Addendum No. 1
Assessment of Corrective Measures
OGS Ash Pond

Ottumwa Generating Station
Ottumwa, Iowa

Prepared for:

Alliant Energy

SCS ENGINEERS

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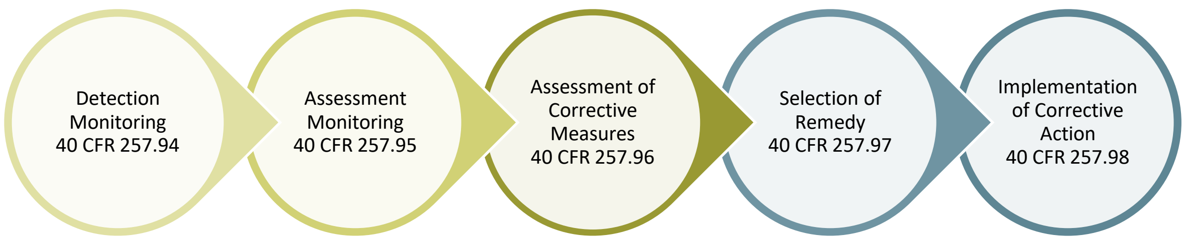
EXECUTIVE SUMMARY

Interstate Power and Light Company (IPL), an Alliant Energy company, operates two ash ponds at the Ottumwa Generating Station (OGS). The ponds are used to manage coal combustion residuals (CCR) and wastewater from the power plant, which burns coal to generate electricity.

IPL samples and tests the groundwater in the area of the ash ponds to comply with U.S. Environmental Protection Agency (USEPA) standards for the Disposal of CCR from Electric Utilities, or the "CCR Rule" (Rule).

Groundwater samples from two of the wells installed to monitor one of the ponds (OGS Ash Pond) contain cobalt at levels higher than the Groundwater Protection Standards (GPS) defined in the Rule. Cobalt occurs naturally and can be present in coal and CCR.

IPL prepared an Assessment of Corrective Measures (ACM) Report in September 2019 response to the groundwater sampling results at the OGS facility. The ACM process is one step in a series of steps defined in the Rule and shown below.



To prepare the ACM, IPL worked to understand the following:

- Types of soil and rock deposits in the area of the OGS facility.
- Depth of groundwater.
- Direction that groundwater is moving.
- Potential sources of the cobalt in groundwater.
- The area where cobalt levels are higher than the USEPA standards.
- The people, plants, and animals that may be affected by levels of cobalt in groundwater that are above the GPS.

Because the time allowed by the Rule to prepare the ACM was limited, IPL has continued work to improve the understanding of the items listed above. Using information obtained between September 2019 and September 2020, IPL selected a remedy and issued a Selection of Remedy Report on September 11, 2020. New information was received following issuance of the Selection of Remedy report, resulting in this addendum to the ACM (Addendum No. 1). Addendum No. 1 includes an update of available site data obtained since the initial ACM was completed and additional Corrective Measures. IPL held a public meeting on June 4, 2020, to discuss the contents of the September 2019 ACM. IPL will hold an additional public meeting with interested and affected parties to discuss the amended ACM and will issue a revised Selection of Remedy report.

IPL has identified appropriate options, or Corrective Measures, to bring the levels of cobalt in groundwater below USEPA standards. In addition to stopping the discharge of CCR and OGS wastewater to the pond, these corrective measures include:

- Cap CCR in Place with Monitored Natural Attenuation (MNA)
- Consolidate CCR and Cap with MNA
- Excavate and Dispose CCR on Site with MNA
- Excavate and Dispose CCR in Off-site Landfill with MNA
- Consolidate and Cap with Chemical Amendment
- Consolidate and Cap with Groundwater Collection
- Consolidate and Cap with Barrier Wall

IPL has also included a "No Action" alternative for comparison purposes only. This alternative will not be selected as a remedy.

Addendum No. 1 includes an updated evaluation that includes all eight options using factors identified in the Rule.

IPL provided a semiannual update in March 2020 on its progress in evaluating Corrective Measures to address the groundwater impacts at OGS. The initial Selection of Remedy report issued in September 2020 also describes progress in evaluating the Corrective Measures.

For more information on Alliant Energy, view our Corporate Responsibility Report at https://poweringwhatsnext.alliantenergy.com/crr/.

1.0 INTRODUCTION AND PURPOSE

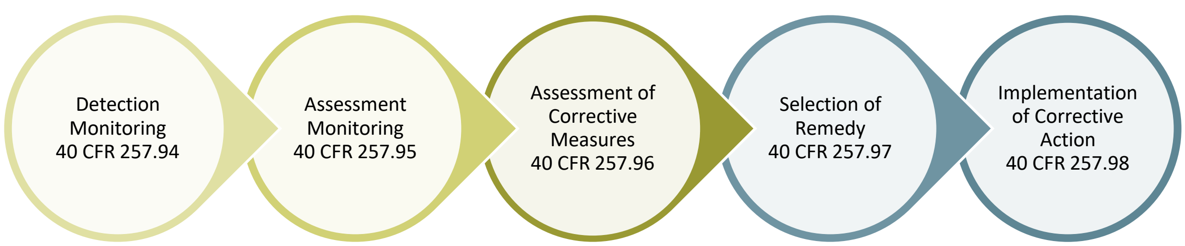
An Assessment of Corrective Measures (ACM) at the Interstate Power and Light Company (IPL) Ottumwa Generating Station (OGS) was prepared to comply with U.S. Environmental Protection Agency (USEPA) regulations regarding the Disposal of Coal Combustion Residuals (CCR) from Electric Utilities [40 CFR 257.50-107], or the "CCR Rule" (Rule). Specifically, the ACM was initiated and this report was prepared to fulfill the requirements of 40 CFR 257.96, including:

- Prevention of further releases
- Remediation of release
- Restoration of affected areas

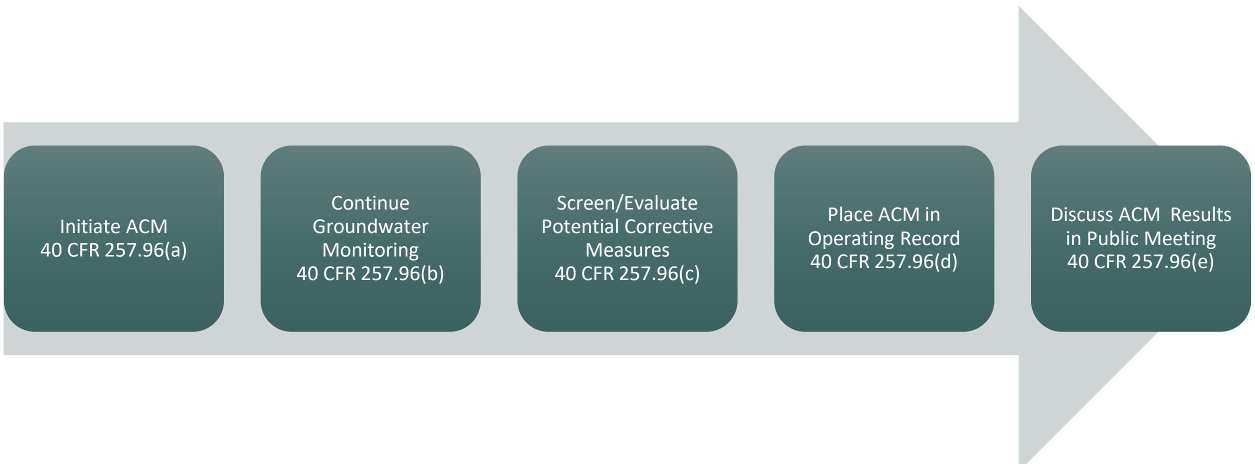
An ACM Report was issued in September 2019 to summarize the remedial alternatives for addressing the Groundwater Protection Standard (GPS) exceedances observed in the October 2018 sampling event for the OGS Ash Pond, and identified in the Notification of Groundwater Protection Standard Exceedance dated January 14, 2019. The September 2019 ACM identified additional information needed to inform the selection of a corrective measure (remedy) for OGS according to 40 CFR 257.97. Using information obtained between September 2019 and September 2020, IPL selected a remedy and issued a Selection of Remedy Report on September 11, 2020. New information was received following issuance of the Selection of Remedy report, resulting in this addendum to the ACM (Addendum No. 1). Addendum No. 1 includes an update of available site data obtained since the initial ACM was completed and additional Corrective Measures. IPL held a public meeting on June 4, 2020, to discuss the contents of the September 2019 ACM. IPL will hold an additional public meeting with interested and affected parties to discuss the amended ACM and will issue a revised Selection of Remedy report.

1.1 ASSESSMENT OF CORRECTIVE MEASURES REQUIREMENTS

As discussed above, Addendum No. 1 was prepared to update the ACM Report developed in response to GPS exceedances observed in groundwater samples collected at the OGS facility. The ACM process is one step in a series of steps defined in the CCR Rule and depicted in the graphic below. To date, IPL has implemented a detection monitoring program per 40 CFR 257.94 and completed assessment monitoring at OGS per 40 CFR 257.95. The September 2019 ACM was required based on the groundwater monitoring results obtained through October 2018. With the ACM completed and now updated with new information, IPL is required to revisit the remedy selection process in 40 CFR 257.97. The remedy selection process must be completed as soon as feasible, and, once selected, IPL is required to start the corrective action process within 90 days.



The process for developing the ACM is defined in 40 CFR 257.96 and is shown in the graphic below. IPL held a public meeting on June 4, 2020, to discuss the September 2019 ACM with interested and affected parties. Additional corrective measure alternatives are identified in Addendum No. 1 that were not discussed at the June 4 meeting. Since IPL is required to discuss the ACM results in a public meeting at least 30 days before selecting a remedy, a second public meeting will be held to discuss the new alternatives. To facilitate the selection of a remedy for the GPS exceedances at OGS, IPL continues to investigate and assess the nature and extent of the groundwater impacts. Information about the site, the groundwater monitoring completed, the groundwater impacts as they are currently understood, and the ongoing assessment activities are discussed in the sections that follow.



1.2 SITE INFORMATION AND MAP

OGS is located southwest of the Des Moines River, approximately 8 miles northwest of the City of Ottumwa in Wapello County, Iowa (**Figure 1**). The address of the plant is 20775 Power Plant Road, Ottumwa, Iowa. In addition to the coal-fired generating station, the property also contains the OGS Ash Pond, the OGS Zero Liquid Discharge (ZLD) Pond, a coal stockpile, and a hydrated fly ash stockpile.

The two CCR units at the facility (OGS Ash Pond and OGS ZLD Pond) are each monitored with single-unit groundwater monitoring systems. The OGS Ash Pond is the subject of this ACM Report.

The pending closure of the OGS Ash Pond was discussed in the IPL Notification of Intent to Close CCR Surface Impoundment, dated April 3, 2019. A map showing the CCR units and all background (or upgradient) and downgradient monitoring wells with identification numbers for the CCR groundwater monitoring program is provided as **Figure 2**.

2.0 BACKGROUND

2.1 REGIONAL GEOLOGIC INFORMATION

The uppermost geologic formation beneath OGS that meets the definition of the "uppermost aquifer," as defined under 40 CFR 257.53, is the Mississippian bedrock aquifer and hydraulically connected overlying unconsolidated sediments. The thickness and water-producing capacity of the unconsolidated material in the area is variable. A summary of the regional hydrogeologic stratigraphy is included in **Attachment A**.

2.2 SITE GEOLOGIC INFORMATION

Monitoring wells MW-301 through MW-306 and MW-305A, MW-310, MW-310A, MW-311, and MW-311A were installed to intersect the uppermost aquifer at the site. Due to variations in the unconsolidated material thickness and the bedrock surface, some wells are screened in unconsolidated material and some are in bedrock. The unconsolidated material at these well locations generally consists of a clay layer overlying clay and sand. The total monitoring well boring depths are between 14 and 79 feet. The depth to bedrock at the site is variable, and the bedrock surface is highly weathered in some areas. Bedrock was encountered as shallow as 7 feet and as deep as 44 feet below ground surface (bgs) in the monitoring well borings. The boring logs for MW-301 through MW-306 and MW-305A, MW-310, MW-310A, MW-311, and MW-311A are included in **Appendix B**.

Shallow and deep groundwater at the site generally flows toward the Des Moines River. The groundwater flow patterns in April and October 2019, and the shallow and deep flow pattern in April 2020 are shown on **Figures 3** through **6**. The groundwater elevation data for the CCR monitoring wells are provided in **Table 1**.

A geologic cross section was prepared for OGS. The cross section line runs through upgradient well MW-301 and downgradient monitoring wells MW-305/MW-305A and MW-310/MW-310A, and crosses the OGS Ash Pond. The cross section location is provided on **Figure 2**, and the geologic cross section is provided on **Figure 3**. Geologic material and estimated water table levels are identified on the cross section.

2.3 CCR RULE MONITORING SYSTEM

The original groundwater monitoring system established in accordance with the CCR Rule consists of one upgradient (background) monitoring well and five downgradient monitoring wells. The upgradient well is MW-301 and the downgradient wells, MW-302 through MW-306 were installed in November and December 2015. Two additional downgradient assessment wells, MW-310 and MW-311 were installed along the Des Moines River in August 2019 to evaluate the downgradient extent of groundwater impacts and groundwater flow direction. Three deeper piezometers, MW-305A, MW-310A, and MW-311A were installed in February and March 2020 to evaluate the vertical components of groundwater impacts and flow. The CCR Rule wells are installed in the uppermost aquifer at the site. Well depths range from approximately 14 to 79 feet bgs.

3.0 NATURE AND EXTENT OF GROUNDWATER IMPACTS

3.1 POTENTIAL SOURCES

The potential sources of groundwater impacts detected in the Ash Pond monitoring system are currently under evaluation. The Closure Plan for CCR Surface Impoundments at OGS issued in September 2016 details the steps to be undertaken to close the OGS Ash Pond by leaving the CCR in place, in accordance with §257.102(b) of the CCR Rule. Based on the Closure Plan, potential sources of groundwater impacts from the Ash Pond CCR unit include the following:

CCR Unit	Potential Sources	Description	Quantity
OGS Ash Pond	CCR	Bottom ash, economizer ash, precipitator fly ash, hydrated fly ash, and pyrites	463,000 CY to this total
	Storm water	Annual precipitation, runoff from surrounding areas	94 AC-FT. (Watershed of 76 acres)
	Low-volume plant wastewater	Discharge from the oil water separator, SCU blowdown, plant drains, cooling tower blowdown, and contact water/leachate from OML	1.62 million gallons per day (MGD)

Note: Storm water volume is calculated based on the watershed area for the OGS Ash Pond and the annual average precipitation for Ottumwa, Iowa, of 37 inches per year. The volume of annual runoff from the surrounding areas that are not open water (58 acres), which are part of the OGS Ash Pond watershed, is estimated using Figure 1. Average Annual Runoff, 1951-1980 from USGS publication Average Annual Runoff in the United States, 1951-80 (Gebert 1987). Figure 1 shows approximately 8.0 inches of runoff from the 58 acres for an estimated 39 acre-feet of storm water annually. The quantity provided for plant wastewater is the average discharge from the ash pond (Outfall 001).

The OGS ZLD Pond is monitored separately from the Ash Pond and is not currently considered a potential source for the groundwater impacts detected in the Ash Pond monitoring system.

3.2 GROUNDWATER ASSESSMENT

3.2.1 Groundwater Depth and Flow Direction

Depth to groundwater as measured in the site CCR monitoring wells varies from 1 to 28 feet bgs due to topographic variations across the facility and seasonal variations in water levels. Groundwater flow at the site is generally to the east-northeast, and the groundwater flow direction and water levels fluctuate seasonally due to the proximity to the river. Groundwater elevations and flow directions are shown on the April and October 2019, and April 2020 potentiometric surface maps (**Figures 3** through **6**)

3.2.2 Groundwater Protection Standard Exceedances Identified

The ACM process was triggered by the detection of cobalt at statistically significant levels exceeding the GPSs in samples from MW-305.

This statistical evaluation of the assessment monitoring results was based on the first four sampling events for the Appendix IV assessment monitoring parameters, including complete sampling events in April, August, and October 2018, and a resampling event for cobalt at selected wells in January 2019. The complete results for these sampling events are summarized in **Table 3**.

For comparison of assessment monitoring data to fixed GPS values, the USEPA's Unified Guidance for Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities (EPA 530-R-09-007, March 2009) recommends the use of confidence intervals. Specifically, the suggested approach for comparing assessment groundwater monitoring data to GPS values based on long-term chronic health risk, such as drinking water Maximum Contaminant Levels (MCLs), is to compare to a lower confidence limit around the arithmetic mean with the fixed GPS.

The calculated lower confidence limit for the means were compared to the cobalt GPS for wells MW-305 and MW-306. Based on these comparisons, a statistically significant exceedance has not occurred for cobalt at MW-306. Monitoring well MW-306 had individual results exceeding the GPS for cobalt, but the exceedances were not determined to be at statistically significant levels.

Lithium was detected above the GPS at new monitoring wells MW-310, MW-310A, and MW-311A. Fluoride was also detected in the deep piezometer MW-311A at a concentration above the GPS in two of the four sampling events. These exceedances have not yet been determined to be statistically significant. Lithium and fluoride concentrations above the GPSs in these three wells are discussed in the technical memorandum provided in Appendix B of the September 2019 ACM, and are most likely due to natural background conditions in the Mississippian bedrock aquifer, rather than a release from the ash pond or other man-made source. Lines of evidence supporting this finding include:

- No lithium or fluoride GPS exceedances have been detected at monitoring wells MW-302, MW-304, MW-305, MW-306, or MW-305A, located adjacent to the OGS Ash Pond, as would be expected if the OGS Ash Pond was the source of elevated fluoride and lithium at wells located further downgradient.

- The lithium and fluoride concentrations detected in samples from MW-310A and MW-311A are well within the range of concentrations naturally present in the Mississippian aquifer based on results from background monitoring wells in the same aquifer at the nearby Ottumwa Midland Landfill (OML) located approximately 5 miles to the east-southeast.

- Analysis of major anions and cations indicates that the water quality in deep piezometers MW-310A and MW-311A is similar to regional water quality for the Mississippian aquifer and different from water quality in the shallower on-site wells.

- Vertical gradients at monitoring well pairs MW-310/MW-310A and MW-311/MW-311A based on water level measurement events in April and October 2020 indicate that groundwater flow is at least intermittently upward from the Mississippian bedrock into the overlying unconsolidated material.

If the lithium and fluoride exceedances are determined to be statistically significant, IPL will be required to either prepare an alternative source demonstration (ASD) or initiate an ACM for these constituents.

Based on the results of assessment monitoring conducted through the April 2019 sampling event, and subsequent sampling rounds in October 2019 and April, June, and October 2020, statistically significant levels exceeding the GPSs were identified for the following well and parameter:

Assessment Monitoring Appendix IV Parameters	Location of GPS Exceedance(s)	Historic Range of Detections at Wells With SSL Above GPS	Groundwater Protection Standard (GPS)
Cobalt (µg/L)	MW-305	14.5-18.	6

µg/L = micrograms per liter

Note: Historic range includes results from assessment monitoring from April 2018 through October 2020.

3.2.3 Expanding the Groundwater Monitoring Network

Monitoring wells MW-310 and MW-311 were installed in the area between the current downgradient wells and the Des Moines River to fulfill the requirements of 40 CFR 257.95(g)(1), which requires additional characterization to support a complete and accurate assessment of corrective measures. The installation of these wells was originally scheduled for spring 2019, but due to state and federal permitting requirements and persistent flooding along the Des Moines River, the installation was delayed. Three deeper piezometers, MW-305A, MW-310A, and MW-311A were installed in February and March 2020 to evaluate the vertical components of groundwater impacts and flow.

3.2.4 Monitored Natural Attenuation Data Collection and Evaluation

An evaluation of the potential for OGS to utilize monitored natural attenuation (MNA) as a corrective action alternative began with the initiation of an ACM at OGS. The tiered analysis approach in the USEPA guidance, "Monitored Natural Attenuation of Inorganic Contaminants in Groundwater, Volume 1 – Technical Basis for Assessment" (USEPA, 2007), is being used as a guide for evaluating MNA as a potential corrective action alternative at OGS.

There are four tiers of analysis to be addressed in evaluating the site for MNA:

1. Demonstrate active contaminant removal from groundwater
2. Determine mechanism and rate of attenuation
3. Determine system capacity and stability of attenuation
4. Design a performance monitoring program and identify an alternative remedy

Data collection activities during the assessment monitoring and ACM process that begins to address the objectives of tiers 1 and 2 include:

- Installation of downgradient assessment wells MW-310 and MW-311 and deeper downgradient piezometers MW-305A, MW-310A, and MW311A to evaluate groundwater flow direction and horizontal and vertical hydraulic gradients.
- Additional groundwater sampling events and analysis of data from all site wells to evaluate contaminant distribution in groundwater and stability of groundwater concentrations over time.
- Analysis of general groundwater chemistry and field parameters in addition to the App III and IV constituents to provide further characterization of groundwater chemistry.
- Analysis of both total and dissolved constituents for selected parameters.

A hydrogeochemical conceptual model and summary of preliminary evaluation of cobalt attenuation in the aquifer at OGS is included in **Appendix C**. Preliminary findings include:

- Cobalt has likely been released from the primary pond to the alluvial aquifer beneath the site.
- Immobilization within the saturated sand is the mechanism that drives natural attenuation of cobalt.
- If cobalt were not attenuated, the 40-year groundwater travel time from the OGS Ash Pond to well MW-310 suggest that cobalt would have already arrived in the approximate 40 year time frame since the primary pond was commissioned if it was not attenuated.

- The cobalt concentration from MW-305 located at the downgradient edge of the primary pond to MW-310, located near the Des Moines River, appears to decrease by a factor of about 60.
- Dilution by mixing with upward flowing deep groundwater at MW-310 may be a factor in the decrease of cobalt concentrations beyond the MW-305 location. Cobalt precipitation, coprecipitation or adsorption likely account for the remaining decrease.
- The groundwater becomes more oxic from the OGS Ash Pond perimeter to MW-310 at the Des Moines River. As the ORP increases, iron precipitates from the water and provides adsorption sites on iron oxyhydroxides for cobalt which is then also removed from the groundwater.
- The iron oxyhydroxides on the aquifer matrix provide potential adsorption sites for the sequestration of cobalt.
- The mass of cobalt in the groundwater where the GPS may be exceeded between MW-305 and MW-310 is estimated at 0.60 kilograms.

A preliminary evaluation of whether the cobalt plume is stable, growing, or decreasing has been completed using a Mann-Kendall trend test. The results of the trend tests are provided in **Appendix D**. No statistically significant increasing or decreasing trends were identified in the results obtained since assessment monitoring was initiated. Additional groundwater sampling rounds that include the deep piezometers are required before a complete evaluation is possible.

Based on the investigations completed to date, evidence of cobalt attenuation by precipitation, coprecipitation, and adsorption is observed making MNA a viable alternative for site remediation. Additional investigation is warranted to increase the understanding of contributing factors to attenuation and to provide the basis for a long term corrective action monitoring program. Recommendations for additional investigation are provided below:

- Install two additional monitoring wells between MW-305 and MW-310 (at ~400-foot spacing) to better define aqueous geochemical trends from the OGS Ash Pond to the Des Moines River. The data will also refine the estimate of cobalt mass in the groundwater downgradient of the OGS Ash Pond.

- Perform additional rounds of groundwater monitoring at the new and existing monitoring wells. In addition to the existing parameters, the following should be added or continued:

  – In-field measurement of pH, ORP, DO, temperature, specific electrical conductance, turbidity, ferrous iron and sulfide; and laboratory analyses of dissolved (0.45 μm filtered) Ca, Mg, Na, K, Fe, Mn, alkalinity (as $CaCO_3$), Cl, SO_4, and TDS to better define the groundwater chemistry and evolution with flow.

  – Laboratory analyses of dissolved (0.45 μm filtered) cobalt to better define the aqueous or “mobile” plume.

  – Laboratory analyses of 0.20 μm filtered cobalt and iron to assess potential adsorption of cobalt to “colloidal” iron.

  – Filtration of turbid groundwater produced by the monitoring wells and analysis of the solid filtrate for aluminum, iron, and cobalt to determine the degree to which the cobalt is associated with suspended solids.

- Continued monitoring of cobalt concentrations over time to determine cobalt migration is completely attenuated or slowed by attenuation.

- Laboratory analyses of the degree of iron precipitation and cobalt coprecipitation and adsorption from MW-305 groundwater with aeration (i.e. redox increase) to better understand the degree to which cobalt adsorption and coprecipitation are contributing to attenuation.

- Collect samples of the saturated sand from the two new well locations and from the area adjacent to MW-305 and MW-310. Analyses of sand would include:

  - Iron and manganese concentrations to assess potential for adsorption.

  - Cobalt concentrations to assess the degree to which cobalt has adsorbed or coprecipitated on to the sand matrix (i.e. defining the "immobile plume").

  - Cobalt adsorption isotherms to assess capacity of the sand to absorb cobalt and determine maximum adsorption capacity.

3.3 CONCEPTUAL SITE MODEL

The following conceptual site model describes the compound and nature of the constituent above the GPS, discusses potential exposure pathways affecting human health and the environment, and presents a cursory review of their potential impacts. The conceptual site model for OGS has been prepared in general conformance with the Standard Guide for Developing Conceptual Site Models for Contaminated Sites (ASTM E1689-95). This conceptual site model is the basis for assessing the efficacy of likely corrective measures to address the source, release mechanisms, and exposure routes.

3.3.1 Nature of Constituent Above Groundwater Protection Standards

The nature and extent of the constituent in groundwater at OGS that is present at a statistically significant concentration greater than the GPS (Cobalt) is described in the September 2019 ACM.

Lithium was detected above the GPS in the new well MW-310, MW-310A, and MW-311A. Fluoride was detected above the GPS in MW-311A. The lithium and fluoride results above the GPS have not yet been determined to be statistically significant and are attributed to natural groundwater quality in the bedrock aquifer; therefore, these constituents are not addressed in the ACM or Addendum No. 1. A discussion of the GPS exceedances is included in **Section 3.2.2** and in Appendix B of the September 2019 ACM.

3.3.2 Potential Receptors and Pathways

As described in **Section 3.3**, ASTM E1689-95 provides a framework for identifying potential receptors (people or other organisms potentially affected by the groundwater impacts at OGS) and pathways (the ways groundwater impacts might reach receptors). In accordance with ASTM E1689-95, we have considered potential human and ecological exposures to groundwater impacted by the constituents identified in **Section 3.2.2**:

Human Health

In general, human health exposure routes to contaminants in the environment include ingestion, inhalation, and dermal contact with the following environmental media:

- Groundwater
- Surface Water and Sediments
- Air
- Soil
- Biota/Food

If people might be exposed to the impacts described in **Section 3.0** via one of the environmental media listed above, a potential exposure route exists and is evaluated further. For the groundwater impacts at OGS, the following potential exposure pathways have been identified with respect to human health:

- Groundwater – Ingestion and Dermal Contact: The potential for ingestion of, or dermal contact with, impacted groundwater from OGS exists if water supply wells are present in the area of impacted groundwater and are used as a potable water supply. Based on a review of the Iowa Department of Natural Resources GeoSam well database, and information provided by OGS:
  - No off-site water supply wells have been identified downgradient or sidegradient in the vicinity of the CCR units.
  - Potable water is not supplied from on-site wells. Potable water at OGS is provided by the Wapello Rural Water Association.

- Surface Water and Sediments – Ingestion and Dermal Contact: The potential for ingestion of or dermal contact with impacted surface water and sediments exists if impacted groundwater from the OGS facility has interacted with adjacent surface water and sediments, to the extent that cobalt is present in these media at concentrations that represent a risk to human health.

- Biota/Food – Ingestion: The potential for ingestion of impacted food exists if impacted groundwater from the OGS facility has interacted with elements of the human food chain. Elements of the food chain may also be exposed indirectly through groundwater-to-surface water interactions.

Based on the lack of groundwater exposure, only the surface water, sediment, and biota/food exposure pathways were retained for further consideration in the September 2019 ACM. Groundwater samples collected from the piezometer nests installed downgradient of the OGS Ash Pond and adjacent to the Des Moines River do not contain cobalt at a concentration above the GPS. None of the additional information obtained since the September 2019 ACM suggests that cobalt is reaching the new wells, and samples indicate that elevated concentrations of cobalt are only present near the pond. Therefore, cobalt does not appear to be migrating to a location where it can impact human health or the environment. In other words, there is no pathway for exposure to cobalt. Implementation of potential corrective measures may introduce secondary exposure pathways that are discussed in **Section 6.0** and will be evaluated further as a corrective measure is selected for OGS.

Ecological Health

In addition to human exposures to impacted groundwater, potential ecological exposures are also considered. If ecological receptors might be exposed to impacted groundwater, the potential exposure routes are evaluated further. Ecological receptors include living organisms, other than humans, the habitat supporting those organisms, or natural resources potentially adversely affected by CCR impacts. This includes:

- Transfer from an environmental media to animal and plant life. This can occur by bioaccumulation, bioconcentration, and biomagnification.
  - Bioaccumulation is the general term describing a process by which chemicals are taken up by a plant or animal either directly from exposure to impacted media (soil, sediment, water) or by eating food containing the chemical.
  - Bioconcentration is a process in which chemicals are absorbed by an animal or plant to levels higher than the surrounding environment.
  - Biomagnification is a process in which chemical levels in plants or animals increase from transfer through the food web (e.g., predators have greater concentrations of a particular chemical than their prey).
- Benthic invertebrates within adjacent waters.

Based on the information available and presented in the September 2019 ACM, both of these ecological exposure routes required additional evaluation at the time.

Both potential ecological exposure pathways require groundwater-to-surface water interactions for the exposure pathway to be complete. As discussed above, none of the additional information obtained since the September 2019 ACM suggests that cobalt is reaching the new wells, and samples indicate that elevated concentrations of cobalt are only present near the pond. Therefore, cobalt does not appear to be migrating to a location where it can impact ecological health.

The surface water/sediment, biota/food, and ecological exposure assessment is incomplete as the extent of groundwater impacts is still being evaluated. If groundwater impacts extend to the river, then these exposure pathways will be evaluated further.

4.0 POTENTIAL CORRECTIVE MEASURES

In this section, we identify potential corrective measures to meet the ACM goals identified in 40 CFR 257.96(a), which are to:

- Prevent further releases
- Remediate releases
- Restore affected areas to original conditions

The development of corrective measure alternatives is described further in the following sections. Corrective measure alternatives developed to address the groundwater impacts at OGS are described in **Section 5.0**. The alternatives selected are qualitatively evaluated in **Section 6.0**.

4.1 IDENTIFICATION OF CORRECTIVE MEASURES

As described in the USEPA Solid Waste Disposal Facility Criteria Technical Manual (USEPA 1998), corrective measures generally include up to three components, including:

- Source Control
- Containment
- Restoration

Within each component, there are alternative measures that may be used to accomplish the component objectives. The measures from one or more components are then combined to form corrective measure alternatives (discussed in **Section 5.0**) intended to address the observed groundwater impacts. Potential corrective measures were identified based on site information available during development of the ACM for the purpose of meeting the goals described in **Section 4.0**.

Each component and associated corrective measures are further identified in subsequent paragraphs. The corrective measures are evaluated for feasibility and combined to create the corrective action alternatives identified in this section, and further evaluated in **Section 5.0**. We continue to evaluate site conditions and may identify additional corrective measures based on new information regarding the nature and extent of the impacts.

4.1.1 Source Control

The source control component of a corrective measure is intended to identify and locate the source of impacts and provide a mechanism to prevent further releases from the source. For the OGS site, the sources to be controlled are the CCR materials in the OGS Ash Pond and the associated process water. Each of the source control measures below require closure of the impoundment, and for waste water to be re-directed from the CCR unit to eliminate the flows that may mobilize constituents from the CCR and transport them to groundwater. We have identified the following potential source control measures:

- **Close and cap in place.** Close the OGS Ash Pond and cap the CCR in place to reduce the infiltration of rain water into the impoundment, and prevent transport of CCR constituents from unsaturated CCR materials into the groundwater, and minimize the potential for CCR to interface with groundwater.

- **Consolidate and cap.** Consolidate CCR from the OGS Ash Pond into one or two areas to reduce the cap area exposed to infiltration, reduce the potential source footprint, prevent transport of CCR constituents from unsaturated CCR materials into the groundwater, and reduce the potential for CCR to interface with groundwater.

- **Consolidate and cap with chemical stabilization.** Consolidate CCR into one or two areas to reduce the cap area exposed to infiltration, reduce the potential source footprint, prevent transport of CCR constituents from unsaturated CCR materials into the groundwater, and minimize the potential for CCR to interface with groundwater. Mix a chemical amendment into CCR in-situ prior to placing additional CCR for consolidation and mix the amendment into CCR as it is excavated and placed for consolidation to reduce the mobility of select CCR constituents in the environment. Chemical stabilization may include the use of one or multiple admixtures that serve to physically and/or chemically stabilize the constituents of concern within the CCR. Physically, this may include solidification with cementitious or polymeric materials. Chemically, this may include precipitation or alteration to render cobalt less mobile in the environment. Evaluation of an appropriate high organic carbon commodity amendment, that may include activated carbon, biochar, locally available aged mulch, and/or proprietary chemicals such as PlumeStop, will occur during the remedy selection process.

- **Excavate and create on-site disposal area.** Excavate and place CCR in a newly lined landfill area on site to prevent further releases from the OGS Ash Pond and isolate the CCR from potential groundwater interactions. Cap the new landfill with final cover to prevent the transport of CCR constituents from unsaturated CCR.

- **Excavate and dispose at a licensed off-site disposal area.** Remove all CCR from the OGS Ash Pond and haul it to a licensed landfill to prevent further releases from the CCR areas.

Water movement through the CCR materials is the mechanism for CCR impacts to groundwater, including surface water that moves vertically through the CCR materials via infiltration of precipitation and surface water runoff. Groundwater can move horizontally through the CCR material in areas where CCR material is at an elevation that is below the water table. Source control measures have been considered to prevent "vertical" migration of water through the CCR via cap and cover systems and potential contact with groundwater.

Based on the available information for this site, all the source control measures have potential to prevent further releases caused by infiltration, thus are retained for incorporation into alternatives for further evaluation.

In conjunction with the ongoing evaluation of MNA mechanisms and site attenuation capacity, chemical stabilization has been added as a source control alternative. Additional source control may be needed to address CCR that could be in contact with groundwater after closure in place, or if further investigation indicates that MNA mechanisms are not sufficient for reaching the groundwater quality objectives at OGS or the site does not have the attenuation capacity to reduce groundwater concentrations of cobalt below the GPS.

4.1.2 Containment

The objective of containment is to limit the spread of the impacts beyond the source. The need for containment depends on the nature and extent of impacts, exposure pathways, and risks to receptors. Containment may also be implemented in combination with restoration as described in **Section 4.1.3**.

Containment may be a recommended element of a corrective measure if needed to:

- Prevent off-site migration of groundwater impacts
- Cease completion of an exposure pathway (e.g., water supply well)

Containment may also be used in lieu of active restoration if an active approach is needed but treatment is not warranted by the aquifer characteristics including:

- Water in the affected aquifer is naturally unsuited for human consumption.
- Contaminants present in low concentration with low mobility.
- Low potential for exposure to contaminants and low risk associated with exposure.
- Low transmissivity and low future user demand.

The following measures have potential to limit the spread of continued or remaining groundwater impacts:

- **Gradient Control with Pumping.** Gradient control includes a measure to alter the groundwater velocity and direction to slow or isolate impacts. This can be accomplished with pumping wells and/or a trench/sump collection system. If groundwater pumping is considered for capturing an impacted groundwater plume, the impacted groundwater must be managed in conformance with all applicable Federal and State requirements.

- **Gradient Control with Phytotechnology.** Gradient control with phytotechnology relies on the ability of vegetation to evapotranspire sources of surface water and groundwater. Water interception capacity by the aboveground canopy and subsequent evapotranspiration through the root system can limit vertical migration of water from the surface downward. The horizontal migration of groundwater can be controlled or contained using deep-rooted species, such as prairie plants and trees, to intercept, take up, and transpire the water. Trees classified as phreatophytes are deep-rooted, high-transpiring, water-loving organisms that send their roots into regions of high moisture and can survive in conditions of temporary saturation.

- **Chemical Stabilization.** Stabilization refers to processes that involve chemical reactions that reduce the leachability of cobalt. Stabilization chemically immobilizes impacts or reduces their solubility through a chemical reaction. The desired results of stabilization methods include converting metals into a less soluble, mobile, or toxic form.

- **Containment Walls.** Containment walls can be applied in two ways. First, a wall that creates a physical barrier to the flow of groundwater to limit the movement of constituents of concern in groundwater. Second, a passive barrier installed to intercept the flow of groundwater and constructed with a reactive media designed to adsorb, precipitate, or degrade groundwater constituents to limit their movement in the environment (FRTR 2020).

Based on the currently available information for this site, active MNA mechanisms including precipitation, coprecipitation, and adsorption of cobalt are observed. The assessment of the site capacity to attenuate the cobalt impacts to groundwater is ongoing. Active containment may be needed to address CCR that could be in contact with groundwater after closure in place, or if further investigation indicates that MNA mechanisms are not sufficient for reaching the groundwater quality objectives at OGS or the site does not have the attenuation capacity to reduce groundwater concentrations of cobalt below the GPS.

4.1.3 Restoration

Restoration is the process through which groundwater quality is restored to meet GPSs. This can be accomplished by way of MNA or intensively addressed by groundwater treatment with or without extraction.

MNA can be a viable remedy or component of a remedial alternative for groundwater impacted with metals. MNA requires ongoing involvement and potentially intense characterization of the geochemical environment to understand the attenuation processes involved, and to justify reliance on them and regular, long-term monitoring to ensure the attenuation processes are meeting remedial goals.

MNA is not a “do-nothing” alternative; rather it is an effective knowledge-based remedy where a thorough engineering analysis provides the basis for understanding, monitoring, predicting, and documenting natural processes. To properly employ this remedy, there needs to be a strong scientific basis supported by appropriate research and site-specific monitoring implemented in accordance with quality controls. The compelling evidence needed to support proper evaluation of the remedy requires that the processes that lower metal concentrations in groundwater be well understood.

If active treatment is implemented, water may be treated in-situ, on site, or off site. The need for active treatment depends on the nature and extent of impacts, potential exposure pathways, and current and anticipated future risks to receptors. If there are no receptors or if the risks are acceptably low, then MNA is an appropriate option. If existing or future risks require a more rapid restoration of groundwater quality, then active restoration may be needed.

Treated groundwater may be re-injected, sent to a local publicly owned treatment works (POTW), or discharged to a local body of surface water, depending on local, state, and federal requirements. Typical on-site treatment practices for metals include coagulation and precipitation, ion exchange, or reverse osmosis. Off-site wastewater treatment may include sending the impacted groundwater that is extracted to a local POTW or to a facility designed to treat the contaminants of concern.

The removal rate of groundwater constituents such as cobalt will depend on the rate of groundwater extraction, the cation exchange capacity of the soil, and partition coefficients of the constituents sorbed to the soil. As the concentration of metals in groundwater is reduced, the rate at which constituents become partitioned from the soil to the aqueous phase may also be reduced. The amount of flushing of the aquifer material required to remove the metals and reduce their concentration in groundwater below the GPS will generally determine the time frame required for restoration. This time frame is site-specific.

In-situ methods may be appropriate, particularly where pump and treat technologies may present adverse effects. In-situ methods may include the introduction of a chemical amendment to adsorb, precipitate, or degrade a contaminant or biological restoration requiring pH control, addition of specific micro-organisms, and/or addition of nutrients and substrate to augment and encourage degradation by indigenous microbial populations. Bioremediation requires laboratory treatability studies and pilot field studies to determine the feasibility and the reliability of full-scale treatment.

Based on current available information, active MNA mechanisms at OGS have been identified, but are still being refined along with the capacity of the site to attenuate the cobalt impacts to groundwater. Other restoration measures have been included in this addendum to increase the breadth of alternatives evaluated and available for consideration during the remedy selection process. These additional alternatives are discussed in **Section 5.0**.

5.0 CORRECTIVE MEASURE ALTERNATIVES

We have preliminarily identified the following corrective measure alternatives for the groundwater impacts at OGS:

- Alternative 1 – No Action
- Alternative 2 – Close and Cap in Place and MNA
- Alternative 3 – Consolidate On Site and Cap with MNA
- Alternative 4 – Excavate and Dispose On Site with MNA
- Alternative 5 – Excavate and Dispose Off Site with MNA

- Alternative 6 – Consolidate and Cap with Chemical Amendment
- Alternative 7 – Consolidate and Cap with Groundwater Collection
- Alternative 8 – Consolidate and Cap with Barrier Wall

These alternatives were developed by selecting components from the reasonable and appropriate corrective measures components discussed above. With the exception of the No Action alternative, each of the corrective measure alternatives meet the requirements in 40 CFR 257.97(b)(1) through (5) based on the information available at the current time. We may identify additional alternatives based on the continued evaluation of site conditions.

5.1 ALTERNATIVE 1 – NO ACTION

IPL is committed to implementing corrective measures as required under the Rule, and the No-Action alternative is included as a baseline condition and a point of comparison for the other alternatives. The consideration of this alternative assumes the monitoring of groundwater continues under this action.

5.2 ALTERNATIVE 2 – CLOSE AND CAP IN PLACE WITH MONITORED NATURAL ATTENUATION

Alternative 2 includes closing the OGS Ash Pond (no further discharge), covering the CCR materials with a cap, and establishing vegetation in accordance with the requirements for closure in place in 40 CFR 257.102(d). This measure is consistent with landfill cover systems to prevent infiltration of surface water into the CCR as described in **Section 4.1.1**. The capped areas will be subject to enhanced groundwater monitoring via MNA.

This alternative eliminates CCR sluicing/plant process water discharges and, with the installation of a cap, will reduce infiltration through the CCR. This is expected to address the major contributor to the observed GPS exceedances, which is exposure of CCR material to precipitation/surface water infiltration. Further leaching of metals and migration within groundwater will be reduced and may be eliminated over time. MNA is included with this alternative to monitor changes in groundwater impacts and the effectiveness of degradation mechanisms on groundwater concentrations over time.

5.3 ALTERNATIVE 3 – CONSOLIDATE ON SITE AND CAP WITH MONITORED NATURAL ATTENUATION

Alternative 3 includes closing the OGS Ash Pond (no further discharge), relocating and consolidating CCR into a smaller footprint within the CCR surface impoundments, covering the CCR materials with a cap, and establishing vegetation in accordance with the requirements for closure in place in 40 CFR 257.102(d). This measure is consistent with landfill cover systems to prevent infiltration of surface water into the CCR as described in **Section 4.1.1**. The consolidated and capped areas will be subject to enhanced groundwater monitoring via MNA.

This alternative eliminates CCR sluicing/plant process water discharges and, with the consolidation of the CCR footprint and the installation of a cap, will reduce infiltration through the CCR. This is expected to address the major contributor to the observed GPS exceedances, which is exposure of CCR material to precipitation/surface water infiltration. Consolidation of CCR into a smaller footprint during closure also reduces the volume of potential source materials that may be in contact with groundwater after closure. Further leaching of metals and migration within groundwater will be reduced and may be eliminated over time. MNA is included with this alternative to monitor changes in groundwater impacts and the effectiveness of degradation mechanisms on groundwater concentrations over time.

5.4 ALTERNATIVE 4 – EXCAVATE AND DISPOSE ON SITE WITH MONITORED NATURAL ATTENUATION

Alternative 4 includes closing the OGS Ash Pond (no further discharge), excavation of CCR from the OGS Ash Pond, and creation of a new on-site disposal area with a liner and cap system. This alternative will serve to entomb the CCR from the OGS Ash Pond and allow for the collection and management of liquids generated from the disposal area. Further releases from the OGS Ash Pond will be prevented by the use of engineering controls constructed/installed to meet the design criteria for new CCR landfills required under 40 CFR 257.70.

This alternative eliminates CCR sluicing/plant process water discharges and, with the consolidation of the CCR footprint and the installation of a new on-site disposal area liner and cap, will reduce infiltration through the CCR. This is expected to address the major contributor to the observed GPS exceedances, which is exposure of CCR material to precipitation/surface water infiltration. MNA is included with this alternative to monitor changes in groundwater impacts and the effectiveness of degradation mechanisms on groundwater concentrations over time.

5.5 ALTERNATIVE 5 – EXCAVATE AND DISPOSE OFF SITE WITH MONITORED NATURAL ATTENUATION

Alternative 5 includes closing the OGS Ash Pond (no further discharge), excavation of all CCR from the OGS Ash Pond, and transport to an approved off-site landfill. Further on-site releases from the OGS Ash Pond will be prevented by removing the source material from the site, which eliminates the potential for ongoing leaching of constituents into groundwater at OGS.

This alternative eliminates CCR sluicing/plant process water discharges and, with the removal of CCR from the site, will eliminate infiltration through the CCR. This is expected to address the major contributor to the observed GPS exceedances, which is exposure of CCR material to precipitation/ surface water infiltration. MNA is included with this alternative to monitor changes in groundwater impacts and the effectiveness of degradation mechanisms on groundwater concentrations over time.

5.6 ALTERNATIVE 6 – CONSOLIDATE AND CAP WITH CHEMICAL AMENDMENT

Alternative 6 includes closing the OGS Ash Pond (no further discharge), adding a chemical amendment to in-place CCR and relocated CCR to reduce the mobilization of cobalt prior to relocating and consolidating CCR into a smaller footprint within the CCR surface impoundments, covering the CCR materials with a cap, and establishing vegetation in accordance with the requirements for closure in place in 40 CFR 257.102(d). This measure is consistent with landfill cover systems to prevent infiltration of surface water into the CCR and the reduced contaminant mobilization achieved by chemical amendment as described in **Section 4.1.1**.

This alternative eliminates CCR sluicing/plant process water discharges and, with the consolidation of the CCR footprint and the installation of a cap, will reduce infiltration through the CCR. This is expected to address the major contributor to the observed GPS exceedances, which is exposure of

CCR material to precipitation/surface water infiltration. Consolidation of CCR into a smaller footprint during closure also reduces the volume of potential source materials that may be in contact with groundwater after closure. Further leaching of metals and migration within groundwater will be reduced by minimizing the footprint of CCR in contact with groundwater and by fixation using a chemical amendment.

5.7 ALTERNATIVE 7 – CONSOLIDATE AND CAP WITH GROUNDWATER COLLECTION

Alternative 7 includes closing the OGS Ash Pond (no further discharge), relocating and consolidating CCR into a smaller footprint within the CCR surface impoundments, covering the CCR materials with a cap, and establishing vegetation in accordance with the requirements for closure in place in 40 CFR 257.102(d). This measure is consistent with landfill cover systems to prevent infiltration of surface water into the CCR as described in **Section 4.1.1**. Impacted groundwater will be collected using pumps and treated prior to discharge according to state and federal requirements as described in **Section 4.1.2.**

This alternative eliminates CCR sluicing/plant process water discharges and, with the consolidation of the CCR footprint and the installation of a cap, will reduce infiltration through the CCR. This is expected to address the major contributor to the observed GPS exceedances, which is exposure of CCR material to precipitation/surface water infiltration. Consolidation of CCR into a smaller footprint during closure also reduces the volume of potential source materials that may be in contact with groundwater after closure. Further leaching of metals and migration within groundwater will be reduced and may be eliminated over time as impacted groundwater is collected to contain and restore cobalt concentrations in groundwater to levels below the GPS.

5.8 ALTERNATIVE 8 – CONSOLIDATE AND CAP WITH BARRIER WALL

Alternative 8 includes closing the OGS Ash Pond (no further discharge), relocating and consolidating CCR into a smaller footprint within the CCR surface impoundments, covering the CCR materials with a cap, and establishing vegetation in accordance with the requirements for closure in place in 40 CFR 257.102(d). This measure is consistent with landfill cover systems to prevent infiltration of surface water into the CCR as described in **Section 4.1.1**. Impacted groundwater will be intercepted with a barrier wall to minimize the migration of cobalt as described in **Section 4.1.2**.

This alternative eliminates CCR sluicing/plant process water discharges and, with the consolidation of the CCR footprint and the installation of a cap, will reduce infiltration through the CCR. This is expected to address the major contributor to the observed GPS exceedances, which is exposure of CCR material to precipitation/surface water infiltration. Consolidation of CCR into a smaller footprint during closure also reduces the volume of potential source materials that may be in contact with groundwater after closure. Further leaching of metals and migration within groundwater will be reduced and may be eliminated over time as impacted groundwater is intercepted with a barrier wall to minimize the spread of cobalt in groundwater.

6.0 EVALUATION OF CORRECTIVE MEASURE ALTERNATIVES

As required by 40 CFR 257.96(c), the following sections provide an evaluation of the effectiveness of corrective measure alternatives in meeting the requirements and objectives outlined in 40 CFR 257.97. The evaluation addresses the requirements and objectives identified in 40 CFR 257.96(c)(1) through (3), which include:

- The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to residual contamination;

- The time required to begin and complete the remedy; and

- The institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy.

In addition to the discussion of the items listed above, **Table 5** provides a summary of the initial evaluation of the alternatives including each of the criteria listed in 40 CFR 257.97.

6.1 ALTERNATIVE 1 – NO ACTION

As described in **Section 5.1**, the No Action alternative is only included as a baseline condition and a point of comparison for the other alternatives. This alternative does not satisfy all five criteria in 40 CFR 257.97(b)(1) through (5), so it is not an acceptable corrective measure under the CCR Rule. For comparison only, Alternative 1 is evaluated with regard to the criteria in 40 FR 257.96(c) below:

- **Performance, Reliability, Implementation, and Impacts.**
  - Performance – The ability to attain the GPS for cobalt without any additional action is unlikely.
  - Reliability – Alternative 1 does not provide any reduction in existing risk.
  - Implementation – Nothing is required to implement Alternative 1.
  - Impacts – No additional safety or cross-media impacts are expected with Alternative 1. This alternative does not control current suspected routes of exposure to residual contamination.

- **Timing.** No time is required to begin. However, the time required to attain the GPS for cobalt under Alternative 1 is unknown.

- **Institutional Requirements.** No institutional requirements beyond maintaining current regulatory approvals exist for Alternative 1.

6.2 ALTERNATIVE 2 – CLOSE AND CAP IN PLACE WITH MONITORED NATURAL ATTENUATION

As described in **Section 5.2**, Alternative 2 includes closing the OGS Ash Pond, covering the CCR materials with a cap, and establishing vegetation in accordance with the requirements for closure in place in 40 CFR 257.102(d).

- **Performance, Reliability, Implementation, and Impacts.**
  - Performance – Ceasing wastewater discharges and closing the impoundments by capping is expected to address infiltration, which is a key contributor to groundwater impacts. MNA monitoring will identify, if active, the natural attenuation processes that reduce mass, toxicity, mobility, volume, or concentrations of the constituents of concern in groundwater. Alternative 2 is capable of and expected to attain the GPS for cobalt.

- Reliability – The expected reliability of capping is good. Capping is a common practice and standard remedial method for closure in place in remediation and solid waste management. There is significant industry experience with the design and construction of this method.

- Implementation – The complexity of constructing the cap is low. Dewatering will be required to the extent a suitable subgrade is established for cap construction, which can likely be achieved through standard dewatering methods. The cap construction may put a high demand on the local supply of suitable cap materials. The local availability of cap materials will be evaluated further during remedy selection. The equipment and personnel required to implement Alternative 2 are not specialized and are generally readily available.

- Impacts – Safety impacts associated with the implementation of Alternative 2 are not significantly different than other heavy civil construction projects. Cross-media impacts are expected to be limited due to the small volume of CCR expected to be relocated on site, the short duration of cap construction, the effectiveness of standard engineering controls during construction (e.g., dust control), and the lack of off-site transportation of CCR. Although the risk to surface water receptors is already low and ending wastewater discharges and capping the impoundment minimizes infiltration (a significant source of water and CCR interaction), the potential for interaction between CCR in the impoundment and groundwater after closure will need to be evaluated. The ease of implementation and low-impact nature of MNA as a groundwater restoration method must be evaluated against the effectiveness of passive groundwater restoration, which is the subject of ongoing evaluations. An insufficient MNA mechanism, insufficient site attenuation capacity, or changes in groundwater conditions may require additional action to restore groundwater or prevent cross-media impacts between groundwater and surface water. The potential for exposure to residual contamination is low since CCR will be capped.

- **Timing.** Closure of the OGS Ash Pond can be completed within 1 to 2 years of remedy selection. At OGS, the closure of the OGS Ash Pond is expected to be complete by August 15, 2023. The time required to attain the GPS for cobalt will be evaluated further during the remedy selection process, but is expected to take between 2 and 10 years after closure construction is complete. Alternative 2 can provide full protection within the 30-year post-closure monitoring period.

- **Institutional Requirements.** The following permits and approvals are expected to be required to implement Alternative 2:
  - Iowa Department of Natural Resources (IDNR) Closure Permit
  - State and local erosion control/construction storm water management permits

6.3 ALTERNATIVE 3 – CONSOLIDATE ON SITE AND CAP WITH MONITORED NATURAL ATTENUATION

As described in **Section 5.3**, Alternative 3 includes closing the OGS Ash Pond, relocating and consolidating CCR into a smaller footprint within the CCR surface impoundments, covering the CCR materials with a cap, and establishing vegetation in accordance with the requirements for closure in place in 40 CFR 257.102(d).

- **Performance, Reliability, Implementation, and Impacts.**
  - Performance – Ceasing wastewater discharges and closing the impoundments by capping is expected to address infiltration, which is a key contributor to groundwater impacts. The consolidation of CCR into a smaller footprint may enhance the performance of the cap by further reducing the area exposed to limited post-construction infiltration through the cap. The smaller closure footprint also reduces the potential for ongoing CCR contact with groundwater. MNA monitoring will identify, if active, the natural attenuation processes that reduce mass, toxicity, mobility, volume, or concentrations of the constituents of concern in groundwater. Alternative 3 is capable of and expected to attain the GPS for cobalt.

  - Reliability – The expected reliability of capping is good. Capping is a common practice and standard remedial method for closure in place in remediation and solid waste management. There is significant industry experience with the design and construction of this method. A consolidated cap footprint may enhance reliability by reducing the scale of post-closure maintenance.

  - Implementation – The complexity of constructing the cap is low. The logistics of moving CCR around the site to consolidate the closure footprint increases the complexity of the alternative. CCR dewatering will be required to the extent required to excavate and relocate CCR within the CCR impoundments and provide a suitable subgrade for cap construction. Some conditioning (e.g., drying) of relocated CCR is expected during on-site re-disposal. Alternative 3 can likely be achieved through standard dewatering and conditioning methods. Although the cap footprint will be minimized, cap construction may put a high demand on the local supply of suitable cap materials. The local availability of cap materials will be evaluated further during remedy selection. The equipment and personnel required to implement Alternative 3 are not specialized and are generally readily available.

  - Impacts – Safety impacts associated with the implementation of Alternative 3 are not significantly different than other heavy civil construction projects. The level of disturbance required to consolidate CCR before capping may represent some increase in safety risk due to site conditions and on-site construction traffic. Cross-media impacts are expected to be limited due to the small volume of CCR expected to be relocated on site, the short duration of cap construction, the effectiveness of standard engineering controls during construction (e.g., dust control), and the lack of off-site transportation of CCR. Although the risk to surface water receptors is already low and ending wastewater discharges and capping the impoundment minimizes infiltration (a significant source of water and CCR interaction), the potential for interaction between CCR in the impoundment and groundwater after closure will need to be evaluated. The consolidation of CCR prior to capping under Alternative 3 reduces the potential for CCR and groundwater interaction after closure. The ease of implementation and low-impact nature of MNA as a groundwater restoration method must be evaluated against the effectiveness of passive groundwater restoration, which is the subject of ongoing evaluations. An insufficient MNA mechanism, insufficient site attenuation capacity, or changes in groundwater conditions may require additional action to restore groundwater or prevent cross-media impacts between groundwater and surface water. The potential for exposure to residual contamination is low since CCR will be capped and the footprint of the cap minimized.

- **Timing.** Closure of the OGS Ash Pond can be completed within 1 to 2 years of remedy selection. At OGS, the closure of the OGS Ash Pond is expected to be complete by August 15, 2023. The time required to attain the GPS for cobalt will be evaluated further during the remedy selection process, but is expected to take between 2 and 10 years after closure construction is complete. The level of source disturbance during construction may increase the time required to reach GPS. The consolidation of CCR into a smaller cap area may decrease the time to reach GPS. Alternative 3 can provide full protection within the 30-year post-closure monitoring period.

- **Institutional Requirements.** The following permits and approvals are expected to be required to implement Alternative 3:
  - IDNR Closure Permit
  - State and local erosion control/construction storm water management permits

6.4 ALTERNATIVE 4 – EXCAVATE AND DISPOSE ON SITE WITH MONITORED NATURAL ATTENUATION

As described in **Section 5.4**, Alternative 4 includes closing the OGS Ash Pond, excavation of CCR from the source area, and creation of a new on-site disposal area that meets the design criteria for new CCR landfills required under 40 CFR 257.70

- **Performance, Reliability, Implementation, and Impacts.**
  - Performance – Ceasing wastewater discharges and closing the OGS Ash Pond by removing and re-disposing CCR in a new lined/capped disposal area is expected to address infiltration, which is a key contributor to groundwater impacts. The consolidation of CCR into a smaller footprint may enhance the performance of the cap by further reducing the area exposed to limited post-construction infiltration through the cap. The separation from groundwater and other location criteria for the new on-site disposal facility may enhance the performance of this alternative. MNA monitoring will identify, if active, the natural attenuation processes that reduce mass, toxicity, mobility, volume, or concentrations of the constituents of concern in groundwater. Alternative 4 is capable of and expected to attain the GPS for cobalt.

  - Reliability – The expected reliability of on-site re-disposal with a composite liner and cap is good. Disposal facilities that meet the requirements in 40 CFR 257.70 or other similar requirements have been used for solid waste disposal including municipal and industrial waste for numerous years. There is significant industry experience with the design and construction of similar disposal facilities. The composite liner and cover, combined with a consolidated disposal footprint, may enhance reliability by reducing infiltration and the scale of post-closure maintenance. At the same time, post-closure maintenance is likely more complex due to maintenance of a leachate collection system and geosynthetic repairs requiring specialized personnel, material, and equipment.

  - Implementation – The complexity of constructing the new liner and cap is moderate due to the composite design. The limited area available at the facility for developing an on-site disposal facility makes this alternative logistically complex. Significant volumes of CCR will be excavated and stored on site while the disposal facility is constructed. Significant dewatering will be required to excavate and relocate CCR to a temporary storage area. Conditioning (e.g., drying) of relocated CCR is expected to facilitate temporary storage and on-site re-disposal. Alternative 4 can likely be achieved through standard dewatering and conditioning methods, but may be impacted by the space available for these activities. Although the post-closure CCR footprint will be minimized, composite liner and cap construction may put a high demand on the local supply of suitable cap materials. The local availability of liner and cap materials will be evaluated further during remedy selection. The equipment and personnel required to implement Alternative 4 are not specialized and are generally readily available, with the exception of the resources needed to install the geosynthetic portions of the composite liner and cover, which are not locally available.

  – Impacts – Safety impacts associated with the implementation of Alternative 4 are not significantly different than other heavy civil construction projects. However, the level of disturbance required to excavate, store, and re-dispose CCR on site and the traffic required to import composite liner and cap material are not typical and likely represent an increase in safety risk due to site conditions, on-site construction traffic, and incoming/outgoing off-site construction traffic. A risk of cross-media impacts is possible due to the large volume of CCR to be excavated, stored, and relocated on site. Although the risk to surface water receptors is already low, Alternative 4 significantly reduces the potential interaction between CCR and water after closure. The ease of implementation and low-impact nature of MNA as a groundwater restoration method must be evaluated against the effectiveness of passive groundwater restoration, which is the subject of ongoing evaluations. An insufficient MNA mechanism, insufficient site attenuation capacity, or changes in groundwater conditions may require additional action to restore groundwater or prevent cross-media impacts between groundwater and surface water. The potential for exposure to residual contamination is low since CCR will be capped and the footprint of the cap minimized.

- **Timing.** Closure of the OGS Ash Pond can be completed within 1 to 2 years of remedy selection. At OGS, the closure of the OGS Ash Pond is expected to be complete by August 15, 2023. However, the time required to permit and develop the on-site disposal facility may extend this schedule. The time required to attain the GPS for cobalt will be evaluated further during the remedy selection process, but is expected to take between 2 and 10 years after closure construction is complete. The level of source disturbance during construction may increase the time required to reach GPS. The consolidation of CCR into a new on-site disposal facility with a composite liner and cap may decrease the time to reach GPS. Alternative 4 can provide full protection within the 30-year post-closure monitoring period.

- **Institutional Requirements.** The following permits and approvals are expected to be required to implement Alternative 4:
  – IDNR Closure Permit
  – IDNR Disposal Facility (Landfill) Permit
  – State and local erosion control/construction storm water management permits

6.5 ALTERNATIVE 5 – EXCAVATE AND DISPOSE OFF SITE WITH MONITORED NATURAL ATTENUATION

As described in **Section 5.5**, Alternative 5 includes closing the OGS Ash Pond, excavation of CCR from the source area, and transporting the CCR off site for disposal.

- **Performance, Reliability, Implementation, and Impacts.**
  - Performance – Ceasing wastewater discharges and closing the OGS Ash Pond by removing and re-disposing CCR off site will eliminate the source material exposed to infiltration, which is a key contributor to groundwater impacts. The off-site disposal of CCR prevents further releases at OGS, but introduces the possibility of releases at the receiving facility. MNA monitoring will identify, if active, the natural attenuation processes that reduce mass, toxicity, mobility, volume, or concentrations of the constituents of concern in groundwater. Alternative 5 is capable of and expected to attain the GPS for cobalt.

  - Reliability – The expected reliability of excavation and off-site disposal is good. Off-site disposal facilities are required to meet the requirements in 40 CFR 257.70 or other similar requirements, which have been used for solid waste disposal including municipal and industrial waste for numerous years. There is significant industry experience with the design and construction of these disposal facilities.

  - Implementation – The complexity of excavating CCR for off-site disposal is low. The scale of CCR excavation (expected to exceed 450,000 cy), off-site transportation, and the permitting/development of off-site disposal facility airspace makes this alternative logistically complex. Significant dewatering will be required to excavate CCR. Conditioning (e.g., drying) of excavated CCR is expected to facilitate off-site transportation and re-disposal. Alternative 5 can likely be achieved through standard dewatering and conditioning methods, but may be impacted by the space available for these activities. Although the source area at OGS is eliminated, the development of off-site disposal airspace will put a high demand on the receiving disposal facility, which may not have the current physical or logistical capacity to receive large volumes of CCR in a short period of time. The equipment and personnel required to implement on-site and off-site aspects of Alternative 5 are not specialized and are generally readily available, with the exception of the resources needed to install the geosynthetic portions of the off-site composite liner and cover, which are not locally available.

  - Impacts – Safety impacts associated with the implementation of Alternative 5 are not significantly different than other heavy civil construction projects. However, the level of disturbance required to excavate, transport, and re-dispose CCR and the traffic required to import composite liner and cap material at the receiving disposal facility are not typical and likely represent an increase in safety risk due to large volumes of incoming/outgoing off-site construction traffic at both sites. A risk of cross-media impacts is possible due to the large volume of CCR to be excavated and transported from the site. Although the risk to surface water receptors is already low, Alternative 5 nearly eliminates the potential interaction between CCR and water after closure. The ease of implementation and low-impact nature of MNA as a groundwater restoration method must be evaluated against the effectiveness of passive groundwater restoration, which is the subject of ongoing evaluations. An insufficient MNA mechanism, insufficient site attenuation capacity, or changes in groundwater conditions may require additional action to restore groundwater or prevent cross-media impacts between groundwater and surface water. The potential for exposure to residual contamination on site is very low since CCR will be removed; however, the off-site potential for exposure to CCR is increased due to the relocation of the source material.

- **Timing.** Closure of the OGS Ash Pond can be completed within 1 to 2 years of remedy selection. At OGS, the closure of the OGS Ash Pond is expected to be complete by August 15, 2023. However, the time required to secure the off-site disposal airspace required to complete this alternative, including potential procurement, permitting, and construction, may extend this schedule significantly. The time required to attain the GPS for cobalt will be evaluated further during the remedy selection process, but is expected to take between 2 and 10 years after closure construction is complete. The level of source disturbance during construction may increase the time required to reach GPS. The removal of CCR from OGS may decrease the time to reach GPS. Alternative 5 can provide full protection within the 30-year post-closure monitoring period.

- **Institutional Requirements.** The following permits and approvals are expected to be required to implement Alternative 5:
  - IDNR Closure Permit
  - Depending on the off-site disposal facility, approval of off-site disposal facility owner or landfill permit for new off-site facility
  - State and local erosion control/construction storm water management permits
  - Transportation agreements and permits (local roads and railroads)

  Depending on the off-site disposal facility, state solid waste comprehensive planning approvals may also be required.

6.6 ALTERNATIVE 6 – CONSOLIDATE AND CAP WITH CHEMICAL AMENDMENT

As described in **Section 5.6**, Alternative 6 includes closing the OGS Ash Pond, relocating and consolidating CCR into a smaller footprint within the CCR surface impoundments, adding a chemical amendment to the CCR to reduce the mobilization of cobalt prior to relocating, covering the CCR materials with a cap, and establishing vegetation in accordance with the requirements for closure in place in 40 CFR 257.102(d).

- **Performance, Reliability, Implementation, and Impacts.**
  - Performance – Ceasing wastewater discharges and closing the impoundment by capping is expected to address infiltration, which is a key contributor to groundwater impacts. The consolidation of CCR into a smaller footprint may enhance the performance of the cap by further reducing the area exposed to limited post-construction infiltration through the cap. The smaller closure footprint also reduces the potential for ongoing CCR contact with groundwater. The application of a chemical amendment to the CCR that will remain on site may further reduce the potential for ongoing groundwater impacts after closure. Although the risk to surface water receptors is already low, the potential for CCR to interact with groundwater will remain after closure. Alternative 6 further reduces the potential for ongoing groundwater impacts from that interaction between CCR and water. If needed to address changes in groundwater conditions or prevent cross-media impacts between

groundwater and surface water, the initial application of a chemical amendment during closure can be supplemented with additional applications in the future outside of capped area. Alternative 6 is capable of and expected to attain the GPS for cobalt.

– Reliability – The expected reliability of capping is good. Capping is a common practice and standard remedial method for closure in place in remediation and solid waste management. There is significant industry experience with the design and construction of this method. A consolidated cap footprint may enhance reliability by reducing the scale of post-closure maintenance. Based on a review of information in the Federal Remediation Technologies Roundtable (FRTR) Technology Screening Matrix, amending source material using site-specific chemistries can be an effective means of sequestering metals to limit the future release to groundwater from residual source material. The technology can be applied to source material and groundwater plumes. The approach has been used at full scale to remediate inorganics (FRTR 2020).

– Implementation – The complexity of constructing the cap is low. The logistics of moving CCR around the site to consolidate the closure footprint increases the complexity of the alternative. CCR dewatering will be required to the extent required to excavate and relocate CCR within the CCR impoundments and provide a suitable subgrade for cap construction. Some conditioning (e.g., drying) of relocated CCR is expected during on-site re-disposal. So long as an appropriate amendment chemistry can be identified for OGS, the technology and equipment used for the in-situ application or mixing as part of excavation/consolidation activities is commercially available. Alternative 6 can likely be achieved through standard dewatering and conditioning methods. Although the cap footprint will be minimized, cap construction may put a high demand on the local supply of suitable cap materials. The local availability of cap materials will be evaluated further during remedy selection. The equipment and personnel required to implement the consolidation and capping portion of Alternative 6 are not specialized and are generally readily available. However, the equipment for the in-situ chemical amendment application is more specialized and may be in high demand.

– Impacts – Safety impacts associated with the implementation of Alternative 6 are not significantly different than other heavy civil construction projects. The level of disturbance required to consolidate CCR before capping may represent some increase in safety risk due to site conditions and on-site construction traffic. Some elevated risk may exist due to the use of and application of amendment chemistry, but can likely be addressed with additional worker protective measures. Cross-media impacts are expected to be limited due to the small volume of CCR expected to be relocated on site, the short duration of cap construction, the effectiveness of standard engineering controls during construction (e.g., dust control), and the lack of offsite transportation of CCR. Although the risk to surface water receptors is already low based on available data, the additional source control provided by Alternative 6 may offer further reduction of risks if groundwater conditions change. The potential for exposure to residual contamination is low since the CCR will be chemically stabilized, capped, and the footprint of the cap minimized.

- **Timing.** Closure of the OGS Ash Pond can be completed within 1 to 2 years of remedy selection. At OGS, the closure of the OGS Ash Pond is expected to be complete by

August 15, 2023. The time required to attain the GPS for cobalt will be evaluated further during the remedy selection process, but is expected to take between 2 and 10 years after closure construction is complete. The level of source disturbance during construction may increase the time required to reach GPS. The consolidation of CCR into a smaller cap area may decrease the time to reach GPS. Alternative 6 can provide full protection within the 30-year post-closure monitoring period.

- **Institutional Requirements.** The following permits and approvals are expected to be required to implement Alternative 6:
  - IDNR Closure Permit
  - Federal, state, and local floodplain permits
  - Injection permits
  - State and local erosion control/construction stormwater management permits
  - Federal and state wetland permitting may also be required

6.7 ALTERNATIVE 7 – CONSOLIDATE AND CAP WITH GROUNDWATER COLLECTION

As described in **Section 5.7**, Alternative 7 includes closing the OGS Ash Pond, relocating and consolidating CCR into a smaller footprint within the CCR surface impoundments, covering the CCR materials with a cap, establishing vegetation in accordance with the requirements for closure in place in 40 CFR 257.102(d), and installing a groundwater pump and treat system to prevent the migration of and/or recover groundwater with cobalt concentrations greater than the GPS.

- **Performance, Reliability, Implementation, and Impacts.**
  - Performance – Ceasing wastewater discharges and closing the impoundment by capping is expected to address infiltration, which is a key contributor to groundwater impacts. The consolidation of CCR into a smaller footprint may enhance the performance of the cap by further reducing the area exposed to limited post-construction infiltration through the cap. The groundwater pump and treat system may further reduce the potential for down-gradient migration of groundwater impacts after closure. Although the risk to surface water receptors is already low, the potential for CCR to interact with groundwater will remain after closure. Alternative 7 further reduces the risk of potential ongoing groundwater impacts from that interaction between CCR and water. The groundwater pump and treat system offers additional flexibility to address changes in groundwater conditions or prevent cross-media impacts between groundwater and surface water. Alternative 7 is capable of and expected to attain the GPS for cobalt.

  - Reliability – The expected reliability of capping is good. Capping is a common practice and standard remedial method for closure in place in remediation and solid waste management. There is significant industry experience with the design and construction of this method. A consolidated cap footprint may enhance reliability by reducing the scale of post-closure maintenance. Similar to capping, groundwater pump and treat is a common method used to limit the migration of impacted groundwater or remove impacted groundwater to restore groundwater concentrations to levels below the GPS.

  - Implementation – The complexity of constructing the cap is low. The logistics of moving CCR around the site to consolidate the closure footprint increases the complexity of the alternative. CCR dewatering will be required to the extent required to excavate and relocate CCR within the CCR impoundments and provide a suitable subgrade for cap construction. Some conditioning (e.g., drying) of relocated CCR is expected during on-site re-disposal. The complexity of the groundwater pump and treat system is also low. Alternative 7 can likely be achieved through standard dewatering and conditioning methods. Although the cap footprint will be minimized, cap construction may put a high demand on the local supply of suitable cap materials. The local availability of cap materials will be evaluated further during remedy selection. The equipment and personnel required to implement Alternative 7 are not specialized and are generally readily available. The development, operation, maintenance and monitoring of adequate treatment for large volumes of groundwater with relatively low concentrations of cobalt likely increases the complexity of implementing this alternative.

– Impacts – Safety impacts associated with the implementation of Alternative 7 are not significantly different than other heavy civil construction projects. The level of disturbance required to consolidate CCR before capping may represent some increase in safety risk due to site conditions and on-site construction traffic. Some elevated risk may exist due to the additional construction involved with the groundwater pump and treat system and the higher complexity of the long term maintenance required. Cross-media impacts are expected to be limited due to the small volume of CCR expected to be relocated on site, the short duration of cap construction, the effectiveness of standard engineering controls during construction (e.g., dust control), and the lack of offsite transportation of CCR. Although the risk to surface water receptors is already low based on available data, the active nature of the groundwater plume containment provided by Alternative 7 may offer further reduction of risks if groundwater conditions change. The potential for exposure to residual contaminated source material is low since CCR will be capped and the footprint of the cap minimized. The potential exposure to contaminated groundwater is increased due to the ex-situ groundwater treatment required and the potential for worker exposure and spills.

- **Timing.** Closure of the OGS Ash Pond can be completed within 1 to 2 years of remedy selection. At OGS, the closure of the OGS Ash Pond is expected to be complete by August 15, 2023. The time required to attain the GPS for cobalt will be evaluated further during the remedy selection process, but is expected to take between 2 and 10 years after closure construction is complete. The level of source disturbance during construction may increase the time required to reach GPS. The additional time required to design and install the groundwater pump and treat system is unlikely to have a significant impact on the implementation timing but may reduce the time required to attain the GPS. The consolidation of CCR into a smaller cap area may decrease the time to reach GPS. Alternative 7 can provide full protection within the 30-year post-closure monitoring period.

- **Institutional Requirements.** The following permits and approvals are expected to be required to implement Alternative 7:
  – IDNR Closure Permit
  – Federal, state, and local floodplain permits
  – State and local well installation permits
  – NPDES permitting for post-treatment groundwater discharges

- State and local erosion control/construction stormwater management permits
- Federal and state wetland permitting may also be required

6.8 ALTERNATIVE 8 – CONSOLIDATE AND CAP WITH BARRIER WALL

As described in **Section 5.8**, Alternative 8 includes closing the OGS Ash Pond, relocating and consolidating CCR into a smaller footprint within the CCR surface impoundments, covering the CCR materials with a cap, establishing vegetation in accordance with the requirements for closure in place in 40 CFR 257.102(d), and installing a downgradient barrier wall to prevent the migration of groundwater with lithium and molybdenum concentrations greater than the GPS.

- **Performance, Reliability, Implementation, and Impacts.**
  - Performance – Ceasing wastewater discharges and closing the impoundment by capping is expected to address infiltration, which is a key contributor to groundwater impacts. The consolidation of CCR into a smaller footprint may enhance the performance of the cap by further reducing the area exposed to limited post-construction infiltration through the cap. The barrier wall may further reduce the potential for ongoing groundwater impacts after closure. Although the risk to surface water receptors is already low, the potential for CCR to interact with groundwater will remain after closure. Alternative 8 further reduces the risk of potential ongoing groundwater impacts from that interaction between CCR and water. Although it acts passively, the barrier wall reduces the risk from a more passive groundwater restoration approach such as MNA if MNA mechanisms are not active, the site has insufficient site attenuation capacity, or groundwater conditions change in a way that increases the potential for cross-media impacts between groundwater and surface water. Alternative 8 is capable of and expected to attain the GPS for lithium and molybdenum.

    Reliability – The expected reliability of capping is good. Capping is a common practice and standard remedial method for closure in place in remediation and solid waste management. There is significant industry experience with the design and construction of this method. A consolidated cap footprint may enhance reliability by reducing the scale of post-closure maintenance. A barrier wall at OGS will likely have to consist of a permeable reactive barrier (PRB) due to the lack of an impermeable layer to key a low permeability barrier wall into. In general the reliability of PRBs for containment of inorganics is favorable based on information available in the FRTR Technology Screening Matrix (FRTR 2020). The reliability of a PRB requires the identification of a suitable reactive media for the conditions at OGS and the ability to effectively locate the barrier, which are both likely but require additional evaluations. PRB performance can diminish over time as consumptive media is exhausted or hydraulic conditions change due to chemical precipitation or biofouling. Long-term monitoring and maintenance is required to ensure continued performance.

  - Implementation – The complexity of constructing the cap is low. The logistics of moving CCR around the site to consolidate the closure footprint increases the complexity of the alternative. CCR dewatering will be required to the extent required to excavate and relocate CCR within the CCR impoundments and provide a suitable subgrade for cap construction. Some conditioning (e.g., drying) of relocated CCR is expected during on-site re-disposal. The complexity of the PRB wall significantly increases the level of complexity for implementing this alternative. PRB installation contractors and equipment have lengthy procurement timelines. Alternative 8 can likely be achieved through standard dewatering and conditioning methods. Although the cap footprint will be minimized, cap construction may put a high demand on the local supply of suitable cap materials. The equipment and personnel required to implement the consolidation and capping portion of Alternative 8 are not specialized and are generally readily available. However, the equipment for the barrier wall is more specialized and may be in high demand.

  - Impacts – Safety impacts associated with the implementation of Alternative 8 are not significantly different than other heavy civil construction projects. The level of disturbance required to consolidate CCR before capping may represent some increase in safety risk due to site conditions and on-site construction traffic. Some elevated risk may exist due to the additional construction involved with the barrier wall construction and the higher complexity of the long term barrier wall performance monitoring. Cross-media impacts are expected to be limited due to the small volume of CCR expected to be relocated on site, the short duration of cap construction, the effectiveness of standard engineering controls during construction (e.g., dust control), and the lack of offsite transportation of CCR. Although the risk to surface water receptors is already low based on available data, the enhanced nature of the passive groundwater plume containment provided by Alternative 8 may offer further reduction of risks if groundwater conditions change. The potential for exposure to residual contaminated source material is low since CCR will be capped and the footprint of the cap minimized.

- **Timing.** Closure of the OGS Ash Pond can be completed within 1 to 2 years of remedy selection. At OGS, the closure of the OGS Ash Pond is expected to be complete by August 15, 2023. The time required to attain the GPS for cobalt will be evaluated further during the remedy selection process, but is expected to take between 2 and 10 years after closure construction is complete. The level of source disturbance during construction may increase the time required to reach GPS. The additional time required to design and install the barrier wall is unlikely to have a significant impact on the implementation timing but may reduce the time required to attain the GPS. The consolidation of CCR into a smaller cap area may decrease the time to reach GPS. Alternative 8 can provide full protection within the 30-year post-closure monitoring period.

- **Institutional Requirements.** The following permits and approvals are expected to be required to implement Alternative 8:
  - IDNR Closure Permit
  - Federal, state, and local floodplain permits
  - State and local well installation permits
  - State and local erosion control/construction stormwater management permits
  - Federal and state wetland permitting may also be required

7.0 SUMMARY OF ASSESSMENT

An initial qualitative assessment of the advantages and disadvantages of each Corrective Measure Alternative presented in **Section 4.0** is provided in **Table 5.** Each of the identified Corrective Measure Alternatives exhibits both favorable and unfavorable outcomes with respect to the assessment criteria. In accordance with 40 CFR 257.97(c), the facility must consider all of the evaluation factors and select a remedy that meets the standards of 257.97(b) as soon as feasible.

We continue to advance additional data collection efforts to identify the appropriate corrective action measure for the Site. We will continue to update **Table 5** and develop a quantitative scoring matrix to identify a preferred corrective action.

8.0 REFERENCES

Federal Remediation Technologies Roundtable (FRTR), (2020), Technology Screening Matrix https://frtr.gov/matrix/default.cfm, Accessed November 17-19, 2020.

United States Environmental Protection Agency (USEPA), (1998) "Solid Waste Disposal Facility Criteria Technical Manual (EPA530-R-93-017), Revised April 13, 1998." Solid Waste and Emergency Response.

USEPA (2007). "Monitored Natural Attenuation of Inorganic Contaminants in Groundwater, Volume 1 – Technical Basis for Assessment, (EPA600-R-07-139). Office of Research and Development, National Risk Management Laboratory, Ada, Oklahoma.

USEPA (2018). Federal Register Volume 83, Number 146, p. 36443-36445, Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Amendments to the National Minimum Criteria (Phase One, Part One). July 30, 2018.

W.A. Gebert, David J. Graczyk, and William R. Krug (1987), Average Annual Runoff in the United States, 1951-80, USGS Hydrologic Atlas 710.

Tables

Table 1. Groundwater Elevations - CCR Rule Monitoring Well Networks
IPL - Ottumwa Generating Station / SCS Engineers Project #25220083.00

Depth to Water in feet below top of well casing/reference elevation														
Raw Data	**MW-301**	**MW-302**	**MW-303**	**MW-304**	**MW-305**	**MW-305A**	**MW-306**	**MW-307**	**MW-308**	**MW-309**	**MW-310**	**MW-310A**	**MW-311**	**MW-311A**	**River at Intake**
Measurement Date															
April 26, 2016	3.83	18.27	8.65	27.47	22.24	NI	12.61				NI	NI	NI	NI	NI
June 23, 2016	4.05	18.25	8.18	26.31	21.55	NI	12.83				NI	NI	NI	NI	NI
August 9, 2016	4.36	18.38	9.31	29.05	23.13	NI	13.12				NI	NI	NI	NI	NI
October 26-27, 2016	4.59	18.23	8.90	27.81	22.54	NI	13.26				NI	NI	NI	NI	NI
January 18-19, 2017	4.96	18.44	9.33	28.34	23.04	NI	13.58	8.75	7.97	8.28	NI	NI	NI	NI	NI
April 19-20, 2017	4.48	17.55	6.50	25.36	20.64	NI	12.78	3.94	4.30	4.78	NI	NI	NI	NI	NI
June 20-21, 2017	4.72	18.25	8.65	28.09	22.65	NI	13.53	7.71	7.13	7.34	NI	NI	NI	NI	NI
August 21-23, 2017	5.35	18.77	10.49	30.45	24.91	NI	14.70	11.78	12.27	13.12	NI	NI	NI	NI	NI
November 8, 2017	5.09	18.50	9.73	29.81	24.15	NI	14.43	10.19	10.40	10.74	NI	NI	NI	NI	NI
April 18, 2018	5.10	18.19	8.60	27.29	22.92	NI	14.55	7.90	7.48	7.29	NI	NI	NI	NI	NI
May 30, 2018	NM	NM	NM	NM	NM	NI	NM	5.11	4.34	3.96	NI	NI	NI	NI	NI
June 28, 2018	NM	NM	NM	NM	NM	NI	NM	4.69	3.96	3.47	NI	NI	NI	NI	NI
July 18, 2018	NM	NM	NM	NM	NM	NI	NM	5.29	4.72	4.25	NI	NI	NI	NI	NI
August 14-15, 2018	5.72	17.85	8.50	26.49	22.35	NI	14.81	NM	NM	NM	NI	NI	NI	NI	NI
August 29, 2018	5.54	18.01	6.00	25.02	NM	NI	NM	NM	NM	NM	NI	NI	NI	NI	NI
October 16, 2018	4.13	16.99	4.90	24.64	20.54	NI	13.23	3.43	NM	3.33	NI	NI	NI	NI	NI
January 8, 2019	4.41	17.87	6.42	26.56	21.78	NI	13.63	NM	NM	NM	NI	NI	NI	NI	NI
April 8, 2019	3.94	16.67	5.52	23.51	19.90	NI	12.51	2.66	1.69	1.39	NI	NI	NI	NI	NI
August 28, 2019	NM	NM	NM	NM	NM	NI	NM	NM	NM	NM	17.65	NI	12.08	NI	NI
October 23-24, 2019	3.56	13.76	7.21	25.13	20.70	NI	12.19	5.67	4.08	3.66	9.32	NI	6.38	NI	NI
December 11, 2019	NM	NM	NM	NM	NM	NI	NM	7.97	8.00	7.70	NM	NI	NM	NI	NI
February 5, 2020	3.33	NM	NM	NM	NM	NI	NM	7.68	5.27	6.60	13.92	NI	9.18	NI	NI
March 12-13, 2020	3.81	NM	NM	NM	22.50	32.39	NM	NM	NM	NM	13.18	40.09	10.00	29.43	NI
April 1, 2020	3.36	16.9	5.18	24.27	23.32	28.98	12.34	3.8	3.51	3.71	7.54	8.77	4.83	5.27	6.6
April 13-14, 2020	3.38	17.45	6.99	26.42	21.47	30.34	12.76	6.90	5.30	5.75	12.72	10.43	7.39	5.12	10.6
May 4, 2020	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
June 30, 2020	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	5.81	NM
October 5-12, 2020	4.29	18.10	10.70	29.89	24.10	36.02	13.29	11.38	12.54	13.44	20.17	17.73	15.45	12.45	NM

Ground Water or Surface Water Elevation in feet above mean sea level (amsl)															
Well Number	**MW-301**	**MW-302**	**MW-303**	**MW-304**	**MW-305**	**MW-305A**	**MW-306**	**MW-307**	**MW-308**	**MW-309**	**MW-310**	**MW-310A**	**MW-311**	**MW-311A**	**River at Intake**
Top of Well Casing Elevation / Surface Water Reference Elevation (feet amsl)	686.63	673.90	661.07	682.84	683.91	684.03	683.47	657.56	655.39	654.94	658.63	657.93	654.18	653.54	656.31
Screen Length (ft)	10.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA
Total Depth (ft from top of casing)	17.0	25.8	17.5	52.3	51.5	81.91	36.6	28.0	25.0	27.5	25.9	55.55	17.9	47.68	NA
Top of Well Screen Elevation (ft)	679.63	653.10	648.57	635.54	637.41	607.12	651.87	634.56	635.39	632.44	637.76	607.38	641.24	610.86	NA
Measurement Date															
April 26, 2016	682.80	655.63	652.42	655.37	661.67	NI	670.86	NI	NI	NI	NI	NI	NI	NI	NI
June 23, 2016	682.58	655.65	652.89	656.53	662.36	NI	670.64	NI	NI	NI	NI	NI	NI	NI	NI
August 9, 2016	682.27	655.52	651.76	653.79	660.78	NI	670.35	NI	NI	NI	NI	NI	NI	NI	NI
October 26-27, 2016	682.04	655.67	652.17	655.03	661.37	NI	670.21	NI	NI	NI	NI	NI	NI	NI	NI
January 18-19, 2017	681.67	655.46	651.74	654.50	660.87	NI	669.89	648.81	647.42	646.66	NI	NI	NI	NI	NI
April 19-20, 2017	682.15	656.35	654.57	657.48	663.27	NI	670.69	653.62	651.09	650.16	NI	NI	NI	NI	NI
June 20-21, 2017	681.91	655.65	652.42	654.75	661.26	NI	669.94	649.85	648.26	647.60	NI	NI	NI	NI	NI
August 21-23, 2017	681.28	655.13	650.58	652.39	659.00	NI	668.77	645.78	643.12	641.82	NI	NI	NI	NI	NI
November 8, 2017	681.54	655.40	651.34	653.03	659.76	NI	669.04	647.37	644.99	644.20	NI	NI	NI	NI	NI
April 18, 2018	681.53	655.71	652.47	655.55	660.99	NI	668.92	649.66	647.91	647.65	NI	NI	NI	NI	NI
May 30, 2018	NM	NM	NM	NM	NM	NI	NM	652.45	651.05	650.98	NI	NI	NI	NI	NI
June 28, 2018	NM	NM	NM	NM	NM	NI	NM	652.87	651.43	651.47	NI	NI	NI	NI	NI
July 18, 2018	NM	NM	NM	NM	NM	NI	NM	652.27	650.67	650.69	NI	NI	NI	NI	NI
August 14-15, 2018	680.91	656.05	652.57	656.35	661.56	NI	668.66	NM	NM	NM	NI	NI	NI	NI	NI
August 29, 2018	681.09	655.89	655.07	657.82	NM	NI	NM	NM	NM	NM	NI	NI	NI	NI	NI
October 16, 2018	682.50	656.91	656.17	658.20	663.37	NI	670.24	654.13	NM	651.61	NI	NI	NI	NI	NI
January 8, 2019	682.22	656.03	654.65	656.28	662.13	NI	669.84	NM	NM	NM	NI	NI	NI	NI	NI
April 8, 2019	682.69	657.23	655.55	659.33	664.01	NI	670.96	654.90	653.70	653.55	NI	NI	NI	NI	NI
August 28, 2019	NM	NM	NM	NM	NM	NI	NM	NM	NM	NM	640.98	NI	642.10	NI	NI
October 23-24, 2019	683.07	660.14	653.86	657.71	663.21	NI	671.28	651.89	651.31	651.28	649.31	NI	647.80	NI	NI
December 11, 2019	NM	NM	NM	NM	NM	NI	NM	649.59	647.39	647.24	NM	NI	NM	NI	NI
February 5, 2020	683.30	NM	NM	NM	NM	NI	NM	649.88	650.12	648.34	644.71	NI	645.00	NI	NI
March 12-13, 2020	682.82	NM	NM	NM	661.41	651.64	NM	NM	NM	NM	645.45	617.84	644.18	624.11	NI
April 1, 2020	683.27	657.00	655.89	658.57	660.59	655.05	671.13	653.76	651.88	651.23	651.09	649.16	649.35	648.27	649.71
April 13-14, 2020	683.25	656.45	654.08	656.42	662.44	653.69	670.71	650.66	650.09	649.19	645.91	647.50	646.79	648.42	645.71
May 4, 2020	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
June 30, 2020	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	647.73	NM
October 5-12, 2020	682.34	655.80	650.37	652.95	659.81	648.01	670.18	646.18	642.85	641.50	638.46	640.20	638.73	641.09	NM
Bottom of Well Elevation (ft)	669.63	648.10	643.57	630.54	632.41	602.12	646.87	629.56	630.39	627.44	632.76	602.38	636.24	605.86	--

Notes:
NM = not measured
NI = not installed

Created by: KAK   Date: 5/1/2017
Last rev. by: SK   Date: 11/24/2020
Checked by: EJN   Date: 11/24/2020
Proj Mgr QA/QC: TK   Date: 11/25/2020

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Table 2. CCR Rule Groundwater Samples Summary
Ottumwa Generating Station / SCS Engineers Project #25220083.00

Sample Dates	Downgradient Wells										Background Well
	MW-302	MW-303	MW-304	MW-305	MW-305A	MW-306	MW-310	MW-310A	MW-311	MW-311A	MW-301
4/26/2016	B	B	B	B	NI	B	NI	NI	NI	NI	B
6/23/2016	B	B	B	B	NI	B	NI	NI	NI	NI	B
8/10-11/2016	B	B	B	B	NI	B	NI	NI	NI	NI	B
10/26-27/2016	B	B	B	B	NI	B	NI	NI	NI	NI	B
1/18/2017	B	B	B	B	NI	B	NI	NI	NI	NI	B
4/19/2017	B	B	B	B	NI	B	NI	NI	NI	NI	B
6/20-21/2017	B	B	B	B	NI	B	NI	NI	NI	NI	B
8/22-23/2017	B	B	B	B	NI	B	NI	NI	NI	NI	B
11/8/2017	D	D	D	D	NI	D	NI	NI	NI	NI	D
4/18/2018	A	A	A	A	NI	A	NI	NI	NI	NI	A
8/14-15/2018	A	A	A	A	NI	A	NI	NI	NI	NI	A
8/29/2018	A-R	A-R	A-R	--	NI	--	NI	NI	NI	NI	A-R
10/16/2018	A	A	A	A	NI	A	NI	NI	NI	NI	A
1/8/2019	A-R	A-R	A-R	A-R	NI	A-R	NI	NI	NI	NI	A-R
4/8/2019	A	A	A	A	NI	A	NI	NI	NI	NI	A
10/24/2019	A	A	A	A	NI	A	A	NI	A	NI	A
2/5/2020	--	--	--	--	NI	--	A	NI	A	NI	A
3/13/2020	--	--	--	A-R	A	--	A-R	A	A-R	A	A
4/14/2020	A	A	A	A	A	A	A	A	A	A	A
6/30/2020	--	--	--	--	--	--	--	--	--	A-R	--
10/8/2020	A	A	A	A	A	A	A	A	A	A	A

Abbreviations:
B = Background Sample Event
D = Detection Monitoring Sampling Event
-- = Not Applicable
A = Assessment Monitoring Sampling Event
A-R = Assessment Monitoring Resampling Event
NI - Not Installed

Created by: NDK Date: 1/8/2018
Last revision by: SK Date: 11/24/2020
Checked by: EJN Date: 11/24/2020

I:\25220083.00\Deliverables\ACM Addendum\Tables\[2_GW_Samples_Summary_Table_OGS.xlsx]GW Summary

Table 3. Groundwater Analytical Results Summary - CCR Program - Assessment Monitoring
Ottumwa Generating Station Ash Pond / SCS Engineers Project #25220083.00

Parameter Name	UPL Method	UPL	GPS	Background Well MW-301 11/8/2017	4/18/2018	8/14/2018, 8/29/2018 ^	10/16/2018, 1/8/2019 ^^	4/8/2019	10/24/2019	2/5/2020	3/12/2020	4/14/2020	10/8/2020	Compliance Wells MW-302 11/8/2017	4/18/2018	8/14/2018, 8/29/2018 ^	10/16/2018, 1/8/2019 ^^	4/8/2019	10/24/2019	4/14/2020	10/8/2020
Appendix III																					
Boron, ug/L	P	820		488	480	735	410	380	680	540	--	700	650 F1	1,320	1,200	1,240	1,100	1,340	1,200	1,200	1300
Calcium, mg/L	P	78.7		65.2	63.0	72.5	47.2	43	78	68	--	84	94	183	177	185	146	199	180	180	180
Chloride, mg/L	P	86.8		59.8	63.4	63.1	33.9	50	110	120	--	140	170	254	246	259	214	240	220	220	230
Fluoride, mg/L	P	0.484		0.27	0.22	0.27	0.3	0.44 J	<0.23	--	--	<0.23	<0.23	0.20 J	0.26	0.26	0.24	<0.23	<0.23	<0.23	<0.23 ^
Field pH, Std. Units	P	6.87		6.41	6.41	6.26	6.27	6.61	6.33	6.39	6.48	6.58	6.22	6.55	6.47	6.76	6.37	6.61	6.55	6.7	7.00
Sulfate, mg/L	P	199		178	186	181	164	81	130	130	--	140	140	786	899	847	785	840	810	790	840
Total Dissolved Solids, mg/L	P	628		448	514	532	392	340	510	570	--	550	660	1,620	1,690	1,840	1,400	1,600	1,600	1,500	1700
Appendix IV		**UPL**	**GPS**																		
Antimony, ug/L	P*	0.22	6	NA	<0.026	0.20 J	<0.078	<0.53	<0.53	--	--	<0.58	<0.51	--	<0.026	<0.15	0.26 J,B	<0.53	<0.53	<0.58	<0.51
Arsenic, ug/L	P*	0.53	10	NA	0.074 J	0.29 J	0.16 J	<0.75	<0.75	<0.88	--	<0.88	<0.88	--	0.16 J	0.30 J	1.9	<0.75	<0.75	<0.88	<0.88
Barium, ug/L	P	68.8	2,000	NA	31.6	44.5	28.1	25	56	43	--	54	58	--	17.7	18.3	28.9	19	21	23	18
Beryllium, ug/L	DQ	DQ	4	NA	<0.012	0.14 J	<0.089	<0.27	<0.27	--	--	<0.27	--	--	<0.012	<0.12	0.22 J	<0.27	<0.27	<0.27	--
Cadmium, ug/L	NP*	0.12	5	NA	0.023 J	0.16 J	<0.033	<0.077	0.040	<0.039	--	<0.039	0.0075 J	--	0.22 J	0.21 J	0.67	0.21 J	0.20	0.23	0.2
Chromium, ug/L	P	1.07	100	NA	<0.054	0.25 J	0.11 J,B	<0.98	<0.98	<1.1	--	<1.1	<1.1	--	0.46 J	0.48 J	1.6	<0.98	<0.98	1.4 J	<1.1
Cobalt, ug/L	NP	4.1	6	NA	0.46 J	1.4	0.36 J,B	0.44 J	0.60	1.1	0.43 J	0.52	0.41 J	--	0.90 J	1.50	4.0	1.2	2.7	5.3	1.5
Fluoride, mg/L	P	0.48	4	NA	0.22	0.27	0.3	0.44 J	<0.23	--	--	<0.23	<0.23	--	0.26	0.26	0.24	<0.23	<0.23	<0.23	<0.23 ^
Lead, ug/L	NP*	0.10	15	NA	0.041 J	0.18 J	<0.13	<0.27	<0.27	<0.27	--	<0.27	<0.11	--	0.098 J	0.12 J	3.9	<0.27	0.29 J	1.0	<0.11
Lithium, ug/L	P	34.2	40	NA	19.1	26.5	19.4	15	24	17	21	24	23	--	7.5 J	6.9 J	8.6 J	10	10	11	9.6 J
Mercury, ug/L	DQ	DQ	2	NA	<0.090	<0.083	<0.090	<0.10	<0.10	--	--	<0.10	--	--	0.096 J	<0.083	<0.090	<0.10	<0.10	<0.10	--
Molybdenum, ug/L	P	1.74	100	NA	0.67 J	1.3	0.72 J	<1.1	1.1	--	--	1.2 J	<1.1	--	0.59 J	0.54 J	<0.57	<1.1	<1.1	<1.1	<1.1
Selenium, ug/L	P	8.55	50	NA	4.3	6.3	3.4	3.1 J	6.2	--	--	6.8	7.7	--	<0.086	<0.16	0.84 J,B	<1.0	<1.0	<1.0	<1.0
Thallium, ug/L	NP*	0.14	2	NA	<0.036	0.16 J	<0.099	<0.27	<0.27	--	--	<0.26	<0.26	--	<0.036	<0.14	0.16 J	<0.27	<0.27	<0.26	<0.26
Radium 226/228 Combined, pCI/L	P	2.15	5	NA	0.513	1.19	1.7	0.0956	0.956	0.228	--	0.315	pending	--	0.746	1.12	1.7	0.116	0.79	1.26	pending
Additonal Parameters - Selection of Remedy																					
Cobalt - dissolved,#	UPL or GPS not applicable			--	--	--	--	--	--	--	0.32 J	0.44 J	--	--	--	--	--	--	--	0.81	--
Lithium - dissolved,#				--	--	--	--	--	--	--	22	--	--	--	--	--	--	--	--	--	--
Iron, dissolved,# ug/L				--	--	--	--	--	--	--	<50	<50	<50	--	--	--	--	--	--	<50	<50
Iron, ug/L				--	--	--	--	--	--	--	<50	50 J	<50	--	--	--	--	--	--	500	100
Magnesium											--	33,000	38,000							50,000	57,000
Manganese, dissolved,# ug/L				--	--	--	--	--	--	--	17	16	13	--	--	--	--	--	--	110	130
Manganese, ug/L				--	--	--	--	--	--	--	16	19	14	--	--	--	--	--	--	200	140
Potassium, ug/L				--	--	--	--	--	--	--	--	1,500	1,500	--	--	--	--	--	--	1,500	1,900
Sodium, ug/L				--	--	--	--	--	--	--	--	77,000	87,000	--	--	--	--	--	--	250,000	280,000
Total Alkalinity, mg/L				--	--	--	--	--	--	--	--	150	160	--	--	--	--	--	--	61	72
Cabonate Alkalinity, mg/L				--	--	--	--	--	--	--	--	<1.9	<3.8	--	--	--	--	--	--	<1.9	<1.9
Bicarbonate Alkalinity, mg/L				--	--	--	--	--	--	--	--	150	160	--	--	--	--	--	--	61	72

4.4	Blue highlighted cell indicates the compliance well result exceeds the UPL (background) and the LOQ.
30.8	Yellow highlighted cell indicates the compliance well result exceeds the GPS.
17	Yellow highlighted cell with bold text indicates the compliance well result exceeds the GPS and the result was determined to be statistically significant(1).
17	Grayscale indicates Additional Parameters sampled for selection of remedy and evaluation of MNA.

Table 3. Groundwater Analytical Results Summary - CCR Program - Assessment Monitoring
Ottumwa Generating Station Ash Pond / SCS Engineers Project #25220083.00

				Compliance Wells															
				MW-303								MW-304							
Parameter Name	UPL Method	UPL	GPS	11/8/2017	4/18/2018	8/14/2018, 8/29/2018 ^	10/16/2018, 1/8/2019 ^^	4/8/2019	10/24/2019	4/14/2020	10/8/2020	11/8/2017	4/18/2018	8/14/2018, 8/29/2018 ^	10/16/2018, 1/8/2019 ^^	4/8/2019	10/23/2019	4/13/2020	10/8/2020
Appendix III																			
Boron, ug/L	P	820		1,070	987	1,010	549	290	440	420	1100	1,040	991	1,000	930	1,110	970	1,000	1000
Calcium, mg/L	P	78.7		234	212	213	195	172	170	170	210	136	131	138	123	130	120	130	120
Chloride, mg/L	P	86.8		185	198	64.8	57	22	35	47	210	417	400	375	410	320	280	250	250
Fluoride, mg/L	P	0.484		0.19 J	0.22	0.31	0.24	<0.23	<0.23	<0.23	0.26 J^	0.96	0.92	1.00	1.0	1.3	0.74	1.1	1.1
Field pH, Std. Units	P	6.87		6.60	6.63	6.83	6.66	7.00	6.83	6.98	8.28	7.00	6.9	7.34	6.86	7.17	7.05	7.12	7.88
Sulfate, mg/L	P	199		348	328	164	389	260	180	180	190	194	198	185	184	180	190	220	230
Total Dissolved Solids, mg/L	P	628		1,290	1,300	832	1,150	890	810	810	1100	1,270	1,300	3,680	1,180	1,100	1100	1,000	1200
Appendix IV		**UPL**	**GPS**																
Antimony, ug/L	P*	0.22	6	--	0.098 J	0.16 J	0.2 J,B	<0.53	<0.53	<0.58	<0.51	--	<0.026	0.19 J	<0.078	<0.53	<0.53	<0.58	<0.51
Arsenic, ug/L	P*	0.53	10	--	0.43 J	0.60 J	0.55 J	<0.75	<0.75	<0.88	<0.88	--	0.68 J	1.3	0.96 J	<0.75	0.83 J	0.96 J	<0.88
Barium, ug/L	P	68.8	2,000	--	69.5	77.3	95.2	54	77	64	94	--	88.5	87.4	91	80	80	80	74
Beryllium, ug/L	DQ	DQ	4	--	0.017 J	<0.12	<0.089	<0.27	<0.27	<0.27	--	--	0.026 J	0.21 J	<0.089	<0.27	<0.27	<0.27	--
Cadmium, ug/L	NP*	0.12	5	--	0.44 J	0.36 J	0.24 J	0.092 J	0.21	0.18	0.46	--	<0.018	0.17 J	0.07 J	<0.077	<0.039	<0.039	<0.049
Chromium, ug/L	P	1.07	100	--	0.12 J	0.19 J	0.15 J,B	<0.098	<0.98	<1.1	<1.1	--	2.0	5.9	1.4	1.6 J	2 J	3.5 J	<1.1
Cobalt, ug/L	NP	4.1	6	--	2.1	2.2	1.7 B	0.42 J	1.2	0.87	2.4	--	0.39 J	0.92 J	0.45 J,B	0.40 J	0.5	0.57	0.41 J
Fluoride, mg/L	P	0.48	4	--	0.22	0.31	0.24	<0.23		<0.23	0.26 J^	--	0.92	1.00	1.0	1.3	0.74	1.1	1.1
Lead, ug/L	NP*	0.10	15	--	0.069 J	0.13 J	<0.13	<0.27	<0.27	<0.27	<0.11	--	0.37 J	0.81 J	0.66 J	<0.27	0.27 J	0.5	<0.11
Lithium, ug/L	P	34.2	40	--	<4.6	6.9 J	<4.6	<2.7	<2.7	4.7 J	5.6 J	--	<4.6	<4.6	<4.6	3.3 J	2.8 J	4.8 J	3.1 J
Mercury, ug/L	DQ	DQ	2	--	<0.090	<0.083	<0.090	<0.10	<0.10	<0.10	--	--	<0.090	<0.083	<0.090	<0.10	<0.10	<0.10	--
Molybdenum, ug/L	P	1.74	100	--	0.61 J	0.98 J	5.5	7.5	5.2	3.6	<1.1	--	2.0	2.4	1.9	1.5 J	2.3	2	1.5 J
Selenium, ug/L	P	8.55	50	--	0.23 J	0.35 J	0.37 J,B	2.1 J	<1.0	5.0	<1.0	--	<0.086	0.50 J	0.26 J,B	<1.0	<1.0	<1.0	<1.0
Thallium, ug/L	NP*	0.14	2	--	<0.036	<0.14	<0.099	<0.27	<0.27	<0.26	<0.26	--	<0.036	0.15 J	<0.099	<0.27	<0.27	<0.26	<0.26
Radium 226/228 Combined, pCI/L	P	2.15	5	--	0.529	1.82	1.68	0.391	0.336	0.229	pending	--	2.08	3.74	1.25	2.42	3.03	2.46	pending
Additonal Parameters - Selection of Remedy																			
Cobalt - dissolved,#	UPL or GPS not applicable			--	--	--	--	--	--	0.37 J	--	--	--	--	--	--	--	0.37 J	--
Lithium - dissolved,#				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron, dissolved,# ug/L				--	--	--	--	--	--	<50	<50	--	--	--	--	--	--	4,600	4,200
Iron, ug/L				--	--	--	--	--	--	280	310	--	--	--	--	--	--	5,200	4,200
Magnesium										23,000	31,000							43,000	40,000
Manganese, dissolved,# ug/L				--	--	--	--	--	--	220	1,600	--	--	--	--	--	--	3,700	3,800
Manganese, ug/L				--	--	--	--	--	--	260	1,600	--	--	--	--	--	--	3,700	3,800
Potassium, ug/L				--	--	--	--	--	--	960	1,100	--	--	--	--	--	--	7,700	7,800
Sodium, ug/L				--	--	--	--	--	--	100,000	150,000	--	--	--	--	--	--	210,000	210,000
Total Alkalinity, mg/L				--	--	--	--	--	--	440	470	--	--	--	--	--	--	370	380
Cabonate Alkalinity, mg/L				--	--	--	--	--	--	<1.9	<3.8	--	--	--	--	--	--	<1.9	<3.8
Bicarbonate Alkalinity, mg/L				--	--	--	--	--	--	440	470	--	--	--	--	--	--	370	380

4.4	Blue highlighted cell indicates the compliance well result exceeds the UPL (background) and the LOQ.
30.8	Yellow highlighted cell indicates the compliance well result exceeds the GPS.
17	Yellow highlighted cell with bold text indicates the compliance well result exceeds the GPS and the result was determined to be statistically significant(1).
17	Grayscale indicates Additional Parameters sampled for selection of remedy and evaluation of MNA.

Table 3. Groundwater Analytical Results Summary - CCR Program - Assessment Monitoring
Ottumwa Generating Station Ash Pond / SCS Engineers Project #25220083.00

Parameter Name	UPL Method	UPL	GPS	Compliance Wells																			
				MW-305									MW-305A			MW-306							
				11/8/2017	4/18/2018	8/15/2018	10/16/2018, 1/8/2019 ^^	4/8/2019	10/23/2019	3/13/2020	4/13/2020	10/8/2020	3/13/2020	4/14/2020	10/8/2020	11/8/2017	4/18/2018	8/15/2018	10/16/2018, 1/8/2019 ^^	4/8/2019	10/23/2019	4/14/2020	10/8/2020
Appendix III																							
Boron, ug/L	P	820		925	886	911	835	1,000	880	--	920	900	250	280	180	881	919	915	862	1,100	980	1,000	1100
Calcium, mg/L	P	78.7		99.5	97.6	102.0	96.2	110	100	--	100	110	100	130	150	73.1	74.1	78.9	80.0	95	77	73	80
Chloride, mg/L	P	86.8		282	289	265	281	250	280	--	270	290	40	89	120	50.4	54.4	58.2	83.3	98	47	41	43
Fluoride, mg/L	P	0.484		0.40	0.40	0.44	0.40	0.75	<0.23	--	0.35 J	0.38 J^	0.77	0.73	0.73	0.11 J	0.11 J	0.13 J	<0.19	0.27 J	<0.23	<0.23	<0.23 ^
Field pH, Std. Units	P	6.87		7.01	6.9	7.21	6.86	7.06	6.91	7.02	7.0	7.44	8.09	7.63	7.46	6.49	6.42	6.74	6.42	6.66	6.74	6.68	6.54
Sulfate, mg/L	P	199		138	147	139	129	110	76	--	63	93	40	93	130	274	289	275	285	270	280	310	360
Total Dissolved Solids, mg/L	P	628		1,040	1,070	1,060	1,070	1,000	1000	--	960	1100	400	570	660	773	805	840	884	930	870	820	900
Appendix IV		**UPL**	**GPS**																				
Antimony, ug/L	P*	0.22	6	--	0.089 J	<0.15	0.096 J,B	<0.53	<0.53	--	<0.58	<0.51	1.3	0.88 J	<0.51	--	0.094 J	<0.15	0.10 J,B	<0.53	<0.53	<0.58	<0.51
Arsenic, ug/L	P*	0.53	10	--	0.51 J	0.72 J	0.66 J	<0.75	<0.75	--	<0.88	<0.88	<0.88	<0.88	<0.88	--	0.38 J	0.65 J	0.60 J	<0.75	0.78 J	<0.88	<0.88
Barium, ug/L	P	68.8	2,000	--	116	118	125	120	110	--	110	120	70	80	75	--	48.2	51.6	56.0	58	51	48	49
Beryllium, ug/L	DQ	DQ	4	--	<0.012	<0.12	<0.089	<0.27	<0.27	--	<0.27	--	<0.27	<0.27	--	--	<0.012	<0.12	<0.089	<0.27	<0.27	<0.27	--
Cadmium, ug/L	NP*	0.12	5	--	0.054 J	0.086 J	0.044 J	<0.077	0.087 J	--	0.14	0.097 J	<0.039	<0.039	<0.049	--	0.88	0.76	0.96	1.1	0.89	0.83	0.92
Chromium, ug/L	P	1.07	100	--	0.26 J	0.41 J	0.3 J,B	<0.98	<0.98	--	<1.1	<1.1	<1.1	<1.1	<1.1	--	0.37 J	0.70 J	0.46 J,B	<0.98	1.0 J	<1.1	<1.1
Cobalt, ug/L	NP	4.1	6	--	14.5	15.6	17.2	17	**17**	**18**	**16**	**17**	2.4	2.7	1.5	--	4.8	5.5	6.4	6.9	6.2	5.5	5.9
Fluoride, mg/L	P	0.48	4	--	0.40	0.44	0.40	0.75	<0.23	--	0.35 J	0.38 J^	0.77	0.73	0.73	--	0.11 J	0.13 J	<0.19	0.27 J	<0.23	<0.23	<0.23 ^
Lead, ug/L	NP*	0.10	15	--	0.12 J	0.31 J	<0.13	<0.27	<0.27	-	0.27 J	<0.11	0.68	<0.27	<0.11	--	0.040 J	0.20 J	<0.13	<0.27	0.34 J	0.37 J	<0.11
Lithium, ug/L	P	34.2	40	--	<4.6	<4.6	<4.6	<2.7	<2.7	2.3 J	3.2 J	<2.5	14	16	13	--	<4.6	<4.6	<4.6	<2.7	<2.7	<2.3	<2.5
Mercury, ug/L	DQ	DQ	2	--	<0.090	<0.090	<0.090	<0.10	<0.10	--	<0.10	--	<0.10	<0.10	--	--	<0.090	<0.083	<0.090	<0.10	<0.10	<0.10	--
Molybdenum, ug/L	P	1.74	100	--	7.1	6.5	7.3	7.2	7.2	--	6.9	7.9	9	17	6.4	--	5.7	4.7	5.1	4.3	4.9	4.4	5.6
Selenium, ug/L	P	8.55	50	--	0.12 J	0.36 J	0.33 J,B	<1.0	<1.0	--	<1.0	<1.0	2.3 J	1.7 J	<1.0	--	<0.086	0.21 J	0.22 J,B	<1.0	<1.0	<1.0	<1.0
Thallium, ug/L	NP*	0.14	2	--	0.32 J	0.33 J	0.33 J	0.33 J	0.38 J	--	0.35 J	0.35 J	<0.26	<0.26	<0.26	--	0.083 J	<0.14	0.12 J	<0.27	<0.27	<0.26	<0.26
Radium 226/228 Combined, pCI/L	P	2.15	5	--	0.676	1.33	1.32	0.685	0.46	--	0.909	pending	1.97	1.26	pending	--	0.305	0.985	1.34	0.155	0.624	0.0738	pending
Additonal Parameters - Selection of Remedy																							
Cobalt - dissolved,#	UPL or GPS not applicable			--	--	--	--	--	--	16	16	17	2.1	2.8	--	--	--	--	--	--	--	5.4	5.1
Lithium - dissolved,#				--	--	--	--	--	--	<2.3	--	--	15	--	--	--	--	--	--	--	--	--	--
Iron, dissolved,# ug/L				--	--	--	--	--	--	51 J	66 J	63 J	<50	<50	<50	--	--	--	--	--	--	140	100
Iron, ug/L				--	--	--	--	--	--	390	330	200	720	64 J	64 J	--	--	--	--	--	--	590	340
Magnesium											47,000	48000	--	28,000	31000							26,000	23,000
Manganese, dissolved,# ug/L				--	--	--	--	--	--	3,100	3,400	3600	150	240	160	--	--	--	--	--	--	16,000	15,000
Manganese, ug/L				--	--	--	--	--	--	3,200	3,300	3600	180	260	150	--	--	--	--	--	--	16,000	16,000
Potassium, ug/L				--	--	--	--	--	--	--	7,600	8300	--	3,800	4200	--	--	--	--	--	--	3,700	3,800
Sodium, ug/L				--	--	--	--	--	--	--	210,000	210000	--	46,000	64000	--	--	--	--	--	--	160,000	170,000
Total Alkalinity, mg/L				--	--	--	--	--	--	--	460	300	--	270	340	--	--	--	--	--	--	280	160
Cabonate Alkalinity, mg/L				--	--	--	--	--	--	--	<1.9	<3.8	--	<1.9	<3.8	--	--	--	--	--	--	<1.9	<3.8
Bicarbonate Alkalinity, mg/L				--	--	--	--	--	--	--	460	300	--	270	340	--	--	--	--	--	--	280	160

Key	Description
4.4	Blue highlighted cell indicates the compliance well result exceeds the UPL (background) and the LOQ.
30.8	Yellow highlighted cell indicates the compliance well result exceeds the GPS.
17	Yellow highlighted cell with bold text indicates the compliance well result exceeds the GPS and the result was determined to be statistically significant[(1)].
17	Grayscale indicates Additional Parameters sampled for selection of remedy and evaluation of MNA.

Table 3. Groundwater Analytical Results Summary - CCR Program - Assessment Monitoring
Ottumwa Generating Station Ash Pond / SCS Engineers Project #25220083.00

Parameter Name	UPL Method	UPL	GPS	Compliance Wells																
				MW-310					MW-310A			MW-311					MW-311A			
				10/24/2019	2/5/2020	3/13/2020	4/13/2020	10/8/2020	3/13/2020	4/14/2020	10/8/2020	10/24/2019	2/5/2020	3/13/2020	4/13/2020	10/8/2020	3/13/2020	4/13/2020	6/30/2020	10/8/2020
Appendix III																				
Boron, ug/L	P	820		720	620	--	550	800	1500	1,600	1700	<110	<100	--	<100	<80	1400	1,500	NA	1600
Calcium, mg/L	P	78.7		230	160	--	200	180	82	87	94	170	130	--	170	160	44	48	NA	51
Chloride, mg/L	P	86.8		150	120	--	130	150	140	130	130	13	14	--	13	14	130	140	NA	150
Fluoride, mg/L	P	0.484		0.31 J	0.85	--	1.1	1	1.7	1.8	2	<0.23	<0.23	--	<0.23	<0.23 ^	3.4	4.1	3.7	4.4
Field pH, Std. Units	P	6.87		7.15	7.08	6.89	7	7.07	7.73	7.85	7.48	6.95	6.72	7.11	6.86	6.93	7.85	8.4	7.64	8.33
Sulfate, mg/L	P	199		610	530	--	590	570	1200	1,100	1100	47	54	--	54	70	1200	1,200	NA	1200
Total Dissolved Solids, mg/L	P	628		260	1200	--	1,300	1200	2300	2,300	2200	530	520	--	570	640	2300	2,400	NA	2400
Appendix IV		**UPL**	**GPS**																	
Antimony, ug/L	P*	0.22	6	<0.53	<0.58	--	<0.58	0.61 J	<0.58	<0.58	<0.51	<0.53	<0.58	--	<0.58	<0.51	<0.58	<0.58	NA	<0.51
Arsenic, ug/L	P*	0.53	10	0.78 J	<0.88	--	<0.88	0.94 J	<0.88	<0.88	<0.88	<0.75	<0.88	--	<0.88	1.7 J	<0.88	<0.88	NA	<0.88
Barium, ug/L	P	68.8	2,000	76	53	--	62	55	16	16	16	200	160	--	180	220	20	20	NA	15
Beryllium, ug/L	DQ	DQ	4	<0.27	<0.27	--	<0.27	--	<0.27	<0.27	--	<0.27	<0.27	--	<0.27	--	<0.27	<0.27	NA	--
Cadmium, ug/L	NP*	0.12	5	0.22	0.12	--	0.16	0.29	<0.039	<0.039	<0.049	0.04 J	<0.039	--	<0.039	0.12	<0.039	<0.039	NA	<0.049
Chromium, ug/L	P	1.07	100	<0.98	<1.1	--	<1.1	<1.1	<1.1	<1.1	<1.1	<0.98	<1.1	--	<1.1	<1.1	<1.1	<1.1	NA	<1.1
Cobalt, ug/L	NP	4.1	6	0.57	0.32 J	0.32 J	0.24 J	0.38 J	0.63	0.39 J	0.43 J	0.78	0.11 J	<0.091	<0.091	2.2	0.19 J	0.13 J	NA	0.12 J
Fluoride, mg/L	P	0.48	4	0.31 J	0.85	--	1.1	1	1.7	1.8	2	<0.23	<0.23	--	<0.23	<0.23 ^	3.4	4.1	3.7	4.4
Lead, ug/L	NP*	0.10	15	<0.27	<0.27	--	<0.27	<0.11	<0.27	<0.27	<0.11	<0.27	<0.27	--	<0.27	1.8	<0.27	<0.27	NA	<0.11
Lithium, ug/L	P	34.2	40	35	42	46	48	42	250	290	240	4.7 J	2.9 J	4.7 J	6.2 J	4.6 J	260	310	NA	240
Mercury, ug/L	DQ	DQ	2	<0.10	<0.10	--	<.10	--	<0.10	<0.10	--	<0.10 F1	<0.10	--	<0.10	--	<0.10	<0.10	NA	--
Molybdenum, ug/L	P	1.74	100	26	29	--	31	39	2.6	2.7	3	<1.1	<1.1	--	<1.1	<1.1	1.2 J	2.8	NA	3.1
Selenium, ug/L	P	8.55	50	5	3.3 J	--	4.5 J	2.4 J	<1.0	<1.0	<1.0	<1.0	1.2 J	--	<1.0	<1.0	<1.0	<1.0	NA	<1.0
Thallium, ug/L	NP*	0.14	2	<0.27	<0.26	--	<0.26	<0.26	<0.26	<0.26	<0.26	<0.27	<0.26	--	<0.26	<0.26	<0.26	<0.26	NA	<0.26
Radium 226/228 Combined, pCI/L	P	2.15	5	0.411	0.0344	--	0.271	pending	3.43	3.9	pending	0.411	0.108	--	0.17	pending	1.47	2.31	NA	pending
Additonal Parameters - Selection of Remedy																				
Cobalt - dissolved,[#]	UPL or GPS not applicable			--	--	0.31 J	0.23 J	--	0.67	0.40 J	--	--	--	0.11 J	<0.091	--	0.36 J	0.12 J	--	--
Lithium - dissolved,[#]				--	--	45	--	44	250	--	230	--	--	8.0 J	--	--	250	--	--	230
Iron, dissolved,[#] ug/L				--	--	<50	<50	<50	<50	220	<50	--	--	<50	<50	<50	<50	<50	--	<50
Iron, ug/L				--	--	<50	<50	<50	99 J	230	280	--	--	<50	<50	630	<50	<50	--	<50
Magnesium							86,000	76,000	--	41,000	45,000			--	40,000	40,000	--	23,000	--	25000 J
Manganese, dissolved,[#] ug/L				--	--	250	280	350	53	39	29	--	--	21	39	75	20	22	--	5.8 J
Manganese, ug/L				--	--	260	280	390	51	38	31	--	--	20	41	180	20	13	--	8.3
Potassium, ug/L				--	--	--	12,000	12,000	--	9,900	11,000	--	--	--	620	810	--	9,000	--	10,000
Sodium, ug/L				--	--	--	100,000	100,000	--	630,000	620,000	--	--	--	5,000	5,100	--	710,000	--	700,000
Total Alkalinity, mg/L				--	--	--	190	410	--	320	260	--	--	--	460	290	--	360	--	400
Cabonate Alkalinity, mg/L				--	--	--	<1.9	<3.8	--	<1.9	<3.8	--	--	--	<1.9	<3.8	--	<1.9	--	<3.8
Bicarbonate Alkalinity, mg/L				--	--	--	190	410	--	320	260	--	--	--	460	290	--	360	--	400

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30.8	Yellow highlighted cell indicates the compliance well result exceeds the GPS.
17	Yellow highlighted cell with bold text indicates the compliance well result exceeds the GPS and the result was determined to be statistically significant[1].
17	Grayscale indicates Additional Parameters sampled for selection of remedy and evaluation of MNA.

Table 3. Groundwater Analytical Results Summary - CCR Program - Assessment Monitoring
Ottumwa Generating Station Ash Pond / SCS Engineers Project #25220083.00

Abbreviations:

-- = Not Analyzed
mg/L = milligrams per liter
ug/L = micrograms per liter
J = Estimated concentration at or above the LOD and below the LOQ.
B = Analyte was detected in the associated Method Blank.
F1 = MS and/or MSD Recovery is outside acceptance limits.
LOD = Limit of Detection
LOQ = Limit of Quantitation
GPS = Groundwater Protection Standard
UPL = Upper Prediction Limit
^ = ICV, CCV, ICB, ISA, ISB, CRI, CRA, DLCK, OR MRL standard: Instrument related QC is outside acceptance limits
P = Parametric UPL with 1-of-2 retesting
DQ = Double Quantification Rule (not detected in background)
NP = Nonparametric UPL (highest background value)
# = Dissolved parameter samples collected for MNA data review
* = UPL is below the LOQ for background sampling. For compliance wells, only results confirmed above the LOQ are evaluated as potential SSIs above background.

Notes:

1. An individual result above the UPL or GPS does not constitute a statistically significant increase (SSI) above background or statistically significant level above the GPS. The cobalt GPS exceedances at MW-305 have been determined to be statistically significant. The cobalt GPS exceedance at MW-306 has been determined not to be statistically significant. Lithium and fluoride GPS exceedances have either been determined not to be statistically significant or the determination is ongoing. See the accompanying reporttext for additional information regarding determinations of statistical significance.
2. GPS is the United States Environmental Protection Agency (US EPA) Maximum Contamination Level (MCL), if established; otherwise, the values are from 40 CFR 257.95(h)(2).
3. Interwell UPLs calculated based on results from background well MW-301.

Created by:	NDK	Date:	5/1/2018
Last revision by:	ACW	Date:	11/25/2020
Checked by:	NDK	Date:	11/25/2020
Proj Mgr QA/QC:	TK	Date:	11/25/2020

Table 4. Groundwater Field Parameters - CCR Program - Assessment Monitoring
Ottumwa Generating Station / SCS Project # 25220083.00
November 2017 - October 2020

Well	Sample Date	Groundwater Elevation (feet)	Field Temperature (deg C)	Field pH (Std. Units)	Oxygen, Dissolved (mg/L)	Field Specific Conductance (umhos/cm)	Field Oxidation Potential (mV)	Turbidity (NTU)
MW-301	11/8/2017	681.54	13.9	6.41	4.16	743	201	1.03
	4/18/2018	681.53	7.2	6.41	6.52	770	106	0.66
	8/14/2018	680.91	20.4	6.26	3.18	867	-56	0.52
	8/29/2018	681.09	20.6	6.31	4.71	781	--	0.63
	10/16/2018	682.50	16.6	6.27	4.12	599	120	2.91
	1/8/2019	682.22	7.9	5.68	5.68	310	118	0.77
	4/8/2019	682.69	7.3	6.61	8.32	501	38	1.87
	10/24/2019	683.07	13.7	6.33	4.94	902	10	1.6
	2/5/2020	683.30	5.4	6.39	7.28	966	68	1.43
	3/12/2020	682.82	6.9	6.48	5.3	962	258.5	1.33
	4/14/2020	683.25	8.7	6.58	5.1	939	176.3	0.87
	10/8/2020	682.34	15.4	6.22	4.2	1035	163.6	0.02
MW-302	11/8/2017	655.40	13.8	6.55	0.4	2274	191.7	1.63
	4/18/2018	655.71	10.7	6.47	0.2	2248	82.6	2.41
	8/14/2018	656.05	14.3	6.76	0.17	2304	-336.6	4.01
	8/29/2018	655.89	14.6	6.77	0.23	2357	--	1.42
	10/16/2018	656.91	14.1	6.37	0.26	1912	114.2	88.24
	1/8/2019	656.03	12.2	6.58	6.4	1473	70.2	4.39
	4/8/2019	657.23	12.3	6.61	0.86	2159	68.3	26.9
	10/24/2019	660.14	12.9	6.55	0.35	2184	-0.5	11.9
	4/14/2020	656.45	10.5	6.70	0.22	1971	135.6	31.1
	10/8/2020	655.80	14.4	7.00	0.14	2100	34.5	18.7

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Well	Sample Date	Groundwater Elevation (feet)	Field Temperature (deg C)	Field pH (Std. Units)	Oxygen, Dissolved (mg/L)	Field Specific Conductance (umhos/cm)	Field Oxidation Potential (mV)	Turbidity (NTU)
MW-303	11/8/2017	651.34	15.2	6.60	0.5	1896	176.8	3.67
	4/18/2018	652.47	8.2	6.63	0.17	1862	3.2	3.69
	8/14/2018	652.57	17.2	6.83	0.19	1833	-307.9	1.51
	8/29/2018	655.07	18.7	7.03	1.92	1161	--	10.13
	10/16/2018	656.17	17.1	6.66	0.29	1573	32.8	5.99
	1/8/2019	654.65	9.1	6.83	3.19	750	73.7	14.2
	4/8/2019	655.55	8.5	7.00	2.29	1181	51.7	3.49
	10/24/2019	653.86	15.3	6.83	0.28	1287	-5.1	4.24
	4/14/2020	654.08	8.9	6.98	1.94	1097	104.3	12.1
	10/8/2020	650.37	17.0	8.28	0.13	1602	-0.4	30.2
MW-304	11/8/2017	653.03	13.3	7.00	0.25	2205	162.7	3.88
	4/18/2018	655.55	12.8	6.90	0.15	2141	137.5	39.29
	8/15/2018	656.35	15.1	7.34	0.21	2085	35.5	81.42
	8/29/2018	657.82	13.7	7.22	0.16	2123	--	55.94
	10/16/2018	658.20	13.5	6.86	0.11	2058	-114.5	17.12
	1/8/2019	656.28	12.8	7.16	0.72	1368	-62.1	4.38
	4/8/2019	659.33	13.8	7.17	0.41	1876	-58.3	57.9
	10/23/2019	657.71	13.6	7.05	0.44	1871	-57.5	18.9
	4/13/2020	656.42	11.9	7.12	0.24	1764	-119.8	54.1
	10/8/2020	652.95	13.6	7.88	0.18	1675	-113	11.1

Table 4. Groundwater Field Parameters - CCR Program - Assessment Monitoring
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November 2017 - October 2020

Well	Sample Date	Groundwater Elevation (feet)	Field Temperature (deg C)	Field pH (Std. Units)	Oxygen, Dissolved (mg/L)	Field Specific Conductance (umhos/cm)	Field Oxidation Potential (mV)	Turbidity (NTU)
MW-305	11/8/2017	659.76	13.2	7.01	0.2	1738	146.1	2.68
	4/18/2018	660.99	12.8	6.90	0.15	1840	-32.7	7.37
	8/15/2018	661.56	14.8	7.21	0.18	1832	31	14.9
	10/16/2018	663.37	13.9	6.86	0.09	1836	-26.8	6.96
	1/8/2019	662.13	12.4	6.99	0.81	1235	36.4	4.76
	4/8/2019	664.01	13.8	7.06	0.59	1728	32.6	21.7
	10/23/2019	663.21	13.2	6.91	0.42	1794	-6.7	6.21
	3/13/2020	661.41	12.4	7.02	0.2	1788	192.6	42.68
	4/13/2020	662.44	9.1	7.00	0.28	1772	6.6	21.7
	10/9/2020	659.81	14.0	7.44	0.13	1810	-13	12.9
MW-305A	3/13/2020	--	11.8	8.09	3.79	745	204.2	63.2
	4/14/2020	--	11.2	7.63	2.26	807	106.7	4.91
	10/5/2020	648.01	14.2	7.46	0.19	1102	11	NM
MW-306	11/8/2017	669.04	13.6	6.49	0.18	1186	174.1	0.82
	4/18/2018	668.92	13.1	6.42	0.14	1228	14.2	0.59
	8/15/2018	668.66	14.6	6.74	0.15	1271	22.8	3.95
	10/16/2018	670.24	13.4	6.42	0.08	1340	13.3	7.07
	1/8/2019	669.84	13.3	6.65	0.47	965	59.5	0.89
	4/8/2019	670.96	13.6	6.66	0.92	1350	49.1	28.5
	10/23/2019	671.28	13.1	6.74	0.29	1266	-0.5	12.3
	4/14/2020	670.71	11.7	6.68	0.21	1158	49.7	15.7
	10/9/2020	670.18	13.4	6.54	0.12	1294	41.4	14

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Well	Sample Date	Groundwater Elevation (feet)	Field Temperature (deg C)	Field pH (Std. Units)	Oxygen, Dissolved (mg/L)	Field Specific Conductance (umhos/cm)	Field Oxidation Potential (mV)	Turbidity (NTU)
MW-307	11/8/2017	647.37	13.2	6.61	0.17	1656	176.7	11.16
	4/16/2018	649.66	11.6	7.04	0.29	1674	-105.9	11.93
	5/30/2018	652.45	12.7	6.44	0.18	1710	-45.8	18.58
	6/28/2018	652.87	13.4	6.87	0.21	1686	-43.4	53.34
	7/18/2018	652.27	12.9	6.62	0.21	1718	-416.3	14.94
	10/16/2018	654.13	14.3	6.54	0.08	1697	-65.7	14.08
	4/8/2019	654.90	12.5	6.76	0.51	1599	-3.7	26
	10/23/2019	651.89	13.4	6.68	0.25	1684	-24.8	12.5
	12/11/2019	649.59	11.5	6.37	0.18	1576	-45.8	43.13
	2/5/2020	649.88	11.7	6.67	0.9	1681	-15.6	9.74
	4/14/2020	650.66	10.6	6.76	0.69	1554	-52.9	28.9
	10/7/2020	646.18	13.2	6.97	0.08	1637	-62.2	4.56
MW-308	11/8/2017	644.99	13.0	6.76	0.12	1577	169.7	0.73
	4/16/2018	647.91	11.8	7.14	0.35	1577	-47.2	0.93
	5/30/2018	651.05	12.1	6.61	0.14	1611	-48.2	3.34
	6/28/2018	651.43	13.1	7.08	0.19	1584	-60.3	5.87
	7/18/2018	650.67	12.6	6.73	0.13	1628	-415.4	1.54
	10/16/2018	--	13.1	6.68	0.08	1594	-80.8	5.49
	4/8/2019	653.70	12.5	6.90	0.66	1539	-23	6.87
	10/23/2019	651.31	13.2	6.78	4.42	1637	-38.7	7.42
	12/11/2019	647.39	10.5	6.55	0.43	1532	-56.6	15.72
	2/5/2020	650.12	11.4	6.78	1.48	1630	-35.9	3.49
	4/14/2020	650.09	10.9	6.90	0.28	1502	-69.1	5.12
	10/7/2020	642.85	13.2	7.24	0.11	1575	-56.5	1.15

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November 2017 - October 2020

Well	Sample Date	Groundwater Elevation (feet)	Field Temperature (deg C)	Field pH (Std. Units)	Oxygen, Dissolved (mg/L)	Field Specific Conductance (umhos/cm)	Field Oxidation Potential (mV)	Turbidity (NTU)
MW-309	11/8/2017	644.20	13.1	7.11	0.13	1431	149.7	3.71
	4/16/2018	647.65	11.2	7.52	0.37	1445	-58.5	36.7
	5/30/2018	650.98	12.4	6.92	0.12	1484	-38	40.55
	6/28/2018	651.47	13.8	7.36	0.17	1477	-45.5	241.4
	7/18/2018	650.69	12.6	7.02	0.11	1501	-432.6	40.38
	10/16/2018	651.61	13.5	6.95	0.03	1464	-81.6	28.27
	4/8/2019	653.55	12.4	7.18	0.66	1396	-3.3	72.1
	10/23/2019	651.28	12.8	6.98	0.36	1461	-27.5	42.6
	12/11/2019	647.24	11.5	6.67	0.26	1350	-37.8	413.6
	2/5/2020	648.34	11.4	7.09	1.07	1433	-7.8	18.1
	4/14/2020	649.19	11.2	7.21	0.16	1322	-51.5	100.1
	10/7/2020	641.50	13.3	7.57	0.09	1371	-71.1	7.7
MW-310	10/24/2019	649.31	13.7	7.15	0.41	1906	-9.3	2.29
	2/5/2020	644.71	12.5	7.08	0.68	1723	42.2	0.9
	3/12/2020	645.45	12.8	6.89	0.3	1902	252.2	2.77
	4/13/2020	645.91	10.3	7.00	0.22	1823	179.4	0.87
	10/12/2020	638.46	13.9	7.07	0.16	1709	146.5	0.02
MW-310A	3/13/2020	--	12.5	7.73	6.28	3160	178.9	109
	4/14/2020	--	8.8	7.85	6.39	2915	146.1	--
	10/5/2020	640.20	13.1	7.48	0.48	3122	89.7	NM
MW-311	10/24/2019	647.80	13.9	6.95	0.29	926	-24.7	3.88
	2/5/2020	645.00	10.2	6.72	2.11	891	21	1.89
	3/13/2020	644.18	10.0	7.11	0.23	877	222.6	3.44
	4/13/2020	646.79	8.8	6.86	0.29	912	103.4	0.44
	10/12/2020	638.73	14.4	6.93	7.12	1024	-53	NM
MW-311A	3/13/2020	--	12.1	7.85	2.29	3336	206	7.74
	4/13/2020	--	7.9	8.40	3.87	3027	115.8	3.19
	6/30/2020	647.73	12.6	7.64	1.51	3391	23.4	1.43
	10/6/2020	641.09	12.7	8.33	0.44	3177	39.6	NM

Table 5. Preliminary Evaluation of Corrective Measure Alternatives
Ottumwa Generating Station / SCS Engineers Project #25220083.00

	Alternative #1 No Action	Alternative #2 Close and Cap in place with MNA	Alternative #3 Consolidate on Site and Cap with MNA	Alternative #4 Excavate and Dispose on site with MNA	Alternative #5 Excavate and Dispose in Off-Site Landfill	Alternative #6 Consolidate and Cap with Chemical Amendment	Alternative #7 Consolidate and Cap with Groundwater Collection	Alternative #8 Consolidate and Cap with Barrier Wall
CORRECTIVE ACTION ASSESSMENT - 40 CFR 257.97(b)								
257.97(b)(1) Is remedy protective of human health and the environment?	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
257.97(b)(2) Can the remedy attain the groundwater protection standard?	Unlikely	Yes	Yes	Yes	Yes	Yes	Yes	Yes
257.97(b)(3) Can the remedy control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in appendix IV to this part into the environment?	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
257.97(b)(4) Can the remedy remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible?	Not Applicable - No release of CCR	Not Applicable - No release of CCR	Not Applicable - No release of CCR	Not Applicable - No release of CCR	Not Applicable - No release of CCR	Not Applicable - No release of CCR	Not Applicable - No release of CCR	Not Applicable - No release of CCR
257.97(b)(5) Can the remedy comply with standards for management of wastes as specified in §257.98(d)?	Not Applicable	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LONG- AND SHORT-TERM EFFECTIVENESS - 40 CFR 257.97(c)(1)								
257.97(c)(1)(i) Magnitude of reduction of existing risks	No reduction of existing risk	Existing risk reduced by achieving GPS	Same as Alternative #2	Same as Alternative #2	Same as Alternative #2	Similar to Alternative #2. Long-term risk may be reduced with additional source control and in-situ stabilization/fixation of CCR that may be in contact with groundwater.	Similar to Alternative #2. Groundwater extraction and treatment presents an additonal risk and potential exposure pathways via surface release or disruption of treatment processes.	Similar to Alternative #2. Long-term risk may be reduced with additional containment offered by barrier wall.
257.97(c)(1)(ii) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy	No reduction of existing risk. Residual risk is limited for all alternatives due to limited extent of impacts and lack of receptors.	Magnitude of residual risk of further releases is lower than current conditions due to final cover eliminating infiltration through CCR; Residual risk is limited for all alternatives due to limited extent of impacts and lack of receptors	Same as Alternative #2 with potential further reduction in release risk due to CCR material footprint; However, limited to no overall risk reduction is provided due to lack of current/anticipated future receptors for groundwater impacts	Same as Alternative #3 with potential further reduction in release risk due to composite liner and cover; However, limited to no overall risk reduction is provided due to lack of current/anticipated future receptors for groundwater impacts	Same as Alternative #3 with potential further reduction in release risk due to removal of CCR from site; However, limited to no overall risk reduction is provided due to lack of current/anticipated future receptors for groundwater impacts	Same as Alternative #2 with potential further reduction in release risk due to CCR material footprint; Residual risk is further reduced by way of chemical / physical alteration of the source of impacts. However, limited to no overall risk reduction is provided due to lack of current/anticipated future receptors for groundwater impacts.	Same as Alternative #2 with potential further reduction in release risk due to CCR material footprint; Residual risk is potentially reduced by way of the ability to respond to potential future/ongoing releases from CCR that might be in contact with groundwater following closure. However, limited to no overall risk reduction is provided due to lack of current/anticipated future receptors for groundwater impacts.	Same as Alternative #2 with potential further reduction in release risk due to CCR material footprint; Residual risk of source material in contact with groundwater is further reduced by the containment of groundwater impacts provided by barrier walls; However, limited to no overall risk reduction is provided due to lack of current/anticipated future receptors for groundwater impacts.
257.97(c)(1)(iii) The type and degree of long-term management required, including monitoring, operation, and maintenance	Not Applicable	30-year post-closure groundwater monitoring; Groundwater monitoring network maintenance and as-needed repair/replacement Final cover maintenance (e.g., mowing and as-needed repair); Periodic final cover inspections; Additional corrective action as required based on post-closure groundwater monitoring	Same as Alternative #2	Same as Alternative #2	No on-site long-term management required; Limited on-site post-closure groundwater monitoring until GPS are achieved; Receiving disposal facility will have same/similar long-term monitoring, operation, and maintenance requirements as Alternative #2	Same as Alternative #2	Same as Alternative #2 with additional effort for groundwater pump operation and maintenance (O&M), groundwater treatment system O&M, and treatment system discharge monitoring/reporting.	Same as Alternative #2 with additional monitoring of wall performance.

Table 5. Preliminary Evaluation of Corrective Measure Alternatives
Ottumwa Generating Station / SCS Engineers Project #25220083.00

	Alternative #1 No Action	Alternative #2 Close and Cap in place with MNA	Alternative #3 Consolidate on Site and Cap with MNA	Alternative #4 Excavate and Dispose on site with MNA	Alternative #5 Excavate and Dispose in Off-Site Landfill	Alternative #6 Consolidate and Cap with Chemical Amendment	Alternative #7 Consolidate and Cap with Groundwater Collection	Alternative #8 Consolidate and Cap with Barrier Wall
LONG- AND SHORT-TERM EFFECTIVENESS - 40 CFR 257.97(c)(1) (continued)								
257.97(c)(1)(iv) Short-term risks - Implementation								
Excavation	None	Limited risk to community and environment due to limited amount of excavation (likely <200K cy) required to establish final cover subgrades and no off-site excavation	Same as Alternative #2 with increased risk to environment due to increased excavation volumes required for consolidation (likely >200K cy but <463K cy)	Same as Alternative #3 with increased risk to environment due to increased excavation volumes (~463K cy) and temporary CCR storage during disposal site construction required for removal and on-site re-disposal	Same as Alternative #4 with reduced risk to environment from excavation due to limited on-site storage	Similar to Alternative #3 with some increased potential risk due to exposure during the application of the chemical amendment.	Similar to Alternative #3 with some increased construction risk due to drilling, trenching, and excavation for groundwater pumping and treatment system construction.	Similar to Alternative #3 with some increased construction risk due to excavation or installation of the barrier wall.
Transportation	None	No risk to community or environment from off-site CCR transportation; Typical risk due to construction traffic delivering final cover materials to site	Same as Alternative #2 with reduced risk from construction traffic due to reduced final cover material requirements (smaller cap footprint)	Same as Alternative #2 with increased risk from construction traffic due to increased material import requirements (liner and cap construction required)	Highest level of community and environmental risk due to CCR volume export (~463K cy)	Similar to Alternative #3 with increased risk from importing chemical material for stabilization/treatment.	Similar to Alternative #3 with increased risk from importing groundwater pumping and treatment system materials.	Similar to Alternative #3 with increased risk from importing barrier wall system materials.
Re-Disposal	None	Limited risk to community and environment due to limited volume of CCR re-disposal (likely <200K cy)	Same as Alternative #2 with increased risk to environment due to increased excavation volumes (likely >200K cy but <463K cy) required for consolidation	Same as Alternative #3 with increased risk to environment due to increased excavation volumes (~463K cy) and temporary CCR storage during disposal site construction required for removal and on-site re-disposal	Same as Alternative #4 with increased risk to community and environment due to re-disposal of large CCR volume (~463K cy) at another facility; Re-disposal risks are managed by the receiving disposal facility	Similar to Alternative #3 with some increased potential risk due to exposure during the application of the chemical amendment.	Same as Alternative #3	Same as Alternative #3
257.97(c)(1)(v) Time until full protection is achieved	Unknown	Closure and capping can be completed by end of 2023. Groundwater protection timeframe to reach GPS potentially 2 to 10 years following closure construction, achievable within 30-year post-closure monitoring period.	Similar to Alternative #2. Potential for increase in time to reach GPS due to significant source disturbance during construction. Potential for decrease in time to reach GPS due to consolidation of CCR. Scoring is based on balance between potential increase or decrease due to factors listed.	Increased time required to implement remedy in comparison to Alternative #2. Anticipated increase in time required to identify, site and develop onsite disposal capacity if located outside of existing impoundment footprint. Increased time required for closure construction due CCR excavation, temporary storage, liner construction, and redisposal if completed within impoundment footprint. Potential for increase in time to reach GPS due to significant source disturbance during construction. Potential decrease in time to reach GPS due to source isolation within liner/cover system.	Increased time required to implement remedy in comparison to Alternative #2, and potentially the longest required time to implement closure. Implementation schedule extends the time required to achieve full protection. Extended implementation timeframe is driven by the time required to identifying and secure off-site disposal capacity, or develop the capacity at an existing Alliant-owned facility. If landfill capacity is not owned by Alliant, additional time may be required to permit and develop the necessary disposal capacity. Increased construction time likely required due to the capacity of the receiving site to unload and place material. Potential for increase in time to reach GPS due to significant source disturbance during construction. Potential decrease in time to reach GPS due to impounded CCR source removal.	Similar to Alternative #2. Potential for reduction in time to reach GPS due to chemical/physical stability of CCR.	Similar to Alternative #2. Potential decrease in time to reach GPS from implementation of groundwater pumping.	Similar to Alternative #2. Potential decrease in time to reach GPS upon implementation of barrier wall.
257.97(c)(1)(vi) Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment	No change in potential exposure	Potential for exposure is low. Remaining waste is capped.	Similar to Alternative #2 with increased risk to construction workers during consolidation of CCR.	Similar to Alternative #2 with increased risk to construction workers during excavation and re-disposal. Increased risk over Alternative #3 due to higher material management volumes.	No potential for on-site exposure to remaining waste since no waste remains on site; Risk of potential exposure is transferred to receiving disposal facility and is likely similar to Alternative #2 Highest level of risk due to excavation, transportation, and re-disposal for construction workers removing CCR and solid waste workers at receiving facility.	Same as Alternative #2	Similar to Alternative #2 with potential for secondary impacts from releases of extracted groundwater or disruption in treatment.	Same as Alternative #2
257.97(c)(1)(vii) Long-term reliability of the engineering and institutional controls	Not Applicable	Long-term reliability of cap is good; Significant industry experience with methods/controls; Capping is common practice/industry standard for closure in place for remediation and solid waste management	Same as Alternative #2 with potentially increased reliability due to smaller footprint and reduced maintenance	Same as Alternative #3	Success of remedy at OGS does not rely on long-term reliability of engineering or institutional controls; Overall success relies on reliability of the engineering and institutional controls at the receiving facility	Same as Alternative #3.	Same as Alternative #3. Remedy relies upon active equipment that will require additonal operations and maintenance.	Same as Alternative #3. Remedy relies on continued hydraulic conductivity of the selected barrier. Breaches or short circuiting can develop and must be monitored.
257.97(c)(1)(viii) Potential need for replacement of the remedy	Not Applicable	Limited potential for remedy replacement if maintained; Some potential for remedy enhancement due to residual groundwater impacts following source control	Same as Alternative #2 with reduced potential need for remedy enhancement with consolidated/smaller closure area footprint	Same as Alternative #2 with further reduction in potential need for remedy enhancement composite with liner	No potential for remedy replacement; Limited potential for remedy enhancement due to residual groundwater impacts following source control	Similar to Alternative #3, with further reduction in potential need for remedy enhancement due to stabilized/solidified CCR material.	Similar to Alternative #2, with reduced potential of remedy replacement, but added expectation for pump, conveyance system and treatment system replacement.	Similar to Alternative #2, with reduced potential of remedy replacement, but added expectation for potential replenishment of consumptive barrier product.

Table 5. Preliminary Evaluation of Corrective Measure Alternatives
Ottumwa Generating Station / SCS Engineers Project #25220083.00

	Alternative #1 No Action	Alternative #2 Close and Cap in place with MNA	Alternative #3 Consolidate on Site and Cap with MNA	Alternative #4 Excavate and Dispose on site with MNA	Alternative #5 Excavate and Dispose in Off-Site Landfill	Alternative #6 Consolidate and Cap with Chemical Amendment	Alternative #7 Consolidate and Cap with Groundwater Collection	Alternative #8 Consolidate and Cap with Barrier Wall
SOURCE CONTROL TO MITIGATE FUTURE RELEASES - 40 CFR 257.97(c)(2)								
257.97(c)(2)(i) The extent to which containment practices will reduce further releases	No reduction in further releases	Cap will reduce further releases by minimizing infiltration through CCR	Same as Alternative #2 with further reduction due to consolidated/smaller closure footprint	Same as Alternative #3 with further reduction due to composite liner and 5-foot groundwater separation required by CCR Rule	Removal of CCR prevents further releases at OGS; Receiving disposal site risk similar to Alternative #3	Similar to Alternative #3 with further reduction due to lower mobility of contaminants in residual source material as a result of chemical amendment.	Similar to Alternative #3 with the added ability to contain or restore groundwater impacts if MNA mechanisms are not active or site attenuation capacity is not adequate.	Similar to Alternative #3 with the added ability to contain groundwater impacts if MNA mechanisms are not active or site attenuation capacity is not adequate.
257.97(c)(2)(ii) The extent to which treatment technologies may be used	Alternative does not rely on treatment technologies	Alternative does not rely on treatment technologies	Alternative does not rely on treatment technologies	Alternative does not rely on treatment technologies	Alternative does not rely on treatment technologies	Alternative relies on the indentification and availability of a suitable chemical amendment. Implementation of and contact with physical/chemical stabilizing agent will require specialized field implementation methods and health and safety measures.	This alternative relies on conventional pump and treat remediation.	Alternative relies on the indentification and availability of a suitable barrier wall technology (e.g., permeable reactive barrier material or slurry wall). Implementation of and contact with barrier wall materials will require specialized field implementation methods and health and safety measures.
IMPLEMENTATION - 40 CFR 257.97(c)(3)								
257.97(c)(3)(i) Degree of difficulty associated with constructing the technology	Not Applicable	Low complexity construction; Potentially lowest level of dewatering effort - dewatering required for cap installation only	Low complexity construction; Moderate degree of logistical complexity; Moderate level of dewatering effort - dewatering required for material excavation/placement and capping	Moderately complex construction due to composite liner and cover; High degree of logistical complexity due to excavation and on-site storage of ~463K cy of CCR while new lined disposal area is constructed; High level of dewatering effort - dewatering required for excavation of full CCR volume	Low complexity construction; High degree of logistical complexity including the excavation and off-site transport of ~463K cy of CCR and permitting/development of off-site disposal facility airspace; High level of dewatering effort - dewatering required for excavation of full CCR volume	Moderate complexity construction due to the equipment required to apply the selected amendment; requirements to ensure consistent contact and dosing of amendment; Medium degree of logistical complexity involving the import of specialty chemicals; Moderate to low level of dewatering effort - dewatering required for material excavation/placement and capping	Low complexity construction; Moderate degree of logistical complexity; Moderate to low level of dewatering effort - dewatering required for material excavation/placement and capping. Moderate complexity contruction for the installation of extraction wells and conveyance to a site-specific groundwater treatment plant.	High complexity construction; Barrier walls require specialty installation equipment and knowledge. Highly specialized and experience contractors required to achieve proper installation. Moderate degree of logistical complexity; Moderate to low level of dewatering effort - dewatering required for material excavation/placement and capping.
257.97(c)(3)(ii) Expected operational reliability of the technologies	Not Applicable	High reliability based on historic use of capping as corrective measure	Same as Alternative #2	Same as Alternative #2	Success at OGS does not rely on operational reliability of technologies; Overall success relies on off-site disposal facility, which is likely same/similar to Alternative #2, but may not be controlled by the Owner.	Similar to Alternative #2; however, success at OGS relies on the successful application of specialty chemicals.	Similar to Alternative #2; however, success of this remedy relies on the successful operation of a site-specific groundwater treatment plant.	Similar to Alternative #2; however, success this remedy relies on continued hydraulic conductivity of the selected barrier. Breaches or short circuiting can develop and must be monitored.
257.97(c)(3)(iii) Need to coordinate with and obtain necessary approvals and permits from other agencies	Not Applicable	Need is low in comparison to other alternatives; State Closure Permit required	Same as Alternative #2	Need is high in comparison to other alternatives State Closure Permit required; State Landfill Permit may be required	Need is highest in comparison to other alternatives; State Closure Permit required; Approval of off-site disposal site owner required; May require State solid waste comprehensive planning approval; Local road use permits likely required	Need is moderate in comparison to other alternatives; State Closure Permit required; Underground Injection Control Permit may be required if chemical materials placed within groudwater. State and local erosion control/construction stormwater management permits required; Federal/State/Local Floodplain permitting likely required.	Need is moderate in comparison to other alternatives; State Closure Permit required; Well permitting for extraction well installation; NPDES Permit for groundwater treatment and discharge; State and local erosion control/construction stormwater management permits required; Federal/State/Local Floodplain permitting likely required.	Need is moderate in comparison to other alternatives State Closure Permit required; Well permitting for barrier wall monitoring; Federal/State/Local Floodplain permitting required; State and local erosion control/construction stormwater management permits required
257.97(c)(3)(iv) Availability of necessary equipment and specialists	Not Applicable	Necessary equipment and specialists are highly available; Highest level of demand for cap construction material, which are readily available and accessible in the area.	Same as Alternative #2; Lowest level of demand for cap construction material. Potentially increased demand for dewatering, treatment and conditioning of CCR.	Same as Alternative #2; Moderate level of demand for liner and cap construction material. Increase in demand for specialty materials and services due to composite liner construction.	Availability of necessary equipment to develop necessary off-site disposal facility airspace and transport ~463K cy of CCR to new disposal facility will be a limiting factor in the schedule for executing this alternative; No liner or cover material demands for on-site implementation of remedy	Similar to Alternative #3; Moderate level of demand for liner and cap construction material. Specialized mixing equipment likely required to apply chemical amendment and achieve required dosing.	Similar to Alternative #3; Moderate level of demand for liner and cap construction material. A site-specific, trained employee will be required to operate the groundwater treatment system.	Similar to Alternative #3; Moderate level of demand for liner and cap construction material; Availability of the necessary specailized equipment and extensive experience required for barrier installation is potentially low or in high demand.
257.97(c)(3)(v) Available capacity and location of needed treatment, storage, and disposal services	Not Applicable	Capacity and location of treatment, storage, and disposal services is not a factor for this alternative	Capacity and location of treatment, storage, and disposal services is unlikely to be a factor for this alternative	Available temporary on-site storage capacity for ~463K cy of CCR while composite liner is constructed is significant limiting factor	Off-site disposal capacity, facility logistical capacity, or the time required to develop the necessary off-site disposal and logistical capacity is a significant limiting factor.	Capacity and location of treatment, storage, and disposal services is unlikely to be a factor for this alternative	Capacity and location of treatment, storage, and disposal services is unlikely to be a factor for this alternative	Capacity and location of treatment, storage, and disposal services is unlikely to be a factor for this alternative
COMMUNITY ACCEPTANCE - 40 CFR 257.97(c)(4)								
257.97(c)(4) The degree to which community concerns are addressed by a potential remedy (Anticipated)	No comments were received during the public meeting held on June 4, 2020. Assume all alternatives are acceptable to interested/affected parties.	No comments were received during the public meeting held on June 4, 2020. Assume all alternatives are acceptable to interested/affected parties.	No comments were received during the public meeting held on June 4, 2020. Assume all alternatives are acceptable to interested/affected parties.	No comments were received during the public meeting held on June 4, 2020. Assume all alternatives are acceptable to interested/affected parties.	No comments were received during the public meeting held on June 4, 2020. Assume all alternatives are acceptable to interested/affected parties.	To be determined. Alternative added after public meeting held on June 4, 2020.	To be determined. Alternative added after public meeting held on June 4, 2020.	To be determined. Alternative added after public meeting held on June 4, 2020.

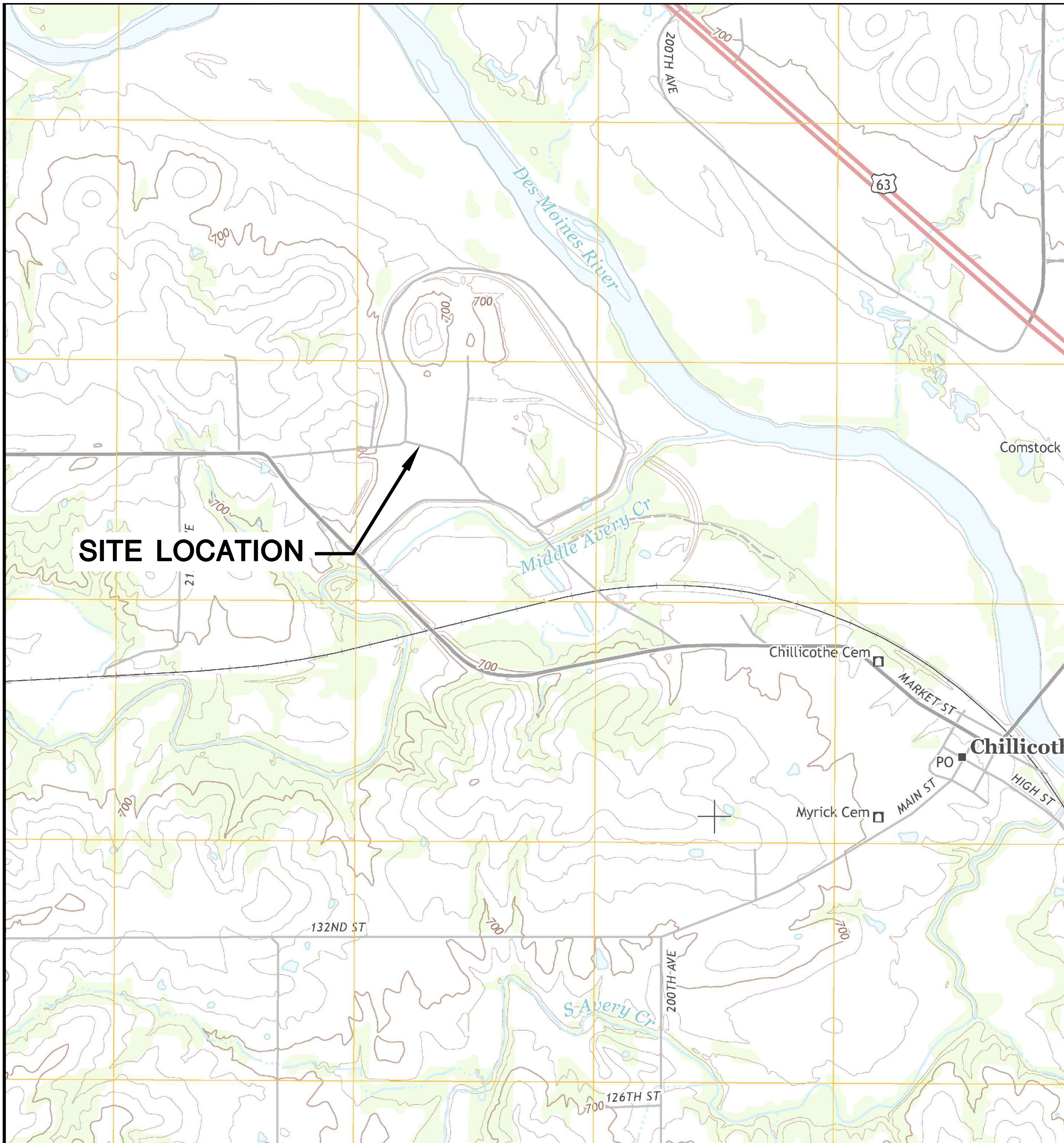
NOTES:

1) Alternatives #1 through #5 were developed and submitted within the Assessment of Correctvie Measures Report (ACM), dated September 2019
2) Alternatives #6 through #8 were added in November 2020 as part of Addendum #1 to the September 2020 ACM Report

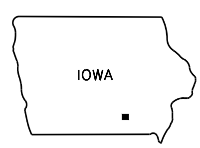
Created by: LAB/SK Date: 6/20/2019
Last revision by: SK Date: 11/23/2020
Checked by: EJN Date: 11/25/2020

I:\25220083.00\Deliverables\ACM Addendum\Tables\[Table 5_Evaluation of Assessment of Corrective Measure_OGS.xlsx]OGS_Evaluation Matrix

Figures



CHILLICOTHE QUADRANGLE
IOWA–WAPELLO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
2013
SCALE: 1" = 2,000'



CLIENT	INTERSTATE POWER AND LIGHT CO. 20775 POWER PLANT ROAD OTTUMWA, IA 52501	SITE	OTTUMWA GENERATING STATION OTTUMWA, IOWA	SITE LOCATION MAP

PROJECT NO.	25218201.00	DRAWN BY:	AHB	ENGINEER	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830	FIGURE
DRAWN:	05/29/15	CHECKED BY:	KAK			1
REVISED:	03/08/16	APPROVED BY:	TJK 09/10/19			

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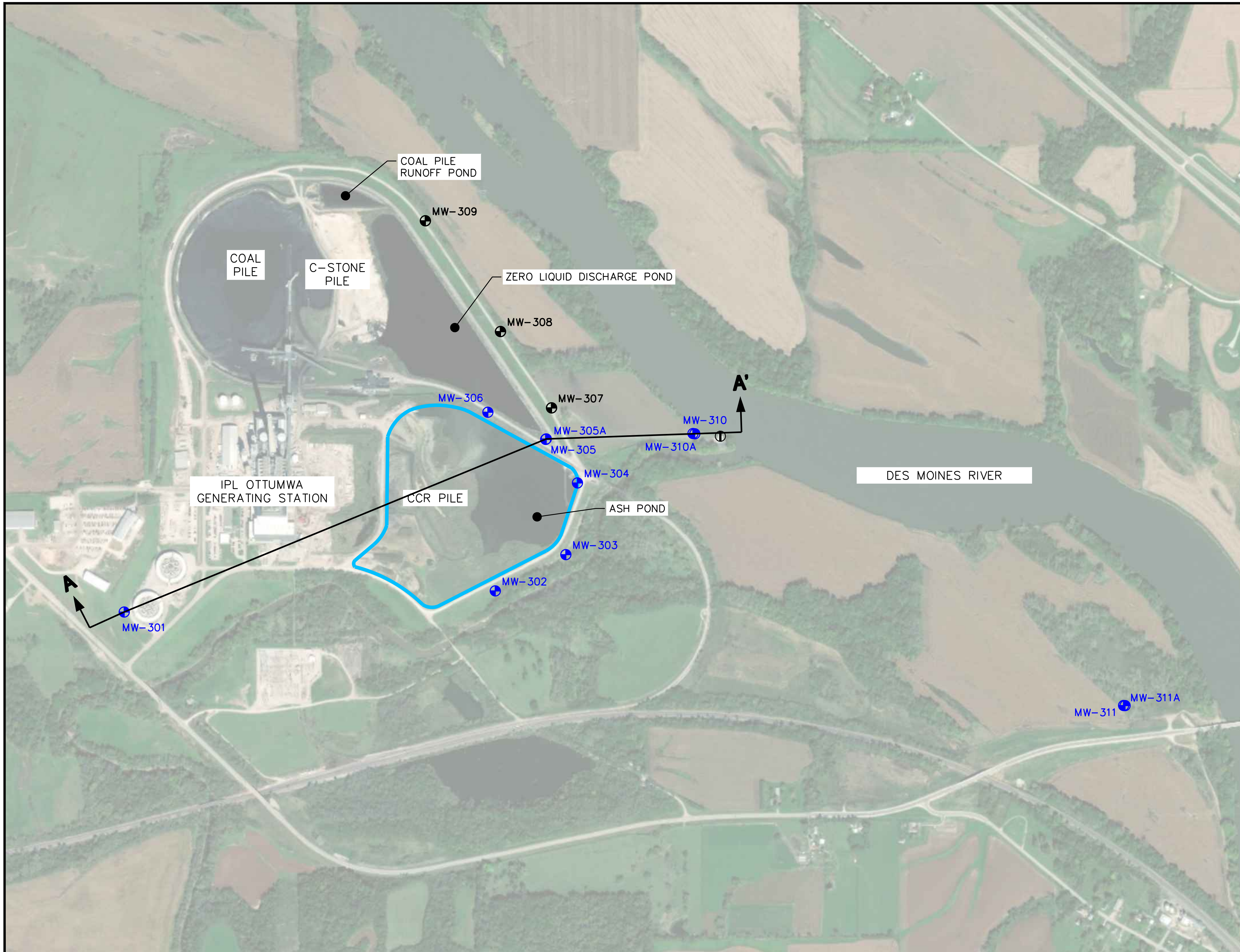

LEGEND

- CCR UNIT
- OGS ASH POND CCR MONITORING WELL
- ADDITIONAL CCR MONITORING WELL
- RIVER ELEVATION MEASUREMENT LOCATION
- GEOLOGIC CROSS SECTION

NOTES:

1. 2014 AERIAL PHOTOGRAPH SOURCES: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA FSA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY.
2. MONITORING WELLS MW-301, MW-302, AND MW-304, WERE INSTALLED BY CASCADE DRILLING, LLP. UNDER THE SUPERVISION OF SCS ENGINEERS FROM NOVEMBER 11-12, 2015.
3. MONITORING WELLS MW-303 AND MW-305 WERE INSTALLED BY CASCADE DRILLING LLP. UNDER THE SUPERVISION OF SCS ENGINEERS ON DECEMBER 7-8, 2015.
4. MONITORING WELLS MW-307, MW-308, AND MW-309 WERE INSTALLED BY CASCADE DRILLING, LLP. UNDER THE SUPERVISION OF SCS ENGINEERS FROM OCTOBER 25-27, 2016.
5. MONITORING WELLS MW-310 AND MW-311 WERE INSTALLED BY ROBERTS ENVIRONMENTAL DRILLING ON AUGUST 27, 2019.
6. MONITORING WELLS MW-305A, MW-310A, AND MW-311A WERE INSTALLED BY ROBERTS ENVIRONMENTAL DRILLING BETWEEN FEBRUARY 27, 2020 AND MARCH 3, 2020.

PROJECT NO.	25220083.00	DRAWN BY:	BSS
DRAWN:	11/15/2019	CHECKED BY:	MDB
REVISED:	11/25/2020	APPROVED BY:	TK 11/25/2020

ENGINEER: SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

CLIENT: INTERSTATE POWER AND LIGHT CO.
20775 POWER PLANT ROAD
OTTUMWA, IA 52501

SITE: ALLIANT ENERGY
OTTUMWA GENERATING STATION
OTTUMWA, IOWA

SITE PLAN
AND MONITORING WELL LOCATIONS

FIGURE 2

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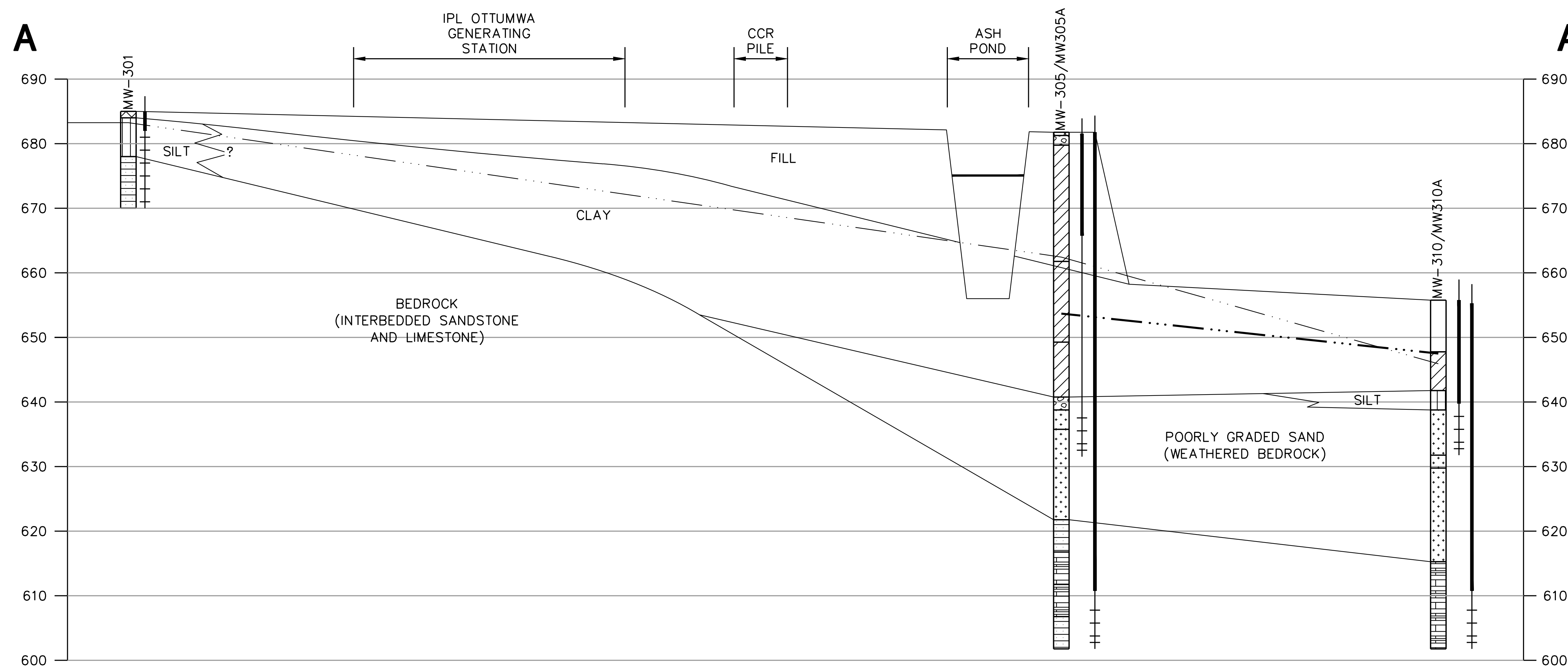
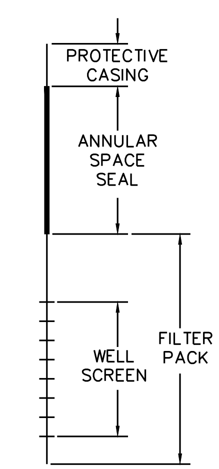


LEGEND

- TOPSOIL/FILL
- SAND, POORLY GRADED (SP)
- SILT, WITH SAND AND GRAVEL (ML)
- CLAY
- GRAVEL, POORLY GRADED, LITTLE OR NO FINES (GP)
- SANDSTONE
- LIMESTONE
- DEEP POTENTIOMETRIC SURFACE MEASURED APRIL 13-14, 2020
- SHALLOW POTENTIOMETRIC SURFACE MEASURED APRIL 13-14, 2020
- POND SURFACE ELEVATION MEASURED JUNE 10-11, 2019



WELL DETAIL

0 500

HORIZONTAL SCALE: 1" = 500'
VERTICAL SCALE: 1" = 20'
VERTICAL EXAGGERATION = 25X

NOTES:

1. MW-305 AND MW-305A WERE HYDROVACED TO APPROXIMATELY 8.5'. MW-310 AND MW-310A WERE HYDROVACED TO APPROXIMATELY 8.0'. HYDROVACING IS PERFORMED TO DETERMINE IF UNDERGROUND UTILITIES ARE PRESENT. HIGH PRESSURE WATER AND A VACUUM ARE USED TO CLEAR THE BOREHOLE AND GEOLOGIC SAMPLES ARE NOT COLLECTED. NATIVE SOIL IN THE VICINITY OF MW-307 IS CLAY.

2. ASH POND BOTTOM ELEVATION IS BASED ON THE EMBANKMENT CREST ELEVATION (681 FEET) AND INTERNAL STORAGE DEPTH (25 FEET) REPORTED IN THE HISTORY OF CONSTRUCTION REPORT ISSUED SEPTEMBER 29, 2016, BY HARD HAT SERVICES.

PROJECT NO.	25220083.00	DRAWN BY:	BSS/KP
DRAWN:	07/03/2019	CHECKED BY:	NDK/MDB
REVISED:	05/13/2020	APPROVED BY:	EJN 09/11/20

ENGINEER: SCS ENGINEERS
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PHONE: (608) 224-2830

CLIENT: INTERSTATE POWER AND LIGHT CO.
15300 130th STREET
OTTUMWA, IA 52501

SITE: OTTUMWA GENERATING STATION
20775 POWER PLANT ROAD
OTTUMWA, IOWA

GEOLOGIC CROSS SECTION A-A'

FIGURE 3

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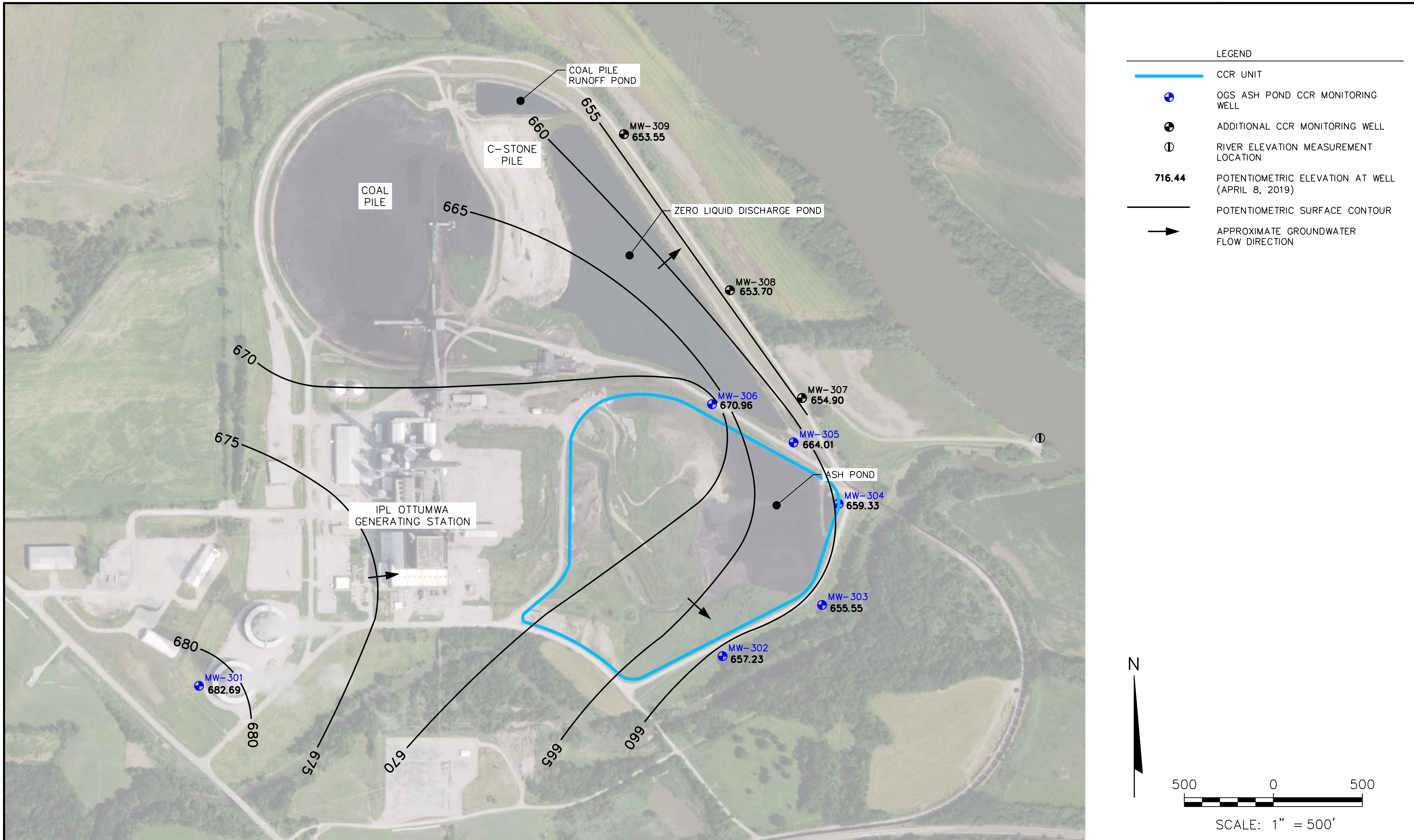
11/25/2020 - Classification: Internal - ECRM7804229



PROJECT NO.	25220083.00	DRAWN BY:	BSS
DRAWN:	07/03/2019	CHECKED BY:	NDK
REVISED:	11/25/2020	APPROVED BY:	TK 11/25/2020

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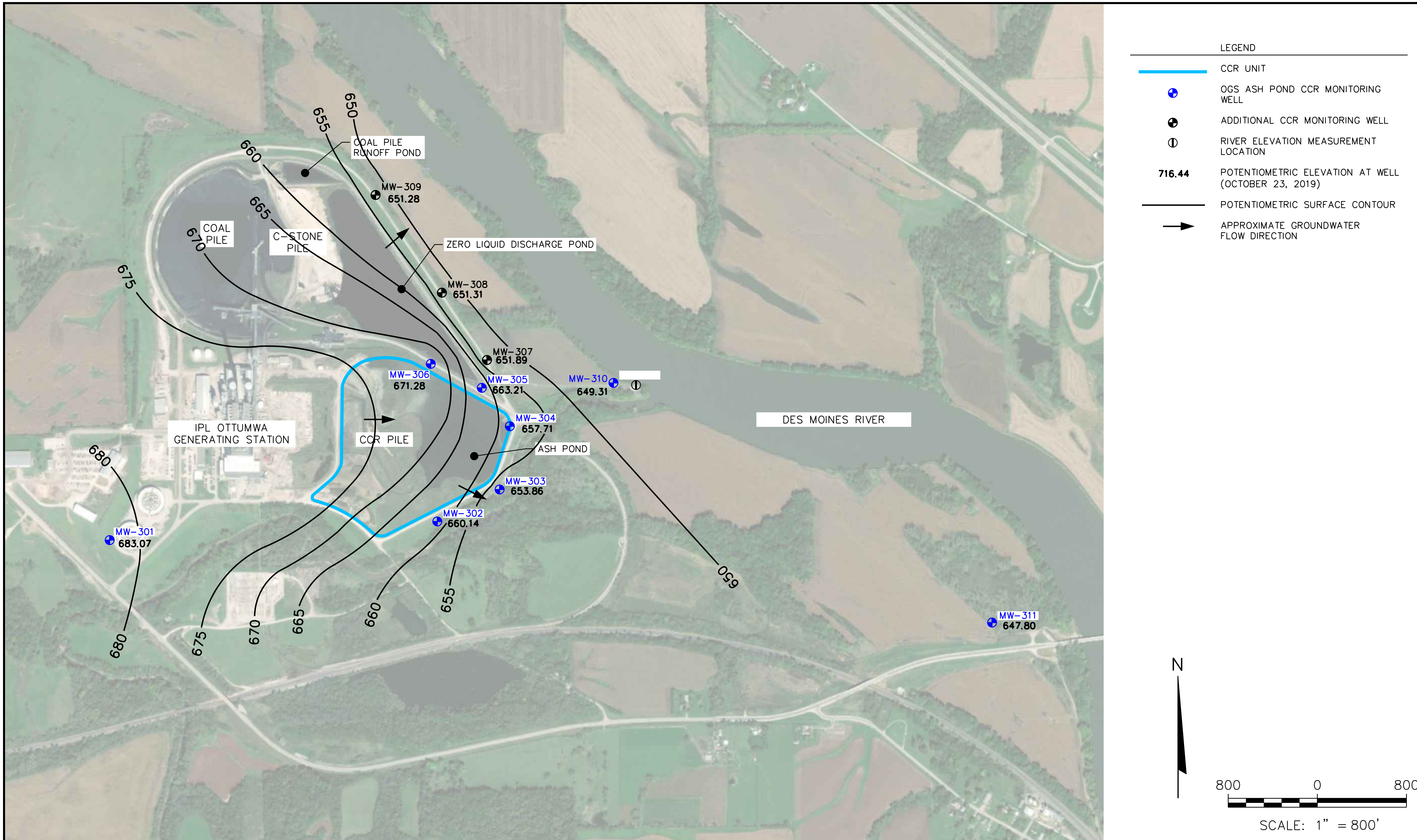
20775 POWER PLANT ROAD
OTTUMWA, IOWA

POTENTIOMETRIC SURFACE – APRIL 2019

FIGURE 4

I:\2522008\.00\Drawings\A\M Addendum\ otentiometric Sur ace A ri 2019.dwg, 11/25/2020 8: 0:55 AM

11/25/2020 - Classification: Internal - ECRM7804229



PROJECT NO.	25220083.00	DRAWN BY:	BSS
DRAWN:	11/15/2019	CHECKED BY:	NDK/SCC
REVISED:	11/25/2020	APPROVED BY:	TK 11/25/2020

ENGINEER: SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

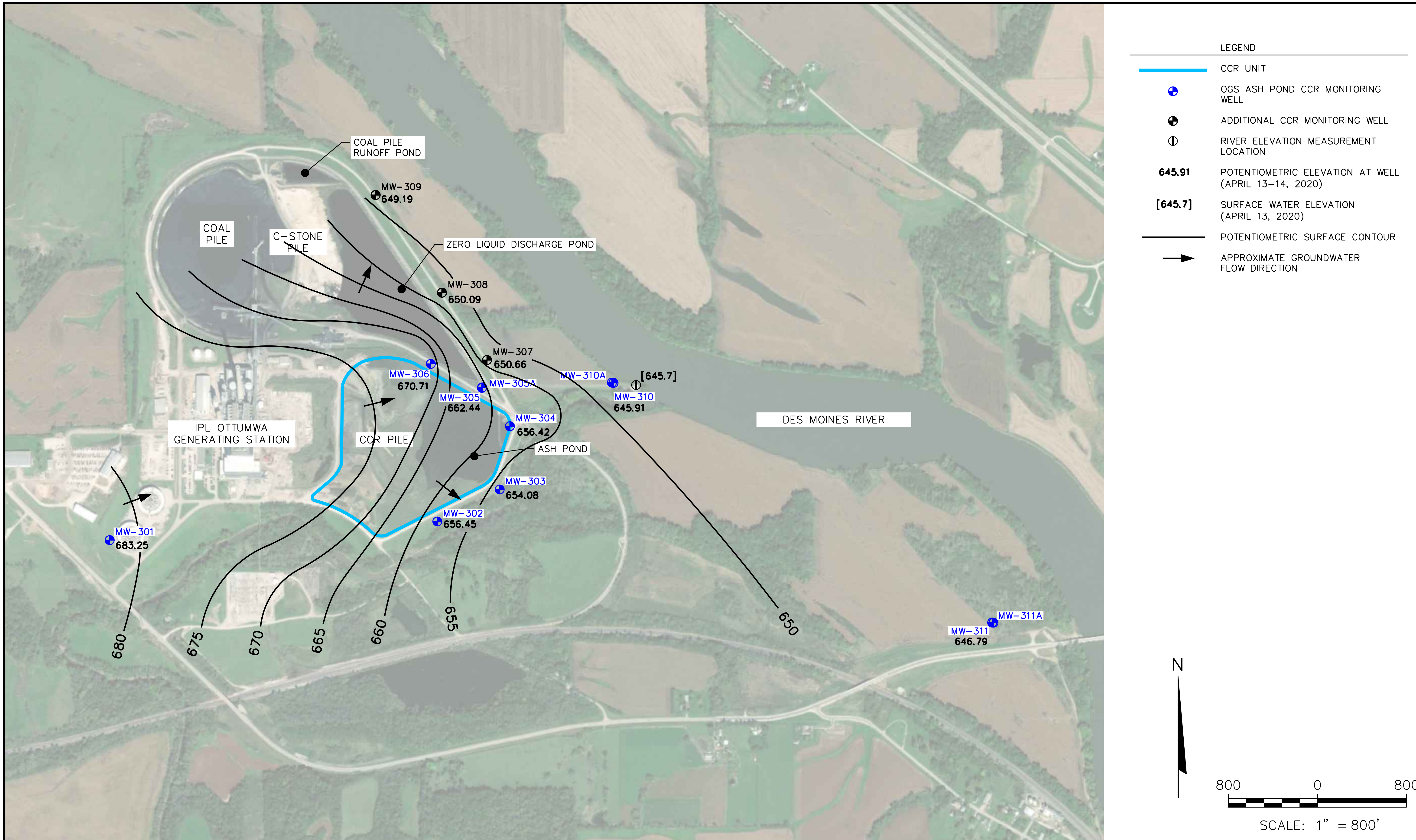
CLIENT: INTERSTATE POWER AND LIGHT CO.
20775 POWER PLANT ROAD
OTTUMWA, IA 52501

SITE: ALLIANT ENERGY
OTTUMWA GENERATING STATION
OTTUMWA, IOWA

POTENTIOMETRIC SURFACE
OCTOBER 2019

FIGURE 5

I:\2522008 .00\Drawings\A M Addendum\ otentiometric Sur ace O O 2019.dwg, 11/25/2020 8: :2 AM



PROJECT NO.	25220083.00	DRAWN BY:	KP/BSS/RJG
DRAWN:	04/28/2020	CHECKED BY:	NDK/SCC
REVISED:	07/30/2020	APPROVED BY:	TK 11/25/2020

ENGINEER: **SCS ENGINEERS**
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

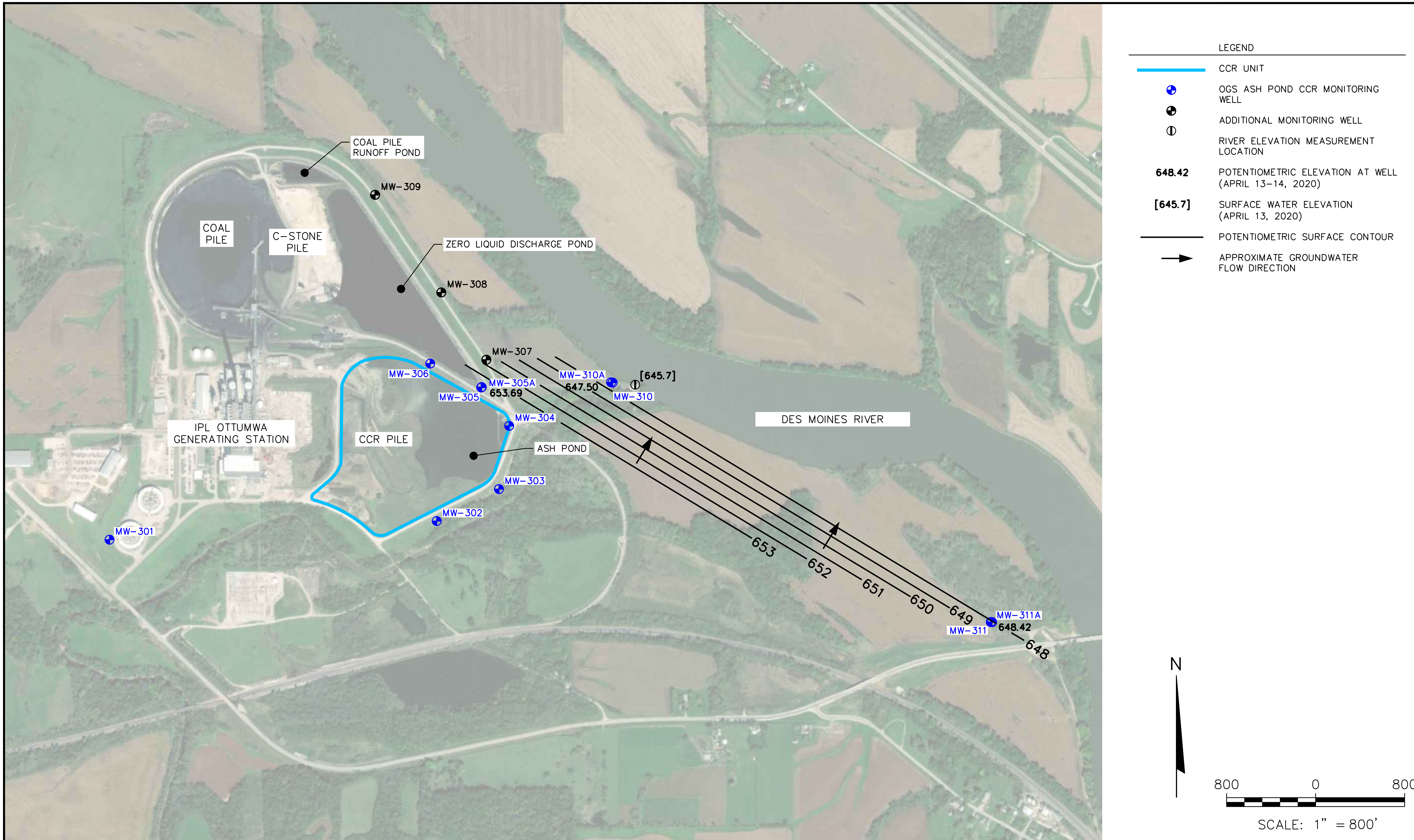
CLIENT: INTERSTATE POWER AND LIGHT CO.
20775 POWER PLANT ROAD
OTTUMWA, IA 52501

SITE: ALLIANT ENERGY
OTTUMWA GENERATING STATION
OTTUMWA, IOWA

SHALLOW POTENTIOMETRIC SURFACE
APRIL 13-14, 2020

FIGURE 6

I:\2522008 .00\Drawings\A M Addendum\ otentiometric Sur ace 2020.dwg, 11/25/2020 8: AM



PROJECT NO.	25220083.00	DRAWN BY:	KP/BSS
DRAWN:	04/28/2020	CHECKED BY:	NDK/SCC
REVISED:	11/25/2020	APPROVED BY:	TK 11/25/2020

ENGINEER: SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

CLIENT: INTERSTATE POWER AND LIGHT CO.
20775 POWER PLANT ROAD
OTTUMWA, IA 52501

SITE: ALLIANT ENERGY
OTTUMWA GENERATING STATION
OTTUMWA, IOWA

DEEP POTENTIOMETRIC SURFACE
APRIL 13–14, 2020

FIGURE
7

I:\2522008 .00\Drawings\A M Addendum\ otentiometric Sur ace 2020.dwg, 11/25/2020 8: :10 AM

11/25/2020 - Classification: Internal - ECRM7804229

Appendix A

Regional Geological and Hydrogeological Information

Regional Hydrogeologic Stratigraphy
Ottumwa Generating Station / SCS Engineers Project #25215053.01

Age of Rocks	Hydrogeologic Unit	General Thickness (feet)	Name of Rock Unit*	Type of Rock
Quaternary (0-1 million years old)	Surficial Aquifers • Alluvial • Buried-Channel • Drift	0 to 320	Undifferentiated	• Sand, gravel, silt, and clay • Sand, gravel, silt, and clay • Till (sandy, pebbly clay), sand, and silt
Pennsylvanian (180 to 310 million years old)	Aquiclude	0 to 370	Undifferentiated	• Shale, sandstone, limestone, and coal
Mississippian (310 to 345 million years old	Mississippian Aquifer • Upper	0 to 600	St. Louis Spergen	• Limestone and sandstone • Limestone
	• Lower		Warsaw Keokuk Burlington Hampton Starrs Cave	• Shale and dolomite • Dolomite, limestone, and shale • Dolomite and limestone • Limestone and dolomite • Limestone
	Aquiclude	0 to 425	Prospect Hill McCraney	• Siltstone • Limestone
Devonian (345 to 400 million years old)			Yellow Spring Lime Creek	• Shale, dolomite, and siltstone • Dolomite and shale
	Devonian Aquifer	110 to 420	Cedar Valley Wapsipinicon	• Limestone and dolomite • Dolomite, limestone, shale, and gypsum
Silurian (400 to 425 million years old)		0 to 105	Undifferentiated	• Dolomite
Ordovician (425 to 500 million years old)	Aquiclude	150 to 600	Maquoketa Galena Decorah Platteville	• Dolomite and shale • Dolomite and chert • Limestone and shale • Limestone, shale, and sandstone
	Cambrian-Ordovician aquifer	750 to 1,110	St. Peter Prairie du Chien	• Sandstone • Dolomite and sandstone
Cambrian (500 to 600 million years old)			Jordan St. Lawrence	• Sandstone • Dolomite
	Not considered an aquifer in southeast Iowa	450 to 750+	Franconia Galesville Eau Claire Mt. Simon	• Shale, siltstone, and sandstone • Sandstone • Sandstone, shale, and dolomite • Sandstone
Precambrian (600 million to 2 billion + years old)				• Sandstone, igneous rocks, and metamorphic rocks

*This nomenclature and classification of rock units in this report are those of the Iowa Geological Survey and do not necessarily coincide with those accepted by the U.S. Geological Survey.

Source: "Water Resources of Southeast Iowa," Iowa Geologic Survey Water Atlas No. 4.

Appendix B

Boring Logs

SCS ENGINEERS — **SOIL BORING LOG INFORMATION**

Environmental Consultants and Contractors

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
IPL- Ottumwa Generating Station SCS#: 25215135.40		MW-301

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Todd Schmalfeld Cascade Drilling	11/10/2015	11/10/2015	4-1/4 hollow stem auger

Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW-301	Feet	684.3 Feet	8.5 in

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 400,077 N, 1,899,709 E S/C/N
NW 1/4 of SW 1/4 of Section 26, T 73 N, R 15 W
Lat ___° ___' ___"
Long ___° ___' ___"
Local Grid Location: Feet ☐ N ☐ S; Feet ☐ E ☐ W

Facility ID	County	Civil Town/City/ or Village
	Wapello	Ottumwa

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			0–1	TOPSOIL.	TOPSOIL									
			1–7	SANDY SILT WITH GRAVEL, gray (7.5YR 6/1), gravel is fine.	ML									
S1	10	woh 1 3 9								W				
			7–15	WEATHERED SANDSTONE, very weak, light gray matrix (10YR 7/1), scondary color very dark gray 910YR 3/1), massive.	SANDSTONE									
S2	13	24 50								W				
S3	5	50								W				
S4	6	50								W				
S5	4	50								W				
			15	Endo of Boring at 15 feet bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: [signature] for Kyle Kramer

Firm: SCS Engineers
2830 Dairy Drive Madison, WI 53718
Tel: (608) 224-2830
Fax:

SCS ENGINEERS
Environmental Consultants and Contractors

SOIL BORING LOG INFORMATION

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name: IPL- Ottumwa Generating Station SCS#: 25215135.40	License/Permit/Monitoring Number:	Boring Number: MW-302

Boring Drilled By: Name of crew chief (first, last) and Firm: Todd Schmalfeld, Cascade Drilling	Date Drilling Started: 11/10/2015	Date Drilling Completed: 11/10/2015	Drilling Method: 4-1/4 hollow stem auger

Unique Well No.	DNR Well ID No.	Common Well Name: MW-302	Final Static Water Level: Feet	Surface Elevation: 671.6 Feet	Borehole Diameter: 8.5 in

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 400,267 N, 1,902,625 E S/C/N
NE 1/4 of SE 1/4 of Section 26, T 73 N, R 15 W
Lat ___° ___' ___"
Long ___° ___' ___"
Local Grid Location: ☐ N ☐ S Feet; ☐ E ☐ W Feet

Facility ID	County: Wapello	Civil Town/City/ or Village: Ottumwa

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			0–1	TOPSOIL.	TOPSOIL									
			1–14	LEAN CLAY WITH SAND, dark gray (10YR 4/1).	CL									
S1	19	1 4 5 7	10–12							M				
S2	19	2 4 7 11	12.5–14.5							M				
			14–16	LEAN CLAY WITH SAND, very dark gray (5Y 3/1).	CL									

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: [signature] for Kyle Kramer

Firm: SCS Engineers
2830 Dairy Drive Madison, WI 53718
Tel: (608) 224-2830
Fax:

Boring Number MW-302

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
S3	24	2 3 9 9	17	POORLY GRADED SAND, olive yellow (2.5Y 6/6).	SP					M				
			18	LEAN CLAY, dark grayish brown (10YR 4/2).	CL									
S4	24	4 4 4 4	19	POORLY GRADED GRAVEL, fine.	GP					W				saturation @ 18 ft bgs.
			20	LEAN CLAY, brownish yellow (10YR 6/8).	CL									
S5	15	2 3 3 6	21	POORLY GRADED GRAVEL WITH CLAY, gray (10YR 5/1), fine.	GP-GC					W				
S6	24	3 4 8 9	22 23							W				
			24	POORLY GRADED SAND, gray (10YR 5/1), medium grained.	SP									
S7	24	4 3 6 8	25 26 27							W				
S8	24	7 8 11 9	28	Same as above, but brown (10YR 5/3).						W				
			29	POORLY GRADED SAND, gray (10YR 5/1), fine grained, (weathered bedrock?).	SP									
S9	23	5 14 33 50/.4	30 31	Medium grained.						W				
S10	12	12 50/.3	32 33							W				
			34	POORLY GRADED SAND, olive yellow (2.5Y 7/1), fine grained, (weathered bedrock?).	SP									
S11	3	50/.3	35 36							W				
			37	End of Boring at 37 feet bgs.										

SCS ENGINEERS
Environmental Consultants and Contractors

SOIL BORING LOG INFORMATION

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
IPL- Ottumwa Generating Station SCS#: 25215135.40		MW-303

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Todd Schmalfeld Cascade Drilling	12/8/2015	12/8/2015	4-1/4 hollow stem auger

Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW-303	Feet	659.0 Feet	8.5 in

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 400,583 N, 1,903,215 E S/C/N
NE 1/4 of SE 1/4 of Section 26, T 73 N, R 15 W
Lat ___° ___' ___"
Long ___° ___' ___"
Local Grid Location ☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	Civil Town/City/ or Village
	Wapello	Ottumwa

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			0–9	FILL, boring location was cleared to 9' bgs by hydrovac, then back filled.	FILL									
			9–14.5	WEATHERED SANDSTONE, medium grained, brown (10YR 5/4).	SANDSTONE									
S1	1	50	11							W				
S2	NR		13.5											
			14.5	End of Boring at 14.5 ft bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: [signature] for Kyle Kramer

Firm SCS Engineers
2830 Dairy Drive Madison, WI 53718
Tel: (608) 224-2830
Fax:

SCS ENGINEERS
Environmental Consultants and Contractors

SOIL BORING LOG INFORMATION

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
IPL- Ottumwa Generating Station SCS#: 25215135.40		MW-304

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Todd Schmalfeld Cascade Drilling	11/11/2015	11/11/2015	4-1/4 hollow stem auger

Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW-304	Feet	680.1 Feet	8.5 in

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 401,152 N, 1,903,287 E S/C/N
SE 1/4 of NE 1/4 of Section 26, T 73 N, R 15 W
Lat ___ ° ___ ' ___ "
Long ___ ° ___ ' ___ "
Local Grid Location: ☐ N ☐ S Feet; ☐ E ☐ W Feet

Facility ID	County	Civil Town/City/ or Village
	Wapello	Ottumwa

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			0–1	TOPSOIL.	TOPSOIL									
			1–12.5	FAT CLAY, black (10YR 2/1).	CH									
S1	23	4 5 4 5	11							M				
			12.5–15	FAT CLAY, yellowish brown (10YR 5/4).	CH									
S2	19.5	4 4 5 5	13.5							M				
			15–	FAT CLAY, yellowish brown (10YR 3/4).	CH									

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm	
[signature] for Kyle Kramer	SCS Engineers 2830 Dairy Drive Madison, WI 53718	Tel: (608) 224-2830 Fax:

Boring Number MW-304

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
S3	12	3 3 4 5		FAT CLAY, yellowish brown (10YR 3/4). *(continued)*	CH					M				
			17											
			18											
S4	22	4 3 7 12	19							M				
			20											
S5	23	2 7 8 9	21							M				
			22											
S6	23	3 4 8 6	23–24							M				
			25											
S7	23	5 11 15 11	26							M				
			27											
S8	15	4 4 5 6	28–29							M				
			30											
S9	18	4 6 9 9	31							M				
			32											
S10	24	4 6 7 6	33–34							M				
			35	FAT CLAY, DARK OLIVE BROWN (2.5Y 3/3).	CH									
S11	16	2 2 4 6	36							M				
			37											
S12	24	4 3 5 5	38–39							M				
			40											
S13	18	2 3 3 3	41							M				
			42											

Boring Number MW-304

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			43	FAT CLAY, DARK OLIVE BROWN (2.5Y 3/3). *(continued)*	CH									
S14	24	3 4 9 14		SANDY SILT, very dark gray.	ML					W				
			44	POORLY GRADED SAND, medium grained, gray (5Y 6/1), (weathered bedrock).	SP									
			45											
S16	15	30 50/.4	46							W				
			47											
			48											
S17	5	33 50/.2								W				
			49											
			50											
S18		50/.4	51							W				
			52	End of Boring at 52 feet bgs.										

SCS ENGINEERS
Environmental Consultants and Contractors

SOIL BORING LOG INFORMATION

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
IPL- Ottumwa Generating Station SCS#: 25215135.40		MW-305

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Todd Schmalfeld Cascade Drilling	12/7/2015	12/8/2015	4-1/4 hollow stem auger

Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW-305	Feet	681.5 Feet	8.5 in

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 401,473 N, 1,903,023 E S/C/N
SE 1/4 of NE 1/4 of Section 26, T 73 N, R 15 W
Lat ___° ___' ___"
Long ___° ___' ___"
Local Grid Location ☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	Civil Town/City/ or Village
	Wapello	Ottumwa

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			0	TOPSOIL	TOPSOIL									
			1	GRAVEL	GP									
			1.5	FAT CLAY	CH									
			10	FAT CLAY, very dark grayish brown (10YR 3/2).										
S1	18	3 6 9 11	11							W				
S2	22	3 7 14 22	13	same as above except, brown (10YR 4/3).						W				

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm	
[signature] for Kyle Kramer	SCS Engineers 2830 Dairy Drive Madison, WI 53718	Tel: (608) 224-2830 Fax:

Boring Number MW-305

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
S3	22	5 15 14 15	17	FAT CLAY *(continued)*										
S4	20	3 5 13 15	18–19		CH									
S5	24	4 5 7 11	20–22	FAT CLAY WITH SILT, dark gray (10YR 4/1).						M				
S6	20	7 11 15 20	23–24	same as above except, very dark brown (10YR 2/2).						M				
S7	24	4 8 11 12	25–27	same as above except, very dark gray (10YR 3/1).	CH					M				
S8	24	8 12 16 21	28–29							M				
S9	13	4 4 7 12	30–32							M				
S10	24	5 6 9	33–34	LEAN CLAY, very dark brown (10YR 2/2).						W				
S11	24	4 4 5 7	35–37		CL					W				
S12	22	2 2 3 5	38–40	same as above except, very dark grayish brown (10YR 3/2).						W				
S13	6	3 9 11	41–42	POORLY GRADED SANDY GRAVEL, fine, brown (10YR 4/3).	GPS					W				water @ 41.0 ft bgs.

Boring Number MW-305

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			43	POORLY GRADED SAND, medium grained, yellowish brown (10YR 5/4), (weathered bedrock). *(continued)*	SP									
S14	22	23 50	44							S				
			45											
S15	6	5 10 50	46		SP					S				
			47											
			48											
S16	6	50	49							S				
			50	End of Boring at 50 ft bgs.										

SCS ENGINEERS — **SOIL BORING LOG INFORMATION**

Environmental Consultants and Contractors

Route To: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
IPL- Ottumwa Generating Station SCS#: 25215135.40		MW-306

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Todd Schmalfeld, Cascade Drilling	11/12/2015	11/12/2015	4-1/4 hollow stem auger

Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW-306	Feet	681.1 Feet	8.5 in

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 401,666 N, 1,902,629 E S/C/N
SE 1/4 of NE 1/4 of Section 26, T 73 N, R 15 W
Lat ___° ___' ___" Long ___° ___' ___"
Local Grid Location: Feet ☐ N ☐ S; Feet ☐ E ☐ W

Facility ID	County	Civil Town/City/ or Village
	Wapello	Ottumwa

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			0–1	TOPSOIL.	TOPSOIL									
			1–13	FAT CLAY, dark olive brown (2.5Y 3/3).	CH									
S1	18	3 6 9 11	11							M				
			13–16	FAT CLAY, gray (10YR 5/1).	CH									
S2	22	5 6 7 9	14							M				

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
[signature] for Kyle Kramer	SCS Engineers, 2830 Dairy Drive Madison, WI 53718 — Tel: (608) 224-2830 Fax:

Boring Number MW-306

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
S3	22	5 10 10 14	17	FAT CLAY, gray (10YR 5/1). *(continued)* FAT CLAY, gray (10YR 5/1).	CH					M				
S4	13	5 8 14 17	18–19	FAT CLAY, dark olive brown (2.5Y 3/3).	CH					M				
S5	15	5 6 13 16	20–21							W				
S6	15	3 5 7 9	22–24							W				
S7	22	2 5 7 11	25–26	POORLY GRADED SAND, very dark grayish brown (10YR 3/2), medium to coarse grained, (weathered bedrock?).	SP					W				
S8	NR	7 3 4 3	27–29							W				
S9	18	1 1 2 2	30–31							W				
S10	13	WOR	32–34							W				
				End of Boring at 34.5 feet bgs.										

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name		License/Permit/Monitoring Number	Boring Number
IPL - Ottumwa Generating Station	SCS#: 25219028.00		MW-310

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Eric Wetzel Roberts Environmental Drilling, Inc.	8/27/2019	8/27/2019	4 1/4 hollow stem auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW-310	Feet MSL	655.76 Feet MSL	8.5 in.

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒		Local Grid Location
State Plane 401,502 N, 1,904,206 E S/C/N 1/4 of 1/4 of Section , T N, R	Lat ° ' " Long ° ' "	Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Wapello		Ottumwa

Sample: Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			0–8	Hydrovac through clay for utility clearances.										
			8	LEAN CLAY, brown, massive.										
S1	11	WOR 10 3 10	9	Some reddish brown and grey mottling, some silt.						M				
S2	15	2 2 3 2	11		CL					M				
S3	20	1 1 1 9	13							M/W				
			14	SILT, brown, with clay.	ML									

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
[signature]	SCS Engineers 2830 Dairy Drive Madison, WI 53718 Tel: 608-224-2830 Fax

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-310 Use only as an attachment to Form 4400-122.

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Sample: Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
S4	24	WOR	16		ML					M/W				
S5	18	1 3 2 3	17	POORLY GRADED SAND, fine to medium, 1/2" coarse sand seam at 17.75'.						W				
			18											
S6	14	WOR WOR 2 3	19							W				
			20		SP									
S7	10	WOR 2 4 2	21							W				
			22	Trace small rounded gravel.										
S8	24	6 6 11 20	23							W				
			24	End of boring at 24'										

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number	
IPL - Ottumwa Generating Station SCS#: 25219028.00		MW-311	
Boring Drilled By: Name of crew chief (first, last) and Firm	**Date Drilling Started**	**Date Drilling Completed**	**Drilling Method**
Eric Wetzel Roberts Environmental Drilling, Inc.	8/27/2019	8/27/2019	4 1/4 hollow stem auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW-311	Feet MSL	651.24 Feet MSL	8.5 in.

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 399,350 N, 1,907,603 E S/C/N
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location: Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Wapello		Ottumwa

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			1	LEAN CLAY, brown, massive, trace fine to medium sand, roots, 1" sand seam at 1.5'.	CL									
S1	14	2 3 4 6	2							M				
S2	14	3 3 4 6	4							M				
S3	6	2 3 4 6	6	SILT, brown, massive.	ML					M				
			7	LEAN CLAY, brown, massive.	CL									
S4	20	2 3 4 3	8	POORLY GRADED SAND, fine to medium, brown, massive.	SP					M/W				
S5	12	2 3 4 5	10	2" clay seam at 10.5'.						W				
S6	14	1 2 4 2	12							W				
S7	14	1 2 3 3	14							W				
			15											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm SCS Engineers
2830 Dairy Drive Madison, WI 53718
Tel: 608-224-2830
Fax:

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-311 Use only as an attachment to Form 4400-122.

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
					SP									
			16	End of boring at 16'.										

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name: IPL - Ottumwa Generating Station Permit No.:

Well or Piezometer No.: MW-310 Dates Started: 8/27/2019 Date Completed: 8/27/2019

A. SURVEYED LOCATION AND ELEVATION OF POINT (+0.5 ft.)

Specify corner of site: Middle Avery Creek @ Des Moines River Distance and direction along boundary: 340' NW

Distance and direction from boundary to surface monitoring well: 45' SW

Elevation (+0.01 ft. MSL):

Ground Surface: 655.76 Top of protective casing: 658.97

Top of well casing: 658.63 Benchmark elevation:

Benchmark description:

B. SOIL BORING INFORMATION

Construction Company Name: Roberts Environmental Drilling Inc.

Address: 1107 South Mulberry Street City, State, Zip Code: Millstadt, IL, 62260

Name of driller: Eric Wetzel

Drilling method: 4 1/4" HSA Drilling fluid: Bore Hole diameter: 8.5"

Soil sampling method: Split Spoon Depth of boring: 24'

C. MONITORING WELL INSTALLATION

Casing material: PVC - Sch. 40

Length of casing: 20.87

Outside casing diameter: 2.4"

Inside casing diameter: 2.0"

Casing joint type: Threaded

Casing/screen joint type: Threaded

Screen material: PVC - Sch. 40

Screen opening size: 0.01'

Screen length: 5'

Depth of Well: 23'

Filter Pack:

- Material: Filter Sand
- Grain Size: #5
- Volume: 1.25 cubic feet

Seal (minimum 3 ft. length above filter pack):

- Material: 3/8" Bentonite Chips

Placement method: Gravity

Volume: 4 cubic feet

Backfill (if different from seal):

- Material:
- Placement method:
- Volume:

Surface seal design: Concrete

- Material of protective casing: Steel
- Material of grout between protective casing and well casing: Bentonite/Filter Sand

Protective cap:

- Material: Steel
- Vented?: [X] Y [ ] N Locking?: [X] Y [ ] N

Well cap:

- Material: Plastic
- Vented?: [ ] Y [X] N

D. GROUNDWATER MEASUREMENT (±0.01 foot below top of inner well casing)

Water level 16.67 **Stabilization time** 5 min

Well development method surge and purge with pump to remove turbidity

Average depth of frost line 3.5'

DRILLER'S CERTIFICATION

I certify under penalty of law I believe the information reported above is true, accurate, and complete.

Signature [signature] **Certification #** 11509 **Date** 10.3.19

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Land Quality Bureau, 502 E. 9th St, Des Moines, IA 50319.
Questions? Call or Email: Nina Booker Environmental Engineer Sr., 515-725-8309, nina.booker@dnr.iowa.gov

ELEVATIONS: ± 0.01 FT. MSL

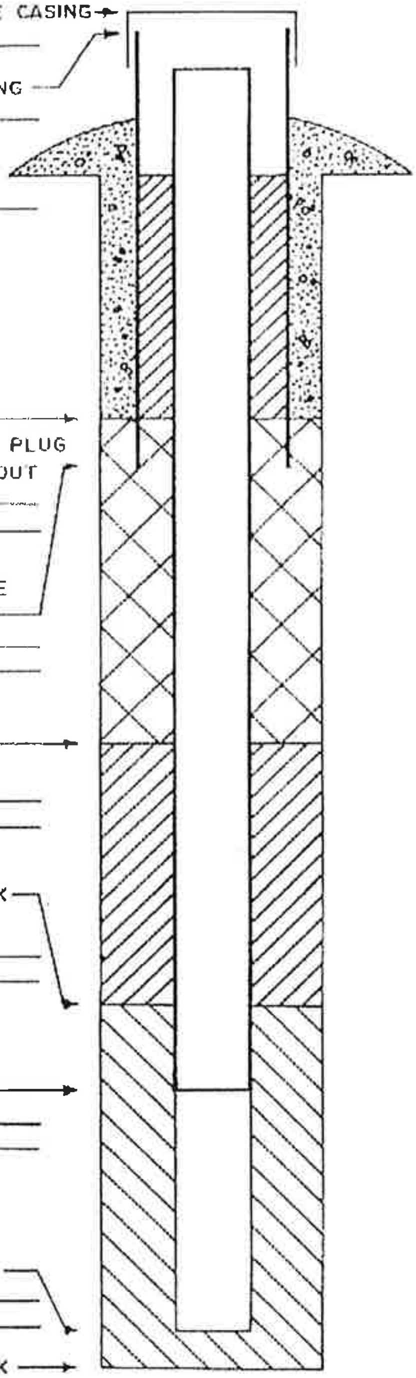
DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).

TOP OF PROTECTIVE CASING
ELEVATION 658.97

TOP OF WELL CASING
ELEVATION 658.63

GROUND SURFACE
ELEVATION 655.76



TOP OF BACKFILL
BASE OF CONCRETE PLUG
AND BENTONITE GROUT
ELEVATION 651.76
DEPTH 4

BASE OF PROTECTIVE CASING
ELEVATION 651.76
DEPTH 4

BASE OF BACKFILL
TOP OF SEAL
ELEVATION
DEPTH N/A

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 639.76
DEPTH 16

TOP OF SCREEN
ELEVATION 637.76
DEPTH 18

BOTTOM OF SCREEN
ELEVATION 632.76
DEPTH 23

BASE OF FILTER PACK
ELEVATION 631.76
DEPTH 24

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name: IPL - Ottumwa Generating Station   Permit No.:

Well or Piezometer No.: MW-311   Dates Started: 8/27/2019   Date Completed: 8/27/2019

A. SURVEYED LOCATION AND ELEVATION OF POINT (+0.5 ft.)

Specify corner of site: SE   Distance and direction along boundary: 730' W

Distance and direction from boundary to surface monitoring well: 160' N

Elevation (+0.01 ft. MSL):

Ground Surface: 651.24   Top of protective casing: 654.49

Top of well casing: 654.18   Benchmark elevation:

Benchmark description:

B. SOIL BORING INFORMATION

Construction Company Name: Roberts Environmental Drilling Inc.

Address: 1107 South Mulberry Street   City, State, Zip Code: Millstadt, IL, 62260

Name of driller: Eric Wetzel

Drilling method: 4 1/4" HSA   Drilling fluid: Bore Hole diameter: 8.5"

Soil sampling method: Split Spoon   Depth of boring: 16'

C. MONITORING WELL INSTALLATION

Casing material: PVC - Sch. 40   Placement method: Gravity

Length of casing: 12.94'   Volume: 2 cubic feet

Outside casing diameter: 2.4"   Backfill (if different from seal):

Inside casing diameter: 2.0"   Material:

Casing joint type: Threaded   Placement method:

Casing/screen joint type: Threaded   Volume:

Screen material: PVC - Sch. 40   Surface seal design: Concrete

Screen opening size: 0.01'   Material of protective casing: Steel

Screen length: 5'   Material of grout between protective casing and well casing: Bentonite/Filter Sand

Depth of Well: 15'   Protective cap:

Filter Pack: Material: Steel

Material: Filter Sand   Vented?: [X] Y [ ] N   Locking?: [X] Y [ ] N

Grain Size: #5   Well cap:

Volume: 1.5 cubic feet   Material: Plastic

Seal (minimum 3 ft. length above filter pack):   Vented?: [ ] Y [X] N

Material: 3/8" Bentonite Chips

D. GROUNDWATER MEASUREMENT (+0.01 foot below top of inner well casing)

Water level 12.04   **Stabilization time** 5 min

Well development method surge and purge with pump to remove turbidity

Average depth of frost line 3.5'

DRILLER'S CERTIFICATION

I certify under penalty of law I believe the information reported above is true, accurate, and complete.

Signature [signature]   **Certification #** 11509   **Date** 12.3.19

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Land Quality Bureau, 502 E. 9th St, Des Moines, IA 50319.
Questions? Call or Email: Nina Booker Environmental Engineer Sr., 515-725-8309, nina.booker@dnr.iowa.gov

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).

TOP OF PROTECTIVE CASING
ELEVATION 654.49

TOP OF WELL CASING
ELEVATION 654.18

GROUND SURFACE
ELEVATION 651.24

TOP OF BACKFILL
BASE OF CONCRETE PLUG AND BENTONITE GROUT
ELEVATION 647.24
DEPTH 4

BASE OF PROTECTIVE CASING
ELEVATION 647.24
DEPTH 4

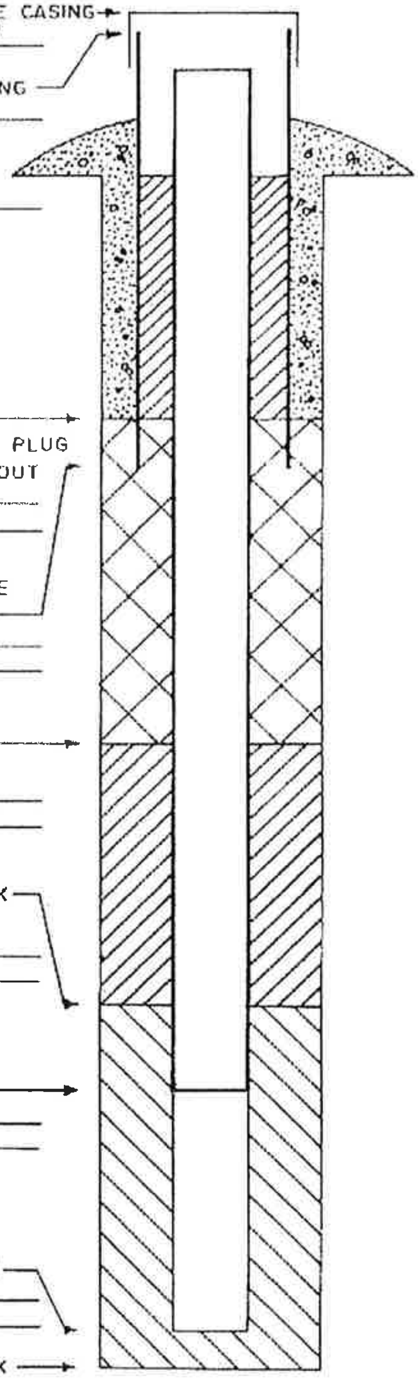
BASE OF BACKFILL
TOP OF SEAL
ELEVATION
DEPTH N/A

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 643.24
DEPTH 8

TOP OF SCREEN
ELEVATION 641.24
DEPTH 10

BOTTOM OF SCREEN
ELEVATION 636.24
DEPTH 15

BASE OF FILTER PACK
ELEVATION 635.24
DEPTH 16



Facility/Project Name	License/Permit/Monitoring Number	Boring Number
IPL-Ottumwa Generating Station SCS#: 25220056.00		MW-305A

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Jeff Crank Roberts Environmental Services	2/25/2020	2/27/2020	6 1/4" HSA and air/mud rotary

	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW-305A	32.7 Feet	681.76 Feet	10" and 6" in.

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 401,461 N, 1,903,028 E S/C/N
SE 1/4 of NE 1/4 of Section 26, T 73 N, R 15 W

Lat ___° ___' ___"
Long ___° ___' ___"

Local Grid Location
Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Wapello		Ottumwa

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			0–9.5	Hydrovaced to 9.5 feet for utility clearance.										Drilled using hollow stem augers to 55 feet
			9.5–15	Blind drilled to 46 feet. See boring log MW-305 for lithology.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm	
[signature]	scs engineers	Tel: Fax:

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number MW-305A Use only as an attachment to Form 4400-122.

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			16											
			17											
			18											
			19											
			20											
			21											
			22											
			23											
			24											
			25											
			26											
			27											
			28											
			29											
			30											
			31											
			32											
			33											
			34											
			35											
			36											
			37											
			38											
			39											
			40											

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number MW-305A Use only as an attachment to Form 4400-122.

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			40–45											Bagged auger samples to ~40 feet
			45											Swithched to mud rotary drilling at 45 feet
S1	5	50/5	46	POORLY GRADED SAND, fine, light brown, (weathered sandstone bedrock).	SP					W				
			55	Same as above but very fine, light brown to light gray, with pieces of rock.										Switched to air rotary drilling at 55 feet
			59											Driller noted rock became more compitant at 59' bgs.
			60	SANDSTONE, fine to medium, light brown, trace gravel and light gray to gray limestone, (bedrock).										
			65											

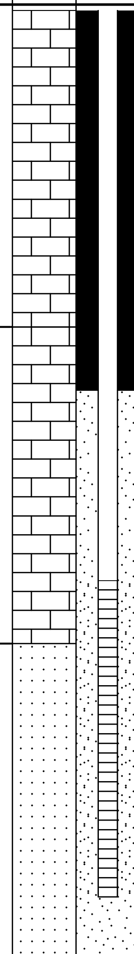
State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number MW-305A Use only as an attachment to Form 4400-122.

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			65–70	LIMESTONE, light gray, with fine, light brown sandstone, (bedrock).										At 68 feet, driller noted a fracture in the bedrock.
			70–75	LIMESTONE, gray, with dark brownish gray shale, (bedrock).										
			75–80	SANDSTONE, fine, light grayish white, with gray limestone, (bedrock).										
			80	End of boring at 80 feet below ground surface.										



Facility/Project Name	License/Permit/Monitoring Number	Boring Number
IPL-Ottumwa Generating Station SCS#: 25220056.00		MW-310A

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Jeff Crank Roberts Environmental Services	2/27/2020	3/2/2020	6 1/4" HSA & air rotary

	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW-310A	12.0 Feet	655.26 Feet	10" and 6" in.

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 401,504 N, 1,904,191 E S/C/N
SW 1/4 of NW 1/4 of Section 25, T 73 N, R 15 W

Lat ___° ___' ____"
Long ___° ___' ____"

Local Grid Location
Feet ☐ N ☐ S
Feet ☐ E ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Wapello		Ottumwa

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			0–8	Hydrovaced to 8 feet for utility clearance.										Drilled using hollow stem augers to 40 feet
			8–15	Blind drilled to 24 feet. See boring log MW-310 for lithology.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm	
	scs engineers	Tel: Fax:

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-310A Use only as an attachment to Form 4400-122.

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			16											
			17											
			18											
			19											
			20											
			21											
			22											
			23											
			24	POORLY GRADED SAND, fine to coarse, brown, trace gravel and lenses of lean clay.	SP									
S1	14	7 20 23 21	25							W				Began collecting split spoon samples at 24 feet
			26	POORLY GRADED SAND, fine, light gray, trace lean clay, (weathered sandstone bedrock).										
S2	17	9 11 12 13	27							W				
			28	Same as above but brown with small gravel.										
S3	13	14 36 50/5	29							W				
			30	Same as above but fine to medium and brown to light gray.										
S4	5	50/5	31							W				
			32	Same as above but fine and light gray.	SP									
S5	5	50/5	33							W				
			34											
S6	5	50/5	35							W				
			36											
S7	5	50/5	37							W				
			38											
S8	4	50/4	39							W				Auger refusal at 39 fet
			40	Same as above but much more competent.										

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-310A Use only as an attachment to Form 4400-122.

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
					SP									
			41	LIMESTONE, light brownish gray, with fine to medium light gray sandstone, (bedrock).										
S9			42							W				Switching to air rotary drilling at 40 feet
			43	Same as above but with gravel and very little sand.										Intermittent gravel between 43 to 54 feet
			44											
			45											
			46											
			47											
			48											
			49											
			50											
			51											
			52											
			53											
			54	End of boring at 54 feet below ground surface.										

Facility/Project Name: IPL-Ottumwa Generating Station SCS#: 25220056.00		License/Permit/Monitoring Number:	Boring Number: MW-311A	
Boring Drilled By: Name of crew chief (first, last) and Firm: Jeff Crank, Roberts Environmental Services		Date Drilling Started: 3/2/2020	Date Drilling Completed: 3/3/2020	Drilling Method: 6 1/4" auger & air rotary
DNR Well ID No.:	Common Well Name: MW-311A	Final Static Water Level: 8.9 Feet	Surface Elevation: 651.16 Feet	Borehole Diameter: 10" and 6" in.
Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒ State Plane 399,349 N, 1,907,615 E S/C/N SW 1/4 of SE 1/4 of Section 25, T 73 N, R 15 W		Lat ___° ___' ___" Long ___° ___' ___"	Local Grid Location Feet ☐ N ☐ S Feet ☐ E ☐ W	
Facility ID:	County: Wapello	County Code:	Civil Town/City/ or Village: Ottumwa	

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			0–15	Blind drilled to 16 feet. See boring log MW-311 for lithology.										Drilled using hollow stem augers to 28 feet

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature:	Firm: scs engineers	Tel: Fax:

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-311A Use only as an attachment to Form 4400-122.

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				POORLY GRADED SAND, fine to coarse, brown, with trace gravel and silt.										
			16											
S1	2		17							W				Began collecting split spoon samples at 16 feet
			18											
S2	11	4 5 6 7	19							W				
			20											
S3	12	5 5 6 7	21		SP					W				
			22											
S4		7 8 9 8	23							W				No return
			24											
S5		3 3 5 10	25							W				No return
			26											
S6	14	5 9 50/5	27							W				Driller noted bedrock at 27.5 feet
			28	POORLY GRADED SAND, very fine, white, with pieces of competent rock, (weatherd sandstone bedrock).	SP									Switched to air rotary drilling at 28 feet
			29	LIMESTONE, gray with fine, light gray to white sandstone, (bedrock).										
			30											
			31	POORLY GRADED SAND, fine to medium, brown, with trace brown limestone, (bedrock).										
			32											
			33											
			34		SP									
			35											
			36											
			37	LIMESTONE, gray, with fine to medium browinsh gray sandstone, (bedrock).										
			38											
			39											
			40											

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-311A Use only as an attachment to Form 4400-122.

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			41											
			42											
			43											
			44											
			45											
			46	End of boring at 46 feet below ground surface.										

Appendix C

Hydrogeochemical Conceptual Model and Preliminary Summary of Groundwater Contaminant Attenuation

Subject:	Cobalt assessment in response to November 2020 e-mail data update	
From:	Bernd W. Rehm	Date: 25 November 2020
Project:	SCS – Alliant OGS Ash pond CCR Evaluations	158-002a

Introduction.

This document focuses the application of monitored natural attenuation with respect to cobalt for the Ottumwa Generating Station Ash Pond. Two of the five shallow monitoring wells on the downgradient perimeter of the Ash Pond consistently exceed one or both of either the cobalt background upper prediction limit (UPL = 4.1 µg/L) or the groundwater protection standard (GPS = 6.0 µg/L):

	MW-305	MW-306
Mean	16.2	5.9
Median	16.0	5.9
Range	14.5 to 17.2	4.8 to 6.9
Number	7	6

One of six observations at MW-302 exceeded the UPL with a concentration of 5.3 µg/L. The final two monitoring wells, MW-303 and MW-304, did not exceed the cobalt UPL.

Conceptual Site Model.

Hydrogeology. Four of the five monitoring wells downgradient of the Ash Pond are completed in saturated poorly graded sand (weathered sandstone) between elevations of approximately 655 to 625 feet above mean sea level. The fifth location (MW-303) encountered sandstone at an elevation of about 650 feet. Clay of variable thickness is generally found above the sand. The degree to which clay separates the Ash Pond from the saturated sand in uncertain. The saturated sand forms a permeable pathway from beneath the Ash Pond to well MW-310 and presumably to the Des Moines River immediately east of MW-310. The horizontal hydraulic gradient of ~0.01 beneath the Ash Pond decreases to ~0.006 from the Ash Pond to the river. The hydraulic conductivity of the sand was observed to range from 3.5 E-4 to 3.2 E-3 cm/s (median 2.8 E-3 cm/s, n=5). Assuming a porosity of 0.3 yields estimated groundwater flow rates on the order of 100 ft/yr below the Ash Pond, to on the order of 60 ft/yr from the pond to the river. The groundwater travel time from the pond to the river is estimated on the order of 30 years. The Ash Ponds were first commissioned in 1981, approximately 40 years ago.

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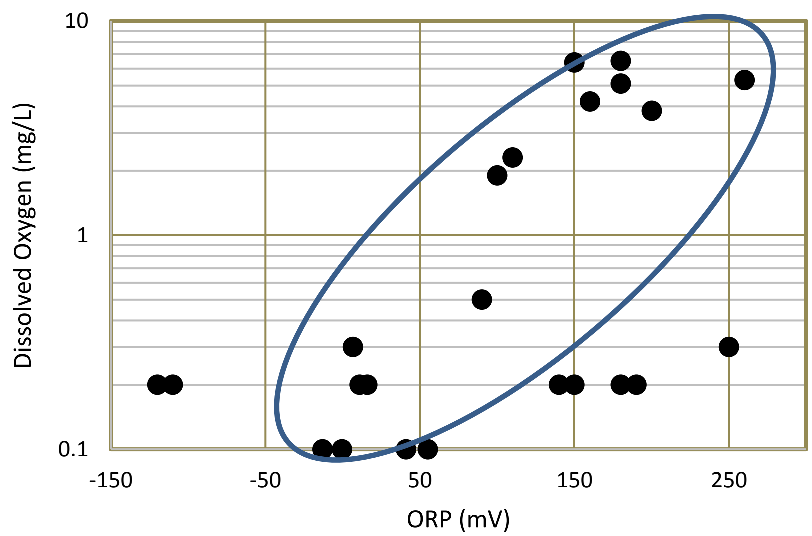
Geochemistry. The groundwater chemistry of the cobalt-bearing monitoring wells and the downgradient monitoring well within the potential groundwater flow path as observed in March, April and October 2020 are used to evaluate the site groundwater chemistry. The wells include MW-301 and MW-302. Table 1 summarizes the overall groundwater chemistry and Table 2 summarizes the data used in the preparation of the figures that follow in this memorandum.

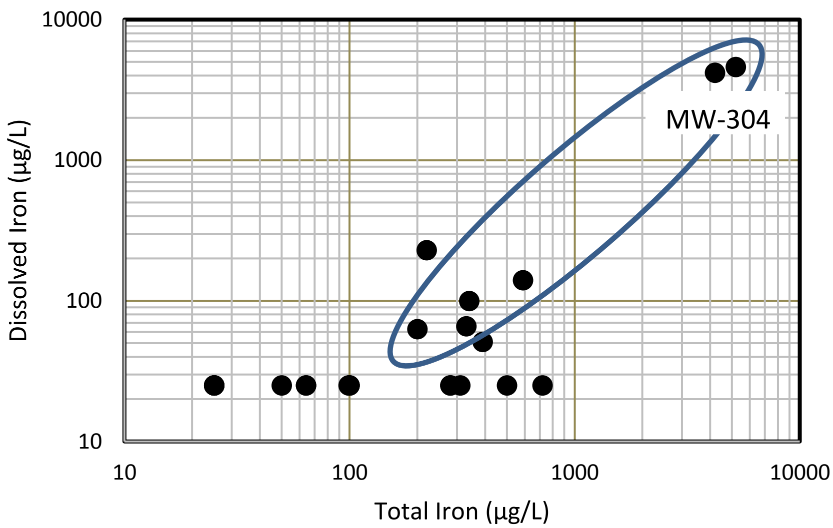
The groundwater has near-neutral pH, with a slight increase east of the Ash Pond with no clear trend over time.

The ORP varies greatly between sampling events. Except for MW-304 and -306, the ORP shows increasing trends to more oxic conditions from March to October. Most samples show a positive correlation between ORP and dissolved oxygen above an ORP of about 0 mV.

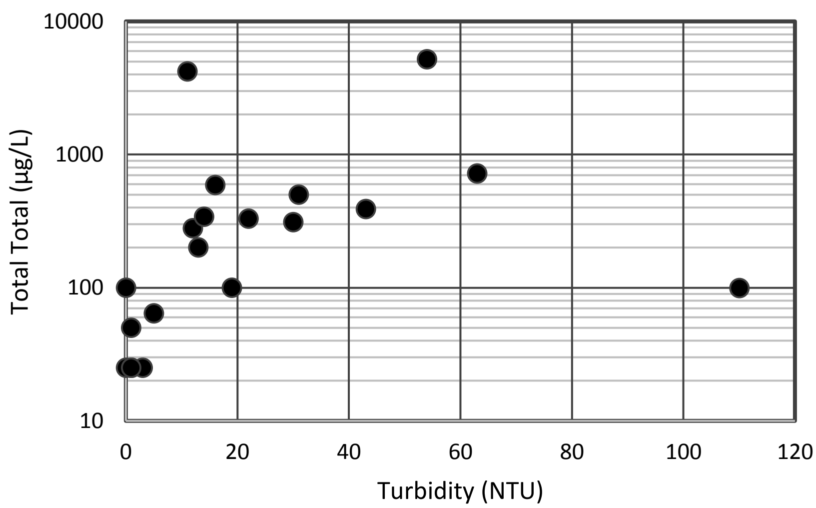


The five possible outliers with high ORP and low dissolved oxygen include all three observations from MW-310 and one from MW-305. The DO measurements indicate the groundwater becomes suboxic as it travels beneath the Ash Pond. The ORP values at the downgradient edge of the Ash Pond range from +55 to -110 mV in the October samples compared to the upgradient value of +160 mV. At the most downgradient location, near the Des Moines River, the October dissolved oxygen increases slightly and the ORP is +90 mV.

There is no measurable total or dissolved iron in the upgradient well consistent with the pH and ORP. At the Ash Pond perimeter, the total iron (including iron associated with suspended sediment) increases to between 64 and 5,200 µg/L. The dissolved iron increases significantly only at MW-304, -305 and -306. At MW-310 the total and dissolved iron return to near or below the laboratory reporting limits.



There is a weak correlation between total and dissolved iron. There is no correlation between the groundwater pH and the total or dissolved iron. Except for MW-304, there is no correlation between total and dissolved iron and ORP. MW-304 reports the lowest ORPs (-110 to -120 mV) and the highest iron concentrations.



As might be expected, the suspended sediment is positively correlated with total iron concentrations (with one outlier from MW-304 and one from MW-310A).

Only dissolved manganese was consistently measured in the groundwater. The lowest concentrations are found at MW-301 and -310 (14 to 53 µg/L). At MW-304, -305 and -306 the concentrations range from 3,100 to 16,000 µg/L. There is a general negative correlation between dissolved manganese and ORP.

Sulfate concentrations increase from MW-301 to MW-306 with the possible seepage from the Ash Pond, and then decreased with continued downgradient migration to MW-305. This may suggest limited sulfate reduction is occurring. The subsequent increase in sulfate at MW-310 is attributed to upward flowing deep groundwater mixing with the shallow groundwater as described elsewhere by SCS. The mixing is supported by the trends in boron and lithium concentrations that show sharp decreases and increases, respectively, as the deeper groundwater mixes with the shallower groundwater.

Cobalt Geochemistry. Cobalt is present as a 2+ cation (Co^{2+}) and is the dominant species found in natural environments. Its valance state is not affected by the oxidation reduction potential in which it is found, but the ORP can affect ligands with which cobalt may complex, precipitate or absorb to. Assuming an ORP on the order of -100 to -400 mV (Eh on the order of 100 to -200 mV) and a pH on the order of 6 to 7 SU suggests cobalt could occur as aqueous Co^{2+} or precipitate as CoS. In many settings the aqueous concentrations are a function of adsorption to, or coprecipitation with iron, manganese or aluminum oxyhydroxides. Iron and manganese oxyhydroxide formation are controlled by pH and ORP. Aluminum oxyhydroxide is controlled by pH with maximum precipitation between pH of 6 to 7 SU.

Total and dissolved iron concentrations are less than 1 µg/L at the upgradient well (MW-301) and the downgradient-most wells (MW-310 and -310A). Cobalt concentrations are also less than 1 µg/L at MW-304. Most of the remaining perimeter wells (MW-302, -303, -305A and -306) yield total and dissolved cobalt concentrations between 1 and 6 µg/L while MW-305 produced about 17 µg/L of both total and dissolved cobalt.

The total cobalt concentrations (which includes cobalt associated with suspended sediment) shows positive correlations with suspended sediment loads as measured by turbidity at the time of sample collection. Three possible outliers on the following chart include one sample each from MW-304, -305 and -310A.

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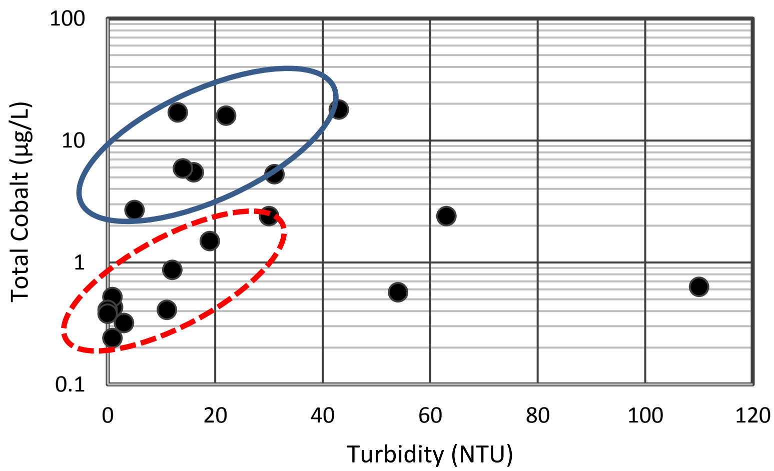
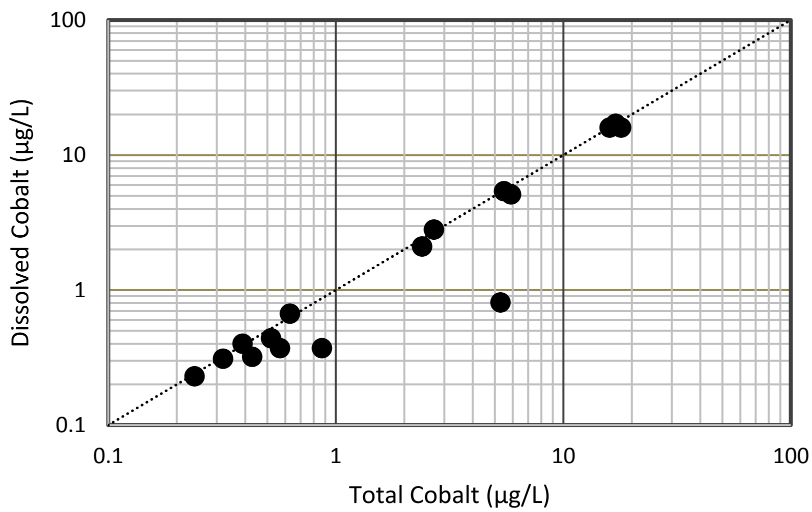


The remaining data appear to fall into two groups. The data from MW-305, -305A and -306 within the solid blue outline suggest the total cobalt concentration increases with the amount of suspended sediment. All the remaining data suggest a similar correlation, but offset by about 10 times lower total cobalt. The correlation between dissolved cobalt and turbidity is nearly identical to the total cobalt plot because dissolved and total cobalt are well correlated.



This suggests the possibility that there is an absorption equilibrium between the aqueous dissolved cobalt and the cobalt associated with the iron-bearing suspended sediment.

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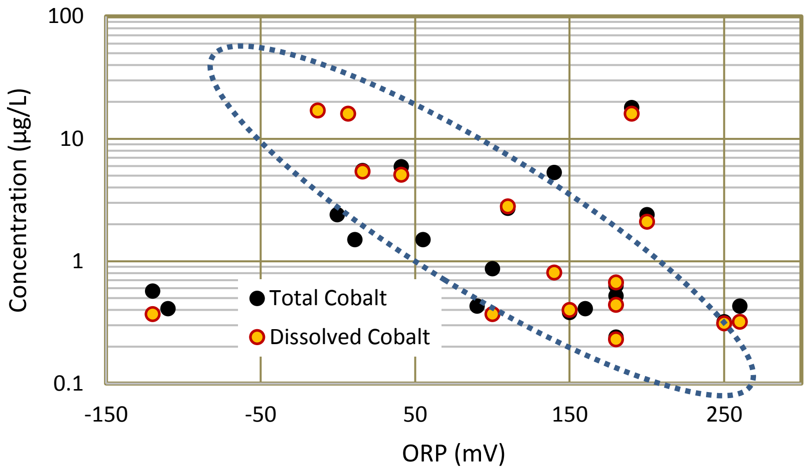
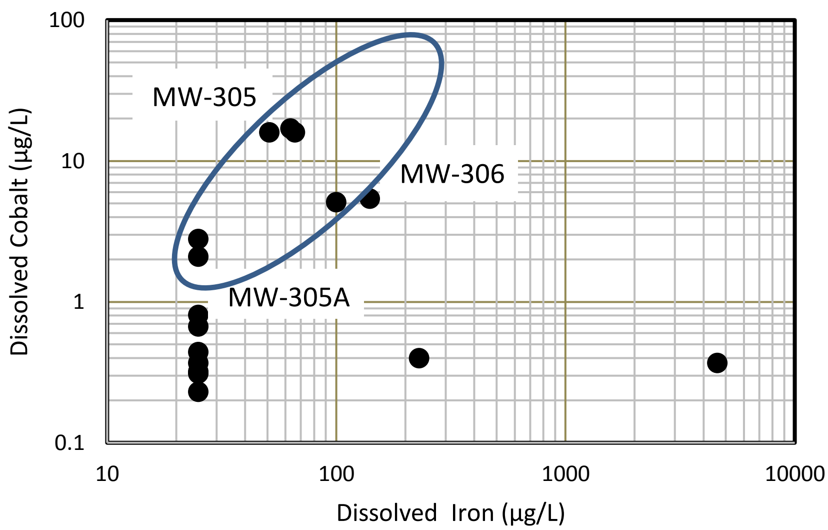


While cobalt's valence state would not be affected by ORP, there is a general correlation between ORP and dissolved or total cobalt in the groundwater (except for possible outliers from MW-304 and -305). When reviewing all the data there was no correlation evident between ORP and iron. However, plotting dissolved iron (which is expected to increase with decreasing ORP) against dissolved cobalt there is a positive correlation for MW-305, -305A and -306 where dissolved cobalt is present above 1 µg/L (one sample from each of MW-304 and MW-310A are potential outliers with high iron concentrations).



This suggests the cobalt that passes a 0.45 µm filter may be absorbed to iron that passes a 0.45 µm filter (i.e. "colloidal" particulate iron).

The mass of cobalt in the groundwater where the GPS may be exceeded between MW-305 and MW-310 is estimated at 0.60 kg assuming:

- Approximate plume dimensions of 120 m wide (assuming ~ half the distance between MW-305 and adjacent wells that do not exceed the GPS) by 320 m long and 6 m thick,
- Total porosity of 0.3
- Cobalt concentration of 8.7 ug/L (average of MW-305 and -310)

Potential for Site-Specific Cobalt Natural Attenuation.

Immobilization within the saturated sand is the mechanism that drives natural attenuation of cobalt. If cobalt were not attenuated, the 30-year groundwater travel time from the Ash Pond to MW-310 suggests that cobalt should have arrived at MW-310 in the ~40 years since the Ash Pond was commissioned if it was not attenuated. The cobalt concentration from MW-305 to MW-310 appears to decrease by a factor of ~60. Dilution by mixing with upward flowing deep groundwater at MW-310 may be a factor in the decrease. Assuming lithium is a conservative constituent in the deep groundwater at 270 µg/L, its concentration is reduced to 48 µg/L by mixing with the 3.2 µg/L from MW-305. The potential mixing does not appear to be sufficient to account for the cobalt concentration reduction. Precipitation, coprecipitation or adsorption likely account for the remaining decrease.

The groundwater becomes more oxic from the Ash Pond perimeter to MW-310 at the Des Moines River. As the ORP increases, iron precipitates from the water and provides adsorption sites on iron oxyhydroxides for cobalt which is then also removed from the groundwater.

In addition, the sand at MW-305 is described as yellow-brown suggesting that some of the iron may be in an oxidized form on the surfaces of the sand. The color of the sand at MW-310 was not recorded. The iron oxyhydroxides on the aquifer matrix provide potential adsorption sites for the sequestration of cobalt.

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Recommendations for Additional Assessment of Site-Specific Cobalt Monitored Natural Attenuation

Lines of evidence for continued evaluation of cobalt natural attenuation are suggested:

- The redox conditions in the saturated sand are key to understanding potential cobalt fate. The cause(s) of possible recent inconsistent ORP values or potential trends of decreasing ORP measured in the field should be evaluated in order to improve these measurements.

- Two additional monitoring wells should be installed between MW-305 and MW-310 (at ~400-foot spacing) to better define aqueous geochemical trends from the Ash Pond to the Des Moines River. The data will also refine the estimate of cobalt mass in the groundwater downgradient of the Ash Pond. Groundwater sample analyses would include:
    - In-field measurement of pH, ORP, DO, ORP, temperature, specific electrical conductance, turbidity, ferrous iron and sulfide; and laboratory analyses of dissolved (0.45 µm filtered) Ca, Mg, Na, K, Fe, Mn, alkalinity (as $CaCO_3$), Cl, SO_4, and TDS to better define the groundwater chemistry and evolution with flow.
    - Laboratory analyses of dissolved (0.45 µm filtered) cobalt to better define the aqueous or “mobile” plume.
    - Laboratory analyses of 0.20 µm filtered cobalt and iron to assess potential adsorption of cobalt to “colloidal” iron.
    - Filtration of turbid groundwater produced by the monitoring wells and analysis of the solid filtrate for aluminum, iron and cobalt to determine the degree to which the cobalt is associated with suspended solids.

  Additional hydrogeologic data collected from the new well locations would include soil descriptions, hydraulic head and hydraulic conductivity.

- Laboratory analyses of the degree of iron precipitation and cobalt coprecipitation and adsorption from MW-305 groundwater with aeration (i.e. redox increase) to better understand the degree to which cobalt adsorption and coprecipitation contributes to attenuation.

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- Continued monitoring of cobalt concentrations over time to determine cobalt migration is completely attenuated or slowed by attenuation.

- Samples of the saturated sand should be collected from the two new well locations and from the area adjacent to MW-305 and MW-310. Analyses of sand would include:
  - iron and manganese concentrations to assess potential for adsorption
  - cobalt concentrations to assess the degree to which cobalt has adsorbed or coprecipitated on to the sand matrix (i.e. defining the "immobile plume")
  - cobalt adsorption isotherms to assess capacity of the sand to absorb cobalt and determine maximum adsorption capacity.

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ReSolution Partners, LLC

Table 1. Groundwater chemistry summary (April 2020).

Parameter	Units	Location (from up to down gradient)			
		MW-301	MW-306	MW-305	MW-310
pH	SU	6.6	6.7	7.0	7.0
ORP	mV	180	50	7	180
Dissolved Oxygen	mg/L	5.1	0.2	0.3	0.2
Specific Conductance	µS/cm	940	1160	1770	1820
Temperature	ºC	8.7	12	9.1	10
Turbidity	NTU	1	16	22	.9
Cobalt (T)	µg/L	0.42	5.5	16	0.24
Cobalt (D)	µg/L		5.4	16	0.23
Lithium (T)	µg/L	24	<2.3	3.2	48
Calcium (T)	mg/L	84	73	100	200
Magnesium (T)	mg/L	33	26	47	86
Sodium (T)	mg/L	77	160	210	100
Potassium(T)	mg/L	1.5	3.7	7.6	12
Iron (T)	µg/L	50	590	330	<50
Iron (D)	µg/L	<50	140	66	<50
Manganese (D)	µg/L	16	16,000	3400	280
Alkalinity (T, as CaCO3)	mg/L	150	280	460	190
Chloride (T)	mg/L	140	41	270	130
Sulfate (T)	mg/L	140	310	63	590
Total Dissolved Solids	mg/L	550	820	960	1,300

(D) Dissolved concentration filtered at 0.45 µm.

(T) Total concentration, unfiltered.

Ferrous iron measured in the field by Hach colorimetric kit.

NA – not analyzed.

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Table 2. Selected groundwater chemistry for March through October 2020.

Parameter	Units	MW-301			MW-302		MW-303		MW-304		MW-305		
		20-Mar	20-Apr	Oct-20	20-Apr	Oct-20	20-Apr	Oct-20	20-Apr	Oct-20	Mar-20	20-Apr	Oct-20
Iron-T	µg/L	<50	50	<50	500	100	280	310	5200	4200	390	330	200
Iron-D	µg/L	<50	<50	<50	<50	<50	<50	<50	4600	4200	51	66	63
Cobalt-T	µg/L	0.43	0.52	0.41	5.3	1.5	0.87	2.4	0.57	0.41	18	16	17
Cobalt-D	µg/L	0.32	0.44	---	0.81	---	0.37	---	0.37	---	16	16	17
Turbidity	NTU	1	0.9	0	31	19	12	30	54	11	43	22	13
pH	SU	6.48	6.58	6.22	6.70	7.00	6.98	8.28	7.12	7.88	7.02	7.00	7.44
ORP	mV	260	180	160	140	55	100	-0.4	-120	-110	190	6.6	-13
Diss. Oxygen	mg/L	5.3	5.1	4.2	0.2	0.1	1.9	0.1	0.2	0.2	0.2	0.3	0.1

Parameter	Units	MW-305A			MW-306		MW-310			MW-310A		
		Mar-20	20-Apr	Oct-20	20-Apr	Oct-20	Mar-20	20-Apr	Oct-20	Mar-20	20-Apr	Oct-20
Iron-T	µg/L	720	64	64	590	340	<50	<50	100	99	220	280
Iron-D	µg/L	<50	<50	<50	140	100	<50	<50	<50	<50	230	<50
Cobalt-T	µg/L	2.4	2.7	1.5	5.5	5.9	0.32	0.24	0.38	0.63	0.39	0.43
Cobalt-D	µg/L	2.1	2.8	---	5.4	5.1	0.31	0.23	---	0.67	0.4	---
Turbidity	NTU	63	5	---	16	14	3	0.9	0	110	---	---
pH	SU	8.09	7.63	7.46	6.68	6.54	6.89	7.00	7.07	7.73	7.85	7.48
ORP	mV	200	110	11	16	41	250	180	150	180	150	90
Diss. Oxygen	mg/L	3.8	2.3	0.2	0.2	0.1	0.3	0.2	0.2	6.5	6.4	0.5

Notes: T – total, result unfiltered with suspended solids. D – Dissolved, result filtered at 0.45 um.
Charts use ½ of the laboratory reporting limits for plotting purposes.

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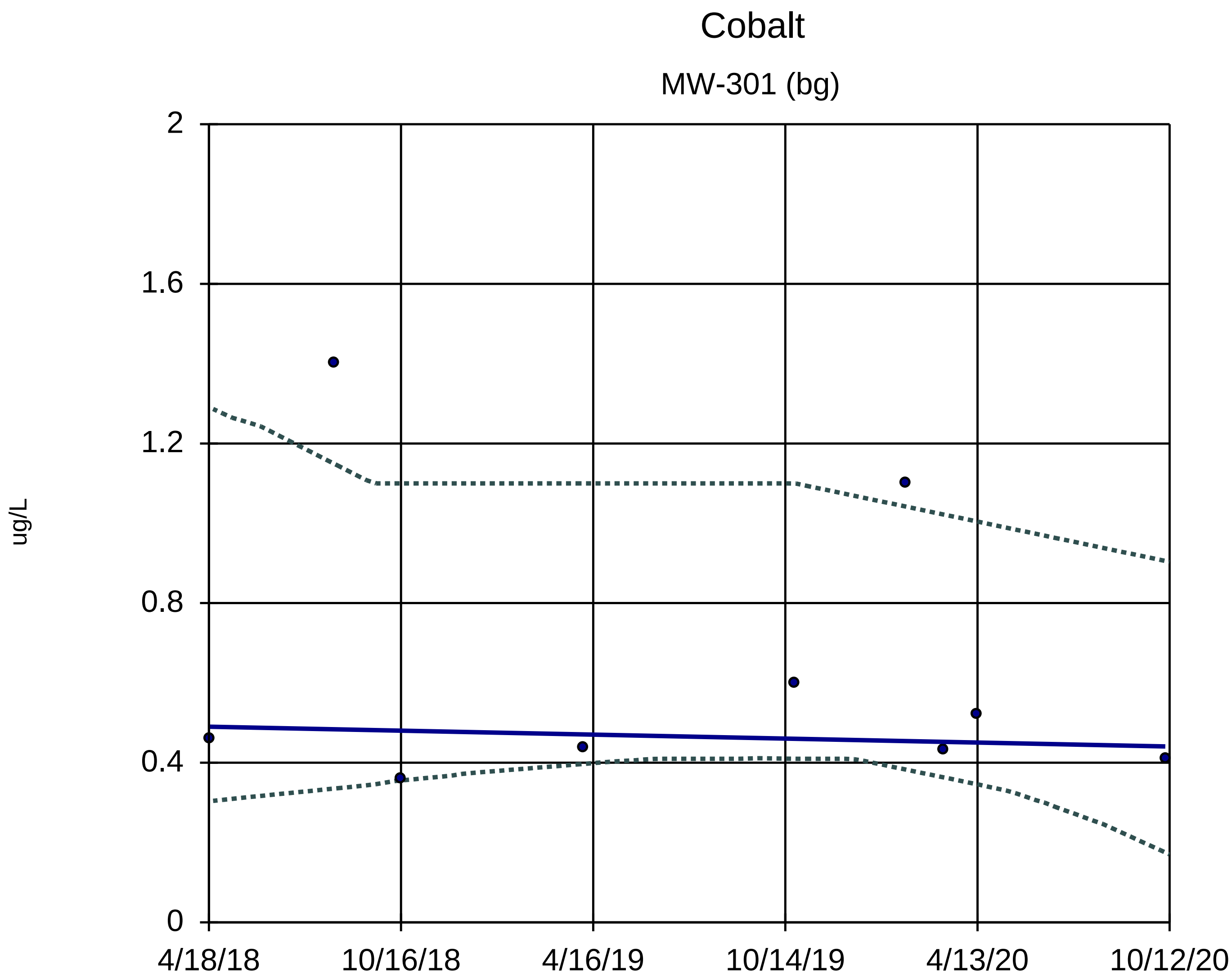
Appendix D

Mann-Kendall Trend Test

Trend Test

Ottumwa Generating Station Client: SCS Engineers Data: OGS_CP_Export_201122 Printed 11/25/2020, 8:41 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Cobalt (ug/L)	MW-301 (bg)	-0.02007	-6	-23	No	9	0	n/a	n/a	0.02	NP
Cobalt (ug/L)	MW-302	0.869	8	17	No	7	0	n/a	n/a	0.02	NP
Cobalt (ug/L)	MW-303	-0.5549	-3	-17	No	7	0	n/a	n/a	0.02	NP
Cobalt (ug/L)	MW-304	0.008075	3	17	No	7	0	n/a	n/a	0.02	NP
Cobalt (ug/L)	MW-305	0.7573	13	23	No	9	0	n/a	n/a	0.02	NP
Cobalt (ug/L)	MW-305A	-1.564	NaN	NaN	No	3	0	n/a	n/a	NaN	NP
Cobalt (ug/L)	MW-306	0.2686	4	20	No	8	0	n/a	n/a	0.02	NP
Cobalt (ug/L)	MW-310	-0.3127	-3	-10	No	5	0	n/a	n/a	0.02	NP
Cobalt (ug/L)	MW-310A	-0.3427	NaN	NaN	No	3	0	n/a	n/a	NaN	NP
Cobalt (ug/L)	MW-311	-0.1731	-1	-10	No	5	40	n/a	n/a	0.02	NP
Cobalt (ug/L)	MW-311A	-0.1222	NaN	NaN	No	3	0	n/a	n/a	NaN	NP



n = 9

Slope = -0.02007 units per year.

Mann-Kendall statistic = -6 critical = -23

Trend not significant at 98% confidence level (α = 0.01 per tail).

Sen's Slope and 95% Confidence Band   Analysis Run 11/25/2020 8:40 AM

Ottumwa Generating Station   Client: SCS Engineers   Data: OGS_CP_Export_201122

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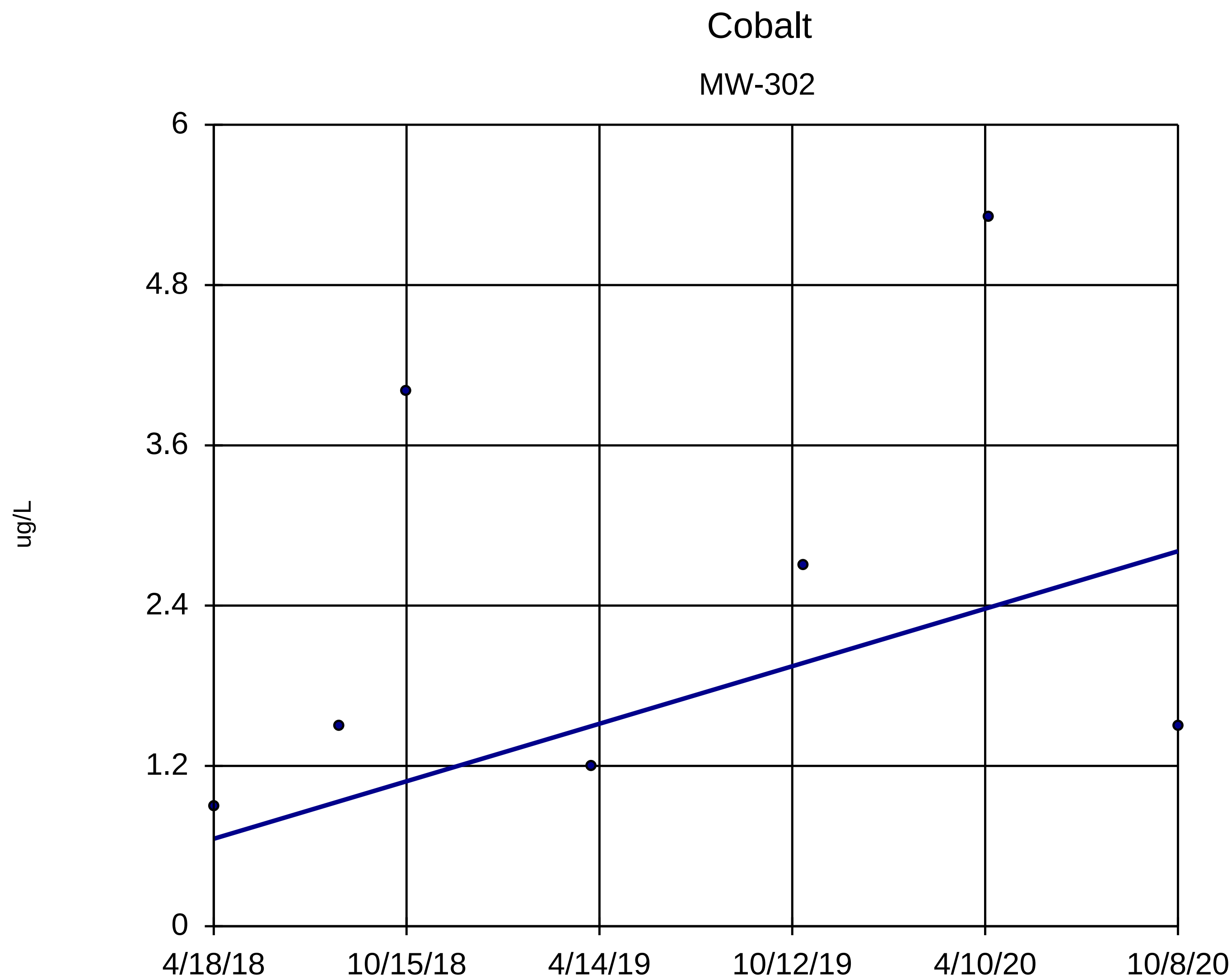


n = 7

Slope = 0.869 units per year.

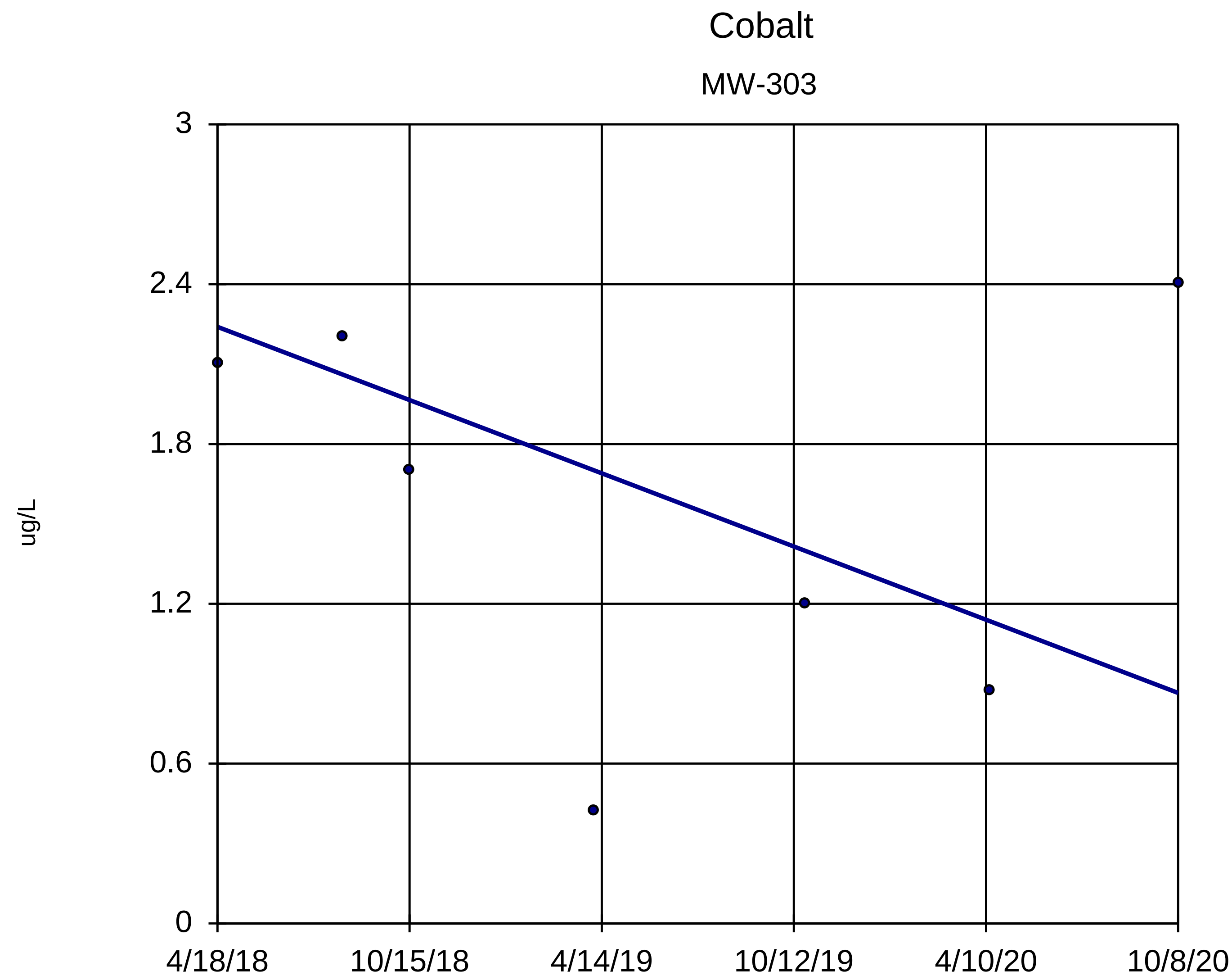
Mann-Kendall statistic = 8 critical = 17

Trend not significant at 98% confidence level (α = 0.01 per tail).

Sen's Slope Estimator   Analysis Run 11/25/2020 8:40 AM

Ottumwa Generating Station   Client: SCS Engineers   Data: OGS_CP_Export_201122

11/25/2020 - Classification: Internal - ECRM7804229



n = 7

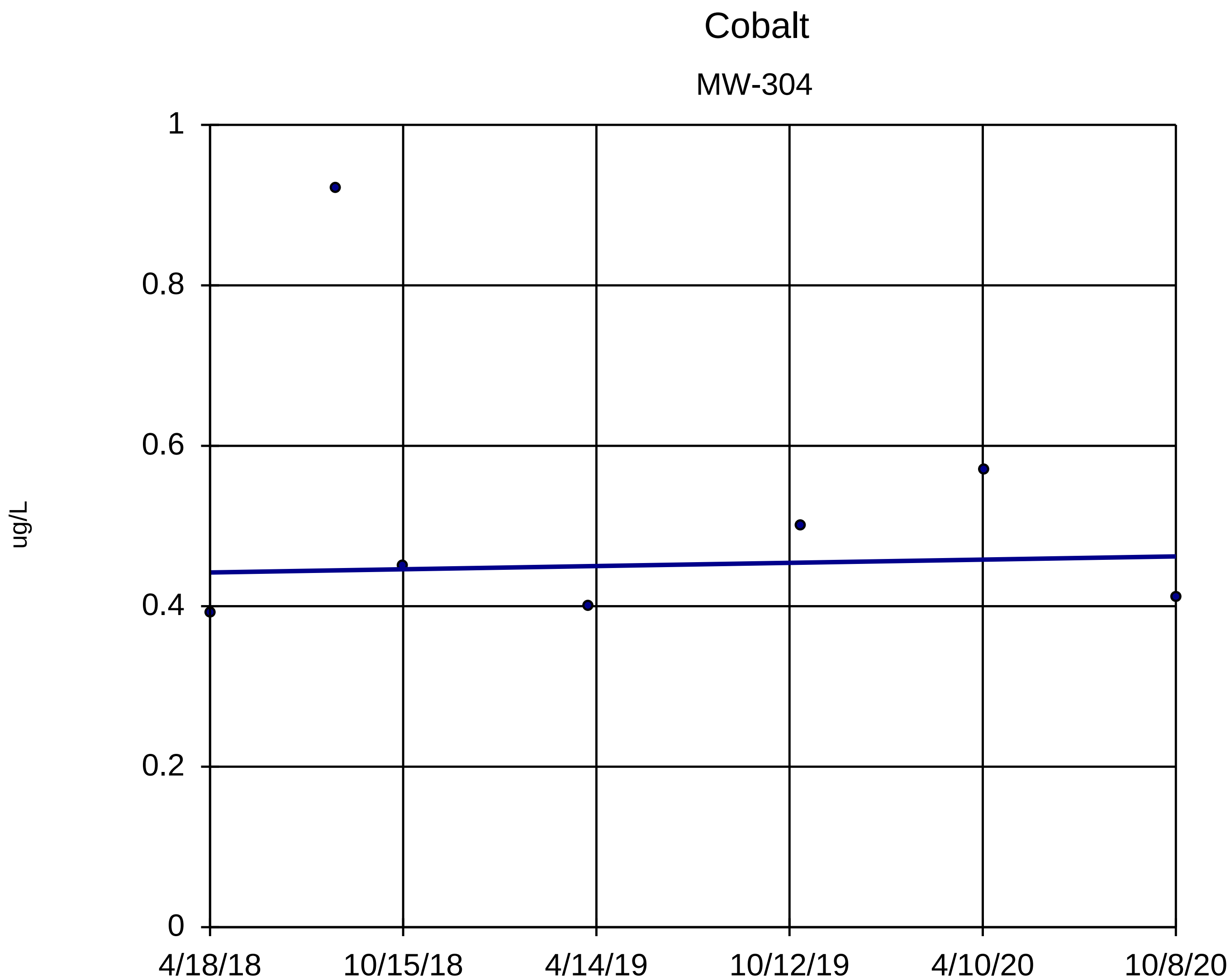
Slope = -0.5549 units per year.

Mann-Kendall statistic = -3 critical = -17

Trend not significant at 98% confidence level (α = 0.01 per tail).

Sen's Slope Estimator   Analysis Run 11/25/2020 8:40 AM

Ottumwa Generating Station   Client: SCS Engineers   Data: OGS_CP_Export_201122



n = 7

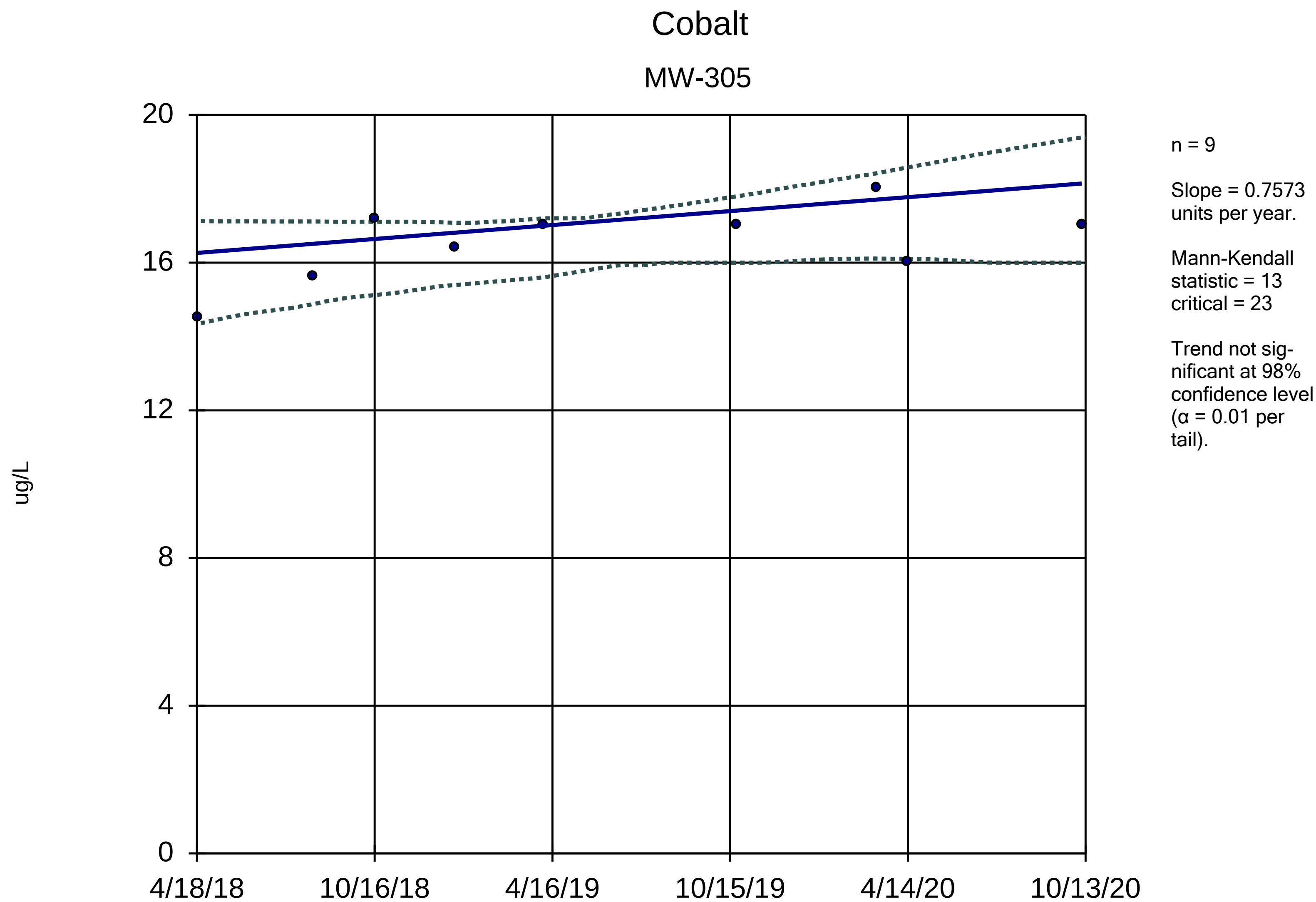
Slope = 0.008075 units per year.

Mann-Kendall statistic = 3 critical = 17

Trend not significant at 98% confidence level (α = 0.01 per tail).

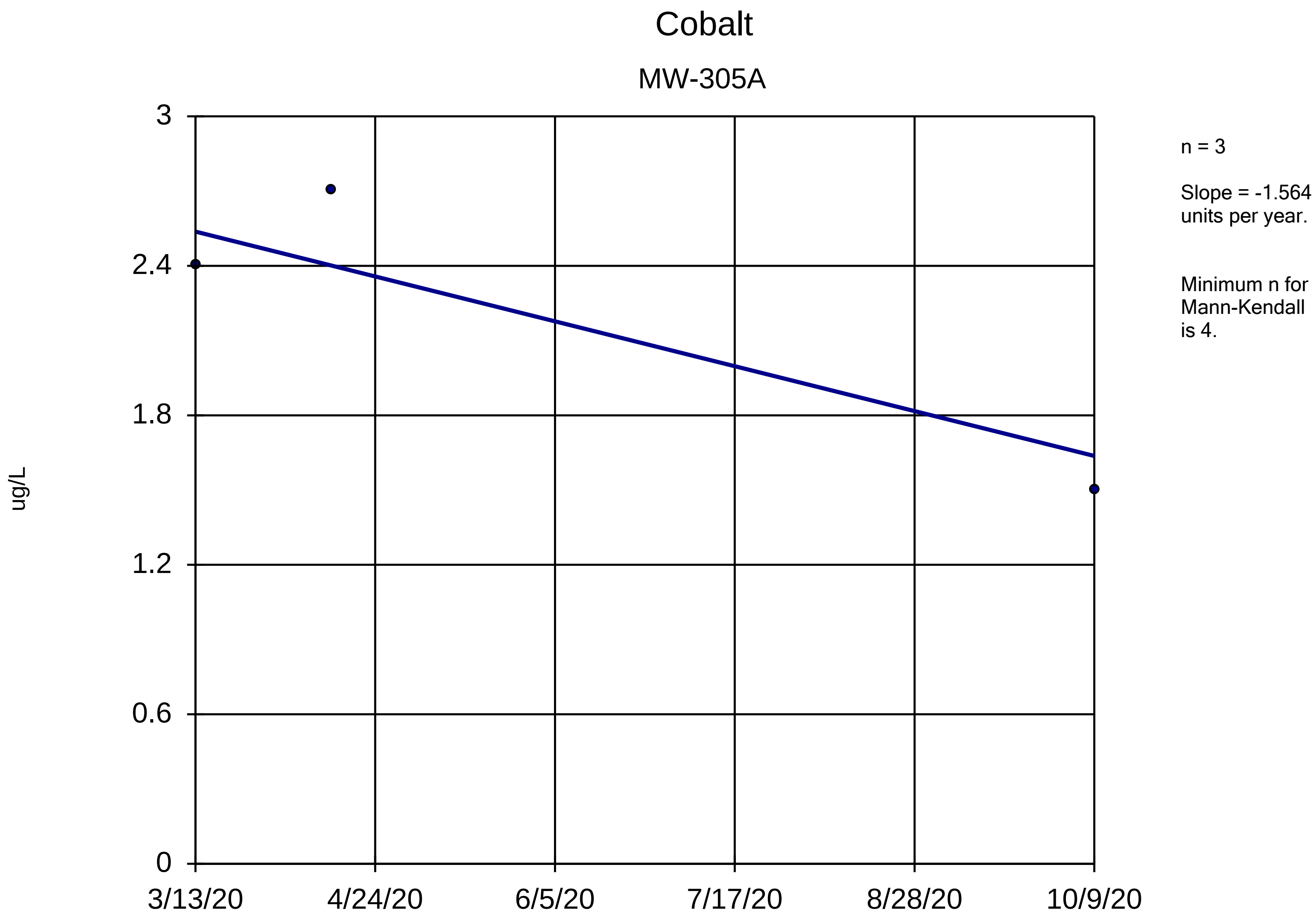
Sen's Slope Estimator   Analysis Run 11/25/2020 8:40 AM

Ottumwa Generating Station   Client: SCS Engineers   Data: OGS_CP_Export_201122



Sen's Slope and 95% Confidence Band   Analysis Run 11/25/2020 8:40 AM

Ottumwa Generating Station   Client: SCS Engineers   Data: OGS_CP_Export_201122



Sen's Slope Estimator   Analysis Run 11/25/2020 8:40 AM

Ottumwa Generating Station   Client: SCS Engineers   Data: OGS_CP_Export_201122

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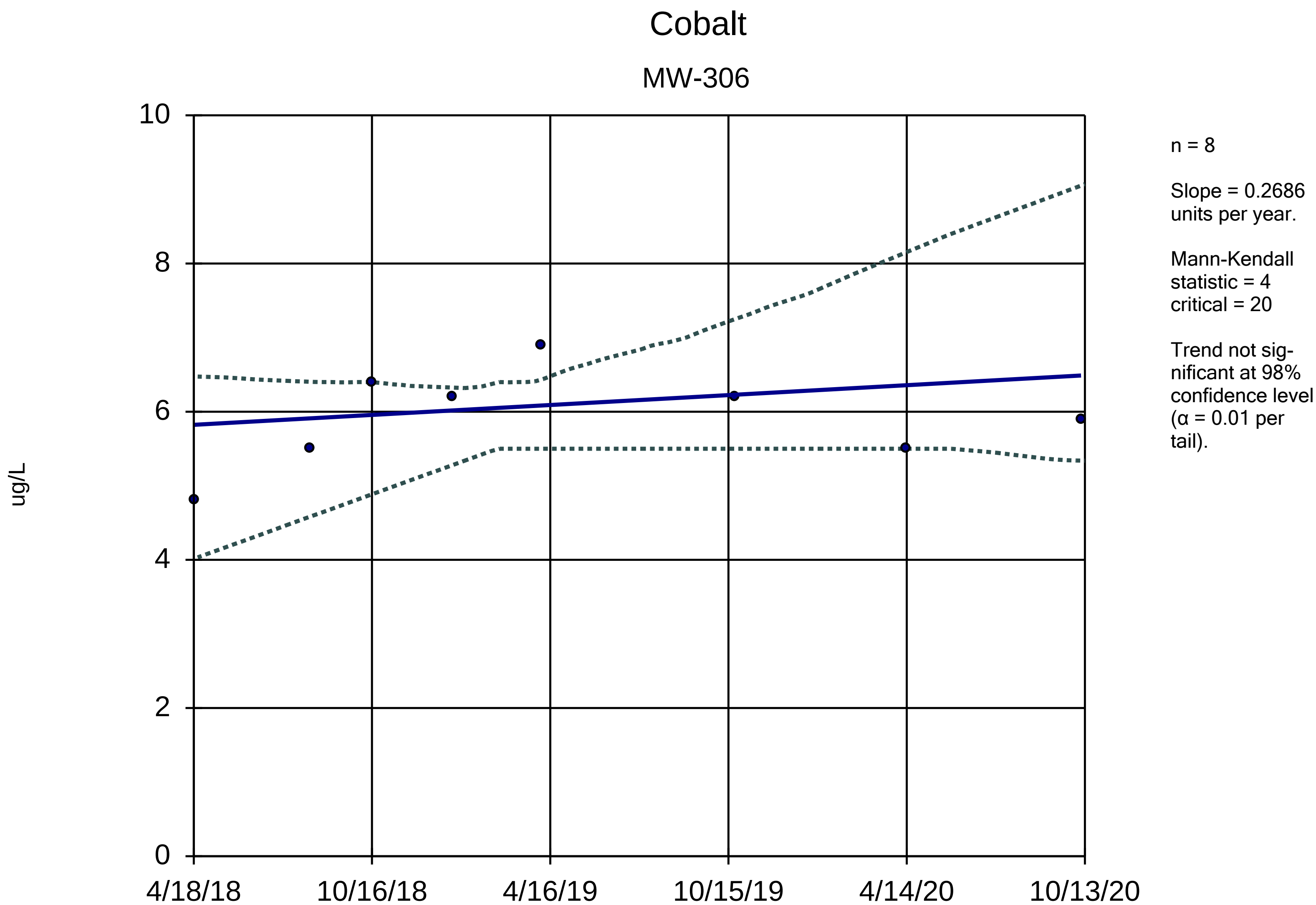
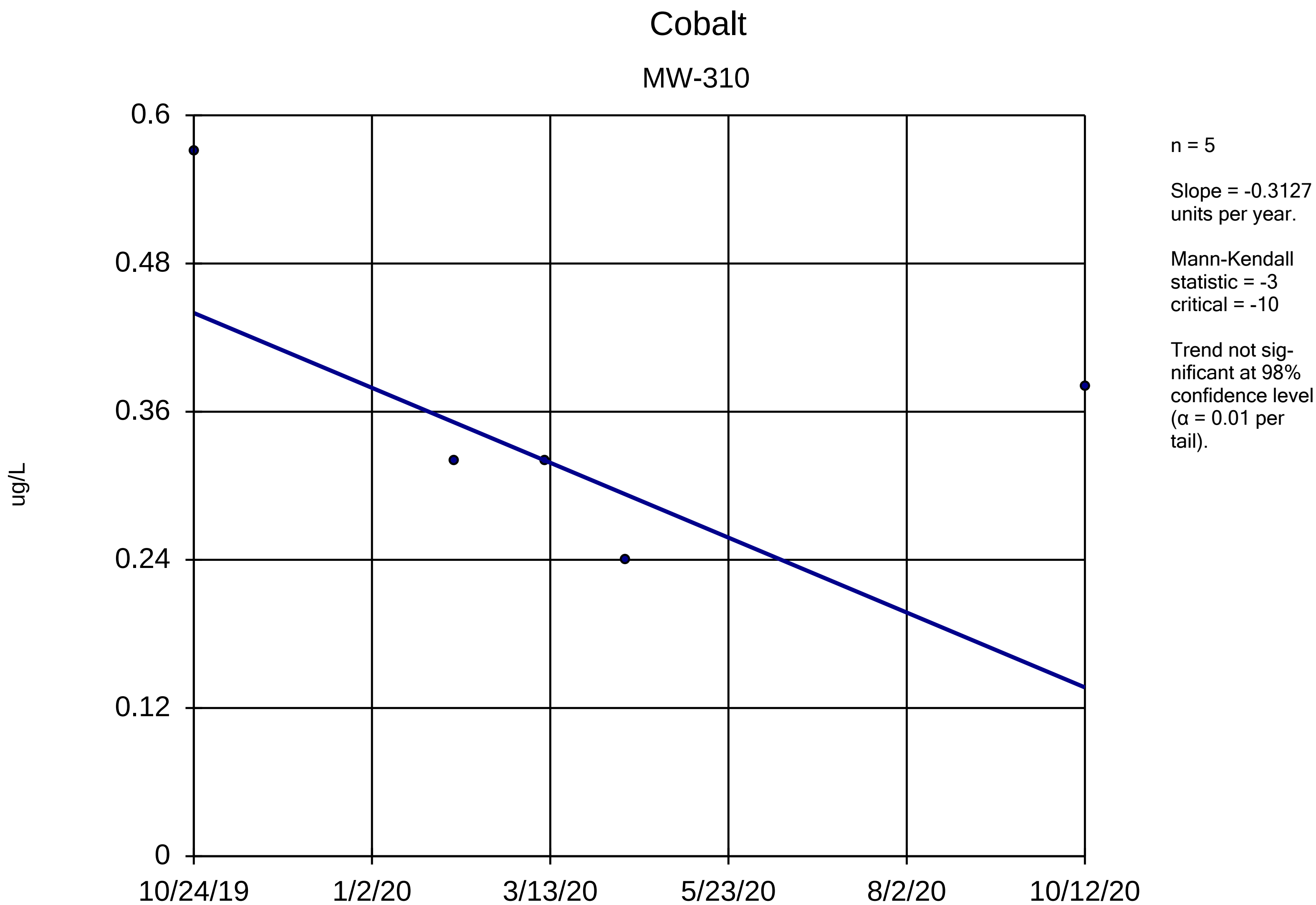


Sen's Slope and 95% Confidence Band   Analysis Run 11/25/2020 8:40 AM

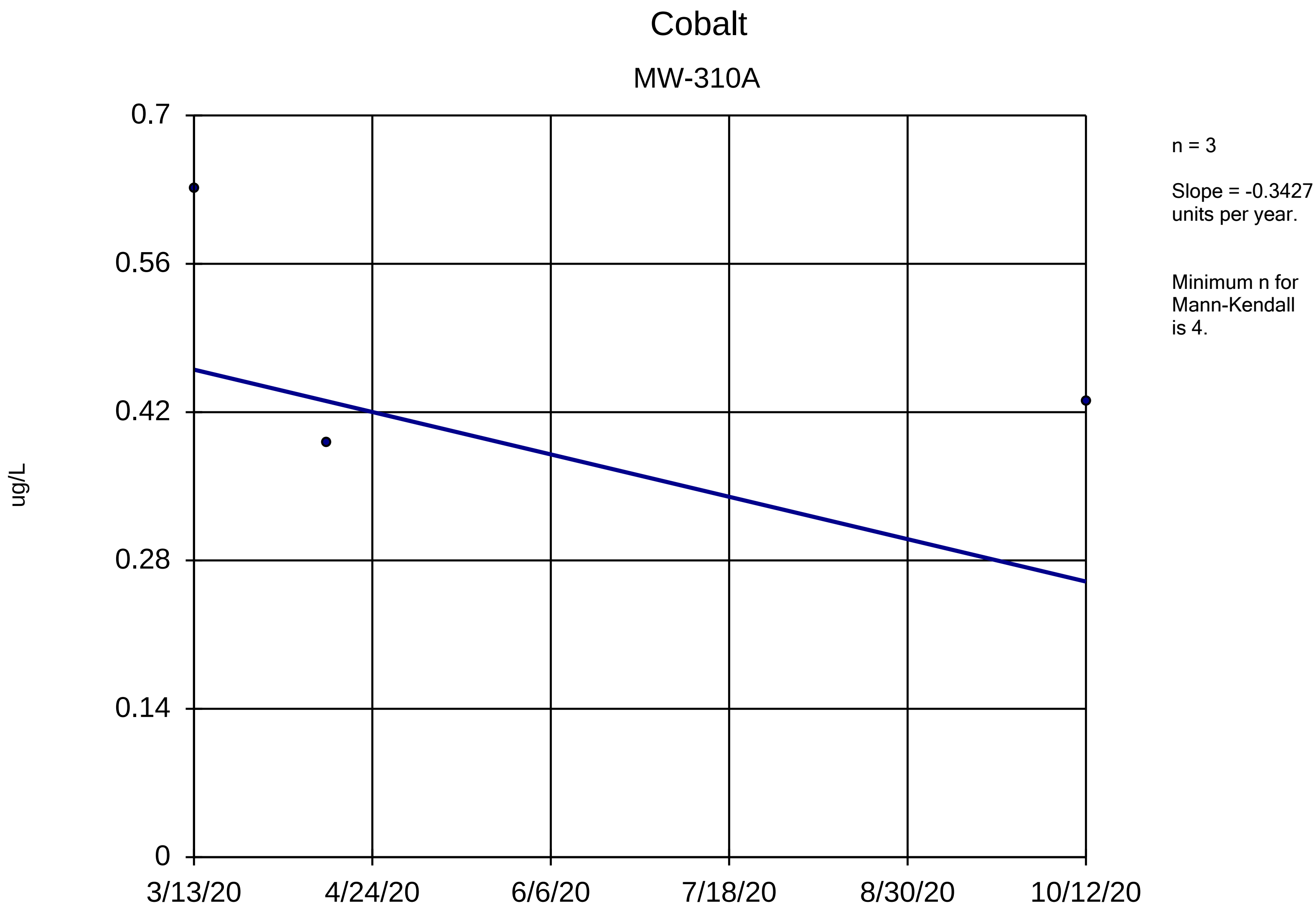
Ottumwa Generating Station   Client: SCS Engineers   Data: OGS_CP_Export_201122

11/25/2020 - Classification: Internal - ECRM7804229



Sen's Slope Estimator   Analysis Run 11/25/2020 8:40 AM

Ottumwa Generating Station   Client: SCS Engineers   Data: OGS_CP_Export_201122



Sen's Slope Estimator   Analysis Run 11/25/2020 8:40 AM

Ottumwa Generating Station   Client: SCS Engineers   Data: OGS_CP_Export_201122

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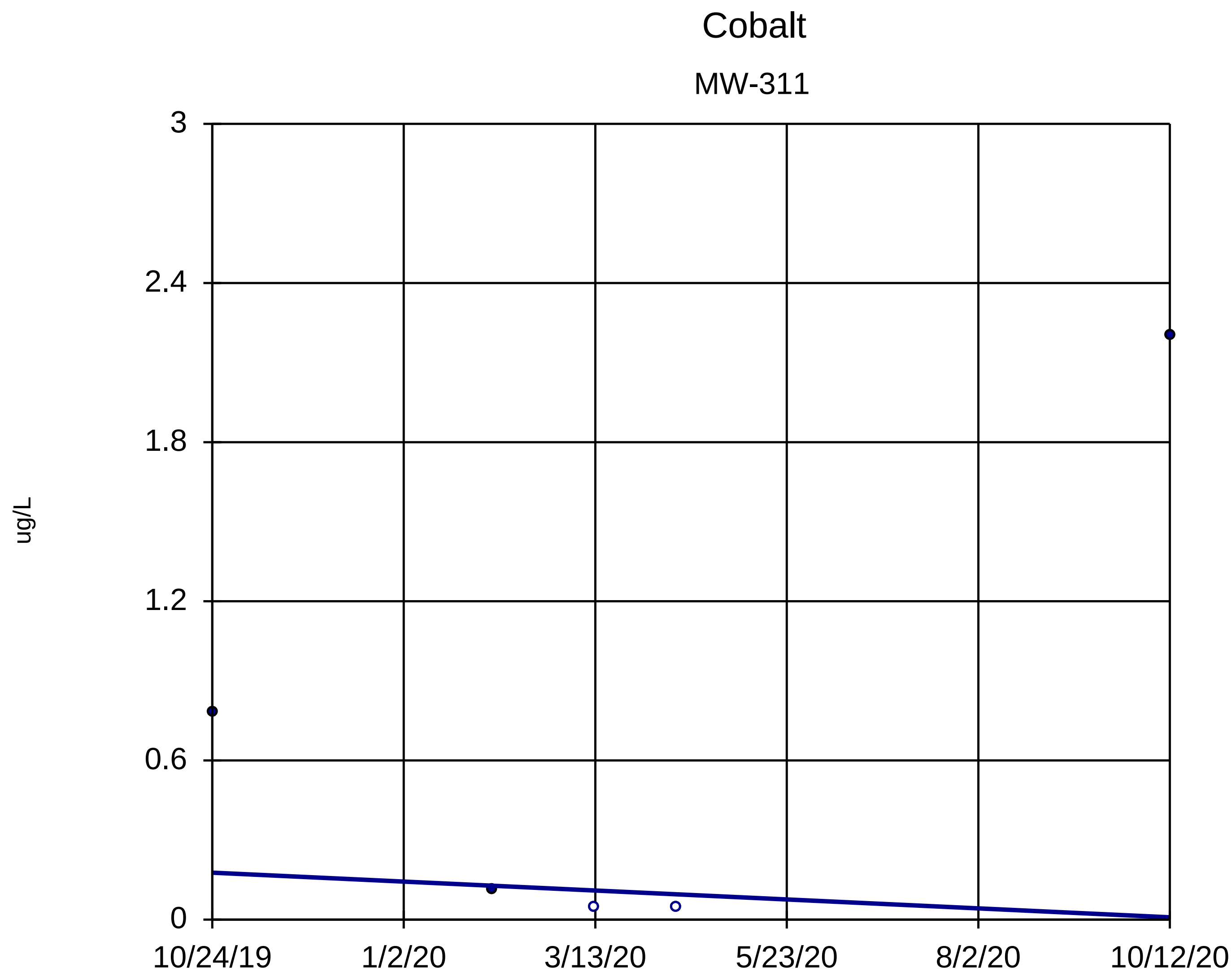
Hollow symbols indicate censored values.



n = 5

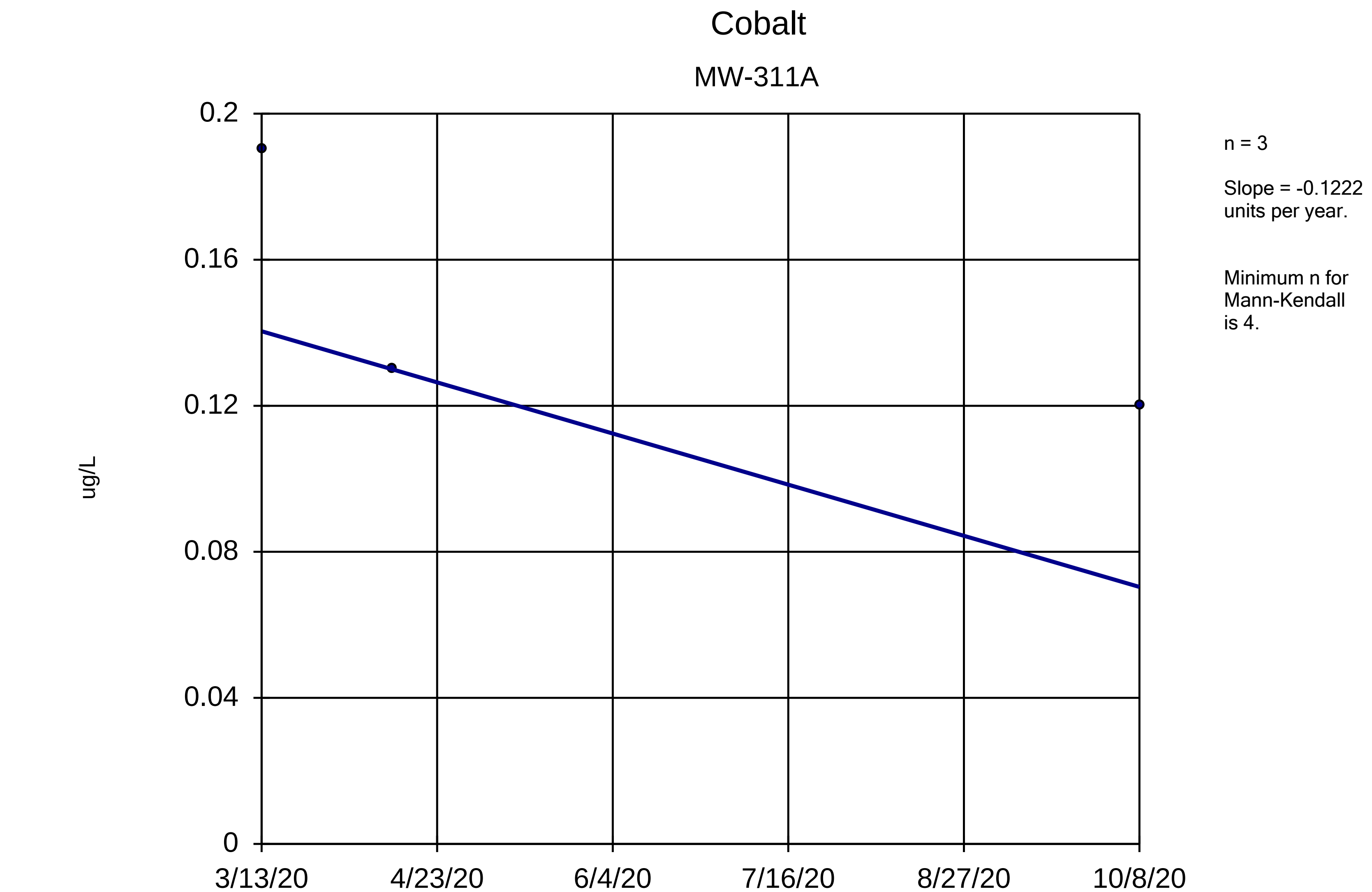
Slope = -0.1731
units per year.

Mann-Kendall
statistic = -1
critical = -10

Trend not sig-
nificant at 98%
confidence level
(α = 0.01 per
tail).

Sen's Slope Estimator   Analysis Run 11/25/2020 8:40 AM

Ottumwa Generating Station   Client: SCS Engineers   Data: OGS_CP_Export_201122



Sen's Slope Estimator   Analysis Run 11/25/2020 8:40 AM

Ottumwa Generating Station   Client: SCS Engineers   Data: OGS_CP_Export_201122