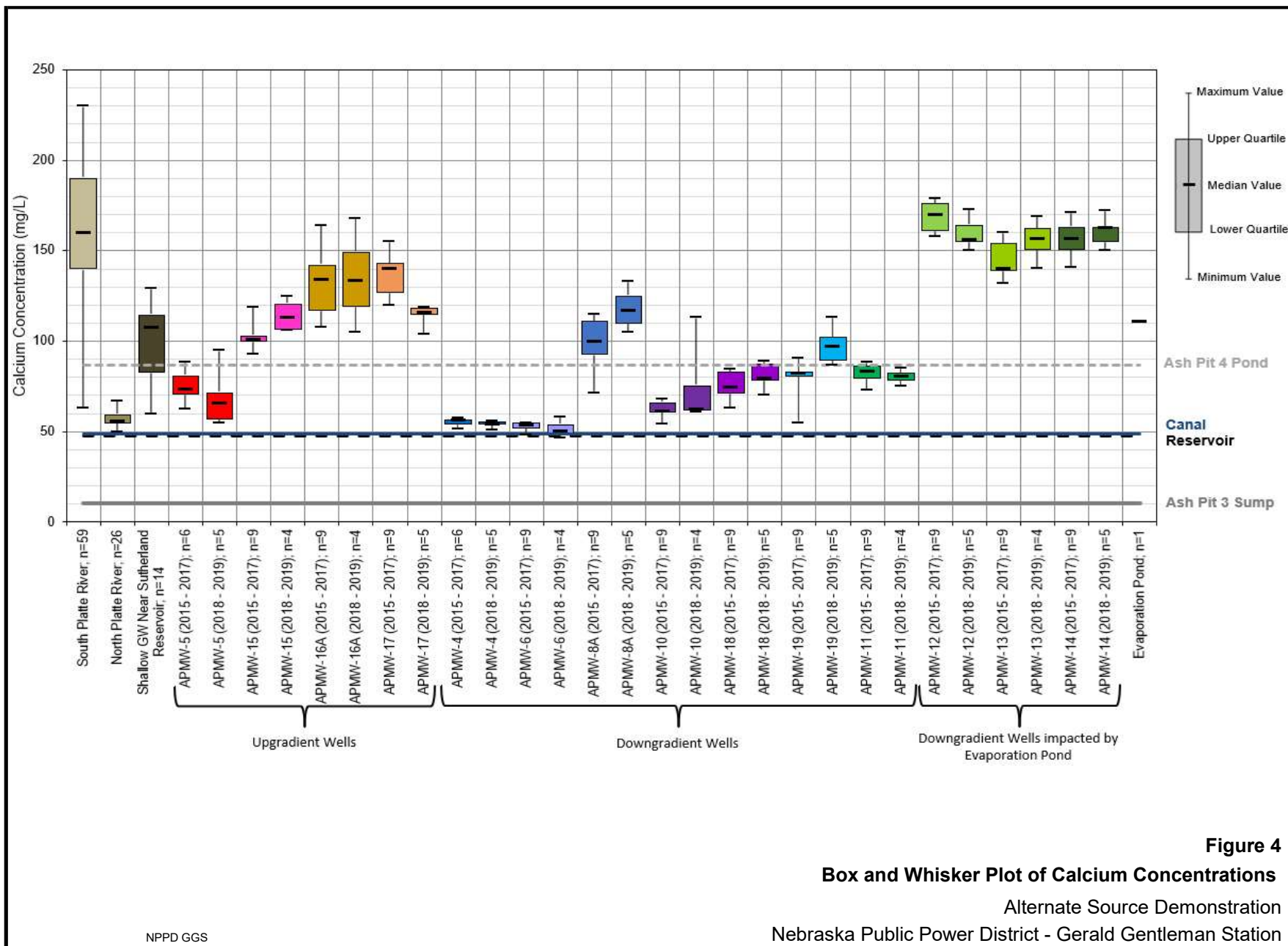
Figure 3

Piper Diagram of Groundwater and Potential Calcium and Sulfate Sources

Alternate Source Demonstration

Nebraska Public Power District - Gerald Gentleman Station

Golder Associates



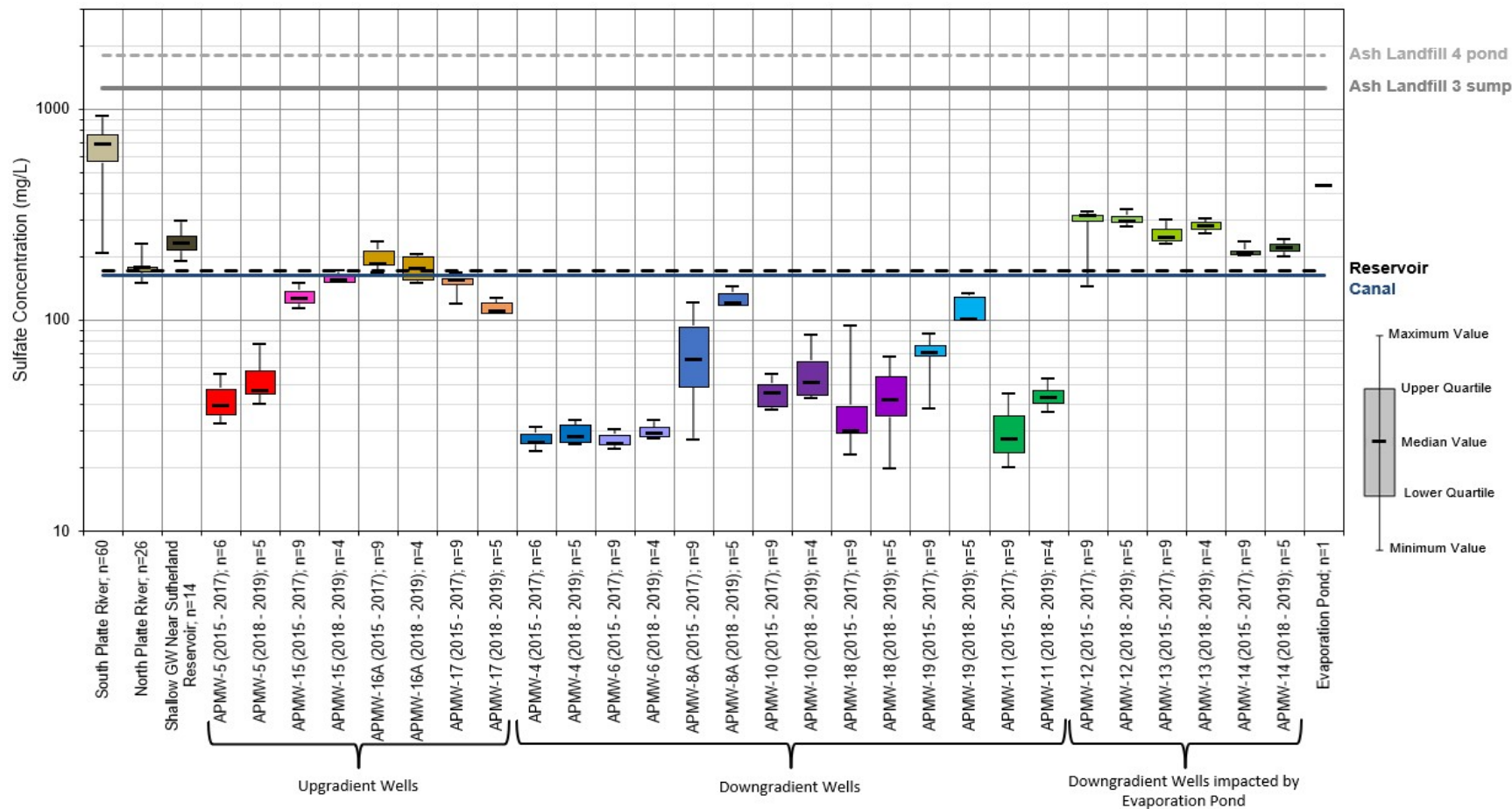


Figure 5

Box and Whisker Plot of Sulfate Concentrations

Alternate Source Demonstration

Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

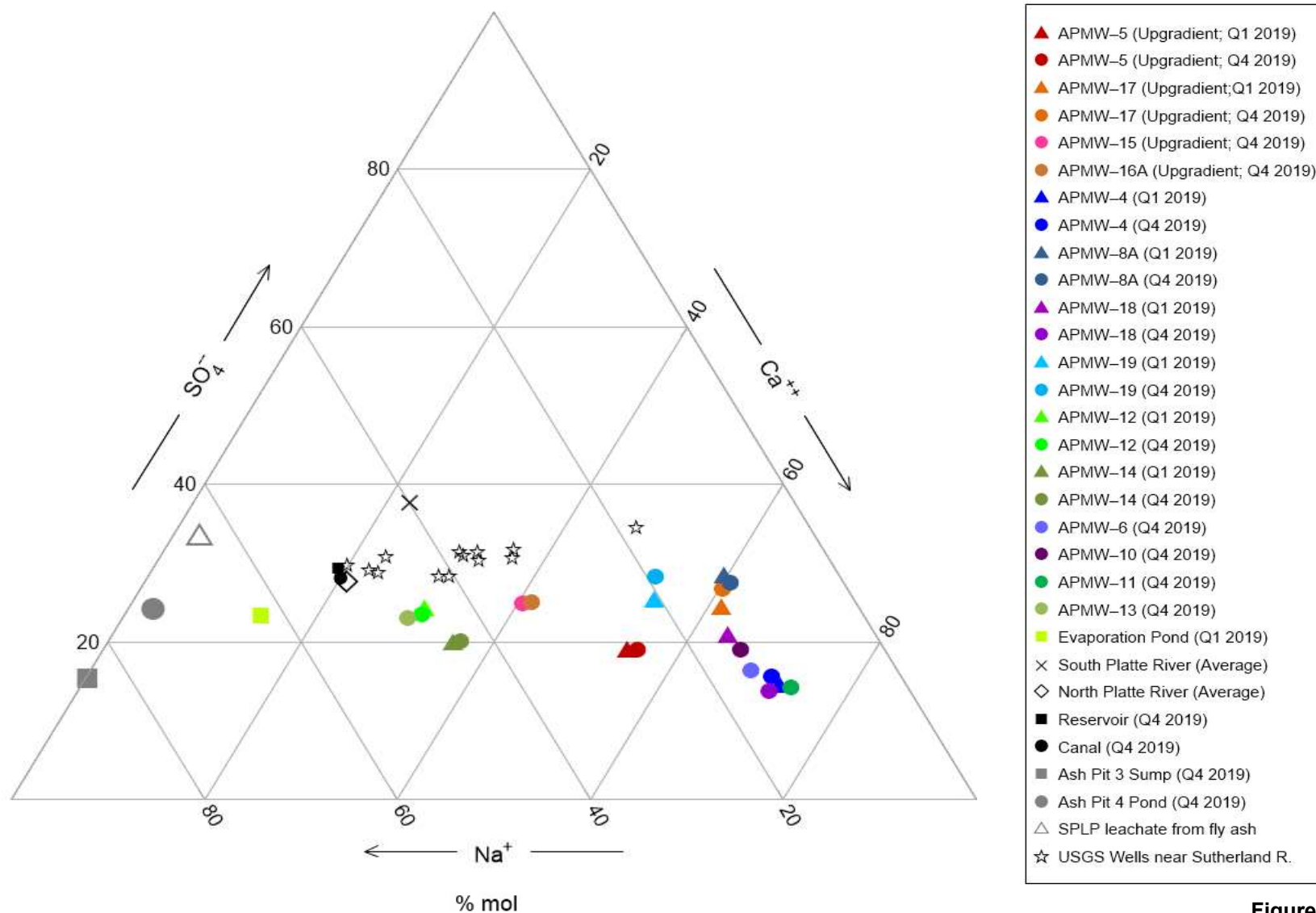


Figure 6
Ternary Diagram of Groundwater and Potential Calcium and Sulfate Sources

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

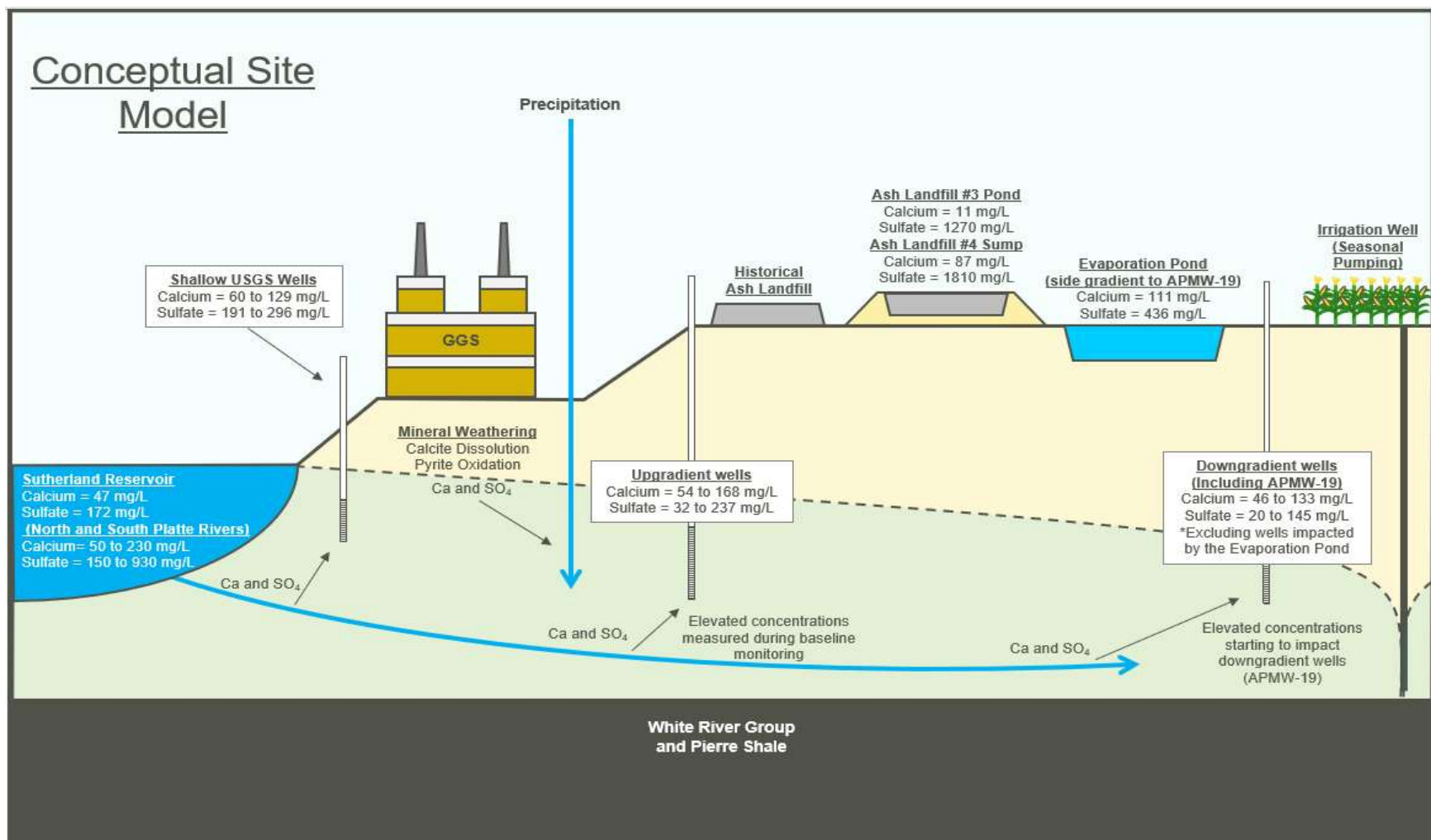


Figure 7
Conceptual Site Model

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

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APPENDIX A

**Historical Concentrations of
Appendix III and Selected Appendix
IV Analytes**

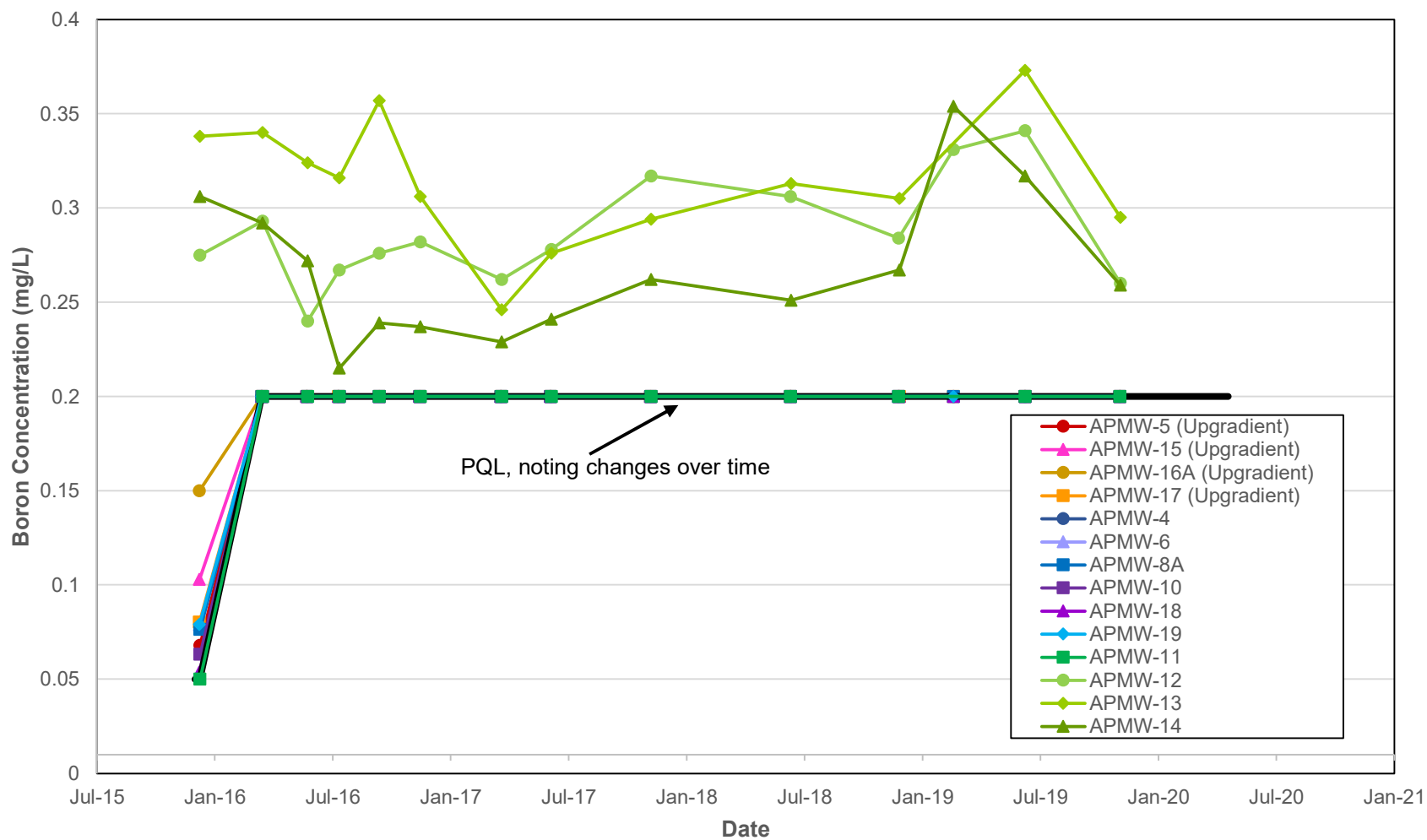


Figure A1
Groundwater Boron Concentrations

CCR Detection Monitoring
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

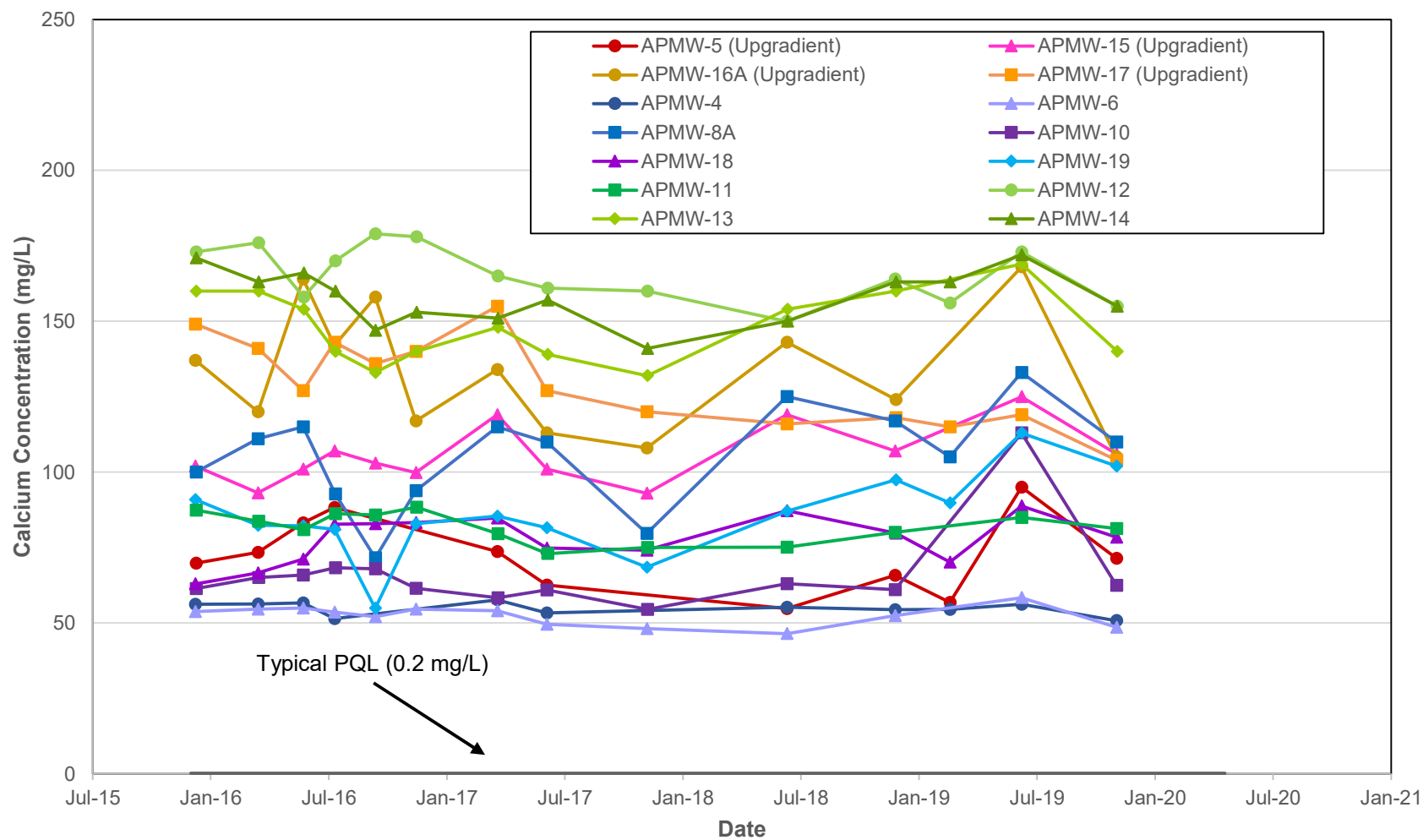


Figure A2
Groundwater Calcium Concentrations

CCR Detection Monitoring
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

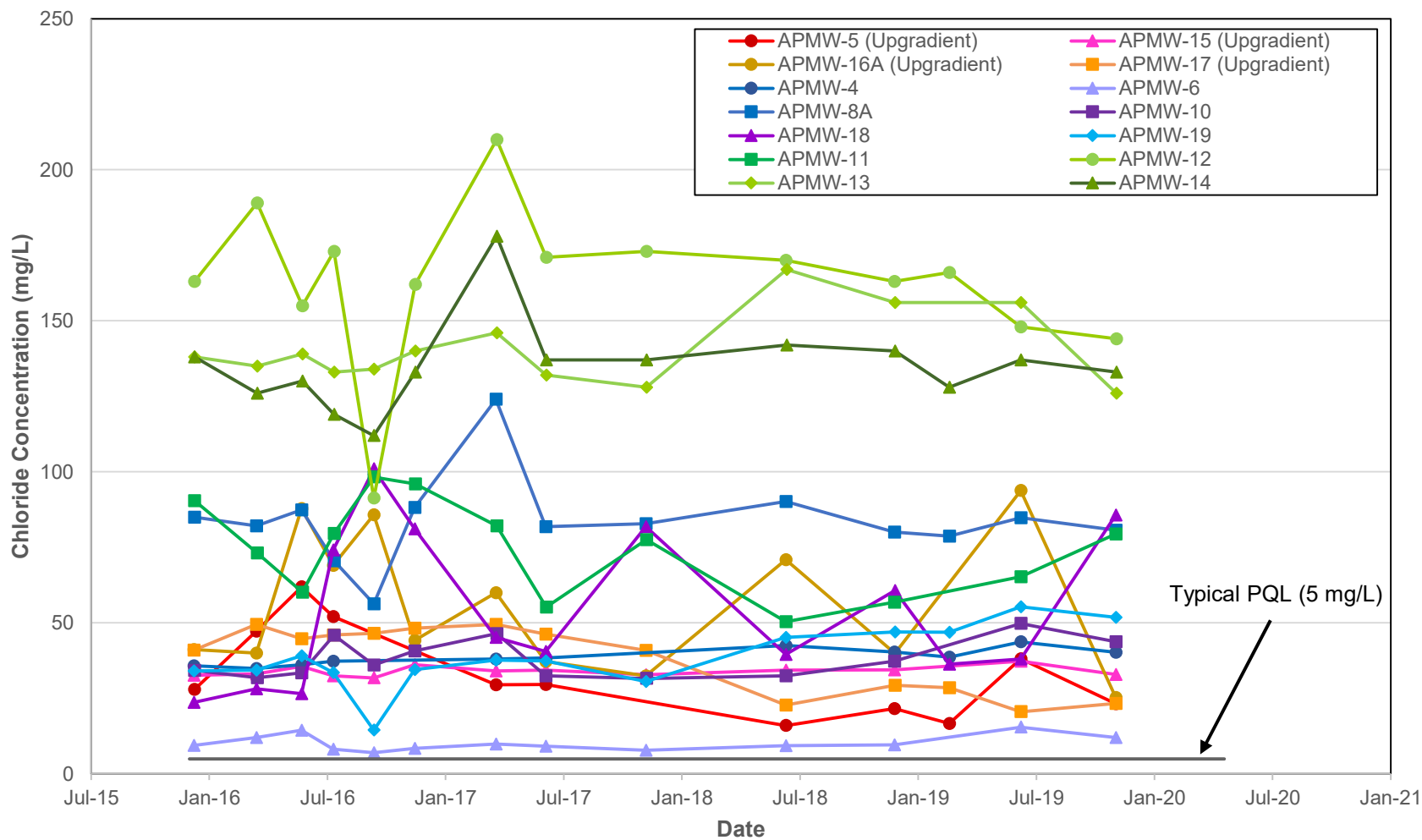


Figure A3
Groundwater Chloride Concentrations

CCR Detection Monitoring
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

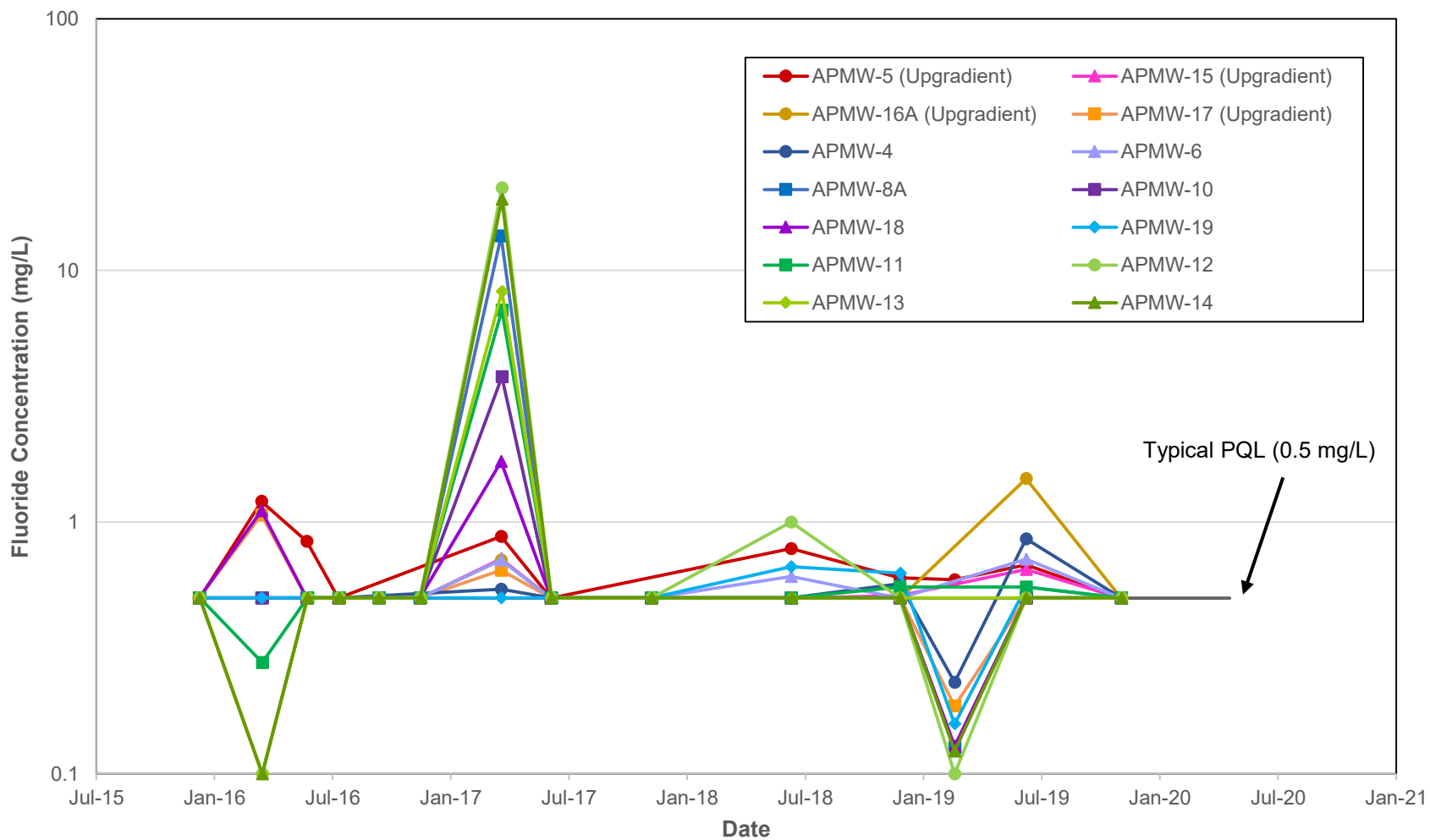


Figure A4
Groundwater Fluoride Concentrations

CCR Detection Monitoring
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

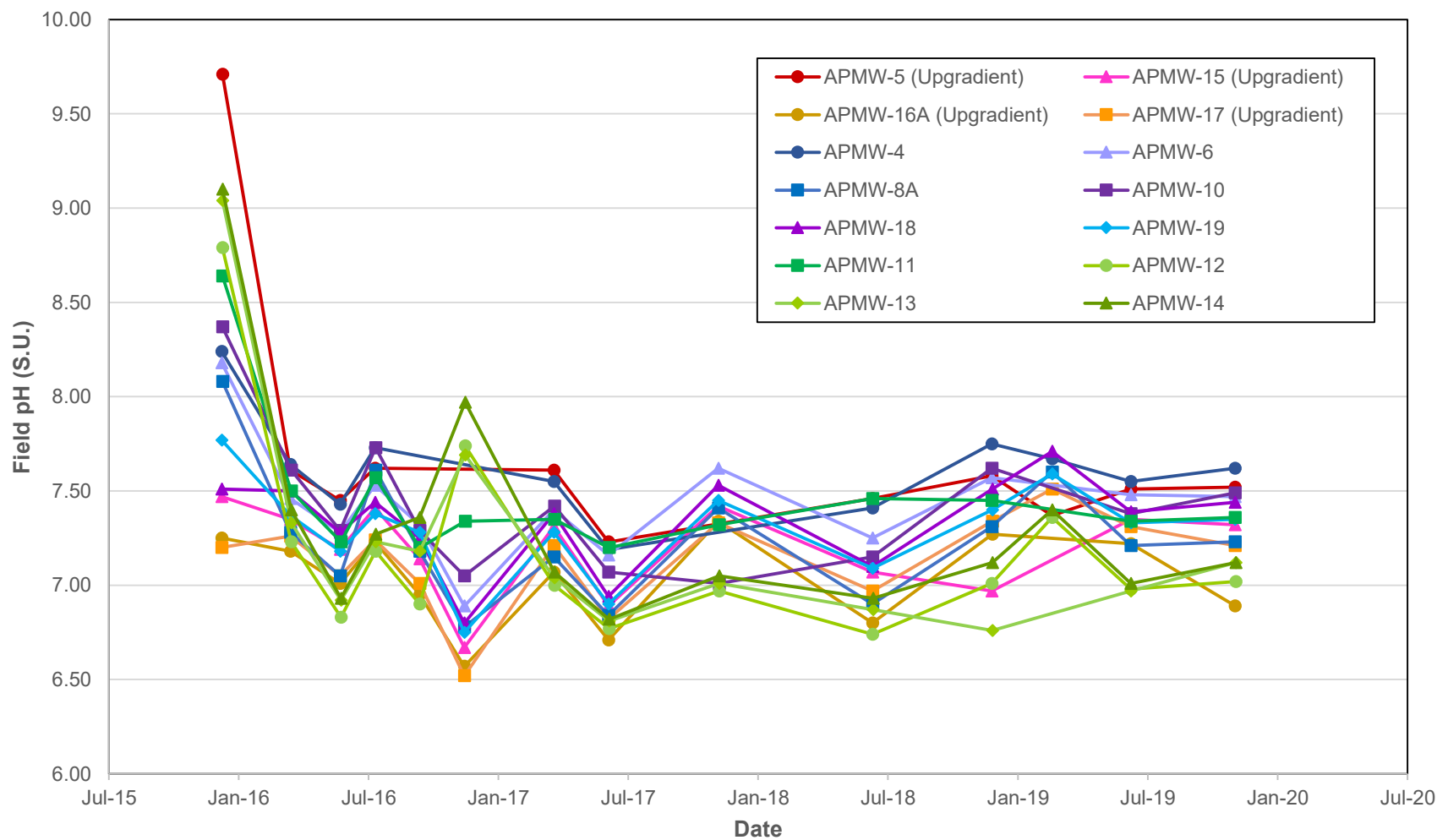


Figure A5
Groundwater Field pH

CCR Detection Monitoring
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

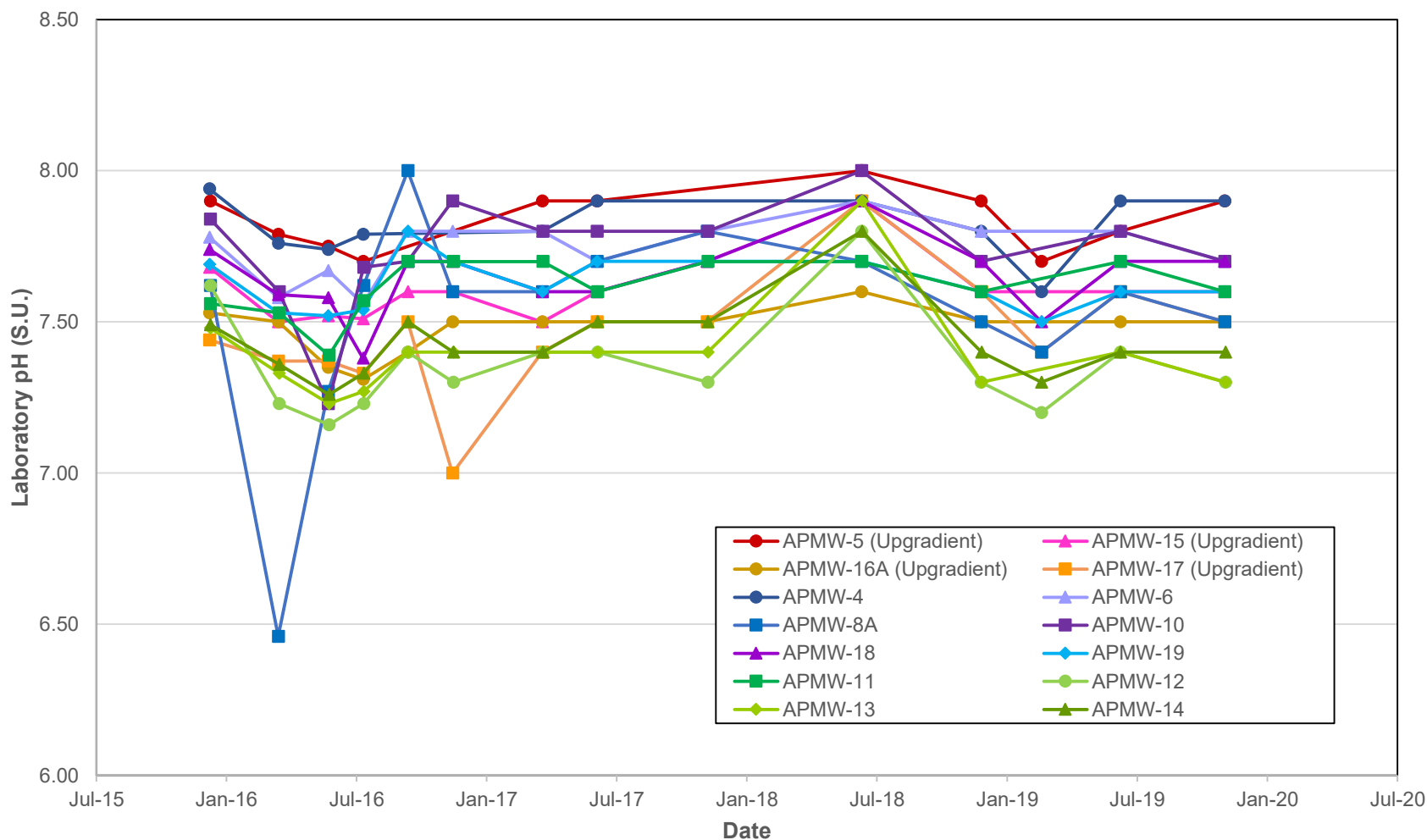


Figure A6
Groundwater Laboratory pH

CCR Detection Monitoring
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

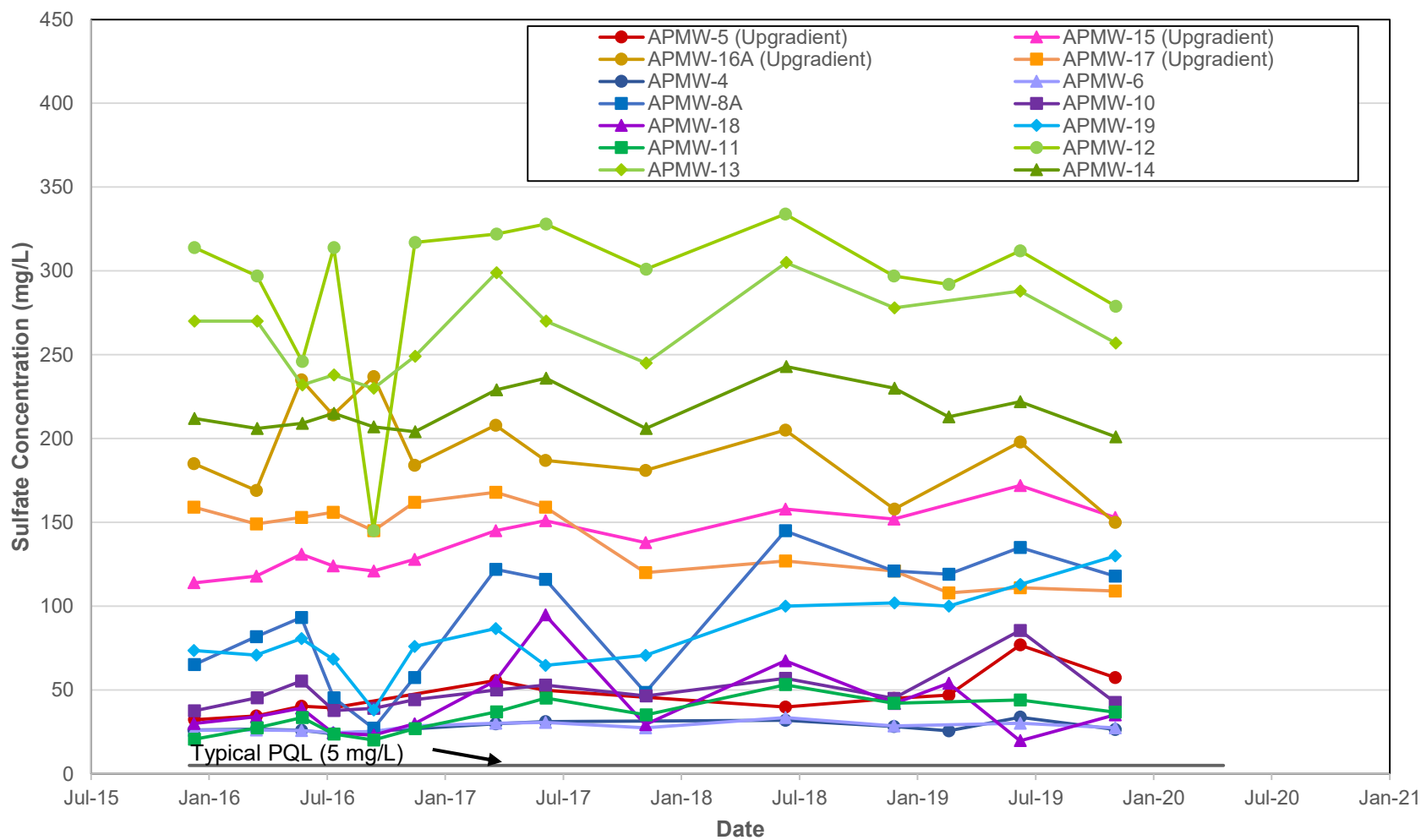


Figure A7
Groundwater Sulfate Concentrations

CCR Detection Monitoring
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

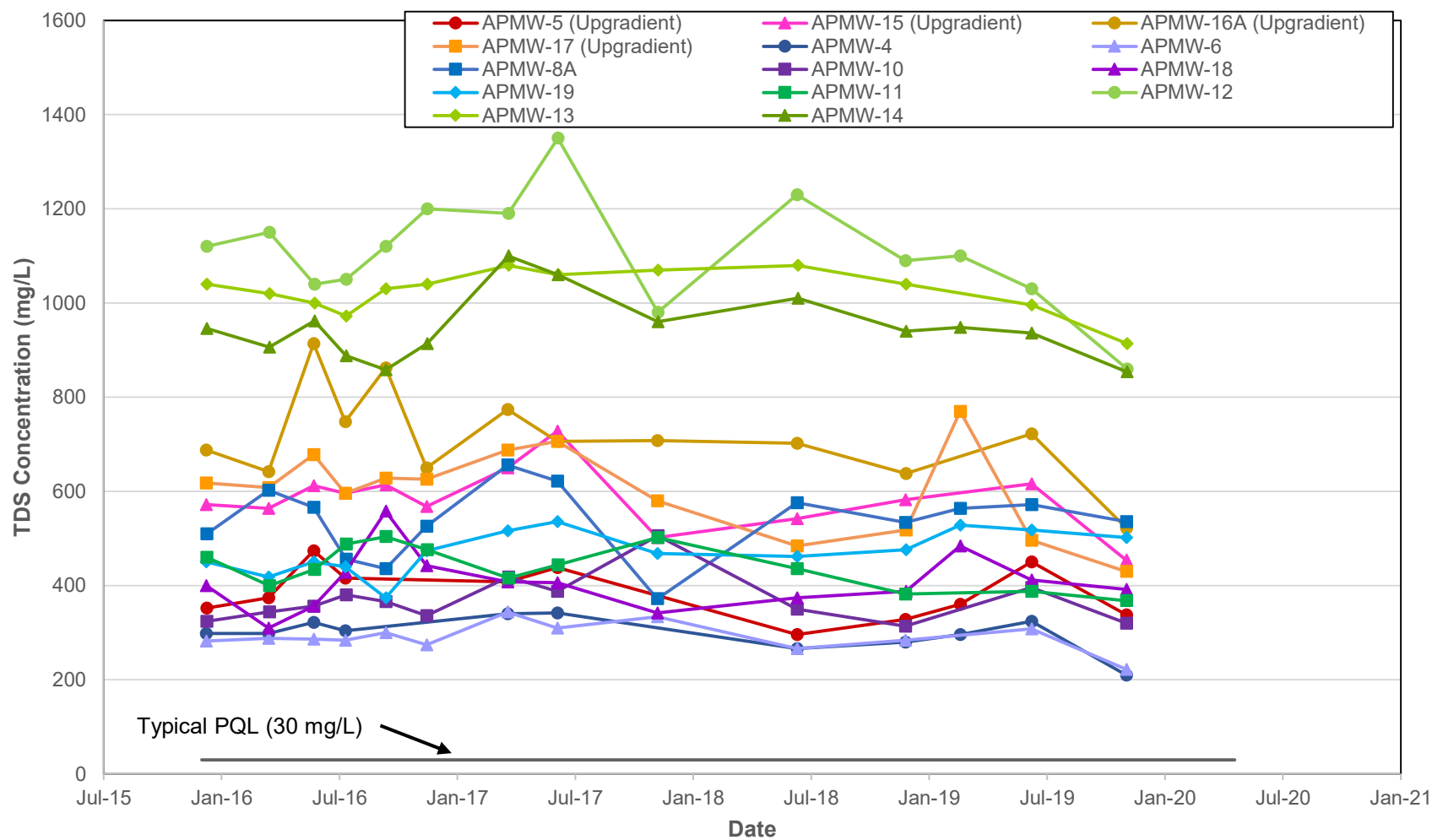


Figure A8
Groundwater TDS Concentrations

CCR Detection Monitoring
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

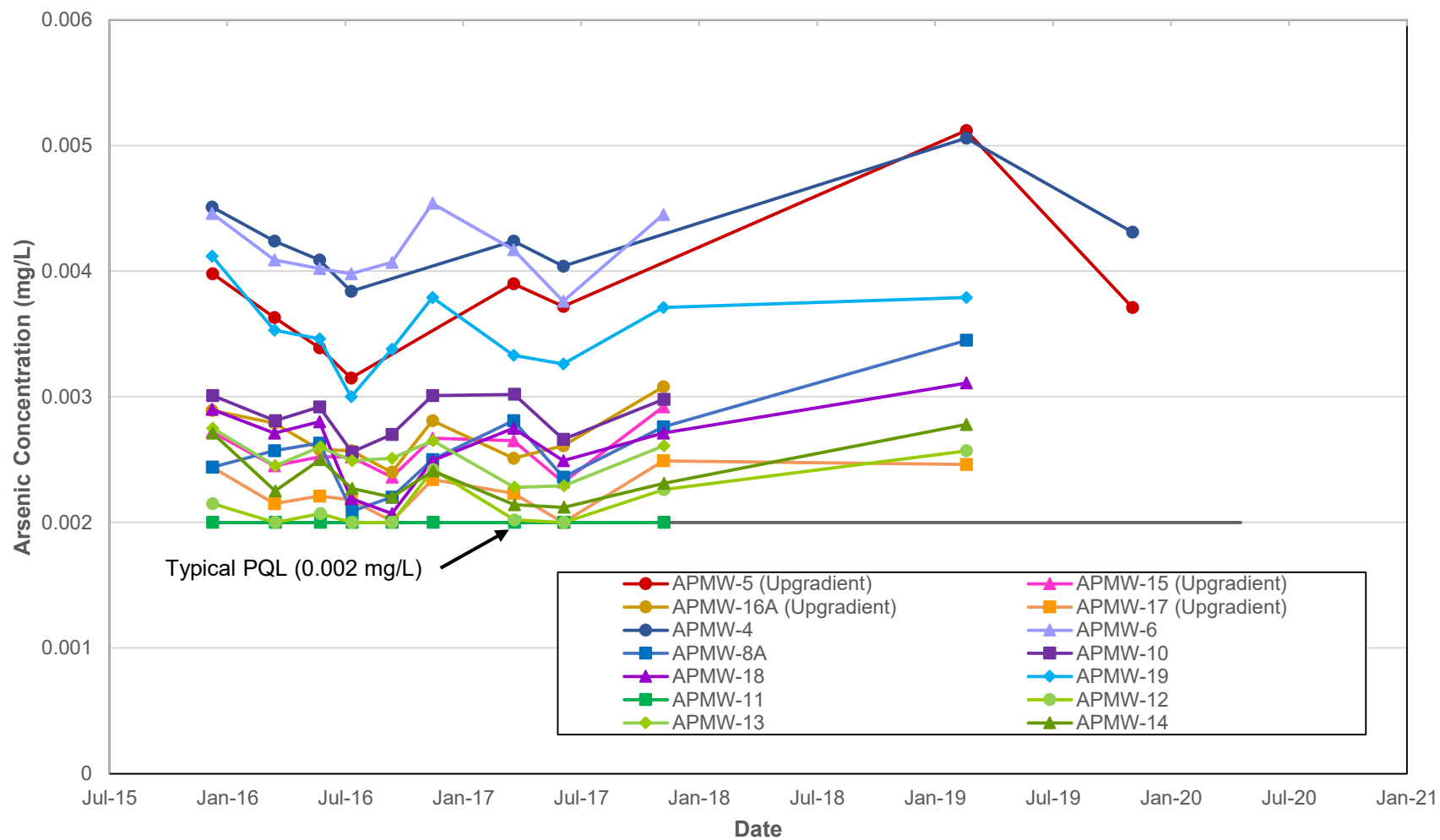


Figure A9
Groundwater Arsenic Concentrations

CCR Detection Monitoring
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

NPPD GGS

4/22/2020

20140070

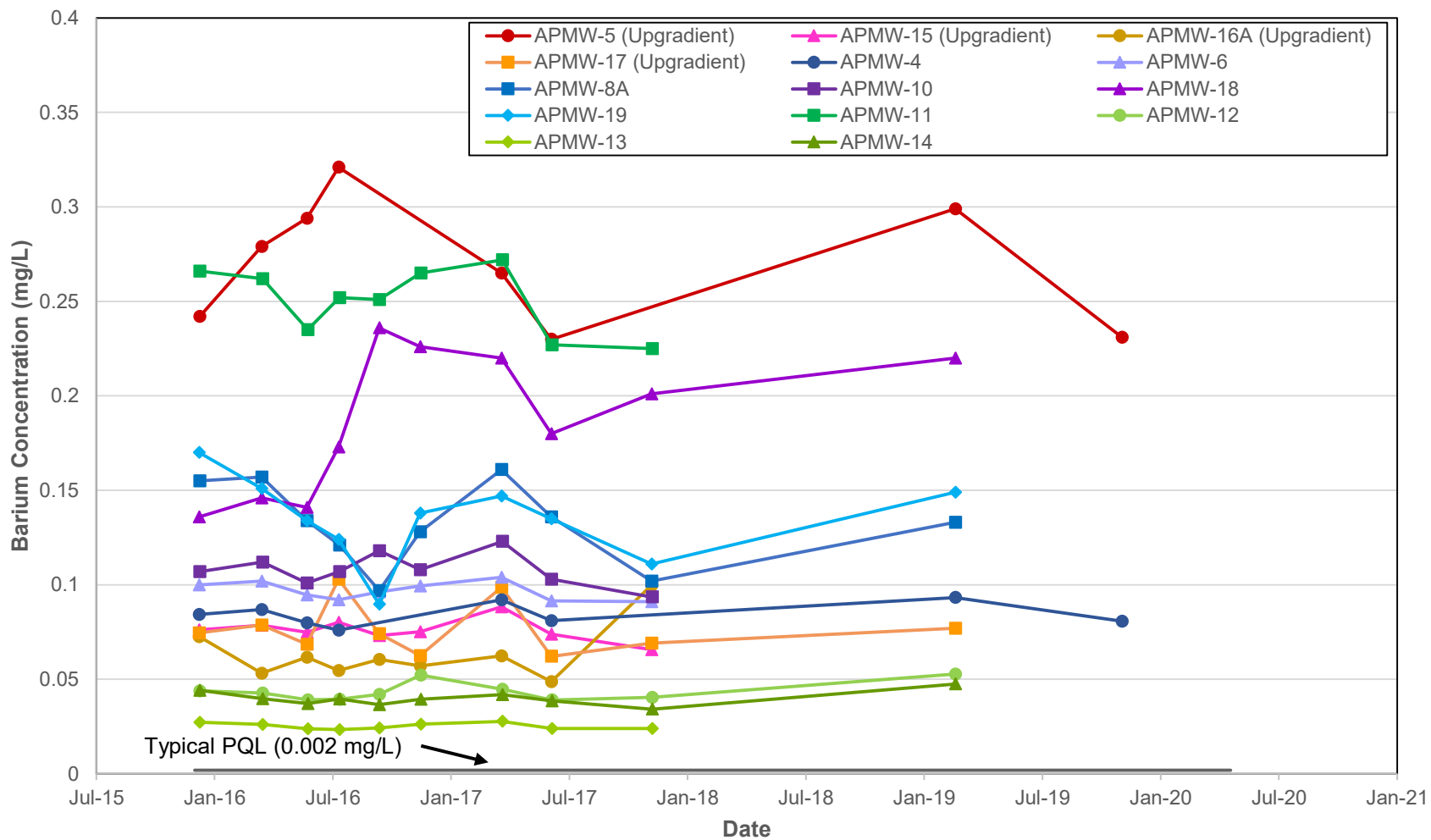


Figure A10
Groundwater Barium Concentrations

CCR Detection Monitoring
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

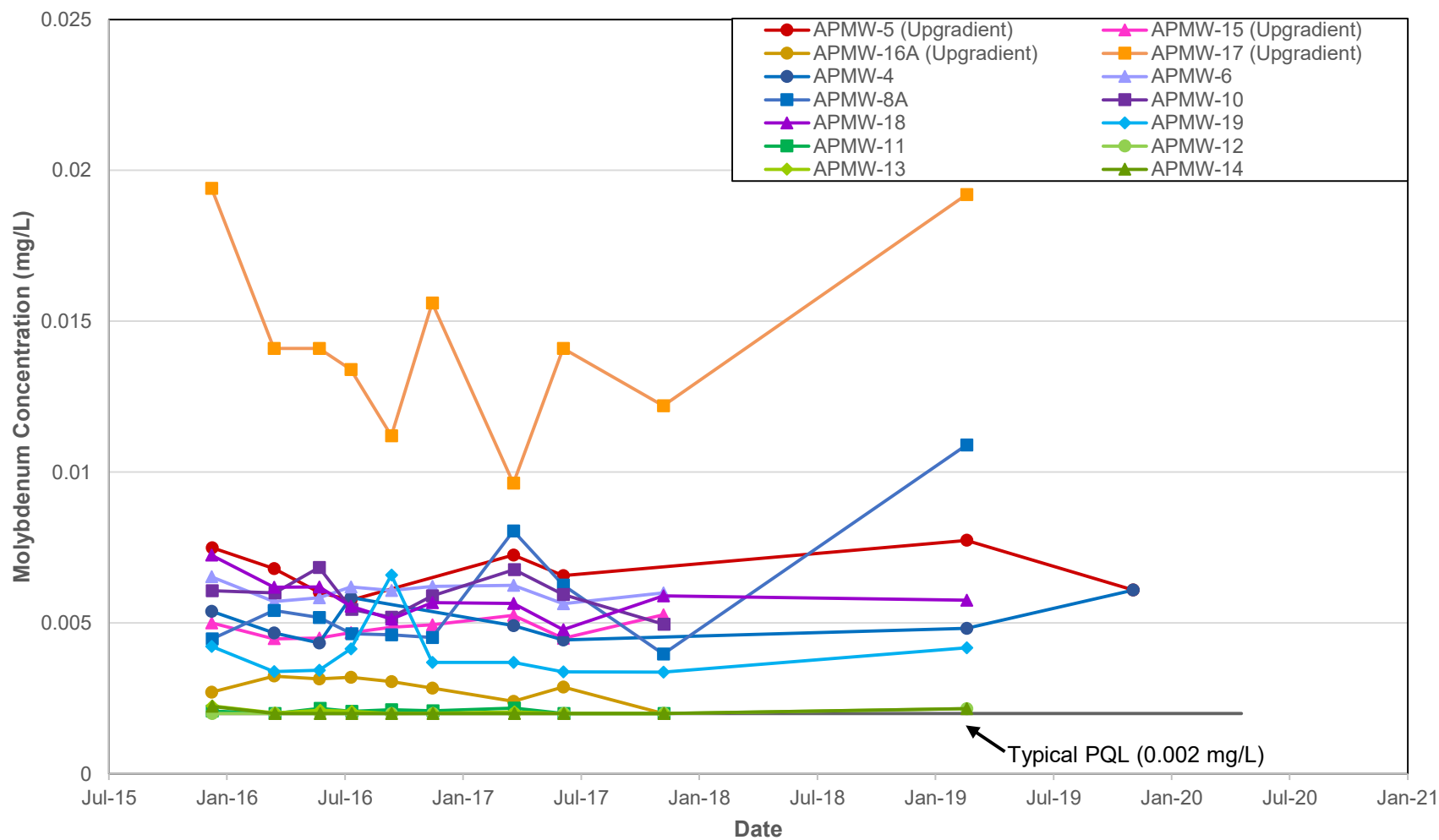


Figure A11
Groundwater Molybdenum Concentrations

CCR Detection Monitoring
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

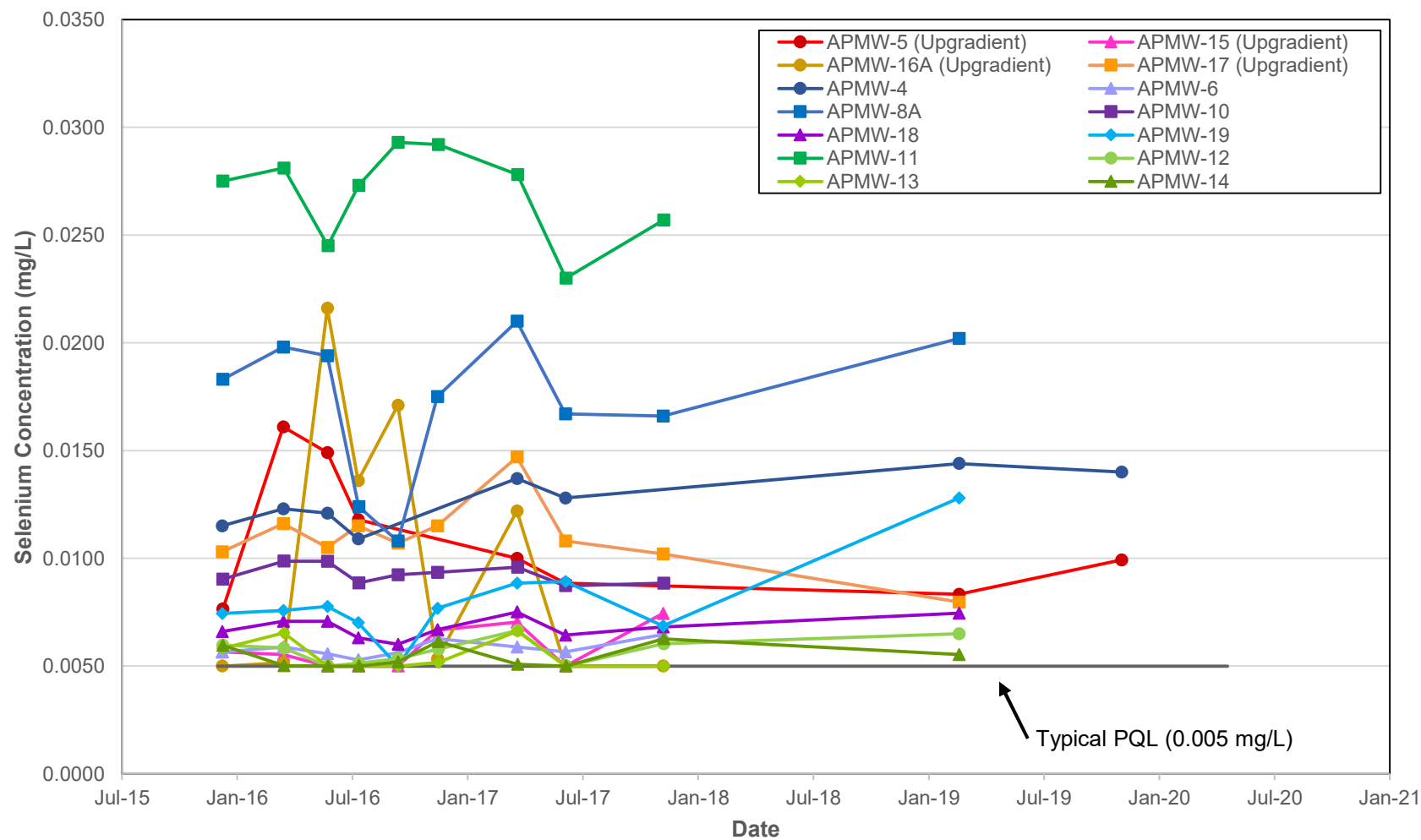


Figure A12
Groundwater Selenium Concentrations

CCR Detection Monitoring
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