Intended for
Illinois Power Generating Company

Date
November 30, 2020

Project No.
1940072856

CORRECTIVE MEASURES ASSESSMENT REVISION 1

COFFEEN ASH POND NO. 2

COFEEN POWER STATION
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COFFEEN, ILLINOIS

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DOCUMENT REVISION RECORD

Issue No.	Date	Details of Revisions
Revision 0	July 8, 2019	Original Document
Revision 1	November 30, 2020	Revised as follows: • Executive Summary - removed • Section 1 - relocated site history to Section 2 and added evaluation criteria • Section 2 – added site history from Section 1 and additional geology/hydrogeology information (Figures 9 and 10, Appendices A and B), added reference to lithium SSLs, and added plume delineation information (Tables 1 and 2, Figures 7 and 8), and trend analysis (Appendix C). • Section 3 – focused on potential groundwater corrective measures • Section 4 – focused on application of evaluation criteria added to Section 1 to potential groundwater corrective measures referenced in Section 3, added Appendix C to supplement evaluation of monitored natural attenuation • Section 5 – focused on potential groundwater corrective measures referenced in Sections 3 and 4 • Table 3 – focused on application of evaluation criteria added to Section 1 to potential groundwater corrective measures referenced in Section 3

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1. INTRODUCTION

Ramboll Americas Engineering Solutions Inc., formerly known as O'Brien & Gere Engineers, Inc. (Ramboll), has prepared this revision of the Corrective Measures Assessment (CMA) for Ash Pond No. 2 (AP2; CCR Unit ID 102) located at Coffeen Power Station (CPS; the Site) near the City of Coffeen, in Montgomery County, Illinois. This CMA report complies with the requirements of Title 40 of the Code of Federal Regulations (C.F.R.) § 257, Subpart D Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments (CCR Rule). Under the CCR Rule, owners and operators of existing CCR surface impoundments (SIs) must initiate a CMA in accordance with 40 C.F.R. § 257.96 when one or more Appendix IV constituents are detected at statistically significant levels (SSLs) above groundwater protection standards (GWPS) and the owner or operator has not demonstrated that a source other than the CCR unit has caused the contamination. This CMA is responsive to the 40 C.F.R. § 257.96 requirements for assessing potential corrective measures to address exceedances of the GWPS for cobalt and lithium at AP2.

In January 2017, Dynegy Operating Company submitted the Closure and Post-Closure Care Plan for the Coffeen Ash Pond No. 2 (Closure Plan, AECOM, 2017) to the Illinois Environmental Protection Agency (IEPA) seeking approval to close AP2 by dewatering the CCR, constructing a geomembrane cover system in direct contact with the graded CCR and existing soil cover material, and performing groundwater monitoring to assess natural attenuation. The IEPA subsequently approved the Closure Plan on January 30, 2018 (IEPA, 2018). Closure activities began in July 2019 and were completed by November 17, 2020. Post-closure activities, including groundwater monitoring and maintenance of the final cover system, are being initiated.

This CMA is the next step in developing a long-term corrective action plan to address cobalt and lithium SSLs in the Uppermost Aquifer. Source control measures have been completed, including pumping to remove surface water, dewatering the CCR, relocating and/or reshaping the existing CCR to achieve acceptable grades for closure, and constructing a geomembrane cover system (additional details are discussed in Section 2). This CMA has been prepared to evaluate applicable remedial measures to address the cobalt and lithium SSLs in the Uppermost Aquifer. The results of the CMA will be used to select a remedy for the Uppermost Aquifer, consistent with 40 C.F.R. § 257.96 and § 257.97 requirements.

1.1 Corrective Measures Assessment Objectives and Methodology

The objective of this CMA is to evaluate appropriate corrective measures to address impacted groundwater associated with AP2 at the CPS. The CMA evaluates the effectiveness of potential corrective measures in meeting all requirements and objectives of the remedy as described under 40 C.F.R. § 257.96(c) by addressing the following:

- Performance
- Reliability
- Ease of implementation
- Potential impacts of appropriate potential remedies (safety impacts, cross-media impacts, and control of exposure to any residual contamination)
- Time required to begin and complete the remedy

- Institutional requirements that may substantially affect implementation of the remedy(s) (permitting, environmental or public health requirements)

The CMA provides a systematic, rational method for evaluating potential corrective measures. The assessment process documented herein: a) identifies the site-specific conditions that will influence the effectiveness of the potential corrective measures (Section 2); b) identifies applicable corrective measures (Section 3); c) assesses the corrective measures against the evaluation criteria to select potentially feasible corrective measures (Section 4); and d) summarizes the remedy selection process and future actions (Section 5).

1.2 Evaluation Criteria

The evaluation criteria are defined below to provide a common understanding and consistent application. The evaluation included qualitative and/or semi-quantitative screening of the corrective measures relative to their general performance, reliability and ease of implementation characteristics, and their potential impacts, timeframes and institutional requirements. Evaluations were at a generalized level of detail in order to screen out corrective measures that were not expected to meet 40 C.F.R. § 257.97 design criteria, while retaining corrective measures that would meet the design criteria.

This evaluation considered the elements qualitatively, applying engineering judgement with respect to known site conditions, to provide a reasoned set of corrective measures that could be used, either individually or in combination, to supplement the source control measures and achieve GWPS in the most effective and protective manner.

1.2.1 Performance

The performance of potentially applicable corrective measures was evaluated for the:

1. Potential to ensure that any environmental releases to groundwater, surface water, soil and air will be at or below relevant regulatory and health-based benchmarks for human and ecological receptors.
2. Degree to which the corrective measure isolates, removes, or contains SSLs identified in the Uppermost Aquifer.
3. Ability of the corrective measure to achieve GWPS within the Uppermost Aquifer at the compliance boundaries.

1.2.2 Reliability

The reliability of the corrective measure is a description of its ability to function as designed until the GWPS are achieved in the Uppermost Aquifer at the compliance boundaries. Evaluation of the reliability included considering:

1. Type and degree of long-term management required, including monitoring, operation, and maintenance.
2. Long-term reliability of the engineering and institutional controls associated with the corrective measure.
3. Potential need for replacement of the corrective measure.

1.2.3 Ease of Implementation

The ease or difficulty of implementing a given corrective measure was evaluated by considering:

1. Degree of difficulty associated with constructing the corrective measure.
2. Expected operational reliability of the corrective measure.
3. Need to coordinate with and obtain necessary approvals and permits.
4. Availability of necessary equipment and specialists.
5. Available capacity and location of needed treatment, storage, and disposal services.

1.2.4 Potential Impacts of the Remedy

Potential impacts associated with a given corrective measure included consideration of impacts on the distribution and/or transport of contaminants, safety impacts (the short-term risks that might be posed to the community or the environment during implementation), cross-media impacts (increased traffic, noise, fugitive dust), and control of potential exposure of humans and environmental receptors to remaining wastes.

1.2.5 Time Required to Begin, Implement, and Complete the Remedy

Evaluating the time required to begin the remedy focused on the site-specific conditions that could require additional or extended timeframes to characterize, design, and/or field test a corrective measure to verify its applicability and effectiveness. The length of time that would be required to begin and implement the remedy was considered to be the total time to: 1) verify applicability and effectiveness; and 2) to complete construction of the corrective measure.

The time required to complete the remedy considered the total time after the corrective measure was implemented until GWPS would be achieved in the Uppermost Aquifer at the compliance boundaries.

1.2.6 Institutional, Environmental or Public Health Requirements

Institutional, environmental, and public health requirements considered state, local, and site-specific permitting or other requirements that could substantially affect construction or implementation of a corrective measure.

2. SITE HISTORY AND CHARACTERIZATION

2.1 Site Description and History

The CPS is owned by Illinois Power Generating Company and is located on a peninsula between two lobes of Coffeen Lake which was created in 1963 by damming a portion of the East Fork of Shoal Creek. The lake covers approximately 1,100 acres and provides cooling water for the CPS. The city of Coffeen is approximately 2 miles north of the CPS and the city of Hillsboro, IL is about 8 miles to the northwest. The CPS is located in an agricultural area. Historically, several coal mines were operated at depth in the vicinity of the site. The CPS property is bordered by Coffeen Lake on the west, east, and south, and by agricultural land to the north. AP2 is located within Section 11 Township 7 North and Range 7 East. Figure 1 shows the location of the plant, Figure 2 is a site plan showing the location of AP2 and CCR monitoring wells.

The CPS began operation in 1972 and CCR from the coal fired units was disposed of in Ash Pond No. 1. AP2 was also utilized in the early 1970's and Ash Pond No. 1 was reconstructed in 1978. Both of these CCR units were used until the mid-1980's. CCR was managed in Ash Pond No. 1, the Landfill, the GMF Gypsum Stack Pond, and the GMF Recycle Pond until operations at CPS ceased in November 2019.

AP2 is an unlined surface impoundment (SI) with a surface area of approximately 60 acres and berms up to 47 feet higher than the surrounding land surface. AP2 was removed from service and capped in the mid 1980's. It contains about 2,200,000 cubic yards (CY) of CCR, covered by vegetated soil. A 2-foot thick clay and soil cap was placed on the surface of the pond in the mid-1980s with contouring and drainage provided to direct storm water to four engineered revetment down drain structures (NRT, 2013). As noted in Section 1, this cap was recently augmented with a geomembrane cover system following CCR dewatering under authorization from IEPA.

2.2 Geology and Hydrogeology

The geology and hydrogeology described in the Hydrogeologic Characterization Report (NRT, 2017b) are summarized and grouped into the following hydrostratigraphic units to define the conceptual site model for AP2; cross-sections are provided in Figures 3-5:

- CCR Fill Unit – CCR within the various CCR Units; the total volume is approximately 2.2 million CY (NRT, 2017c).
- Upper Confining Unit – Low permeability clays and silts, including the Loess Unit (combined silts of the Roxana Silt and Peoria Silt stratigraphic units) and the upper clayey till portion of the Hagarstown Member (unit consisting of gravelly clay till and sandy materials, also referred to as Hagarstown beds).
  - The Loess Unit is relatively thin in the area of AP2, observed at less than 1 foot in thickness, and was likely removed from within the footprint of AP2 during its construction. Excavation and removal of this layer was required during construction of the Landfill and GMF units located to the north of AP2 where the observed thickness of the Loess Unit was greater, with a maximum observed thickness of less than 6 feet. Laboratory tests from recent geotechnical analysis reported vertical hydraulic conductivity values ranging from 1.3×10^{-8} to 5.0×10^{-7} centimeters per second (cm/s), with a geometric mean of 1.0×10^{-7} cm/s (Appendix A).

  - The upper clayey till portion of the Hagarstown Member has varying observed thicknesses ranging from 1.9 ft to over 12 ft as observed adjacent to, south and west of AP2.

- Uppermost Aquifer (Groundwater Monitoring Zone) – Thin (generally less than 3 feet), moderate to high permeability sand, silty sand, and sandy silt/clay units that include the sandy materials of the Hagarstown beds and the upper Vandalia Member (unit consisting of a sandy/silty till with thin, discontinuous lenses of silt, sand, and gravel), where weathered. Regionally, the Hagarstown beds can be found in elongate ridges consisting of well sorted gravel and interbedded sand. In the drift plain between those ridges the beds contain gravely till which grades into poorly sorted gravel near the ridges. The different types of Hagarstown beds grade into one another, varying with the degree of water sorting during deposition (Jacobs and Lineback, 1969). The beds were deposited when till was thrust to the surface of the glacier, subjected to washing and mass movement and deposited when the ice melted beneath it (ablation). This depositional environment is responsible for the variability within the unit, which is gradational between till and outwash. The thin and variable composition of the Hagarstown beds observed at AP2 indicate deposition occurred in the drift plains between ridges of gravel deposits. The results of single-well field permeability tests indicate horizontal hydraulic conductivity values ranging from 3.1×10^{-5} to 1.6×10^{-3} cm/s, with a geometric mean of 2.9×10^{-4} cm/s (Appendix A).
- Lower Confining Unit – Thick (generally greater than 15 feet), very low permeability sandy silt till or clay till that includes the unweathered lower Vandalia Member, Mulberry Grove Member, and Smithboro Member.
  - The Vandalia Member is a sandy/silty till with thin, discontinuous lenses of silt, sand, and gravel. Laboratory tests reported vertical hydraulic conductivity values for the Vandalia Member ranging from 6.8×10^{-9} to 4.5×10^{-6} cm/s, with a geometric mean of 4.9×10^{-8} cm/s (Appendix A). Field hydraulic conductivity tests completed in temporary piezometers indicate horizontal conductivities of 9.0×10^{-7} and 3.4×10^{-5} cm/s, respectively. The maximum value was measured in a sand seam within the Vandalia Member, but likely is not representative because sand seams are infrequent and discontinuous.
  - The Mulberry Grove Member is a discontinuous, lenticular unit of gray sandy silt deposited in depressions found in the surface of the underlying Smithboro Member, generally less than 2 ft thick, but not encountered in the borings near AP2.
  - The Smithboro Member is a gray, compact, silty, clayey diamicton. Laboratory tests indicate vertical hydraulic conductivity values ranging from 1.1×10^{-9} to 1.0×10^{-7} cm/s with a geometric mean of 1.3×10^{-8} cm/s. Horizontal hydraulic conductivities calculated from single well tests performed in wells G45D and G46D were 4.0×10^{-8} and 4.9×10^{-7} cm/s, respectively.

CCR is underlain by the low-permeability Upper Confining Unit in the majority (98.3%) of the AP2 footprint. The remaining areas of the AP2 footprint overlie the Vandalia Till and may be in contact with the Hagarstown beds where former drainage features were present prior to construction and filling (Figure 6). Mounding of infiltrated surface water in AP2 prior to construction of the geomembrane cover system saturated the CCR in AP2 and created a component of radial flow out from AP2. However, the extent of this water movement appeared to be limited because the hydraulic heads measured within AP2 were elevated and these elevated heads overlying the Upper Confining Unit dissipated across the AP2 containment berms. In the areas where the Vandalia Till is in contact with CCR, the CCR may also come into contact with the profile of the

Hagarstown beds along the sidewalls of the drainage features (see Figures 3-5). The thin, discontinuous nature of the Hagarstown beds and the limited opportunity for CCR to be in contact with the Hagarstown beds significantly reduces the potential for lateral migration out of AP2, which is expressed in the accumulation and mounding of groundwater presently observed within AP2. Water from seeps observed along the berms may partially infiltrate through the Upper Confining Unit and/or run off with surface water toward the discharge flume or Unnamed Creek. The Uppermost Aquifer is confined except where the Hagarstown beds are exposed along the eastern-side of the impoundment within the sidewalls of former ravines. In these areas, groundwater appears to migrate in the Uppermost Aquifer beneath the constructed berms and flows through seeps along the ravine into the Unnamed Creek to the east.

Based on hydraulic conductivities and vertical gradients (Appendix A), horizontal groundwater flow in the overlying clays and underlying tills is negligible. Groundwater flow occurs primarily in the more permeable zones within the Hagarstown beds. Appendix B contains groundwater contour maps depicting potentiometric surface elevations measured during groundwater sampling events from 2015-2020. Groundwater near AP2 flows predominantly to the east and south. There is limited groundwater flow from AP2 toward the west due to a thinning or lower hydraulic conductivity of the Hagarstown beds and radial flow toward the discharge flume and Unnamed Creek. Moderate horizontal groundwater gradients on the order of 0.006 feet per feet (ft/ft) are typically observed. Groundwater velocities may vary significantly, depending on the thickness and continuity of sand seams within the Hagarstown Beds. However, migration of impacts to the east and south is limited by the presence of the Unnamed Creek and a surface water discharge flume associated with CPS, both of which are areas of groundwater discharge and act as hydraulic barriers and/or groundwater divides.

Vertical groundwater gradients were measured at two locations between the Hagarstown Beds and Vandalia Till. Vertical flow was upward into the more permeable Hagarstown Beds with gradients of 0.009 to 0.4 (Appendix A). Vertical groundwater gradients measured in the lower confining unit between the Vandalia Till and underlying Smithboro Till indicated steeply downward gradients exceeding 1, indicating very low vertical hydraulic conductivity and that groundwater in the Vandalia Till is perched.

A groundwater flow and transport model was developed for the IEPA-approved AP2 Closure Plan with the objective of evaluating the effect that a geomembrane cover system will have on surrounding groundwater quality. Boron was modeled to simulate migration of CCR leachate because it is relatively conservative for simulating transport in the subsurface since it is not as subject to processes that retard migration, such as sorption, as other CCR parameters are. The conceptual model for transport assumes boron leaching to recharge water during percolation through CCR above the water table. The model also includes changes in concentration applied to recharge zones where saturated CCR was known or likely to be present. For prediction modeling, constant concentration cells were placed into the model in portions of AP2 that contain CCR at or below the elevation of the Hagarstown beds to simulate leaching from groundwater flow through AP2 CCR where in contact with the Hagarstown beds.

The Hagarstown beds were simulated in the model using contoured surfaces generated from soil boring observations and maintaining a minimum thickness of 2 feet with a calibrated horizontal hydraulic conductivity of 1.6×10^{-3} cm/sec. The model simulation of the Hagarstown beds as a homogenous unit with consistent hydraulic conductivity was done to make the upper aquifer as transmissive as possible for the conservative evaluation of boron transport, and likely overestimates the interconnectedness of the Uppermost Aquifer. The simulated maximum extent of the boron groundwater plume occurs 1 year after placement of the cap. Although boron concentrations above the Class I Standard are present in the upper portion of the Lower Confining Unit, these concentrations also recede following cap placement, and they do not exceed the maximum footprint of boron concentration exceedances simulated in the Uppermost Aquifer (Hagarstown beds). Boron exceedances do not extend into the lower portion of the Lower Confining Unit. During the prediction scenario following geomembrane cap placement, concentrations of boron within AP2 decline and the footprint of the boron plume retreats toward the limits of AP2.

2.3 Potable Water Well Inventory

A potable water well inventory was completed in 2013. Public records were searched to identify water supply wells located within 2,500 feet of the unlined impoundments at the CPS and the results are discussed in the Hydrogeologic Site Characterization Report (NRT, 2017b). All but one of the wells identified in the well search were located either east or west of Coffeen Lake, which is a hydraulic boundary for potentially impacted groundwater. The one water well located between the east and west branches of the lake was reportedly removed during construction of the CPS Recycle Pond (NRT, 2017b). Public water supply (PWS) wells within a ten-mile radius of the CPS were also identified. Three wells belonging to the Village of Fillmore are located within the search radius, the closest one is approximately eight miles northeast of the CPS.

2.4 Groundwater Quality and Plume Delineation

Groundwater monitoring per 40 C.F.R. § 257.90 commenced in November 2015. Monitoring wells around AP2 were installed beginning in 2010, and additional wells and piezometers were installed in 2015 and 2016 to comply with the CCR Rule and define the extent of CCR impacts. Monitoring includes groundwater elevation measurements and collection of water quality samples from background monitoring wells G270 and G281, and downgradient wells G401, G402, G403, G404, and G405 (Figure 2). Detection monitoring per 40 C.F.R. § 257.90 was initiated in October 2017; statistically significant increases (SSIs) of Appendix III parameters over background concentrations were detected in October 2017. Alternate source evaluations were inconclusive for one or more of the SSIs. Therefore, in accordance with 40 C.F.R. § 257.94(e)(2), an Assessment Monitoring Program was established for AP2 on April 9, 2018.

Table 1 provides a summary of the Assessment Monitoring Program at AP2. Statistically significant levels (SSLs) of the Appendix IV parameters cobalt and lithium over the GWPS were identified in downgradient monitoring wells G401 and G402. In accordance with the Statistical Analysis Plan for CPS (NRT, 2017d), SSLs are based on a Lower Confidence Limit (LCL) calculated from all observed concentrations for each Appendix IV parameter at each monitoring well (2015 through the current sampling event) compared to the GWPS. Maximum LCL concentrations associated with the cobalt SSLs at G401 and G402 are 0.276 milligrams per liter (mg/L) and 0.0066 mg/L, respectively (Table 2). The maximum LCL concentration associated with the lithium SSL at G401 is 0.050 mg/L. No other SSLs have been identified for AP2.

Figures 7 and 8 depict the horizontal extent of cobalt and lithium SSLs at AP2, respectively. Additional monitoring wells were not previously installed for delineation due to the proximity of the SSLs to the CPS discharge flume to the south and wetland restrictions adjacent to the Unnamed Creek to the east of AP2. However, a realignment of the Unnamed Creek was completed in July 2020 which will allow for further delineation efforts in 2021 in the formerly restricted wetland area as part of the MNA Tier 1 evaluation (Appendix C).

Figures 9 and 10 summarize cobalt and lithium concentrations over time, respectively, at G401 and G402. Trend analysis (Appendix C) yielded statistically significant decreasing trends for G402 cobalt and G401 lithium concentrations. No statistically significant trend was identified for G401 cobalt concentrations.

2.5 Potential Groundwater Impacts to Surface Water

Boron is a common indicator parameter for the presence of CCR impacts in groundwater in part because it is more mobile than other contaminants potentially associated with CCR. Boron and sulfate loading calculations into the discharge flume to the south and the Unnamed Creek to the east were completed in the Closure Plan for AP2 (NRT, 2017b) and indicated that calculated boron concentrations into the Unnamed Creek would be approximately 0.115 mg/L and calculated sulfate concentrations would be approximately 1.9 mg/L. In the discharge flume the calculated concentration of boron was 0.01 mg/L; the calculated concentration of sulfate was estimated at 50.1 mg/L. In both discharge areas the resulting concentrations do not exceed the Public Food Processing Water Supply Use Standard at 35 Illinois Adm. Code 302 Subpart C Section 302.304 (1.0 mg/L boron and 250 mg/L sulfate). Nor does the calculated boron concentration exceed the General Use Standards for Protection of Aquatic Organisms at 35 Ill. Adm. Code 302 Subpart C Section 302.208 (40.1 mg/L, acute & 7.6 mg/L, chronic). Compared to these protection standards, the low levels of calculated concentrations under current conditions are protective of surface water receptors.

Surface water sampling confirmed that Coffeen Lake was not impacted by AP2 because measured concentrations of boron, ≤280 micrograms per Liter (ug/L) (0.280 mg/L), and sulfate (~55 mg/L) are well below standards and similar to background groundwater concentrations measured elsewhere onsite (NRT, 2017b).

35 Ill. Adm Code 302 does not contain a published surface water standard for cobalt. Also, cobalt has a recognized higher potential for sorption to aquifer solids than boron (EPRI, 2012). Consequently, the percentage of cobalt that may be released from AP2 that potentially impacts surface water is anticipated to be less than the percentage of boron that may be released from AP2 that potentially impacts surface water.

3. DESCRIPTION OF CORRECTIVE MEASURES

3.1 Objectives of the Corrective Measures

The following performance standards, per 40 C.F.R. § 257.97, must be met by the selected corrective measures:

- Be protective of human health and the environment
- Attain the groundwater protection standards per 40 C.F.R. § 257.95(h)
- Provide source control to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents
- Remove from the environment as much of the contaminated material as feasible
- Comply with waste management standards, per 40 C.F.R. § 257.98(d)

3.2 Potential Groundwater Corrective Measures

Site-specific considerations regarding AP2 provided in Section 2 were used to evaluate potential groundwater corrective measures. Each of the corrective measures evaluated may be capable of satisfying the performance standards listed above to varying degrees of effectiveness. The corrective measure review process yields a set of applicable corrective measures that can be used to supplement the source control activities described in Section 1 (CCR dewatering and geomembrane cover system). The corrective measures may be used independently or may be combined into specific remedial alternatives to leverage the advantages of multiple corrective measures to attain GWPS in the Uppermost Aquifer.

The following potential corrective measures are commonly used to mitigate groundwater impacts and were considered as a part of the CMA process:

- Monitored Natural Attenuation (MNA)
- Groundwater Extraction
- Groundwater Cutoff Wall
- Permeable Reactive Barrier
- In-Situ Chemical Treatment

3.2.1 Monitored Natural Attenuation (MNA)

Both federal and state regulators have long recognized that MNA can be an acceptable component of a remedial action when it can achieve remedial action objectives in a reasonable timeframe. In 1999, the USEPA published a final policy directive (USEPA, 1999) for use of MNA for groundwater remediation and described the process as follows:

- The reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. The 'natural attenuation processes' that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants.

The USEPA has stated that source control is the most effective means of ensuring the timely attainment of remediation objectives (USEPA, 1999). Natural attenuation processes may be appropriate as a "finishing step" after effective source control implementation, if there are no risks to receptors and/or the contaminant plume is not expanding. Thus, MNA would be used in conjunction with the recently completed, IEPA-approved CCR dewatering and geomembrane cover system described in Section 1.

The 1999 USEPA MNA document was focused on organic compounds in groundwater. However, in a 2015 companion document, the USEPA addressed the use of MNA for inorganic compounds in groundwater. The USEPA noted that the use of MNA to address inorganic contaminants: (1) is not intended to constitute a treatment process for inorganic contaminants; (2) when appropriately implemented, can help to restore an aquifer to beneficial uses by immobilizing contaminants onto aquifer solids and providing the primary means for attenuation of contaminants in groundwater; and (3) is not intended to be a "do nothing" response (USEPA, 2015). Rather, documenting the applicability of MNA for groundwater remediation should be thoroughly and adequately supported with site-specific characterization data and analysis in accordance with the USEPA's tiered approach to MNA (USEPA 1999, 2007, and 2015):

1. Demonstrate that the area of groundwater impacts is not expanding.
2. Determine the mechanisms and rates of attenuation.
3. Determine that the capacity of the aquifer is sufficient to attenuate the mass of constituents in groundwater and that the immobilized constituents are stable and will not remobilize.
4. Design a performance monitoring program based on the mechanisms of attenuation and establish contingency remedies (tailored to site-specific conditions) should MNA not perform adequately.

Both physical and chemical attenuation processes can contribute to the reduction in mass, toxicity, mobility, volume, or concentration of contaminants in groundwater. Physical attenuation processes applicable to CCR include dilution, dispersion and flushing. Chemical attenuation processes applicable to CCR include precipitation and coprecipitation (*i.e.*, incorporation into sulfide minerals), sorption (*i.e.*, to iron, manganese, aluminum, or other metal oxides or oxyhydroxides, or to sulfide minerals or organic matter), and ion exchange.

All inorganic compounds are subject to physical attenuation processes. Physical mechanisms may be the primary natural attenuation processes acting upon CCR constituents, such as boron, chloride and lithium, that are relatively mobile (poorly chemically attenuated). The performance of MNA as a groundwater corrective measure varies based on site-specific conditions. Additional data collection and analysis may be required to support the USEPA's tiered approach to MNA (USEPA, 2015) and obtain regulatory approval.

3.2.2 Groundwater Extraction

Groundwater extraction is one of the most widely used groundwater corrective measures and has a long history of performance. This corrective measure includes installation of one or more groundwater pumping wells or trenches to control and extract impacted groundwater.

Groundwater extraction captures and contains impacted groundwater and can limit plume expansion and/or off-site migration. Construction of a groundwater extraction system typically includes, but is not limited to, the following primary components:

- Designing and constructing a groundwater extraction system consisting of one or more extraction wells and operating at a rate to allow capture of CCR impacted groundwater within the Uppermost Aquifer.
- Management of extracted groundwater, which may include modification to the existing NPDES permit, including treatment prior to discharge, if necessary.
- Ongoing inspection and maintenance of the groundwater extraction system.

Remediation of inorganics by groundwater extraction can be effective, but systems do not always perform as expected. A combination of factors, including geologic heterogeneities, difficulty in flushing low permeability zones, and rates of contaminant desorption from aquifer solids can limit effectiveness. Groundwater extraction systems require ongoing operation and maintenance to ensure optimal performance and the extracted groundwater must be managed, either by ex-situ treatment or disposal.

3.2.3 Groundwater Cutoff Wall

Since the late 1970s and early 1980s, vertical cutoff walls have been used to control and/or isolate impacted groundwater. Low-permeability cutoff walls can be used to prevent horizontal off-site migration of potentially impacted groundwater. Cutoff walls act as barriers to transport of impacted groundwater and can isolate soils that have been impacted by CCR to prevent contact with unimpacted groundwater. Cutoff walls are often used in conjunction with an interior pumping system to establish a reverse gradient within the cutoff wall. The reverse gradient imparted by the pumping system maintains an inward flow through the wall, keeping it from acting as a groundwater dam and controlling potential end-around or breakout flow of contaminated groundwater. Constructing the cutoff wall such that it intersects a low-permeability material at its base, referred to as “keying”, greatly increases its effectiveness.

A commonly used cutoff wall construction technology is the slurry trench method, which consists of excavating a trench and backfilling it with a soil-bentonite mixture, often created with the soils excavated from the trench. The trench is temporarily supported with bentonite slurry that is pumped into the trench as it is excavated (D’Appolonia & Ryan, 1979). Excavation for cutoff walls is conducted with conventional hydraulic excavators, hydraulic excavators equipped with specialized booms to extend their reach (*i.e.*, long-stick excavators), or chisels and clamshells, depending upon the depth of the trench and the material to be excavated.

Cutoff walls could be used in combination with groundwater extraction or as part of a permeable reactive barrier system (as the “funnel” in a funnel-and-gate system; Section 3.2.4).

3.2.4 Permeable Reactive Barrier

Chemical treatment via a Permeable Reactive Barrier (PRB) is defined as an emplacement of reactive materials in the subsurface designed to intercept a contaminant plume, provide a flow path through the reactive media, and transform or otherwise render the contaminant(s) into environmentally-acceptable forms to attain remediation concentration goals downgradient of the barrier (EPRI, 2006).

As groundwater passes through the PRB under natural gradients, dissolved constituents in the groundwater react with the media and are transformed or immobilized. A variety of media have been used or proposed for use in PRBs. Zero-valent iron has been shown to effectively immobilize some CCR constituents, including arsenic, chromium, cobalt, molybdenum, selenium, and sulfate. Zero-valent iron has not been proven effective for boron, antimony, or lithium (EPRI, 2006).

System configurations include continuous PRBs, in which the reactive media extends across the entire path of the contaminant plume; and funnel-and-gate systems, where low-permeability barriers are installed to control groundwater flow through a permeable gate containing the reactive media. Continuous PRBs intersect the entire contaminant plume and do not materially impact the groundwater flow system. Design may or may not include keying the PRB into a low-permeability unit at depth. Funnel-and-gate systems utilize a system of barriers to groundwater flow (funnels) to direct the contaminant plume through the reactive gate. The barriers, typically some form of cutoff wall, are keyed into a low-permeability unit at depth to prevent short circuiting of the plume. Funnel-and-gate design must consider the residence time to allow chemical reactions to occur. Directing the contaminant plume through the reactive gate can significantly increase the flow velocity, thus reducing residence time.

3.2.5 In-Situ Chemical Treatment

In-situ chemical treatment for inorganics are being tested and applied with increasing frequency. In-situ chemical treatment includes the targeted injection of reactive media into the subsurface to mitigate groundwater impacts. Inorganic contaminants are typically remediated through immobilization by reduction or oxidation followed by precipitation or adsorption (EPRI, 2006). Chemical reactants that have been applied or are in development for application in treating inorganic contaminants include ferrous sulfate, nanoscale zero-valent iron, organo-phosphorus nutrient mixture (PrecipiPHOS™) and sodium dithionite (EPRI, 2006). Zero-valent iron has been shown to effectively immobilize cobalt and molybdenum. However, lithium has not been proven to be amenable to transformation or immobilization using reactive media.

4. EVALUATION OF POTENTIAL CORRECTIVE MEASURES

4.1 Evaluation Criteria

The potential groundwater corrective measures described in the previous section were evaluated relative to the criteria presented in Section 1.2 and reiterated below:

- Performance
- Reliability
- Ease of implementation
- Potential impacts of appropriate potential remedies (safety impacts, cross-media impacts, and control of exposure to any residual contamination)
- Time required to begin and complete the remedy
- Institutional requirements that may substantially affect implementation of the remedy(s) (permitting, environmental or public health requirements)

These factors are presented in Table 3 to allow a qualitative evaluation of the ability of each potential corrective measure to address SSLs for cobalt and lithium in the Uppermost Aquifer. The goal is to understand which potential corrective measures could be used, either independently or in combination, to attain the GWPS, as discussed in the following sections.

Discussion of potential groundwater corrective measures is provided below with content pertaining to each evaluation criteria provided above highlighted in **bold** text.

4.2 Potential Groundwater Corrective Measure Evaluation

As presented in the previous section, the following groundwater corrective measures are potentially viable to address SSLs for cobalt and lithium in the Uppermost Aquifer:

- MNA
- Groundwater Extraction
- Groundwater Cutoff Wall
- Permeable Reactive Barrier
- In-Situ Chemical Treatment

These potential corrective measures are discussed below relative to their ability to effectively address the SSLs for cobalt and lithium in the Uppermost Aquifer.

4.2.1 Monitored Natural Attenuation

MNA is an in-situ remedial technology which relies on source control and natural processes occurring in aquifers to attenuate dissolved constituents and thereby reduce their concentrations in groundwater. MNA is most effective at sites where the source is controlled, the contaminant plume is stable or shrinking, contaminant concentrations are low, and potential receptors are not exposed to concentrations greater than health-based values. The **performance** of MNA as a groundwater remedy can vary based on site-specific conditions; these conditions should be evaluated in accordance with USEPA's tiered approach to MNA (USEPA 1999, 2007, and 2015).

The results of an in-progress independent evaluation regarding the potential feasibility of MNA as a groundwater remedy are provided as Appendix C. This evaluation considered whether site-specific conditions appear favorable for **implementation** of MNA. As part of this evaluation, the likely ability of MNA, in combination with source control, to meet the criteria provided in 40 CFR 257.96(c) was completed; these results are also summarized in Table 3. As discussed in the independent evaluation in Appendix C, MNA is likely to achieve the 40 C.F.R. § 257.97 performance criteria based on the conclusions of the evaluation. Additional efforts will be completed to gather information to complete the tiered evaluation in accordance with USEPA guidance which will support the selection of MNA, in combination with source control, as a groundwater remedy. The MNA evaluation is currently underway at AP2 and will be completed in 2021.

4.2.2 Groundwater Extraction

Groundwater extraction is a widely accepted groundwater corrective measure with a long track record of performance and reliability. It is routinely approved by the IEPA. The **performance and reliability** of a groundwater extraction system is dependent on site-specific hydrogeologic conditions and would require additional data collection (aquifer testing) and possibly additional groundwater fate and transport modeling to support the design and regulatory approval. The heterogeneous and discontinuous nature of the Uppermost Aquifer could present limitations in system effectiveness. Hydraulic conductivity observations based upon single-well field permeability tests varied by two orders of magnitude (3.1×10^{-5} to 1.6×10^{-3} cm/s). For a corrective measure using groundwater extraction to effectively control off-site flow or to remove potentially contaminated groundwater, horizontal and vertical capture zone(s) must be created using pumping wells. Pumping from portions of the Uppermost Aquifer with higher permeability would produce the largest capture zones. However, the portions of the Uppermost Aquifer having lower permeability would restrict the ability to pump at rates high enough to establish the required capture zone(s) in the higher permeability portions or require a high density of wells. The proximity of the cobalt and lithium groundwater plumes to the CPS discharge flume may also limit capture. Cutoff walls (Section 4.2.3) could also be used in conjunction with a pumping system to control groundwater movement. The recently completed CCR dewatering and geomembrane cover system will reduce the mass loading to the Uppermost Aquifer, thus reducing the total contaminant mass that would need to be captured to attain GWPS.

Implementation of a groundwater extraction system presents design challenges due to the heterogeneous and discontinuous nature of the Uppermost Aquifer. Design and implementation would benefit from additional characterization activities to increase the density and resolution of data. Specialized contractors may be necessary depending upon the construction/implementation method (e.g., horizontal extraction well). Extracted groundwater would need to be managed, which may include modification to the existing NPDES permit and treatment prior to discharge, if necessary. Treatment may also require specialized equipment and/or installation contractors.

There could be some **impacts** associated with constructing and operating a groundwater extraction system, including alteration of groundwater flow patterns in the Uppermost Aquifer and some limited exposure to extracted groundwater. Additional data collection and analyses would be required to design an extraction system. Construction could be completed within 1 year. **Time of implementation** is approximately 3 to 4 years, including characterization, design, permitting and construction. **Timeframes to achieve GWPS** are dependent on site-specific conditions, which require detailed technical analysis. **IEPA approval** is anticipated to be required for discharge of extracted groundwater.

4.2.3 Groundwater Cutoff Wall

Groundwater cutoff walls are a widely accepted groundwater corrective measure used to control and/or isolate impacted groundwater and are routinely approved by the IEPA. Cutoff walls are designed to act as hydraulic barriers, as a result, inherently alter the existing groundwater flow system. Changes to the existing groundwater flow system may need to be controlled to maximize the **performance** of the remedy, for example, a cutoff wall may need to be combined with another groundwater corrective measure, such as groundwater extraction or a permeable reactive barrier, to control build-up of hydraulic head upgradient and around the cutoff wall.

Cutoff walls have a long history of **reliable** performance as hydraulic barriers provided they are properly designed and constructed. As mentioned above, a cutoff wall may need to be combined with another groundwater corrective measures, such as groundwater extraction or a permeable reactive barrier, to ultimately achieve and maintain GWPS.

Additional subsurface data collection and analyses would be required to provide the density of data required for design and **implementation** of a cutoff wall. The proximity of the cobalt and lithium groundwater plumes to the CPS discharge flume and Unnamed Tributary may limit space available for cutoff wall implementation, and complicate construction activities by requiring staging away from the construction area and transport of materials between the staging and construction areas. Specialized contractors may be necessary depending upon the construction/implementation method.

There could be some **impacts** associated with constructing and operating a groundwater cutoff wall, including changes to the groundwater flow system that have to be considered for effective groundwater corrective action. Construction could be completed within 1 to 2 years depending upon the size of the cutoff wall and construction/implementation method. **Time of implementation** is approximately 4 to 5 years, including characterization, design, permitting and construction. To attain GWPS, cutoff walls require combination with other groundwater corrective measure(s) to operate in concert with the hydraulic barriers. Cutoff walls are commonly coupled with MNA, groundwater extraction, and permeable reactive barriers as groundwater corrective measures. The **time to attain GWPS** is dependent on the selected groundwater corrective measure or measures that are coupled with the cutoff walls. Cutoff walls require **approval by the IEPA** to be implemented.

4.2.4 Permeable Reactive Barrier

Cobalt is amendable to remediation using permeable reactive barriers (PRBs) with appropriate selection of reactive media (EPRI, 2006). However, PRB application as a groundwater corrective measure for lithium is not well established and more research is needed, therefore, **performance and reliability for lithium are unknown**.

PRB treatment of cobalt is expected to have variable reliability based on site-specific hydrogeologic and geochemical conditions and the nature of the reactive media. The capacity of the reactive media may be exceeded and require replacement or rejuvenation. Conservative estimates indicate iron-based reactive media are expected to require maintenance every 10 years (ITRC, 2005). Implementation of PRBs may have design challenges associated with both groundwater hydraulics and plume configuration that are similar to those associated with groundwater extraction and cutoff walls, specifically, the heterogeneous and discontinuous nature of the Uppermost Aquifer.

Funnel-and-gate PRBs inherently alter the existing groundwater flow system. These groundwater flow system changes may need to be controlled to reduce **potential impacts** of the remedy. Construction of PRBs could be completed within 1 to 2 years. **Time of implementation** is approximately 5 to 7 years, including characterization, design, permitting and construction. **Timeframes to achieve GWPS** are dependent on site-specific conditions, including reactivity and maintenance (replacement or rejuvenation requirements) which require detailed technical analysis. PRBs and potentially associated groundwater cutoff walls (funnel-and-gate system) **require approval by the IEPA** to be implemented.

4.2.5 In-Situ Chemical Treatment

In-situ chemical treatment of cobalt and lithium is not well established and more research is needed (EPRI, 2006); therefore, **performance and reliability** are unknown.

Implementation of in-situ chemical treatment may have chemical delivery challenges associated with groundwater hydraulics.

Injections of treatment media could be completed within 1 to 2 years. **Time of implementation** is approximately 5 to 7 years, including characterization, design, permitting and injections. Chemical treatment alters groundwater geochemical conditions, which may result in potential **impacts** associated with implementation of the remedy. **Timeframes to achieve GWPS** are dependent on site-specific conditions, including reactivity and maintenance (replacement or rejuvenation requirements) which require detailed technical analysis. Since in-situ chemical treatment alters groundwater geochemistry implementation of the remedy **may require Underground Injection Control (UIC) approval**.

In-situ chemical treatment is not retained as a viable corrective measure to address SSLs of cobalt and lithium in the Uppermost Aquifer since its performance and reliability are unknown.

5. REMEDY SELECTION PROCESS

5.1 Retained Corrective Measures

This CMA was prepared to address the requirements of 40 C.F.R. § 257.96. The following potentially viable corrective measures were identified based upon site-specific conditions:

- MNA
- Groundwater Extraction
- Groundwater Cutoff Wall
- PRB

Per 40 C.F.R. § 257.97, a remedy must be selected to address the SSLs in the Uppermost Aquifer, based on the results of the CMA. The remedy should be selected as soon as feasible and must meet the following standards:

- Be protective of human health and the environment
- Attain the groundwater protection standard as specified pursuant to § 257.95(h)
- 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
- Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems
- Comply with standards for management of wastes as specified in § 257.98(d)

The recently completed CCR dewatering and geomembrane cover system will significantly minimize water infiltration into the closed CCR unit and allow surface water to drain off the cover system, thus reducing the generation of potentially impacted water and reducing the extent of groundwater impacts by natural attenuation.

Based on the analysis completed to date (Appendix C), MNA combined with source control appears to be a promising groundwater remedy at AP2 when evaluated against the requirements in 40 C.F.R. § 257.96(c). Further investigation will be completed in 2021 to collect sufficient evidence to support the tiered MNA evaluation, which will include a better understanding of site hydrogeology and conditions after closure to develop multiple lines of evidence in accordance with USEPA guidance.

Additional investigation is also required to increase the density and resolution of Uppermost Aquifer data to facilitate design of a groundwater extraction system, cutoff wall, and/or PRB, if necessary to evaluate other corrective measures. Bench-scale evaluation of reactive media is also required for design of a PRB.

The Post-Closure Care Plan includes on-going groundwater monitoring to demonstrate that the extent of groundwater impacts is decreasing in size and concentration in the Uppermost Aquifer following closure. In accordance with the IEPA-approved Groundwater Monitoring Plan (NRT, 2017e), if a statistically significant increasing trend is observed to continue over a period of two or more years, and a subsequent hydrogeologic site investigation demonstrates that such exceedances are due to a release from AP2, and corrective actions are necessary and appropriate to mitigate the release, a corrective action plan will be proposed as a modification to the Post-Closure Care Plan. The corrective action plan may incorporate one or more of the corrective measures identified in this CMA to address impacts from CCR constituents in the Uppermost Aquifer.

5.2 Future Actions

Source control was completed on November 17, 2020. MNA will be implemented as part of the approved Closure Plan, including monitoring of the Uppermost Aquifer. Additional investigation will be completed to support analysis of the attenuation mechanism, rate, and aquifer capacity to complete the tiered MNA evaluation recommended by USEPA guidance. Additional Uppermost Aquifer data needed for design of groundwater extraction, cutoff wall, and/or PRB will also be collected during the MNA investigation to the extent allowed by the scope of the MNA investigation.

Semiannual reports per § 257.97 will continue to be prepared to describe the progress in selecting and designing the remedy that addresses SSLs for cobalt and lithium in the Uppermost Aquifer. A final report describing the selected remedy and how it meets the standards listed above will also be prepared, per § 257.97.

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TABLES

TABLE 1. ASSESSMENT MONITORING PROGRAM SUMMARY
CORRECTIVE MEASURES ASSESSMENT, REVISION 1
COFFEEN ASH POND NO. 2
COFEEN POWER STATION
COFFEEN, ILLINOIS

Sampling Dates	Analytical Data Receipt Date	Parameters Collected	SSL(s) Appendix IV	SSL(s) Determination Date	ASD Completion Date	CMA Completion / Status
August 3 - 4, 2018	October 8, 2018	Appendix III	--	--	--	--
		Appendix IV Detected[1]	Cobalt (G401)	January 7, 2019	NA	July 8, 2019 (completed CMA)
January 21 - 25, 2019	April 15, 2019	Appendix III	--	--	--	--
		Appendix IV	Cobalt (G401, G402)	July 15, 2019	NA	ongoing
August 13 - 20, 2019	October 15, 2019	Appendix III	--	--	--	--
		Appendix IV Detected[1]	Cobalt (G401, G402)	January 13, 2020	NA	Feasibility study phase of CMA; Public meeting held October 7, 2019
			Lithium (G401)			
January 22 - 24, 2020	April 15, 2020	Appendix III	--	--	--	--
		Appendix IV	Cobalt (G401)	July 14, 2020	NA	January 8, 2020 (Semiannual remedy selection progress report)
			Lithium (G401)			
August 12, 2020	October 15, 2020	Appendix III	--	--	--	--
		Appendix IV Detected[1]	TBD	TBD	TBD	TBD

[O:KLT 11/23/20, C: RAB 11/24/2020]

Notes:
-- = SSL evaluation does not apply to Appendix III parameters
ASD = Alternate Source Demonstration
CMA = Corrective Measures Assessment
NA = Not Applicable
SSL = Statistically Significant Level
TBD = To Be Determined
1. Groundwater sample analysis was limited to Appendix IV parameters detected in previous events in accordance with 40 C.F.R. Part 257.95(d)(1).

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TABLE 2. GROUNDWATER CONCENTRATIONS DELINEATING THE COBALT AND LITHIUM PLUMES
CORRECTIVE MEASURES ASSESSMENT, REVISION 1
COFFEEN ASH POND NO. 2
COFEEN POWER STATION
COFFEEN, ILLINOIS

Monitoring Well ID	Parameter:	Cobalt (mg/L)											
	Date:	8/3-4/2018		1/21-25/2019		8/13-20/2019		1/22-24/2020		5/6/2020		8/12/2020	
	GWPS	Result	Comparison Value	Result	Comparison Value	Result	Comparison Value	Result	Comparison Value	Result	Comparison Value	Result	Comparison Value
G270	0.006	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	NS	NS	<0.0020	TBD
G281	0.006	0.0036	0.0036	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	NS	NS	<0.0020	TBD
G401	0.006	0.420	**0.2653**	0.310	**0.2760**	0.300	**0.2690**	0.0460	**0.215**	NS	NS	0.260	TBD
G402	0.006	0.010	0.0045	0.0076	**0.0066**	0.0045	**0.00621**	0.0021	0.00559	NS	NS	<0.0020	TBD
G403	0.006	0.0034	0.0016	0.0031	0.0024	0.0029	0.00208	<0.0020	0.00207	NS	NS	<0.0020	TBD
G404	0.006	<0.0020	0.0020	<0.0020	0.0020	0.0027	0.0020	<0.0020	0.0020	NS	NS	<0.0020	TBD
G405	0.006	<0.0020	0.0019	0.0038	0.0020	<0.0020	0.0020	<0.0020	0.0020	NS	NS	<0.0020	TBD

[O: RAB 11/23/2020, C:KLT 11/23/20]

Notes:
< = Not Detected at Reporting Limit
-- = No sample; monitoring well not part of CCR program during sampling event
Bold red highlighted concentration indicates exceedance of GWPS for parameter indicated
GWPS = Groundwater Protection Standard
mg/L = milligrams per liter
NS = Not Sampled
1. Negative comparison values are the result of the Lower Confidence Band around a negative slope.
2. Comparison Values are presented on plume maps.

TABLE 2. GROUNDWATER CONCENTRATIONS DELINEATING THE COBALT AND LITHIUM PLUMES
CORRECTIVE MEASURES ASSESSMENT
COFFEEN ASH POND NO. 2
COFEEN POWER STATION
COFFEEN, ILLINOIS

Monitoring Well ID	Parameter:	Lithium (mg/L)											
	Date:	8/3-4/2018		1/21-25/2019		8/13-20/2019		1/22-24/2020		5/6/2020		8/12/2020	
	GWPS	Result	Comparison Value	Result	Comparison Value	Result	Comparison Value	Result	Comparison Value	Result	Comparison Value	Result	Comparison Value
G270	0.04	<0.010	<0.010	<0.010	<0.010	0.012	0.012	<0.020	<0.020	NS	NS	<0.020	TBD
G281	0.04	<0.010	<0.010	<0.010	<0.010	0.014	0.014	<0.020	<0.020	NS	NS	<0.020	TBD
G401	0.04	0.320	0.003	0.096	0.019	0.092	**0.050**	0.024	**0.050**	0.035	**0.046**	0.036	TBD
G402	0.04	0.030	0.029	0.024	0.009	0.046	0.031	0.026	0.0301	NS	NS	0.022	TBD
G403	0.04	<0.010	0.010	<0.010	0.010	<0.010	0.010	<0.020	0.010	NS	NS	<0.020	TBD
G404	0.04	<0.010	0.010	<0.010	0.010	0.0130	0.010	<0.020	0.010	NS	NS	<0.020	TBD
G405	0.04	<0.010	0.010	<0.010	0.010	<0.010	0.010	<0.020	0.010	NS	NS	<0.020	TBD

[O: RAB 11/23/2020, C:KLT 11/23/20]

Notes:
< = Not Detected at Reporting Limit
-- = No sample; monitoring well not part of CCR program during sampling event
Bold red highlighted concentration indicates exceedance of GWPS for parameter indicated
GWPS = Groundwater Protection Standard
mg/L = milligrams per liter
NS = Not Sampled
1. Negative comparison values are the result of the Lower Confidence Band around a negative slope.
2. Comparison Values are presented on plume maps.

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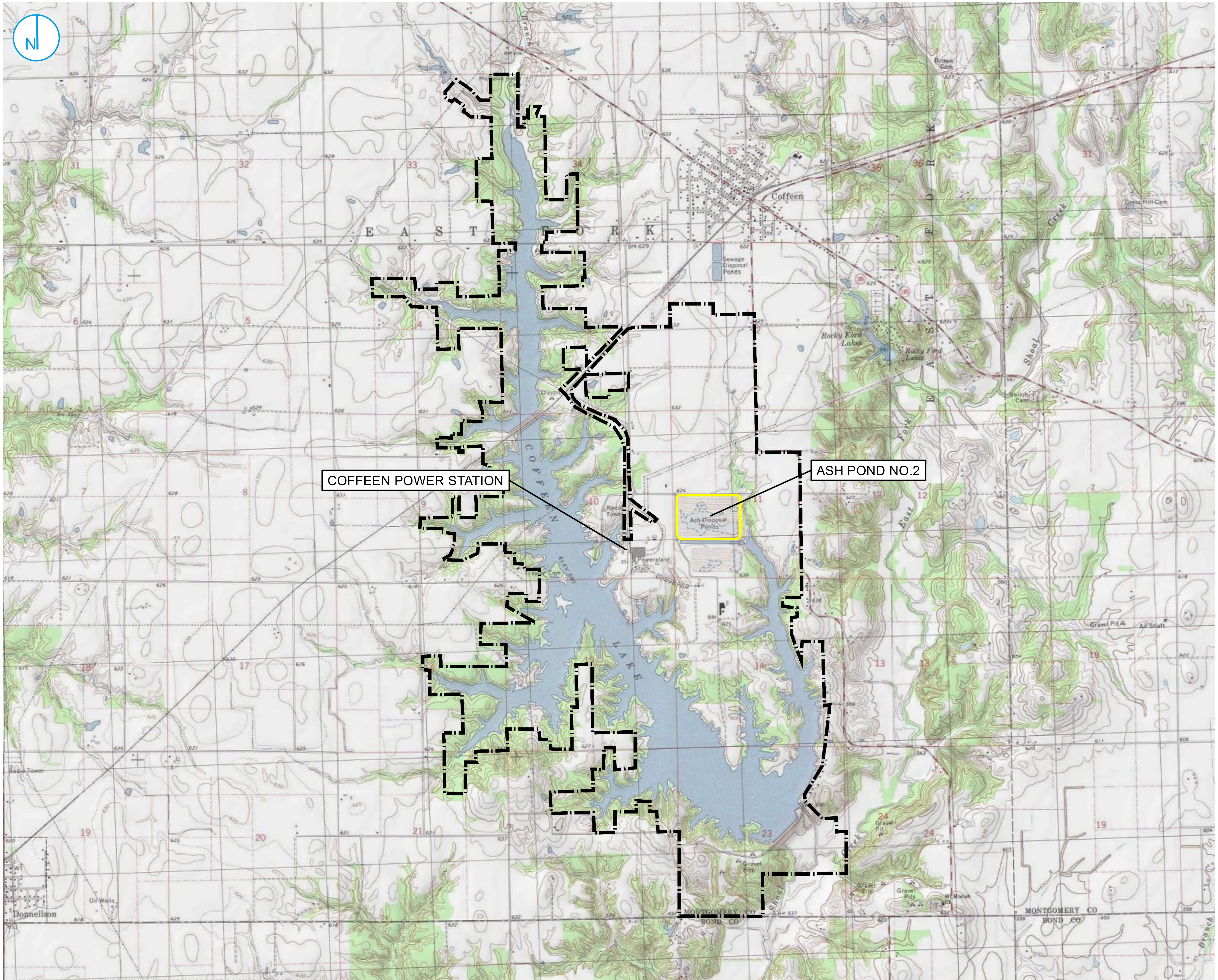
TABLE 3. CORRECTIVE MEASURES ASSESSMENT MATRIX
CORRECTIVE MEASURES ASSESSMENT, REVISION 1
COFFEEN ASH POND NO. 2
COFEEN POWER STATION (CPS)
COFFEEN, ILLINOIS

Evaluation Factors	Performance	Reliability	Ease of Implementation	Potential Impacts of Remedy (safety impacts, cross-media impacts, control of exposure to any residual contamination)	Time Required to Begin and Implement Remedy[1]	Time to Attain Groundwater Protection Standards	Institutional Requirements (state/local permit requirements, environmental/public health requirements that affect implementation of remedy)
MNA	Performs best paired with source control completed at the site in 2020. Performance appears likely to be good given existing information including declining trends of the constituents of concern and other site conditions	Planned additional testing will evaluate if the attenuation mechanism has low reversability, the aquifer has sufficient capacity, and the hydrogeology is favorable for lithium dilution/dispersion	Easy - completion of tiered evaluation and long-term monitoring required, neither of which require extensive specialized equipment or contractors	None identified.	1 year.	Dependent on site-specific condtions. Planned additional testing will evaluate attenuation rate and capacity	No institutional requirements are anticipated.
Groundwater Extraction	Widely accepted, routinely approved; variable performance anticipated in heterogeneous, discontinuous nature of Uppermost Aquifer and possibly due to proximity of CPS discharge flume.	Reliable if properly designed, constructed and maintained. Heterogeneous, discontinuous nature of Uppermost Aquifer would present challenges.	Design challenges due to heterogeeous, discontinuous nature of Uppermost Aquifer. Specialized contractors may be necessary depending upon implementation method (e.g., horizontal wells). Extracted groundwater would require management, possibly including treatment, which may also require specialized equipment/contractors.	Alters groundwater flow system. Potential for some limited exposure to extracted groundwater.	3 to 4 years.	Dependent on site-specific conditions not yet fully characterized.	IEPA approval is anticipated to be required for discharge of extracted groundwater.
Groundwater Cutoff Wall	Widely accepted, routinely approved, good performance if properly designed and constructed. May need to be combined with another groundwater corrective measure, such as groundwater extraction or a permeable reactive barrier, to achieve GWPS.	Reliable if properly designed and constructed. May need to be combined with another groundwater corrective measure, such as groundwater extraction or a permeable reactive barrier, to achieve and maintain GWPS.	Widely used, established technology. Proximity of the CPS discharge flume and Unnamed Tributary may limit available space for and complicate implementation. Specialized contractors may be necessary depending upon the construction/implementation method.	Alters groundwater flow system.	4 to 5 years.	Needs to be combined with other groundwater corrective measure(s). Time required to attain GWPS dependent on combined measures.	Requires IEPA approval.
Permeable Reactive Barrier	Permeable Reactive Barrier treatment not well established for lithium, therefore performance is unknown.	Variable reliability for cobalt based on site-specific groundwater hydraulics and geochemical conditions. Unknown reliability for lithium.	Design challenges due to heterogeeous, discontinuous nature of Uppermost Aquifer.	Alters groundwater flow system.	5 to 7 years.	Dependent on conditions specific to the reactive media used and the site.	Requires IEPA approval.
In-Situ Chemical Treatment	In-Situ treatment not well established for cobalt or lithium, therefore performance is unknown.	In-Situ treatment not well established for cobalt or lithium, therefore reliability is unknown.	Design challenges due to heterogeeous, discontinuous nature of Uppermost Aquifer.	Alters groundwater geochemistry.	5 to 7 years.	Dependent on site-specific conditions.	May require Underground Injection Control approval.

Notes:
[1]Time required to begin and implement remedy includes design, permitting and construction.

FIGURES



CCR UNIT BOUNDARY, SUBJECT SITE

COFFEEN OWNED PROPERTY

0 1,500 3,000 Feet

SITE LOCATION MAP
COFFEEN ASH POND NO. 2 (UNIT ID: 102)

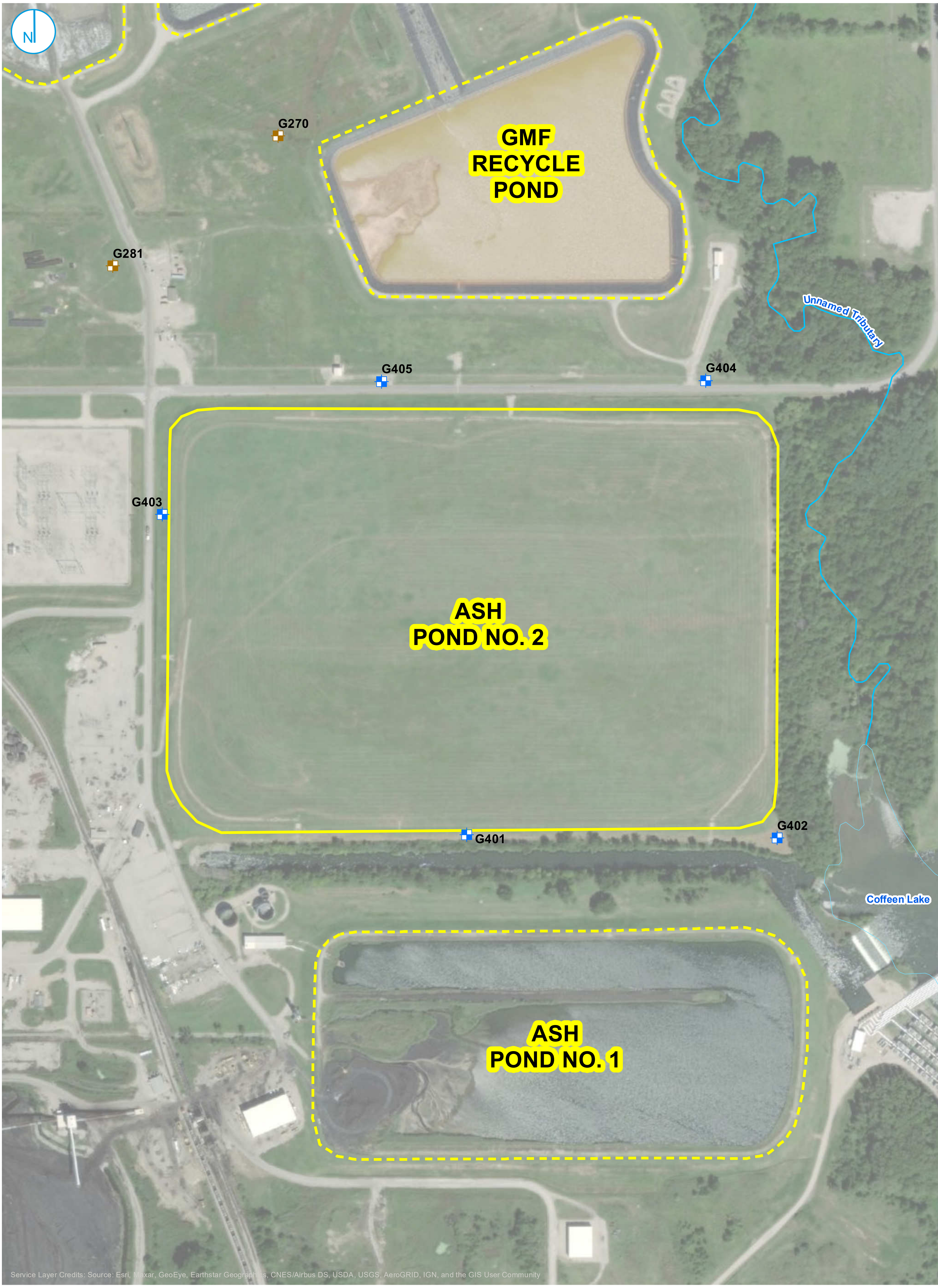
ASH POND NO. 2 (UNIT ID:102)
COFFEEN POWER STATION
COFFEEN, ILLINOIS

FIGURE 1

RAMBOLL US CORPORATION
A RAMBOLL COMPANY

Y:\Mapping\Projects\22\2285\MXD\Coffeen_CMA_figs\CMA 112320\Figure 1_Site Location Map.mxd

PROJECT: 169000XXXX | DATED: 11/25/2020 | DESIGNER: MARRAMJ



BACKGROUND CCR MONITORING WELL
DOWNGRADIENT CCR MONITORING WELL
CCR MONITORED UNIT, SUBJECT SITE
CCR MONITORED UNIT
SURFACE WATER FEATURE

0 150 300 Feet

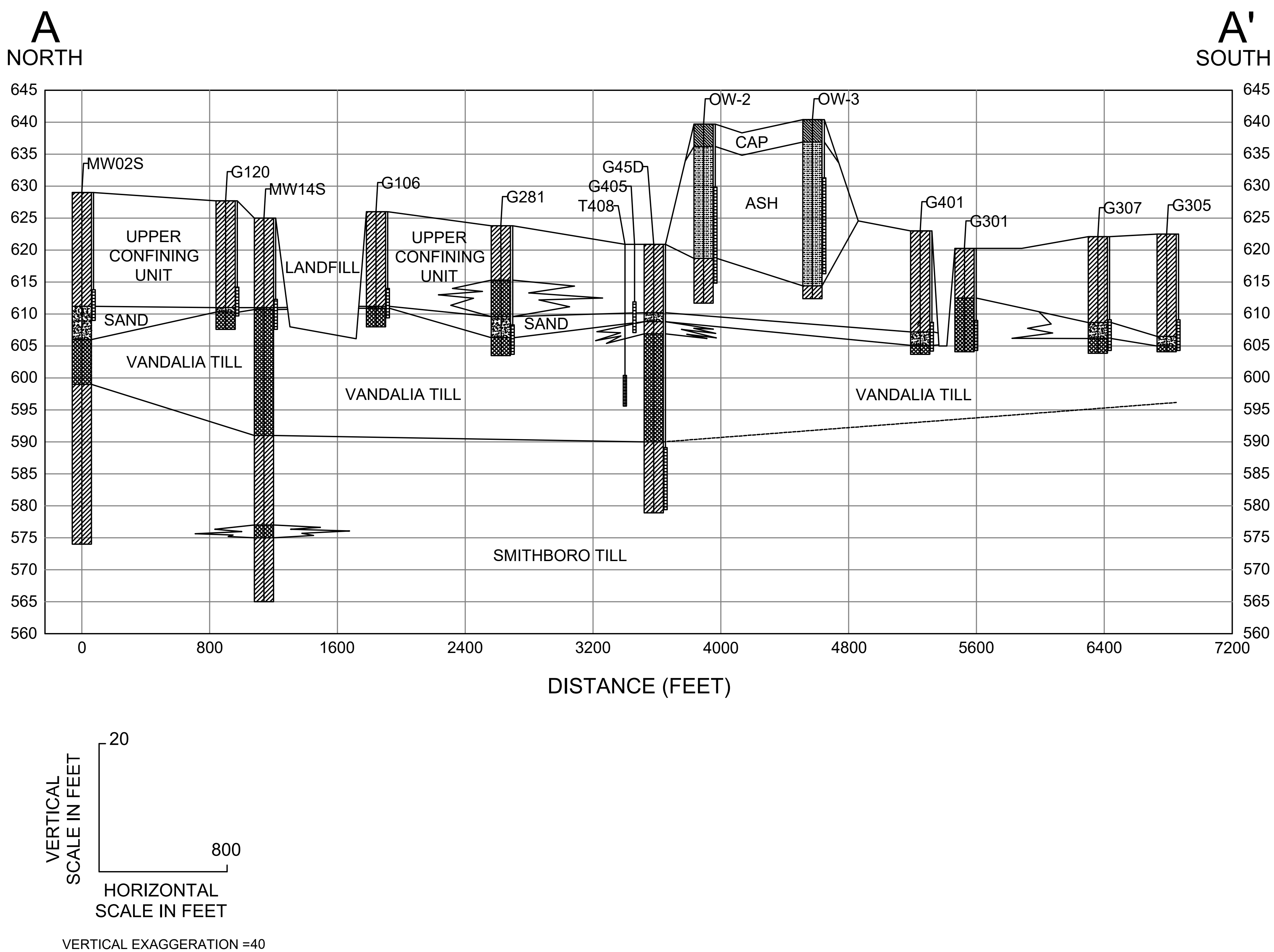
COFFEEN ASH POND NO. 2 WITH CCR GROUNDWATER MONITORING SYSTEM (UNIT ID: 102)

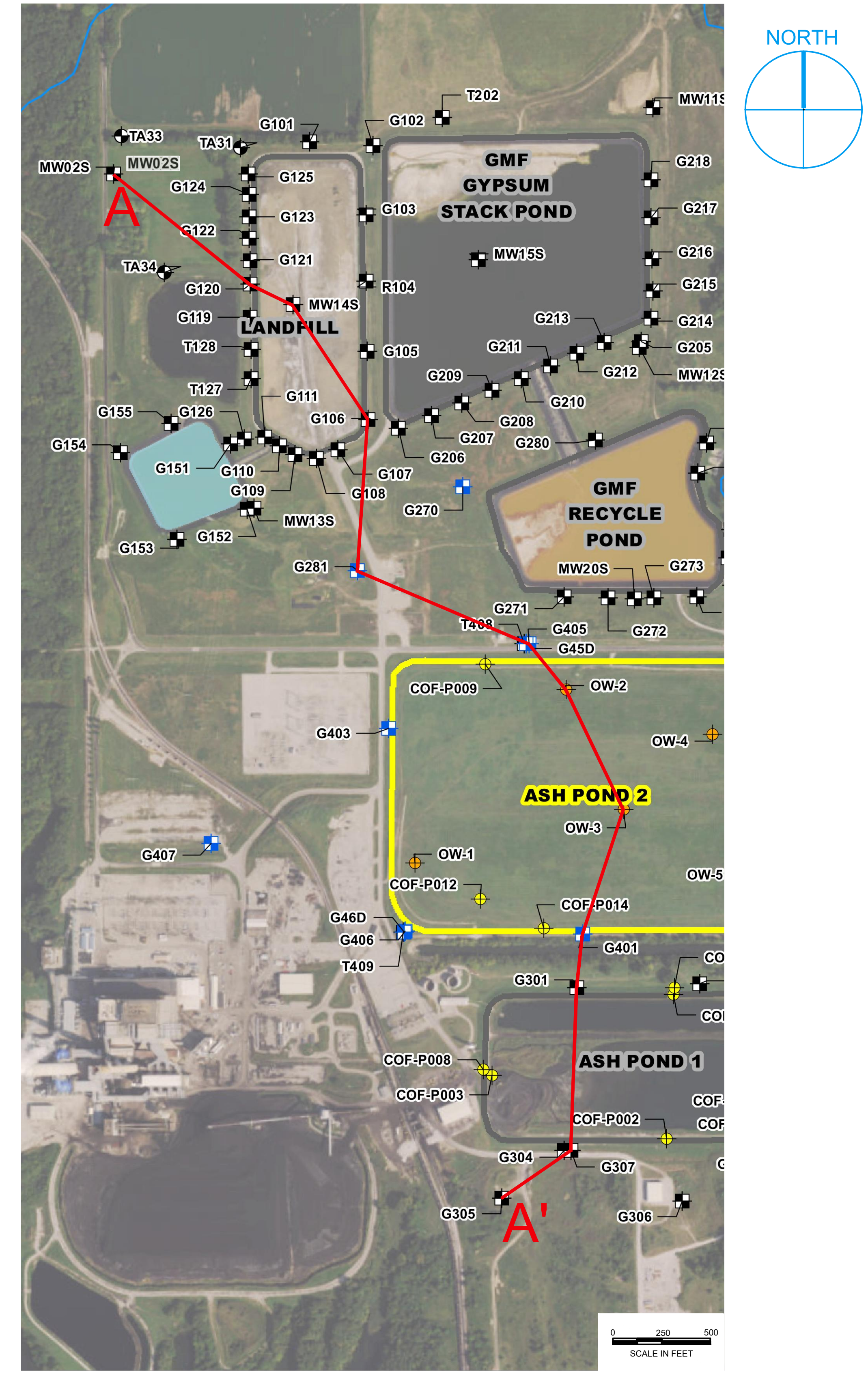
FIGURE 2

RAMBOLL US CORPORATION
A RAMBOLL COMPANY

ASH POND NO. 2 (UNIT ID:102)
COFFEEN POWER STATION
COFFEEN, ILLINOIS

RAMBOLL





LEGEND

- A—A' CROSS-SECTION TRANSECT
- CLAY
- SOIL
- SAND
- SILT
- ASH
- WELL SCREEN

GEOLOGIC CROSS SECTION A-A'

ASH POND NO. 2 (UNIT ID: 102)
COFFEEN POWER STATION
COFFEEN, ILLINOIS

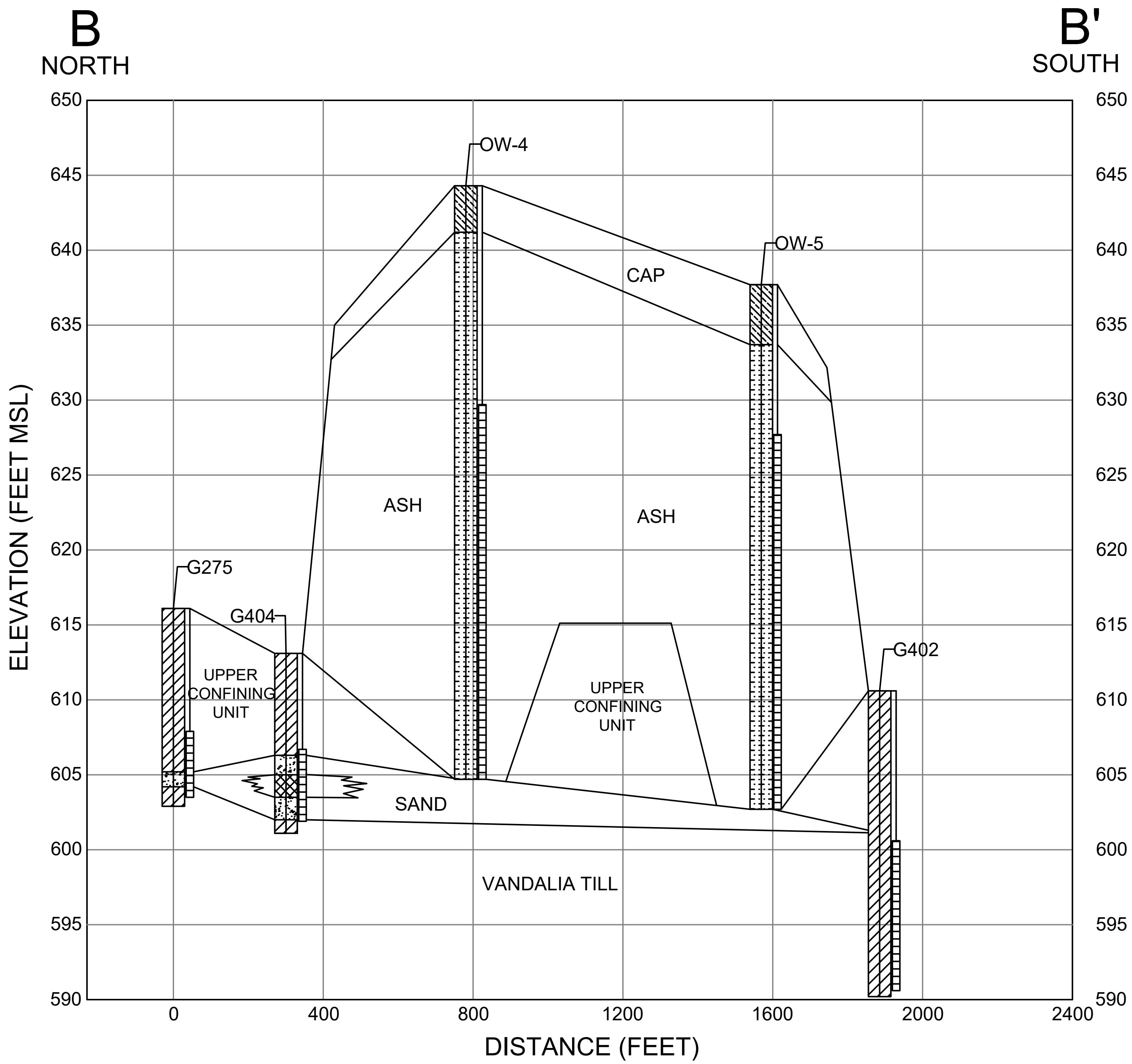
FIGURE 3

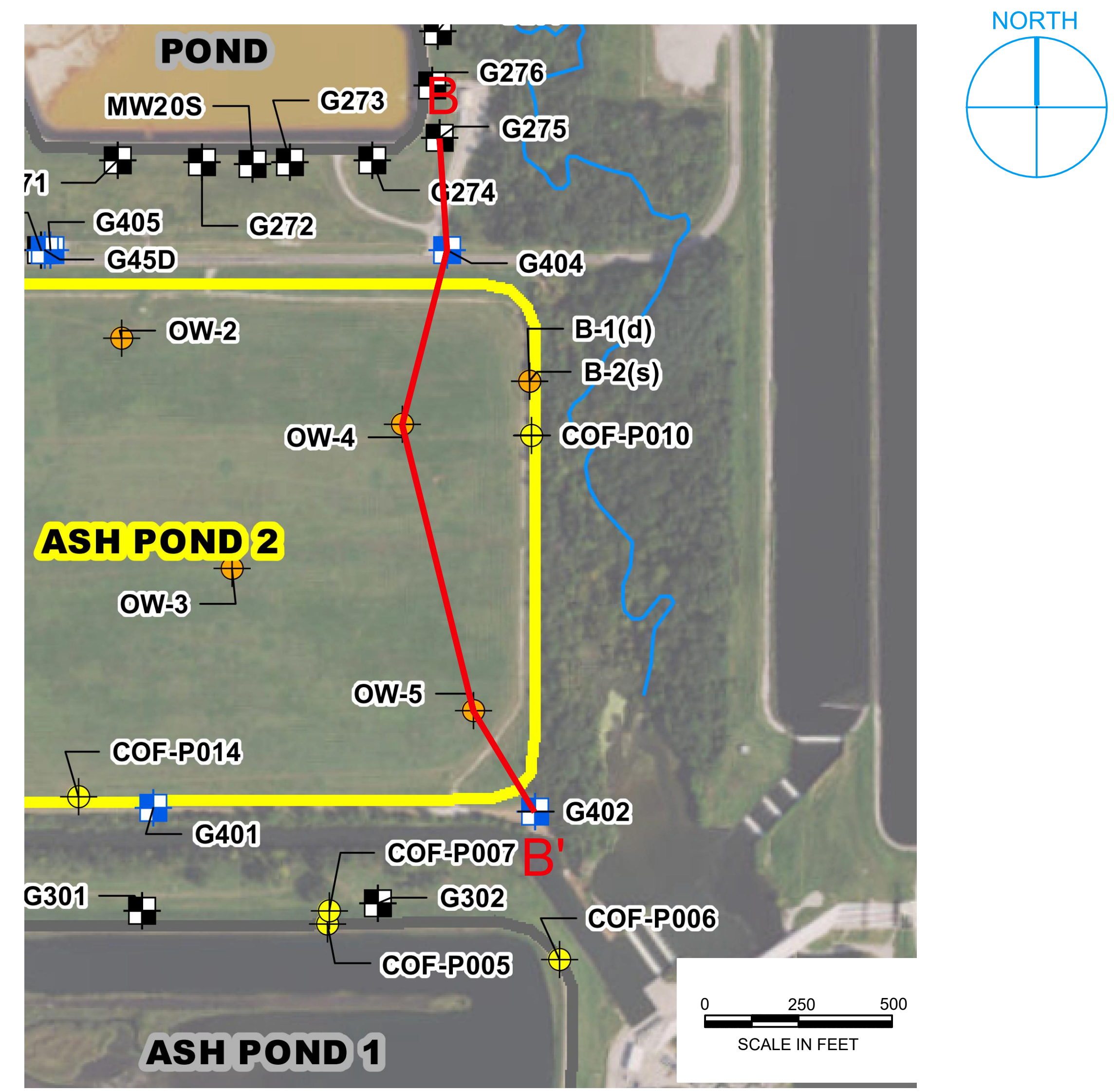
RAMBOLL US CORPORATION
A RAMBOLL COMPANY

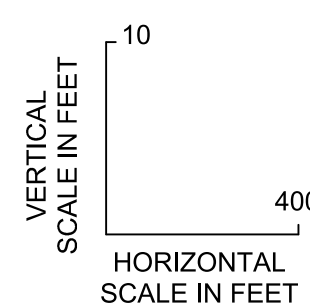
RAMBOLL

\\server27-01\Y Drive\Mapping\Projects\22\2285\CAD\Coffeen-CMA\Figure 4_Geologic Cross-Section A-A'.dwg

PROJECT: 1940100101 DATED: 11/25/2020 1:44 PM DESIGNER: ENGELHSA







VERTICAL EXAGGERATION =40

LEGEND

- B—B' CROSS-SECTION TRANSECT
- CLAY
- SOIL
- SAND
- SILT
- ASH
- WELL SCREEN

GEOLOGIC CROSS SECTION B-B'

ASH POND NO. 2 (UNIT ID: 102)
COFFEEN POWER STATION
COFFEEN, ILLINOIS

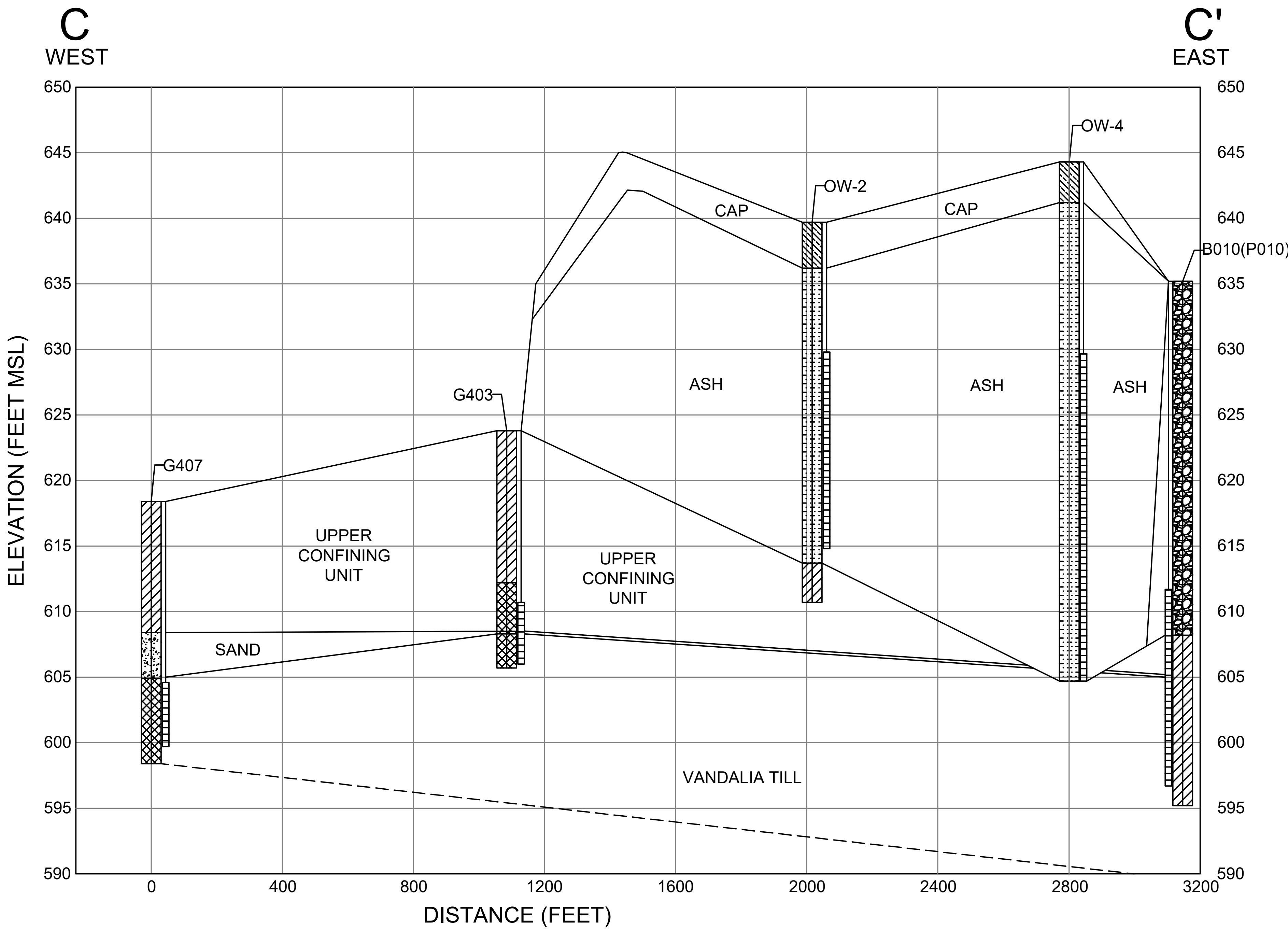
FIGURE 4

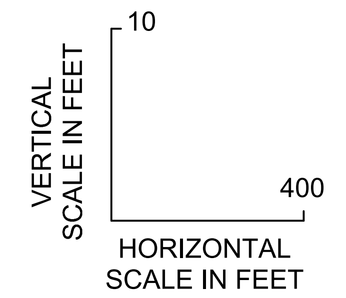
RAMBOLL US CORPORATION
A RAMBOLL COMPANY

RAMBOLL

PROJECT: 194010101 DATED: 11/25/2020 1:41 PM DESIGNER: ENGELHSA
\\server27-01\Y Drive\Mapping\Projects\22\2285\CAD\Coffeen-CMA\Figure 5_Geologic Cross-Section B-B'.dwg

\\server27-01\Y Drive\Mapping\Projects\22\2285\CAD\Coffeen-CMA\Figure 6_Geologic Cross-Section C-C'.dwg





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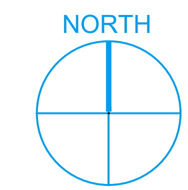
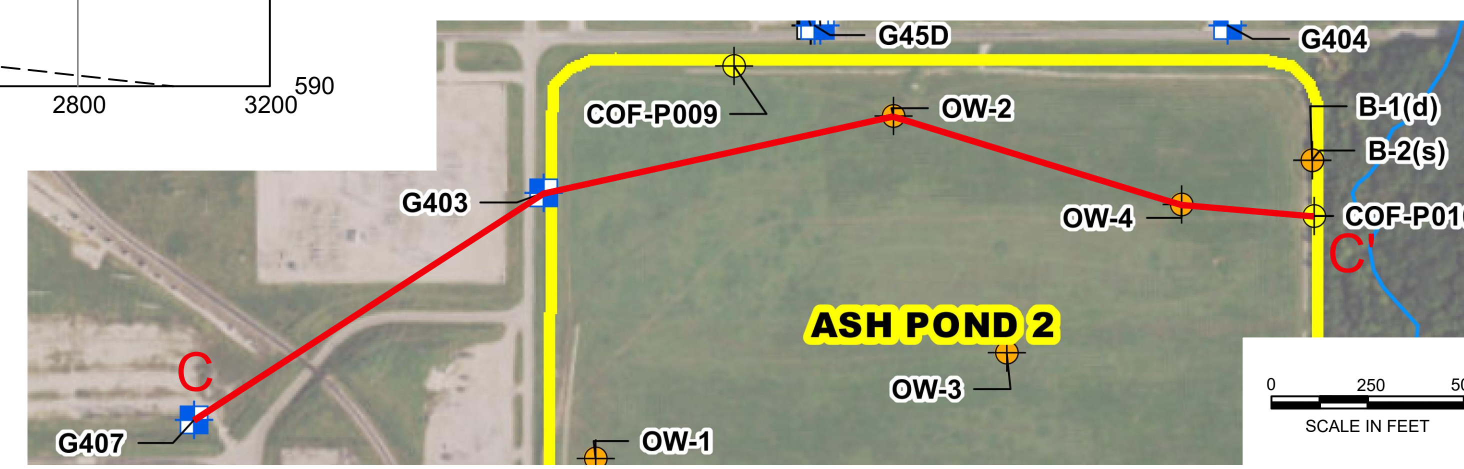




PROJECT: 1940100101 DATED: 11/25/2020 1:40 PM DESIGNER: ENGELHSA

LEGEND

C—C' CROSS-SECTION TRANSECT
CLAY
SOIL
SAND
SILT
ASH
FILL
WELL SCREEN

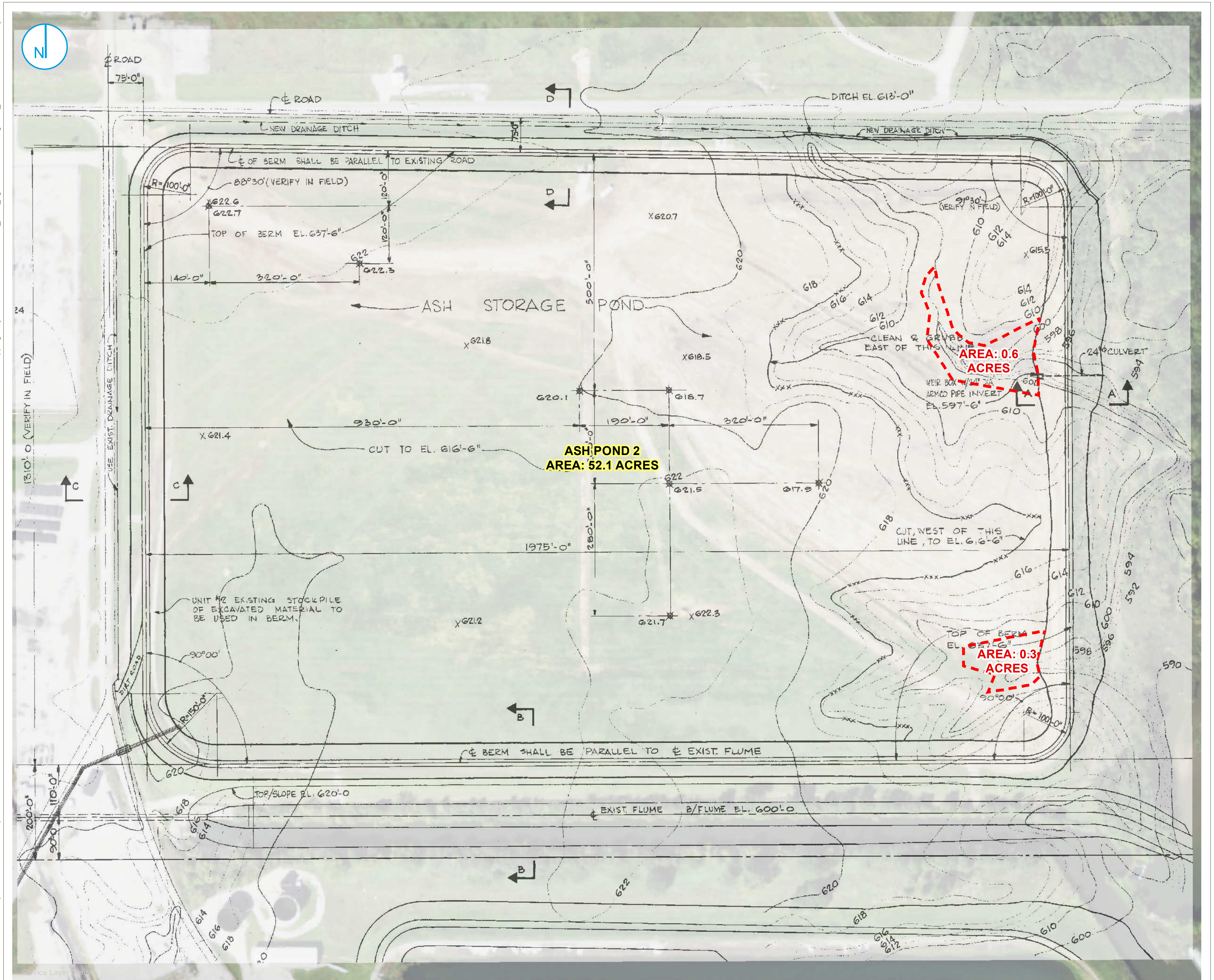
GEOLOGIC CROSS SECTION C-C'

ASH POND NO. 2 (UNIT ID: 102)
COFFEEN POWER STATION
COFFEEN, ILLINOIS

FIGURE 5

RAMBOLL US CORPORATION
A RAMBOLL COMPANY

RAMBOLL



HAGARSTOWN BEDS IN CONTACT WITH ASH

Note: Historical topography from Drawing No. B-560 (Sargent & Lundy, 1971)

0 100 200 Feet

AREAL EXTENT OF UPPER CONFINING UNIT

COFFEEN ASH POND NO. 2 (UNIT ID: 102)

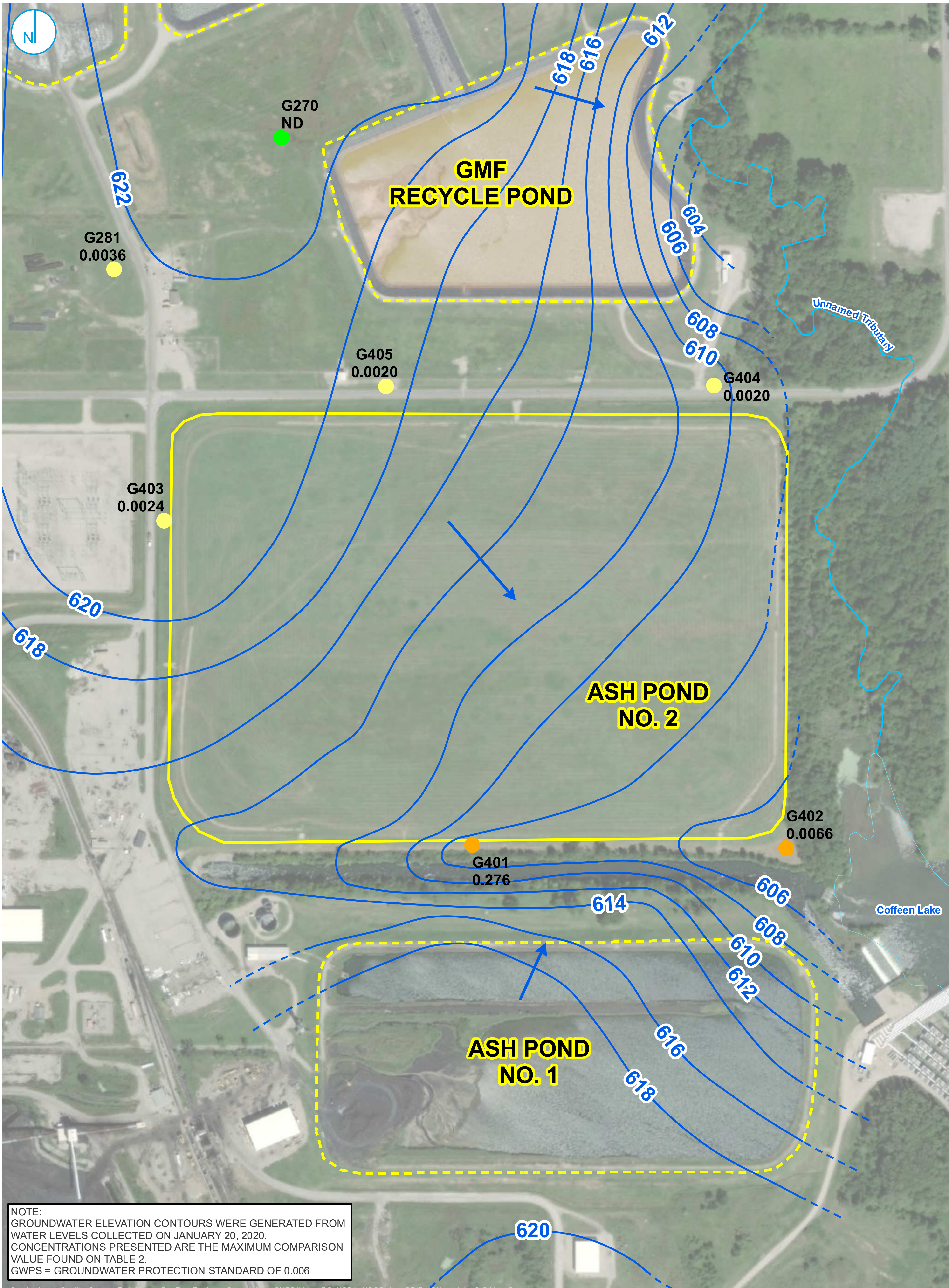
ASH POND NO. 2 (UNIT ID: 102)
COFFEEN POWER STATION
COFFEEN, ILLINOIS

FIGURE 6

RAMBOLL US CORPORATION
A RAMBOLL COMPANY

PROJECT: 169000XXXX | DATED: 11/25/2020 | DESIGNER: MARRAMJ

Y:\Mapping\Projects\22\2285\MXD\Coffeen_CMA_figs\CMA 112320\Figure 3_Thickness of Loess Clay.mxd



COBALT, TOTAL (mg/L)

- NON-DETECT
- DETECTED
- DETECTED, >GWPS
- CCR MONITORED UNIT, SUBJECT SITE
- CCR MONITORED UNIT

- GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
- INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FEATURE

0 150 300 Feet

TOTAL COBALT PLUME MAP

FIGURE 7

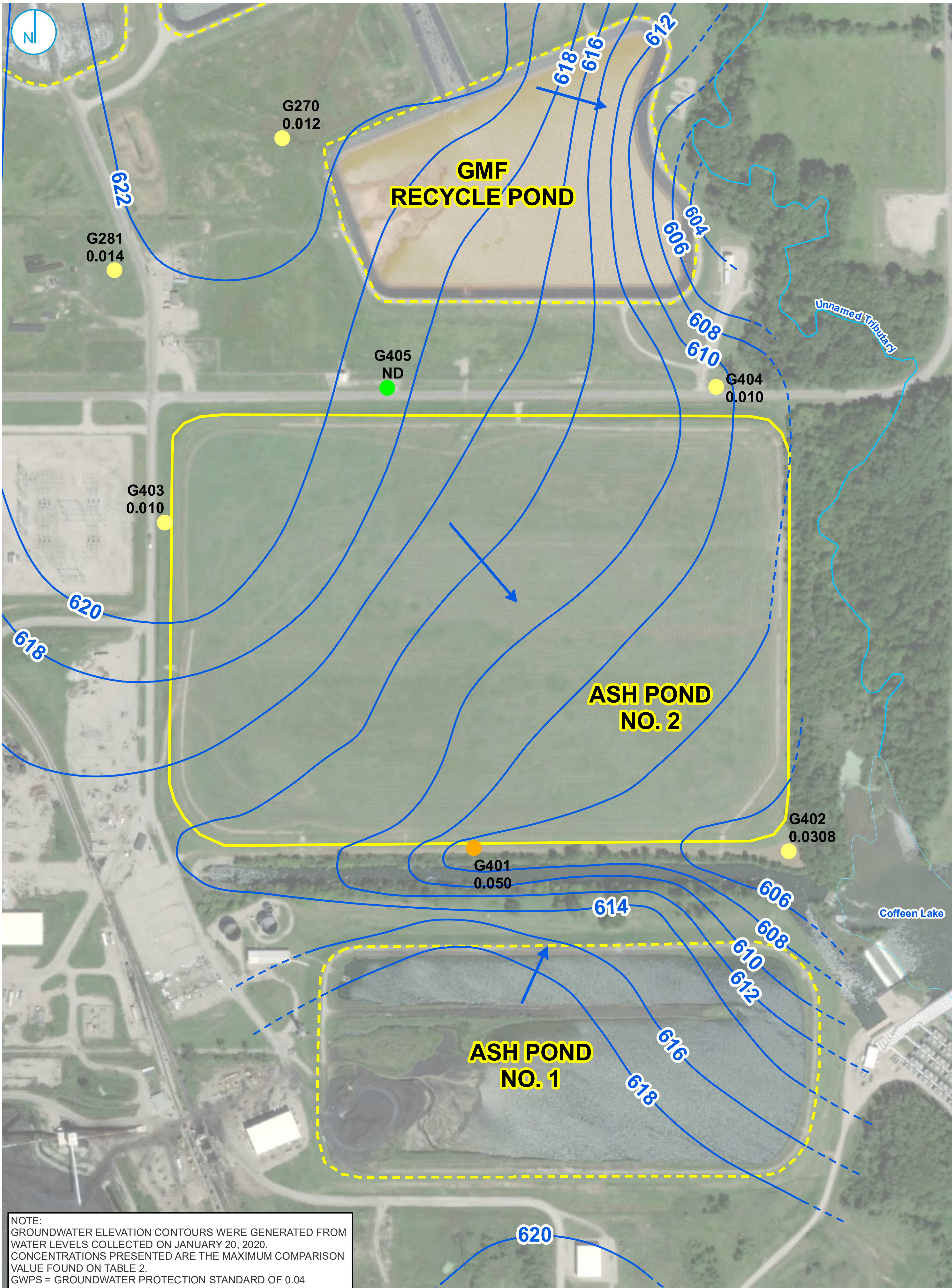
RAMBOLL US CORPORATION
A RAMBOLL COMPANY

ASH POND NO. 2 (UNIT ID:102)
COFFEEN POWER STATION
COFFEEN, ILLINOIS

RAMBOLL

PROJECT: 169000XXXX | DATED: 11/30/2020 | DESIGNER: MARRAMJ

Y:\Mapping\Projects\22\2285\MXD\Coffeen_CMA_figs\Coffeen_AP2_GW_Lithium Plume Map_2020.pdf.mxd



LITHIUM, TOTAL (mg/L)

- NON-DETECT
- DETECTED
- DETECTED, >GWPS
- CCR MONITORED UNIT, SUBJECT SITE
- CCR MONITORED UNIT

- GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
- INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FEATURE

0 150 300 Feet

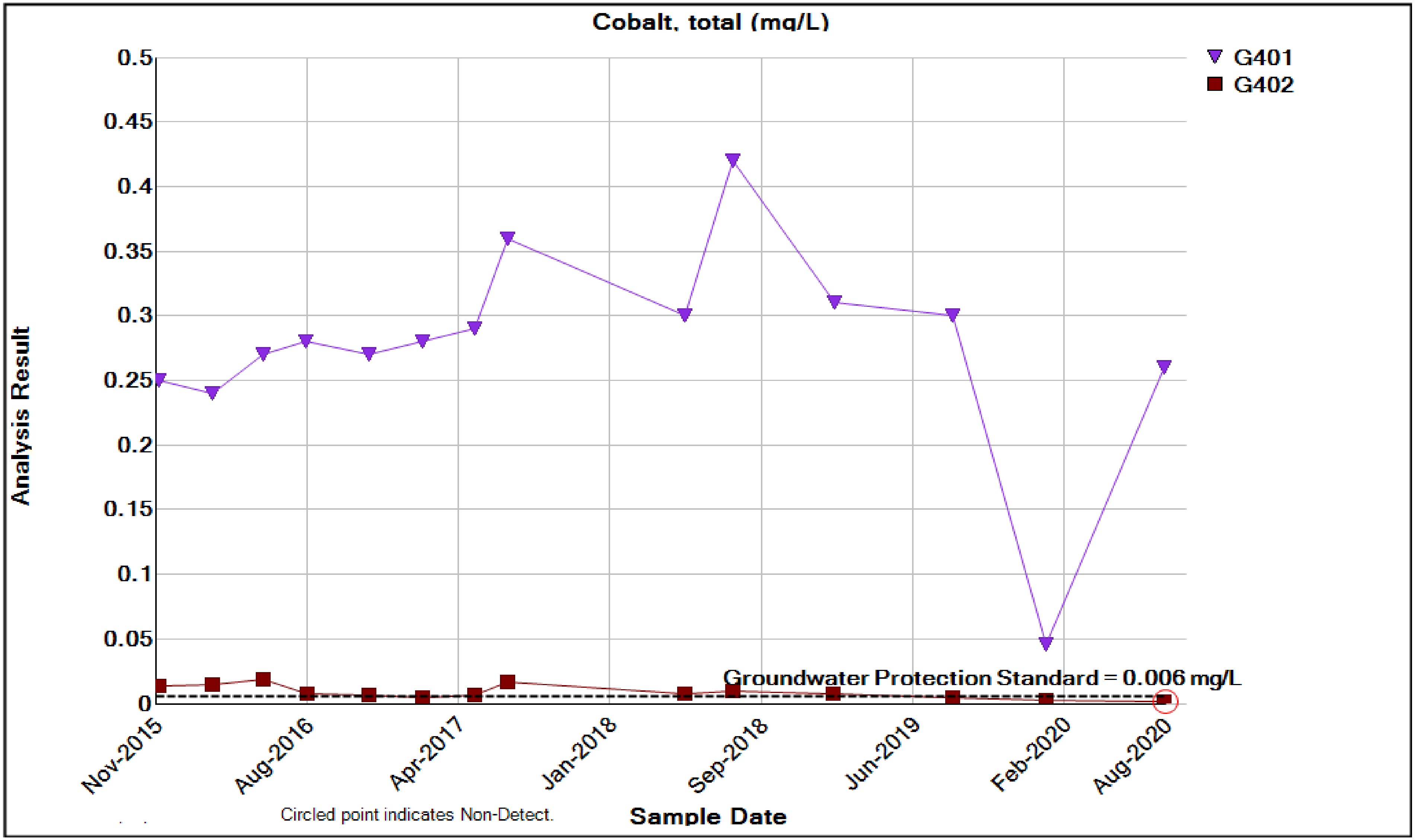
TOTAL LITHIUM PLUME MAP

FIGURE 8

RAMBOLL US CORPORATION
A RAMBOLL COMPANY

ASH POND NO. 2 (UNIT ID:102)
COFFEEN POWER STATION
COFFEEN, ILLINOIS

RAMBOLL



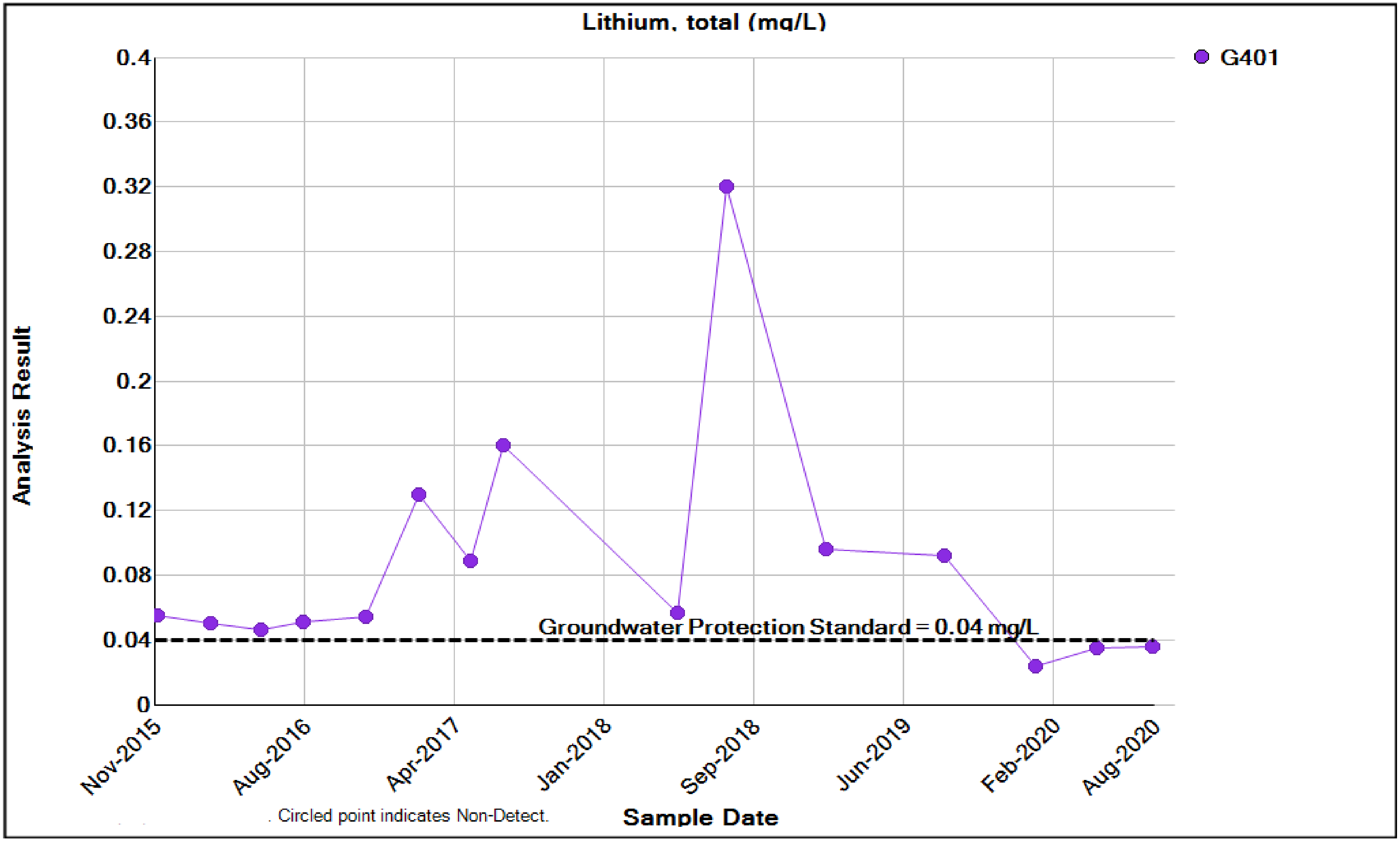
COBALT - TIMESERIES

FIGURE 9

O'BRIEN & GERE ENGINEERS, INC.
A RAMBOLL COMPANY

COFFEEN ASH POND NO. 2 (UNIT ID: 102)
COFFEEN POWER STATION
COFFEEN, ILLINOIS

RAMBOLL



LITHIUM - TIMESERIES

FIGURE 10

O'BRIEN & GERE ENGINEERS, INC.
A RAMBOLL COMPANY

COFFEEN ASH POND NO. 2 (UNIT ID: 102)
COFFEEN POWER STATION
COFFEEN, ILLINOIS

APPENDIX A
HYDRAULIC CONDUCTIVITY DATA

TABLE A1. SUMMARY OF LABORATORY HYDRAULIC CONDUCTIVITY IN CONFINING UNITS
CORRECTIVE MEASURES ASSESSMENT, REVISION 1
COFFEEN ASH POND NO. 2
COFEEN POWER STATION
COFFEEN, ILLINOIS

Laboratory Tests			
Well/ Soil Boring ID	**Approximate Sample Elevation (ft)**	**Hydraulic Conductivity (cm/sec)**	**Interpreted Unit**
COF-B001	613.0	1.3E-08	Loess - Upper Confining Unit
COF-B003	606.5	2.2E-07	
COF-B004	610.5	5.0E-07	
COF-B007	615.0	7.0E-08	
	Geometric Mean	**1.0E-07**	
G46D	599.2	4.5E-06	Vandalia Till
T408	597.6	1.5E-07	
SB-12	577.7-572.7	6.8E-09	
SB-13	598-593	7.0E-09	
SB-18	603.5-603	8.8E-09	
	Geometric Mean	**4.9E-08**	
SB-09	598.5-598	1.9E-06	Mulberry Grove Silt
SB-16	589-588.5	1.6E-06	
	Geometric Mean	**1.7E-06**	
G45D	586.4	1.0E-07	Smithboro Till
G46D	578.9	2.1E-08	
SB-07	572-571.5	1.1E-09	
	Geometric Mean	**1.3E-08**	
SB-19	569-564	3.4E-09	Deep Confining Unit
SB-16	548-547.5	1.3E-08	
	Geometric Mean	**6.6E-09**	

TABLE A2. SUMMARY OF FIELD HYDRAULIC CONDUCTIVITY TESTS
CORRECTIVE MEASURES ASSESSMENT, REVISION 1
COFFEEN ASH POND NO. 2
COFEEN POWER STATION
COFFEEN, ILLINOIS

Well ID	Unit	Method (fh)	Method (rh)	K (fh)	K (rh)	Well Geometric Mean	Approximate Screened Elevation (ft)	Interpreted Unit
				Uppermost Aquifer				
R104	**Landfill**	KGS	B-R	7.0E-05	2.8E-04	1.4E-04	614.4-609.7	Hagarstown Beds
G105		KGS	KGS	1.5E-04	5.7E-05	9.2E-05	613.2-608.4	
G106		B-R	B-R	4.0E-05	7.4E-04	1.7E-04	614.0-609.4	
G107		KGS	KGS	6.3E-05	8.9E-05	7.5E-05	613.9-609.3	
G110		KGS	KGS	4.7E-05	2.0E-05	3.1E-05	612.0-607.4	
G119		KGS	KGS	8.6E-05	8.2E-05	8.4E-05	611.6-607	
G120		low water elevation; no test conducted					614.2-609.7	
G125		KGS	KGS	4.8E-05	4.1E-05	4.4E-05	613.7-609.1	
T127		KGS	KGS	1.2E-03	1.7E-05	1.4E-04	610.5-606	
			Unit Geometric Mean			8.5E-05		
T202	**Gypsum Pond**	KGS	KGS	4.5E-04	5.5E-04	5.0E-04	614.0-609.6	Hagarstown Beds
G206		B-R	KGS	3.0E-04	1.6E-04	2.2E-04	613.0-608.6	
G208		KGS	KGS	6.0E-05	2.1E-05	3.5E-05	613.0-608.5	
G209		KGS	KGS	2.0E-04	1.6E-04	1.8E-04	612.8-608.3	
G210		KGS	KGS	5.0E-04	4.8E-04	4.9E-04	611.1-606.6	
G212		KGS	KGS	1.3E-04	1.8E-04	1.5E-04	613.9-609.3	
G215		KGS	KGS	5.0E-04	3.5E-04	4.2E-04	611.1-606.7	
G218		KGS	KGS	4.1E-04	4.1E-04	4.1E-04	610.3-605.9	
			Unit Geometric Mean			2.3E-04		
G270	**Recycle Pond**	KGS	KGS	5.5E-04	4.8E-04	5.1E-04	609.8-605.0	Hagarstown Beds
G271		KGS	KGS	1.6E-04	1.1E-03	4.2E-04	612.9-608.6	
G273		KGS	KGS	1.0E-03	8.3E-04	9.1E-04	611.1-605.6	
G276		low water					606.7-601.9	Hagarstown Beds, v. thin
G279		KGS	KGS	1.7E-03	1.5E-03	1.6E-03	606.8-602.4	Hagarstown Beds
G280		KGS	KGS	1.3E-03	1.3E-03	1.3E-03	610.2-605.3	
G281		KGS	KGS	2.1E-03	8.9E-04	1.4E-03	608.3-603.7	
			Unit Geometric Mean			9.0E-04		
G301	**Ash Pond 1**	KGS	KGS	2.7E-04	5.0E-04	3.7E-04	609-604.3	Upper Vandalia Till
G302		KGS	KGS	4.9E-04	6.3E-04	5.6E-04	604.7-600.1	
G303		KGS	KGS	5.6E-05	3.1E-05	4.2E-05	609.1-599.1	Hagarstown/Vandalia Till Contact
G304		KGS	KGS	8.9E-04	1.0E-03	9.4E-04	613.5-603.5	Hagarstown Beds
			Unit Geometric Mean			3.0E-04		
G401	**Ash Pond 2**	B-R	B-R	1.8E-04	2.8E-04	2.2E-04	608.7-603.7	Hagarstown Beds
G402		KGS	KGS	4.5E-04	1.9E-04	2.9E-04	600.6-590.6	Upper Vandalia Till
G403		KGS	KGS	4.3E-05	7.2E-05	5.6E-05	610.7-606.0	Hagarstown Beds, v. thin
G404		KGS	KGS	4.2E-04	3.8E-04	4.0E-04	606.7-601.9	Hagarstown Beds
G405		KGS	KGS	9.8E-04	9.7E-04	9.7E-04	611.9-607.1	
			Unit Geometric Mean			2.7E-04		
G153	**SW Pond**	KGS	KGS	2.5E-04	5.4E-04	3.7E-04	607.5-603.0	Hagarstown Beds
			Unit Geometric Mean			3.7E-04		
MW03S	**2009 Hydrogeo. Inves**	B-R	B-R	6.0E-04	1.1E-03	8.1E-04	613.7-608.6	Hagarstown Beds
MW04S		B-R	B-R	1.3E-03	8.0E-04	1.0E-03	612.6-607.6	
MW10S		B-R	B-R	8.0E-04	8.0E-04	8.0E-04	610.9-604.9	
MW13S		B-R	B-R	1.0E-03	2.0E-04	4.5E-04	611.3-606.1	
MW14S		B-R	B-R	1.0E-03	5.0E-04	7.1E-04	612.4-607.2	
MW15S		B-R	B-R	1.5E-04	8.1E-05	1.1E-04	609.3-604.2	
MW16S		B-R	B-R	6.0E-04	4.5E-04	5.2E-04	611.5-606.3	
MW17S		B-R	B-R	5.8E-04	5.5E-04	5.6E-04	613.1-603	
			Unit Geometric Mean			5.4E-04		

RAMBOLL

Lower Confining Unit (Vandalia and Smithboro Till)								
T408	**Ash Pond 2**	KGS	KGS	2.15E-06	7.50E-08	9.02E-07	600.4-595.2	Vandalia Till
T409		KGS	KGS	3.6E-05	3.20E-05	3.41E-05	600.1-594.9	Vandalia Till (sand seam)
G405D		KGS	KGS			4.90E-07	589.1-579	Smithboro Till
G406D		KGS	KGS			4.00E-08	580.3-570.3	
			Unit Geometric Mean			5.55E-06		

Notes:

fh = Falling head test

rh = Rising head test

Hydraulic Conductivity tests analyzed using Aqtesolv® Pro version 4.50 (HydroSOLVE, Inc.)

Test Methods

B-R Bouwer and Rice, 1976. "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifer with Completely or Partially Penetrating Wells", Water Resources Research v.12, no. 3. American Geophysical Union, Washington, DC. pp. 423-428.

KGS Hyder, Z., J.J. Butler, C.D. McElwee, and W. Liu, 1974. "Slug tests in partially penetrating wells", Water Resources Research, v. 30, no. 11. American Geophysical Union, Washington, DC. pp. 2945-2957.

[O:RJH 9/2016, C: KLT 12/2016)

TABLE A3. HORIZONTAL GRADIENTS AND GROUNDWATER FLOW VELOCITIES - MAY AND NOVEMBER 2016
CORRECTIVE MEASURES ASSESSMENT, REVISION 1
COFFEEN ASH POND NO. 2
COFEEN POWER STATION
COFFEEN, ILLINOIS

May 2016				
	Average Hydraulic Conductivity (cm/s)	**Horizontal Hydraulic Gradient**	**Effective Porosity**	**Velocity (ft/day)**
Well G403 to Well G402	2E-04	0.0060	0.20	0.02
Well G405 to Well G404	7E-04	0.0060	0.20	0.06
November 2016				
	Average Hydraulic Conductivity (cm/s)	**Horizontal Hydraulic Gradient**	**Effective Porosity**	**Velocity (ft/day)**
Well G403 to Well G402	2E-04	0.0064	0.20	0.02
Well G405 to Well G404	7E-04	0.0063	0.20	0.06

Note:
1) cm/sec x 2,835 = feet/day
2) Source of hydraulic conductivity values was the Hydrogeologic Characterization Report for the Ash Pond 2 Closure Plan (NRT, 2017)

TABLE A4. SUMMARY OF VERTICAL HYDRAULIC GRADIENTS
CORRECTIVE MEASURES ASSESSMENT, REVISION 1
COFFEEN ASH POND NO. 2
COFEEN POWER STATION
COFFEEN, ILLINOIS

Well ID	Date	Screen Elev. (ft)[1]	Formation	Groundwater Elevation (ft MSL)	Vertical Gradient [2]
G405	11/12/2016	609.515	Hagarstown Beds	618.48	-0.009
T408	11/12/2016	598.015	Vandalia Till	618.58	
T408	11/12/2016	598.015	Vandalia Till	618.58	2.44
G45D	11/12/2016	584.24	Smithboro Till	584.91	
G406	11/12/2016	605.895	Hagarstown Beds	612.51	-0.42
T409	11/12/2016	597.66	Vandalia Till	615.98	
T409	11/12/2016	597.66	Vandalia Till	615.98	1.46
G46D	11/12/2016	575.475	Smithboro Till	583.59	

Notes:
1. Center of screen
2. Based on dates when both wells were sampled, **negative** values indicate upward gradients while **positive** indicate downward gradients

[O:NRK, 12/2016, C:JJW 12/2016]

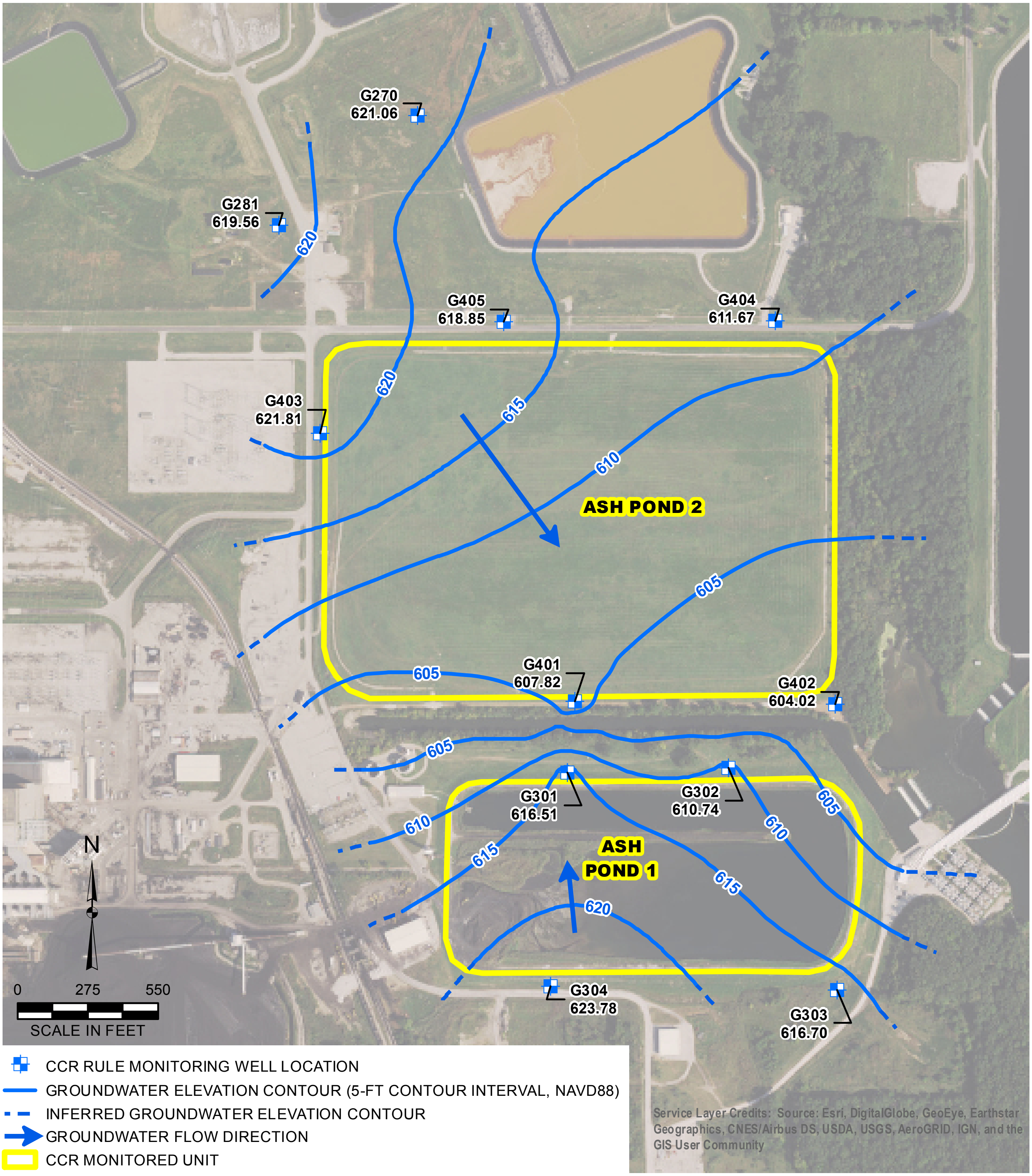
APPENDIX B
GROUNDWATER ELEVATION CONTOUR MAPS FOR SAMPLING EVENTS 2015-2020

OPERATING RECORD
REVISION 1

TITLE 40 CFR PART 257 SECTION 257.91

GROUNDWATER ELEVATION CONTOUR MAPS
MONITORING PERIOD 2015 - QUARTER 1, 2020

LOCATION: COFFEEN POWER STATION
LEGAL ENTITY: ILLINOIS POWER GENERATING COMPANY
UNIT IDENTIFICATION NUMBER: 102
UNIT NAME: COFFEEN ASH POND NO. 2



DRAWN BY/DATE:
SDS 1/23/17
REVIEWED BY/DATE:
TBN 1/25/17
APPROVED BY/DATE:
JJW 2/7/17

COFFEEN ASH POND NO. 1 (UNIT ID: 101) AND COFFEEN ASH POND NO. 2 (UNIT ID: 102)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 1: NOVEMBER 16, 2015

DYNEGY CCR RULE GROUNDWATER MONITORING
COFFEEN POWER STATION
COFFEEN, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

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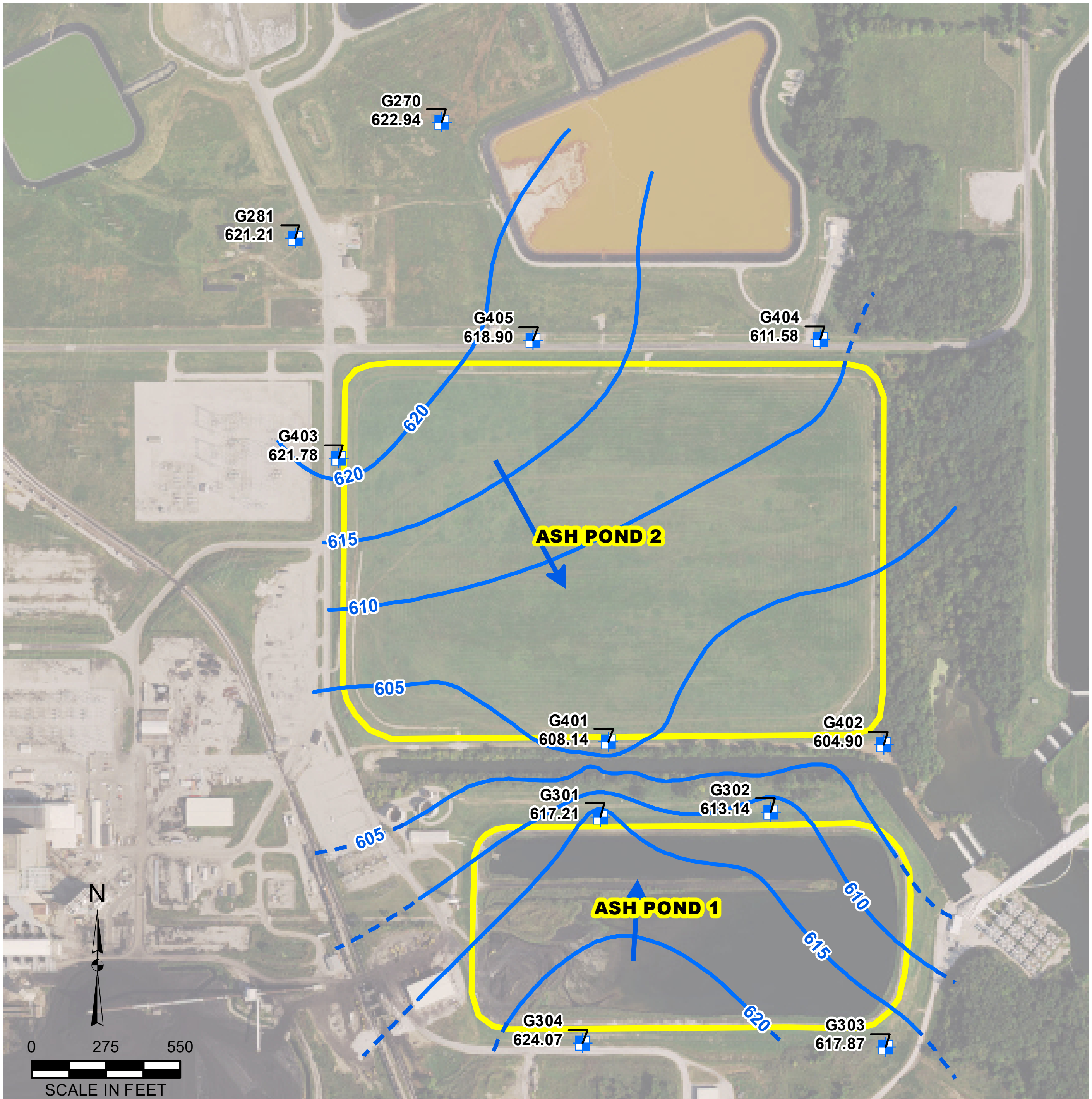

- CCR RULE MONITORING WELL LOCATION
- GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)
- INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- CCR MONITORED UNIT

DRAWN BY/DATE:
SDS 1/23/17
REVIEWED BY/DATE:
TBN 1/25/17
APPROVED BY/DATE:
JJW 2/8/17

COFFEEN ASH POND NO. 1 (UNIT ID: 101) AND COFFEEN ASH POND NO. 2 (UNIT ID: 102) UPPERMOST AQUIFER UNIT GROUNDWATER ELEVATION CONTOUR MAP ROUND 2: FEBRUARY 8, 2016

DYNEGY CCR RULE GROUNDWATER MONITORING
COFFEEN POWER STATION
COFFEEN, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

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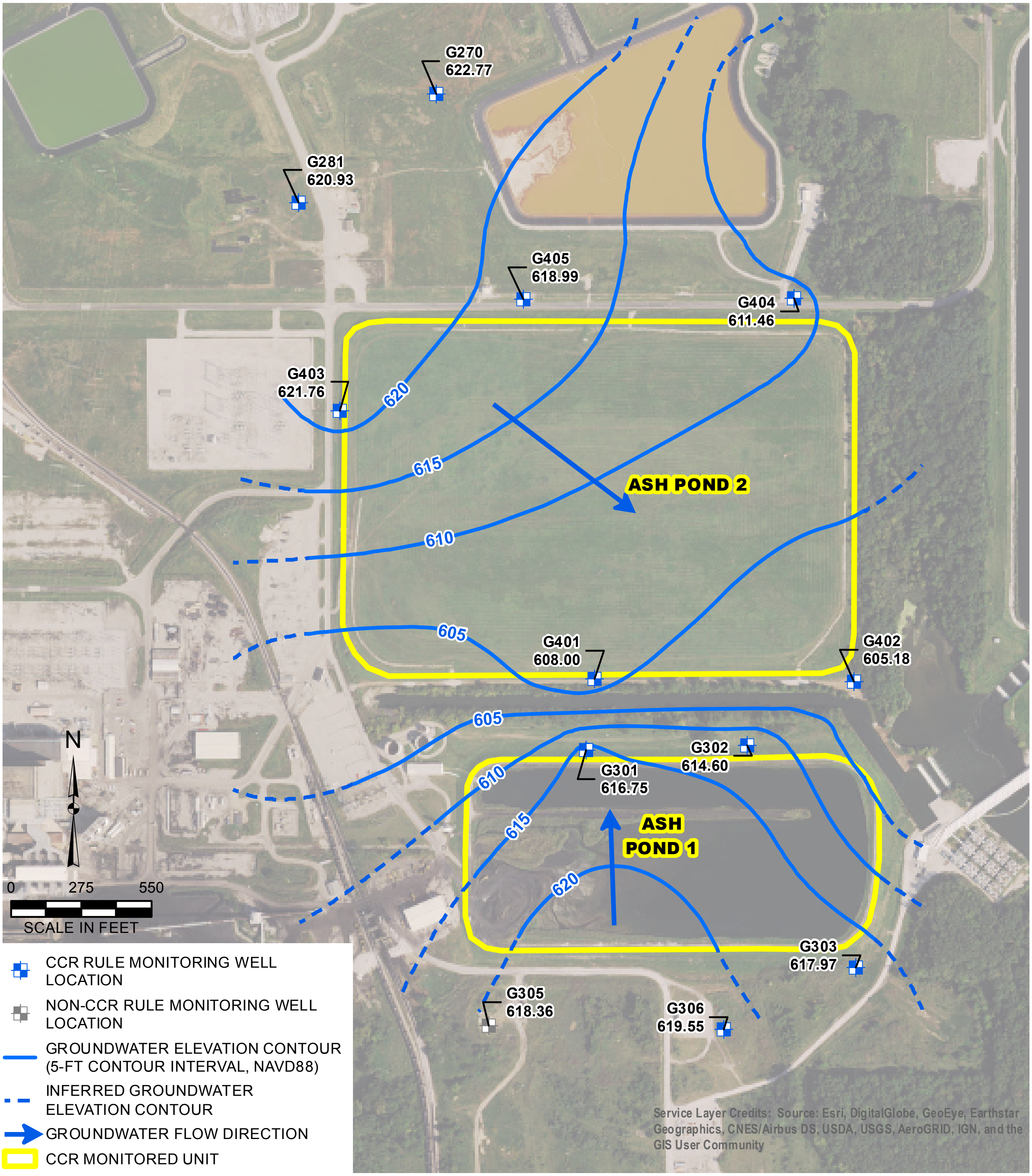

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DRAWN BY/DATE:
SDS 1/23/17
REVIEWED BY/DATE:
TBN 1/25/17
APPROVED BY/DATE:
JJW 2/8/17

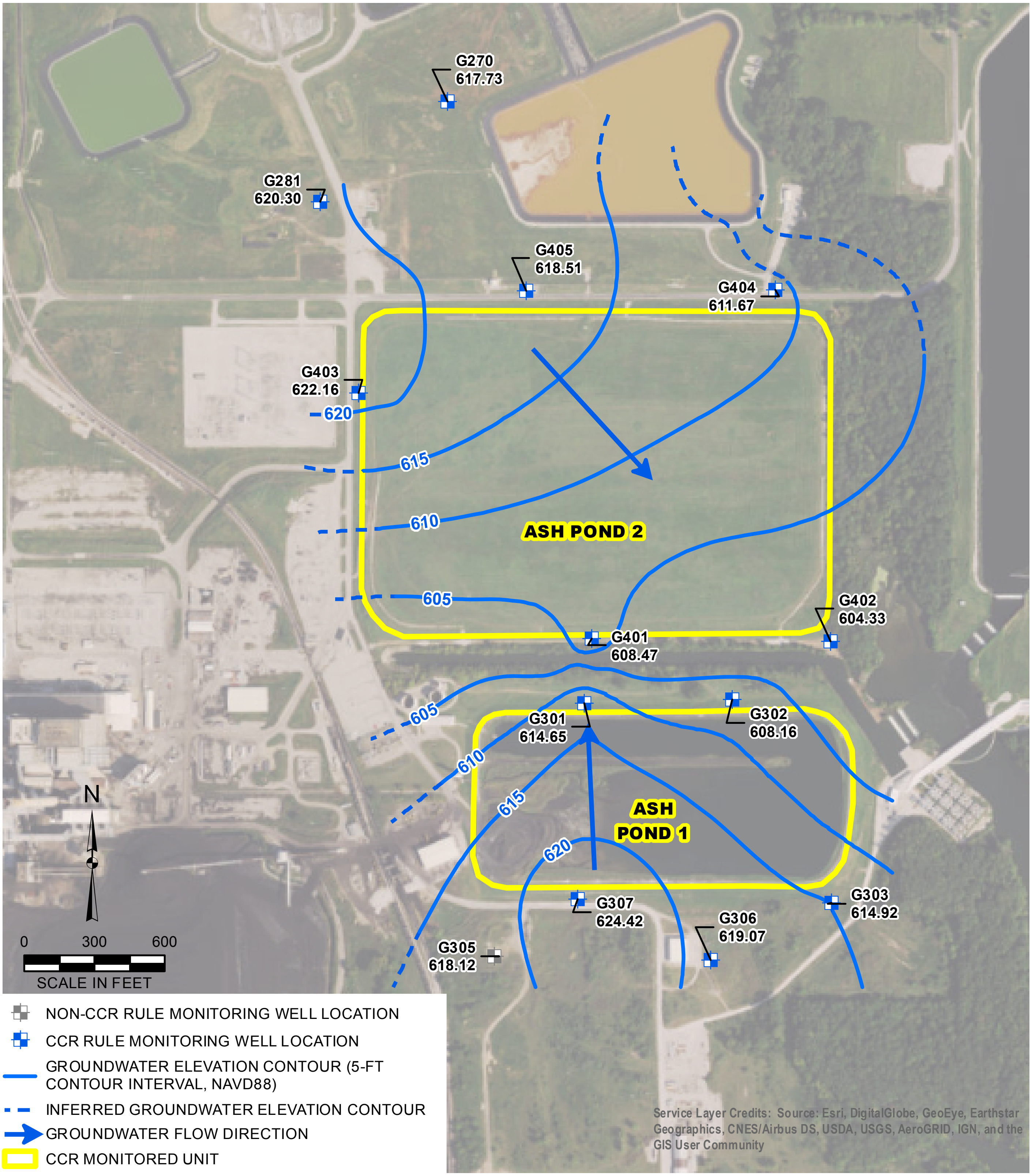
COFFEEN ASH POND NO. 1 (UNIT ID: 101) AND COFFEEN ASH POND NO. 2 (UNIT ID: 102) UPPERMOST AQUIFER UNIT GROUNDWATER ELEVATION CONTOUR MAP ROUND 3: MAY 9, 2016

DYNEGY CCR RULE GROUNDWATER MONITORING
COFFEEN POWER STATION
COFFEEN, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY



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REVIEWED BY/DATE:
ANS 1/25/17
APPROVED BY/DATE:
JJW 2/8/17

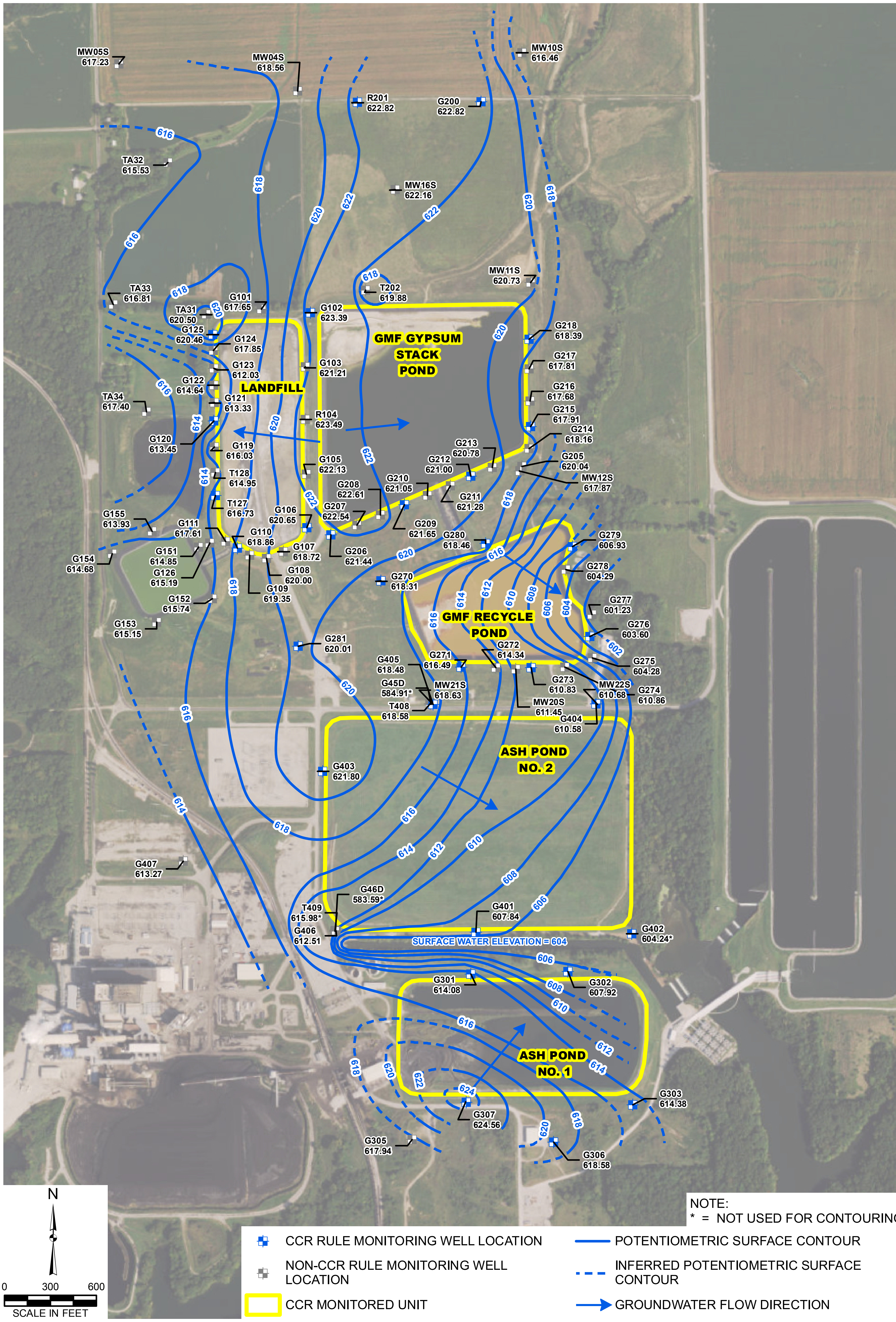
COFFEEN ASH POND NO. 1 (UNIT ID: 101) AND COFFEEN ASH POND NO. 2 (UNIT ID: 102) UPPERMOST AQUIFER UNIT GROUNDWATER ELEVATION CONTOUR MAP ROUND 4: JULY 25, 2016

DYNEGY CCR RULE GROUNDWATER MONITORING
COFFEEN POWER STATION
COFFEEN, ILLINOIS

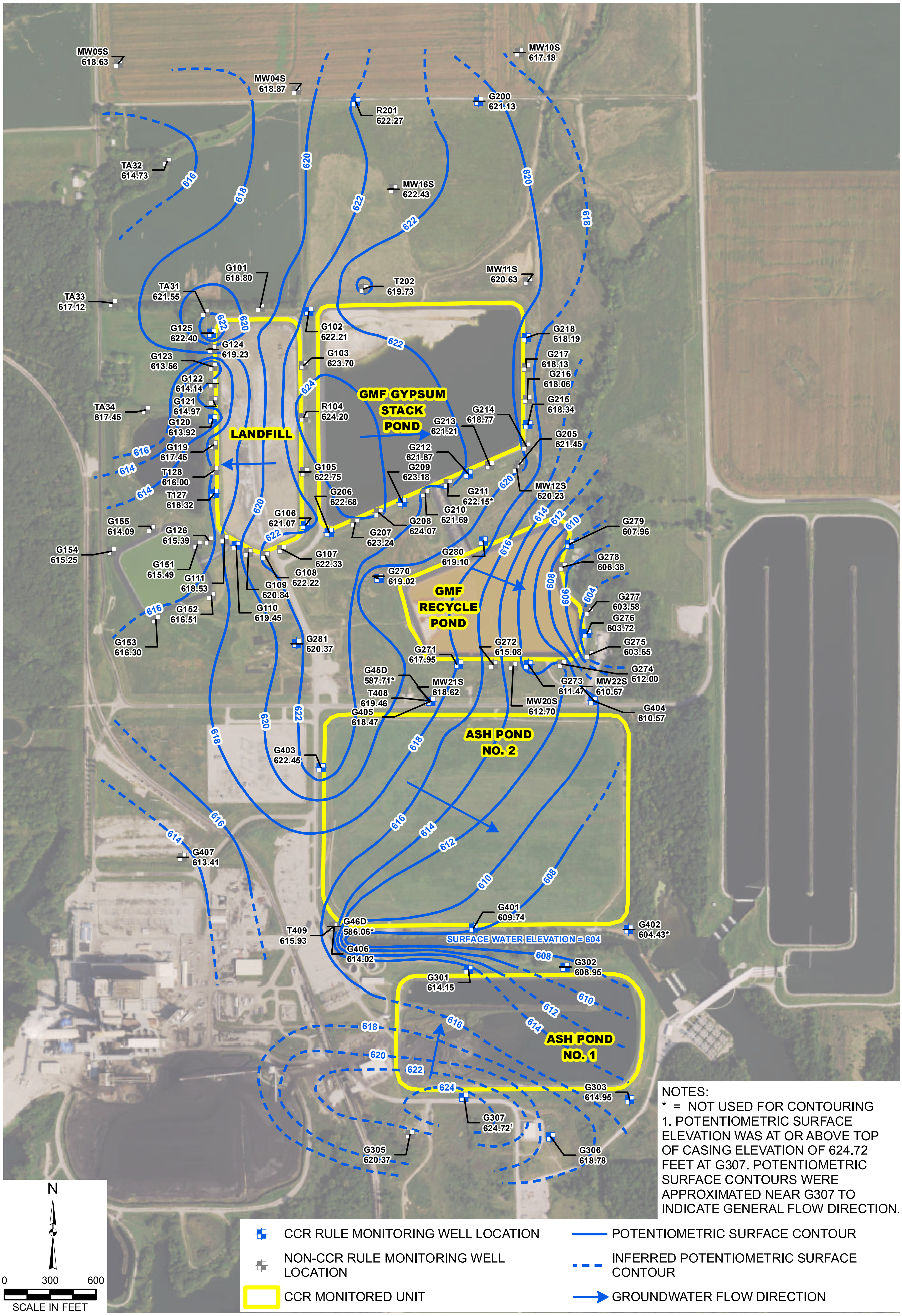
PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY



DRAWN BY/DATE: SDS 3/3/17 REVIEWED BY/DATE: TBN 3/3/17 APPROVED BY/DATE: JJW 8/30/17	**COFFEEN ASH POND NO. 1 (UNIT ID: 101), COFFEEN ASH POND NO. 2 (UNIT ID: 102), COFFEEN GMF GYPSUM STACK POND (UNIT ID: 103), COFFEEN GMF RECYCLE POND (UNIT ID: 104) AND COFFEEN LANDFILL (UNIT ID: 105) UPPERMOST AQUIFER UNIT GROUNDWATER ELEVATION CONTOUR MAP** **ROUND 5: NOVEMBER 12, 2016** DYNEGY CCR RULE GROUNDWATER MONITORING COFFEEN POWER STATION COFFEEN, ILLINOIS	PROJECT NO: 2285 FIGURE NO: 1 Natural Resource Technology AN OBG COMPANY



NOTES:

* = NOT USED FOR CONTOURING

1. POTENTIOMETRIC SURFACE ELEVATION WAS AT OR ABOVE TOP OF CASING ELEVATION OF 624.72 FEET AT G307. POTENTIOMETRIC SURFACE CONTOURS WERE APPROXIMATED NEAR G307 TO INDICATE GENERAL FLOW DIRECTION.

- CCR RULE MONITORING WELL LOCATION
- NON-CCR RULE MONITORING WELL LOCATION
- CCR MONITORED UNIT
- POTENTIOMETRIC SURFACE CONTOUR
- INFERRED POTENTIOMETRIC SURFACE CONTOUR
- GROUNDWATER FLOW DIRECTION

DRAWN BY/DATE: SDS 4/14/17
REVIEWED BY/DATE: TBN 4/14/17
APPROVED BY/DATE: JJW 8/30/17

COFFEEN ASH POND NO. 1 (UNIT ID: 101), COFFEEN ASH POND NO. 2 (UNIT ID: 102), COFFEEN GMF GYPSUM STACK POND (UNIT ID: 103), COFFEEN GMF RECYCLE POND (UNIT ID: 104) AND COFFEEN LANDFILL (UNIT ID: 105) UPPERMOST AQUIFER UNIT GROUNDWATER ELEVATION CONTOUR MAP

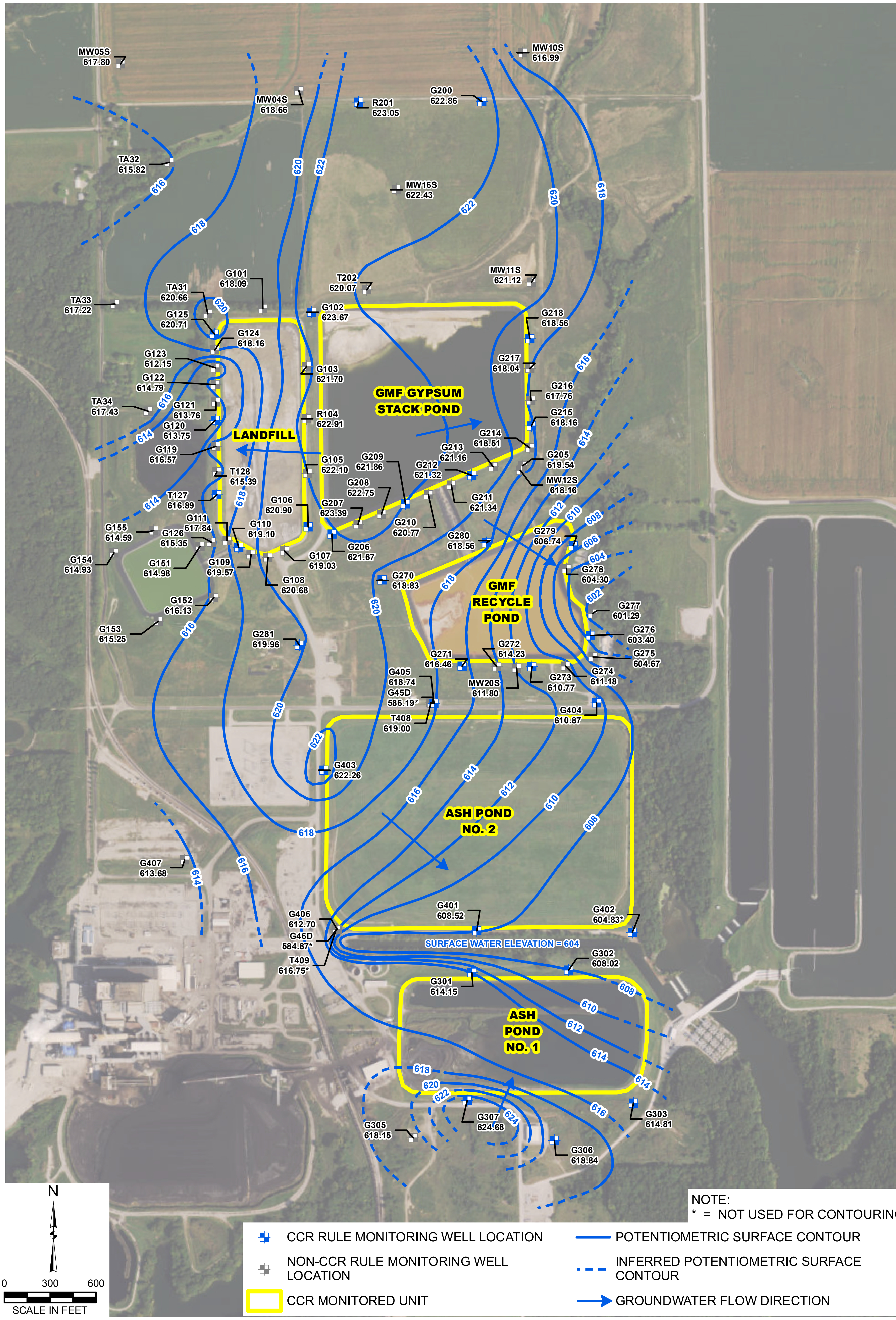
ROUND 6: FEBRUARY 4, 2017

DYNEGY CCR RULE GROUNDWATER MONITORING
COFFEEN POWER STATION
COFFEEN, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY



NOTE:
* = NOT USED FOR CONTOURING

- CCR RULE MONITORING WELL LOCATION
- NON-CCR RULE MONITORING WELL LOCATION
- CCR MONITORED UNIT
- POTENTIOMETRIC SURFACE CONTOUR
- INFERRED POTENTIOMETRIC SURFACE CONTOUR
- GROUNDWATER FLOW DIRECTION

DRAWN BY/DATE: SDS 7/12/17
REVIEWED BY/DATE: TBN 7/12/17
APPROVED BY/DATE: JJW 8/30/17

COFFEEN ASH POND NO. 1 (UNIT ID: 101), COFFEEN ASH POND NO. 2 (UNIT ID: 102), COFFEEN GMF GYPSUM STACK POND (UNIT ID: 103), COFFEEN GMF RECYCLE POND (UNIT ID: 104) AND COFFEEN LANDFILL (UNIT ID: 105) UPPERMOST AQUIFER UNIT GROUNDWATER ELEVATION CONTOUR MAP

ROUND 7: MAY 13, 2017

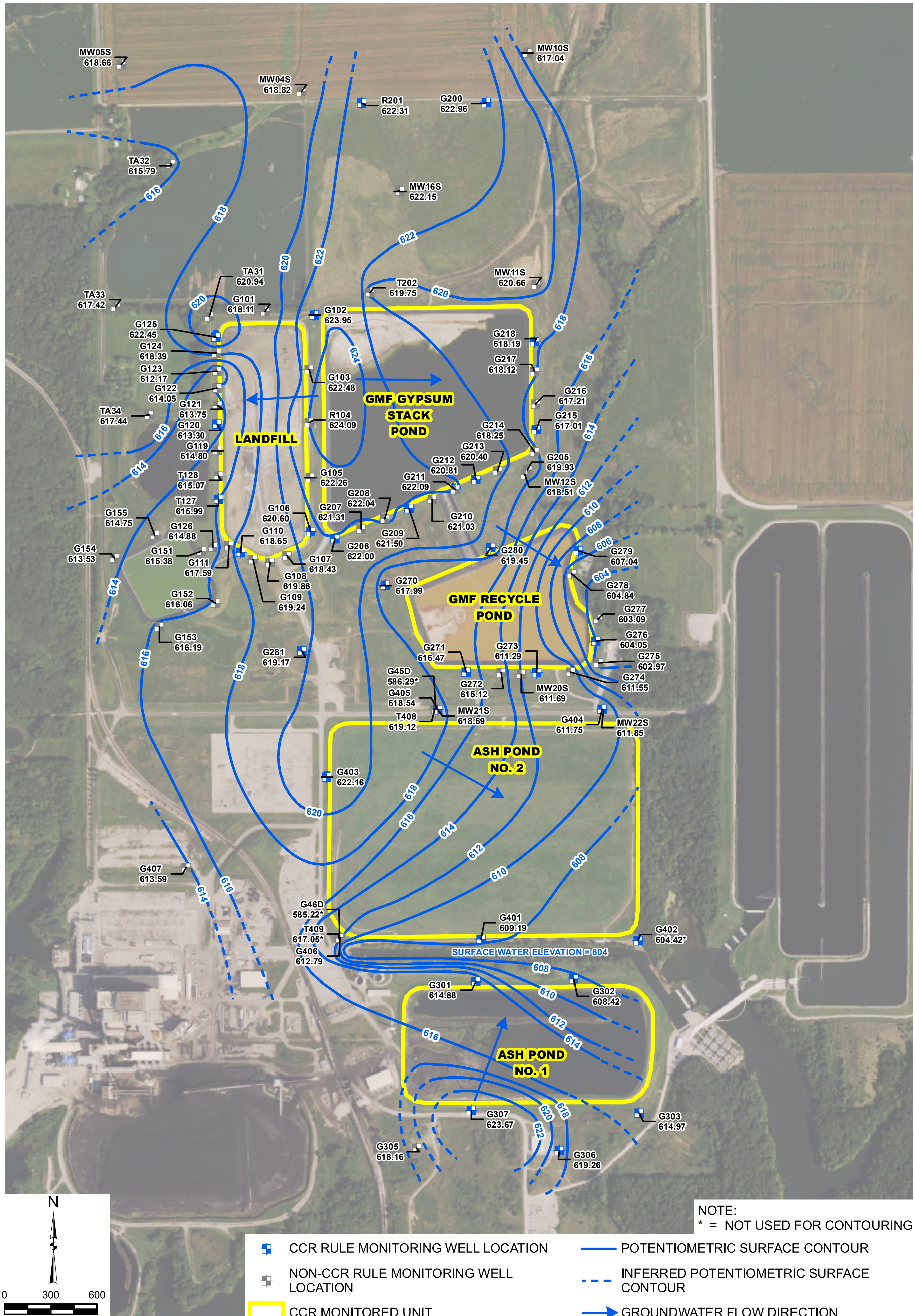
DYNEGY CCR RULE GROUNDWATER MONITORING
COFFEEN POWER STATION
COFFEEN, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

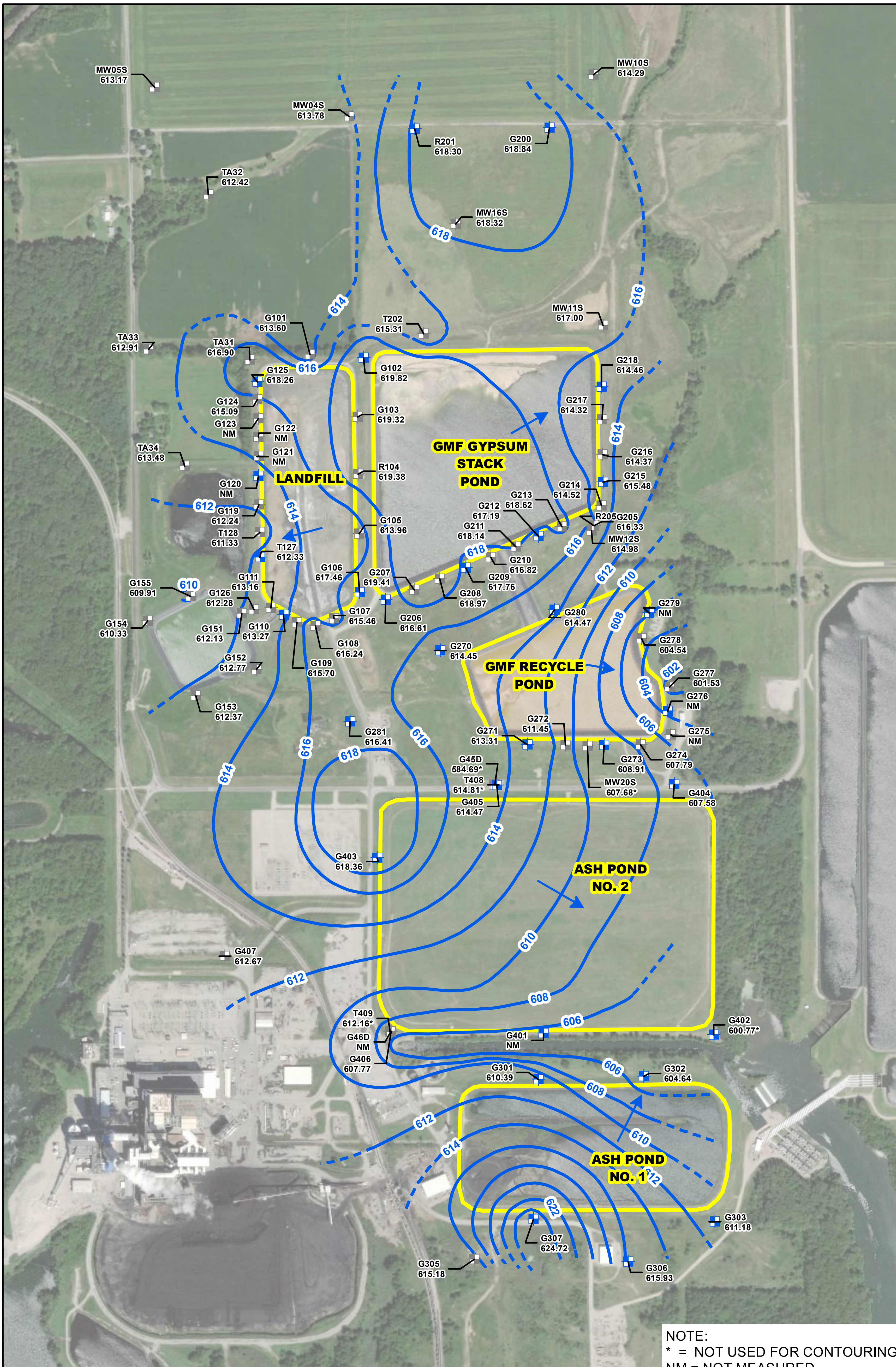
Natural Resource Technology
AN OBG COMPANY

Y:\Mapping\Projects\22\2285\MXD\GW_Contours\Round_07\R7_Coffeen_GW_Contours.mxd Author: stolzsd; Date/Time: 9/1/2017, 4:57:33 PM



Y:\Mapping\Projects\22\2285\MXD\GW_Contours\Round_08\R8_Coffeen_GW_Contours.mxd Author: stolzsd; Date/Time: 9/12/2017, 3:44:11 PM

DRAWN BY/DATE: SDS 8/12/17 REVIEWED BY/DATE: TBN 8/10/17 APPROVED BY/DATE: JJW 8/30/17	**COFFEEN ASH POND NO. 1 (UNIT ID: 101), COFFEEN ASH POND NO. 2 (UNIT ID: 102), COFFEEN GMF GYPSUM STACK POND (UNIT ID: 103), COFFEEN GMF RECYCLE POND (UNIT ID: 104) AND COFFEEN LANDFILL (UNIT ID: 105) UPPERMOST AQUIFER UNIT GROUNDWATER ELEVATION CONTOUR MAP** **ROUND 8: JULY 8, 2017** DYNEGY CCR RULE GROUNDWATER MONITORING COFFEEN POWER STATION COFFEEN, ILLINOIS	PROJECT NO: 2285 FIGURE NO: 1 Natural Resource Technology AN OBG COMPANY



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LEGEND

- CCR RULE MONITORING WELL LOCATION
- NON-CCR RULE MONITORING WELL LOCATION
- GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
- INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- CCR MONITORED UNIT

COFFEEN ASH POND NO. 1 (UNIT ID: 101), COFFEEN ASH POND NO. 2 (UNIT ID: 102), COFFEEN GMF GYPSUM STACK POND (UNIT ID: 103), COFFEEN GMF RECYCLE POND (UNIT ID: 104) AND COFFEEN LANDFILL (UNIT ID: 105)
GROUNDWATER ELEVATION CONTOUR MAP
OCTOBER 21, 2017

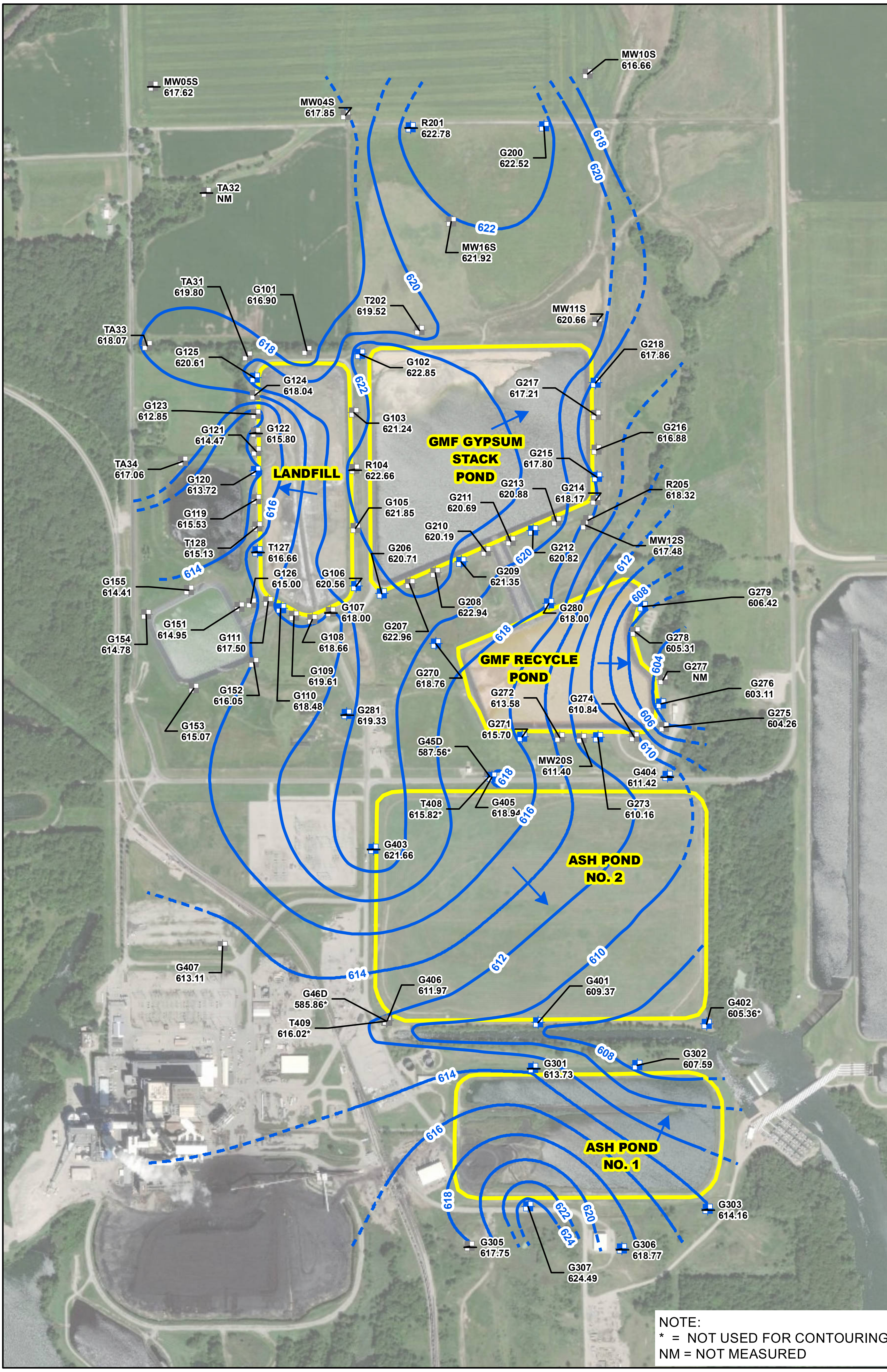
CCR RULE GROUNDWATER MONITORING
COFFEEN POWER STATION
COFFEEN, ILLINOIS

0 150 300 600
Feet

N

FILE_NO. 70099
DATE 8/1/2018

O'BRIEN & GERE ENGINEERS, INC.



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LEGEND

- CCR RULE MONITORING WELL LOCATION
- NON-CCR RULE MONITORING WELL LOCATION
- GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
- INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- CCR MONITORED UNIT

COFFEEN ASH POND NO. 1 (UNIT ID: 101), COFFEEN ASH POND NO. 2 (UNIT ID: 102), COFFEEN GMF GYPSUM STACK POND (UNIT ID: 103), COFFEEN GMF RECYCLE POND (UNIT ID: 104) AND COFFEEN LANDFILL (UNIT ID: 105)
GROUNDWATER ELEVATION CONTOUR MAP
MAY 8, 2018

CCR RULE GROUNDWATER MONITORING
COFFEEN POWER STATION
COFFEEN, ILLINOIS

0 150 300 600
Feet

N

FILE_NO. 70099
DATE 8/1/2018

O'BRIEN & GERE ENGINEERS, INC.

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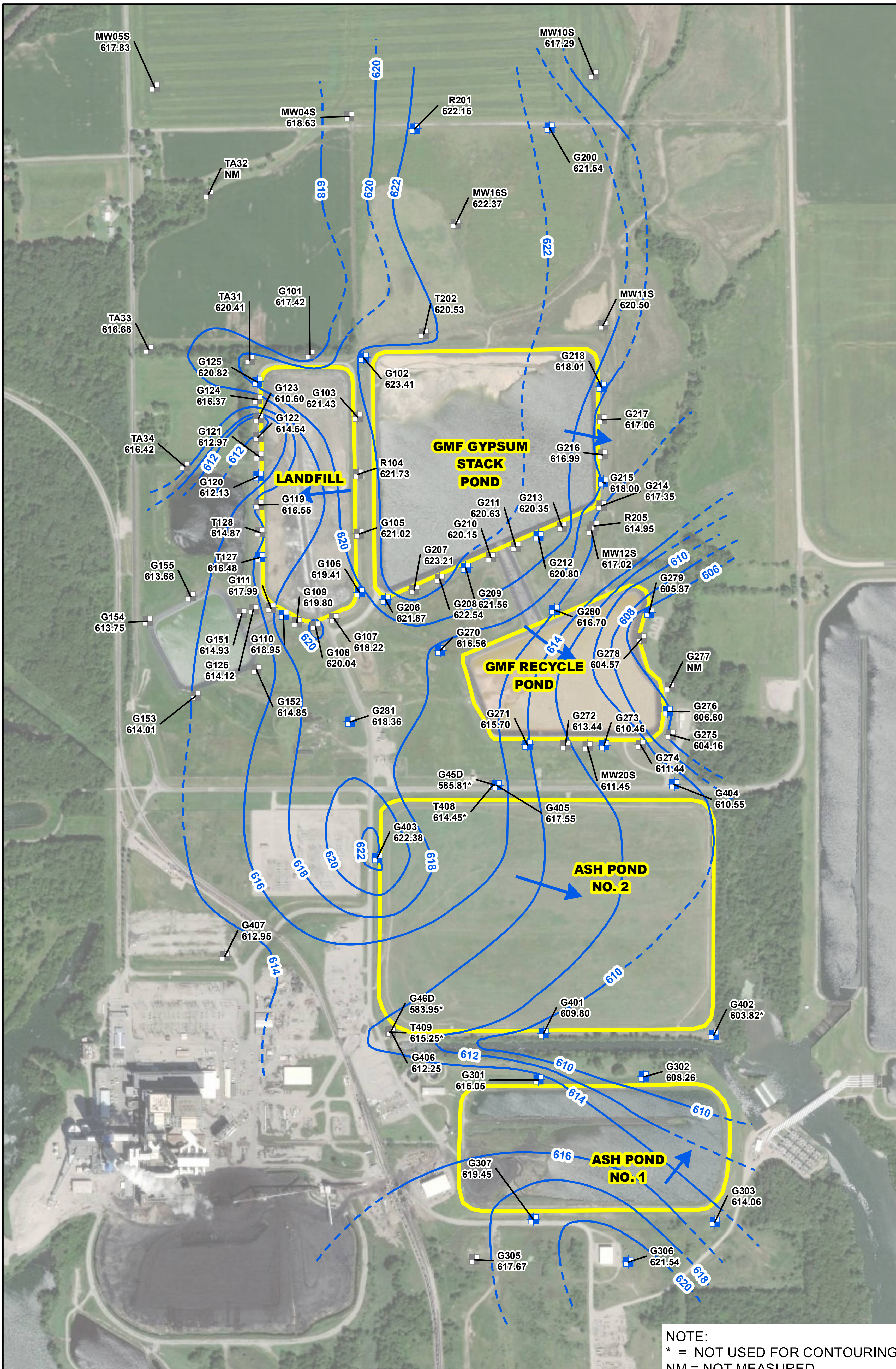

CCR RULE MONITORING WELL LOCATION

NON-CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

COFFEEN ASH POND NO. 1 (UNIT ID: 101), COFFEEN ASH POND NO. 2 (UNIT ID: 102), COFFEEN GMF GYPSUM STACK POND (UNIT ID: 103), COFFEEN GMF RECYCLE POND (UNIT ID: 104) AND COFFEEN LANDFILL (UNIT ID: 105)

GROUNDWATER ELEVATION CONTOUR MAP

AUGUST 2, 2018

CCR RULE GROUNDWATER MONITORING
COFFEEN POWER STATION
COFFEEN, ILLINOIS

N

0 150 300 600
Feet

O'BRIEN & GERE ENGINEERS, INC.

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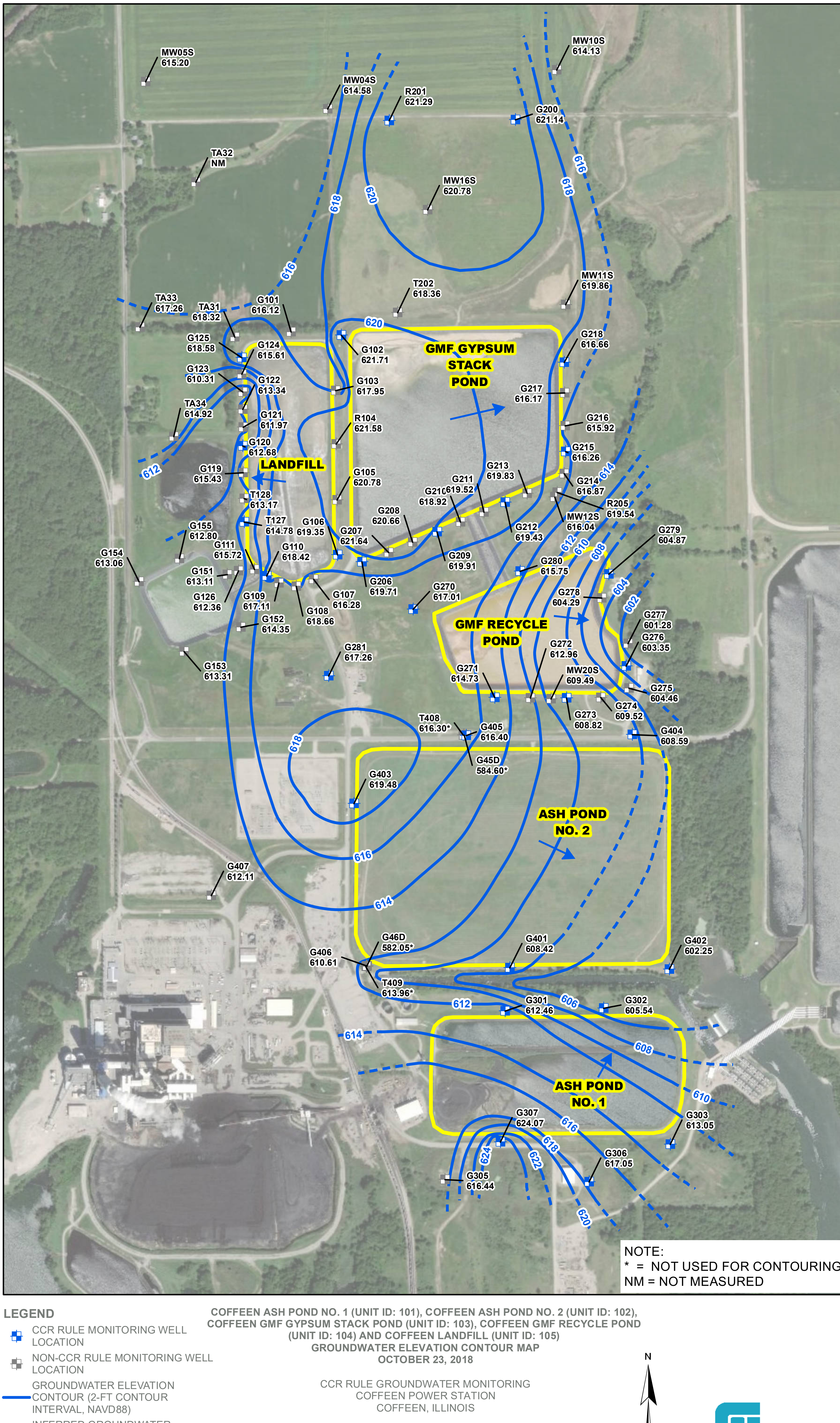

LEGEND

CCR RULE MONITORING WELL LOCATION

NON-CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

COFFEEN ASH POND NO. 1 (UNIT ID: 101), COFFEEN ASH POND NO. 2 (UNIT ID: 102), COFFEEN GMF GYPSUM STACK POND (UNIT ID: 103), COFFEEN GMF RECYCLE POND (UNIT ID: 104) AND COFFEEN LANDFILL (UNIT ID: 105)
GROUNDWATER ELEVATION CONTOUR MAP
OCTOBER 23, 2018

CCR RULE GROUNDWATER MONITORING
COFFEEN POWER STATION
COFFEEN, ILLINOIS

0 150 300 600
Feet

N

O'BRIEN & GERE ENGINEERS, INC.

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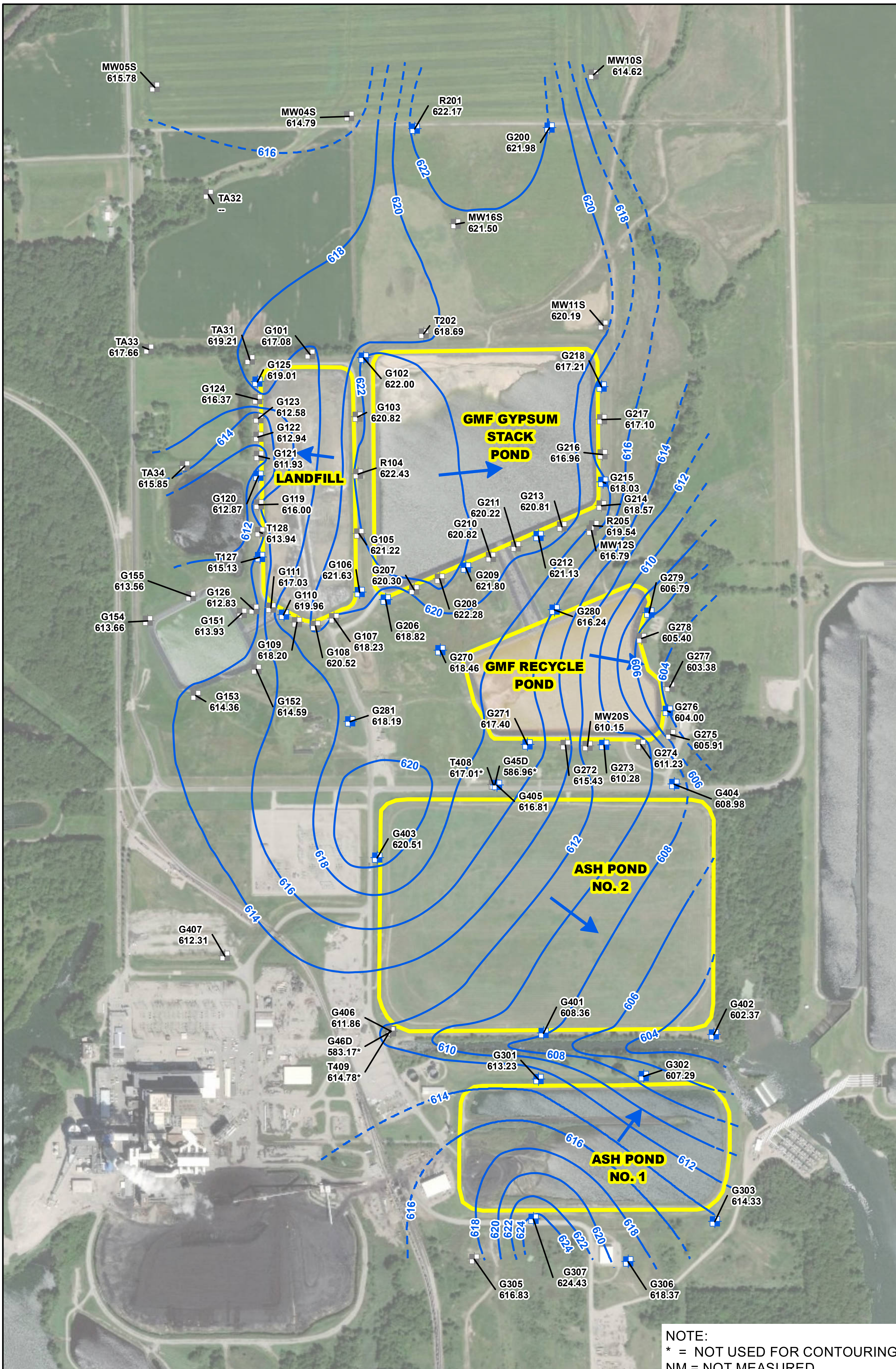


CCR RULE MONITORING WELL LOCATION

NON-CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

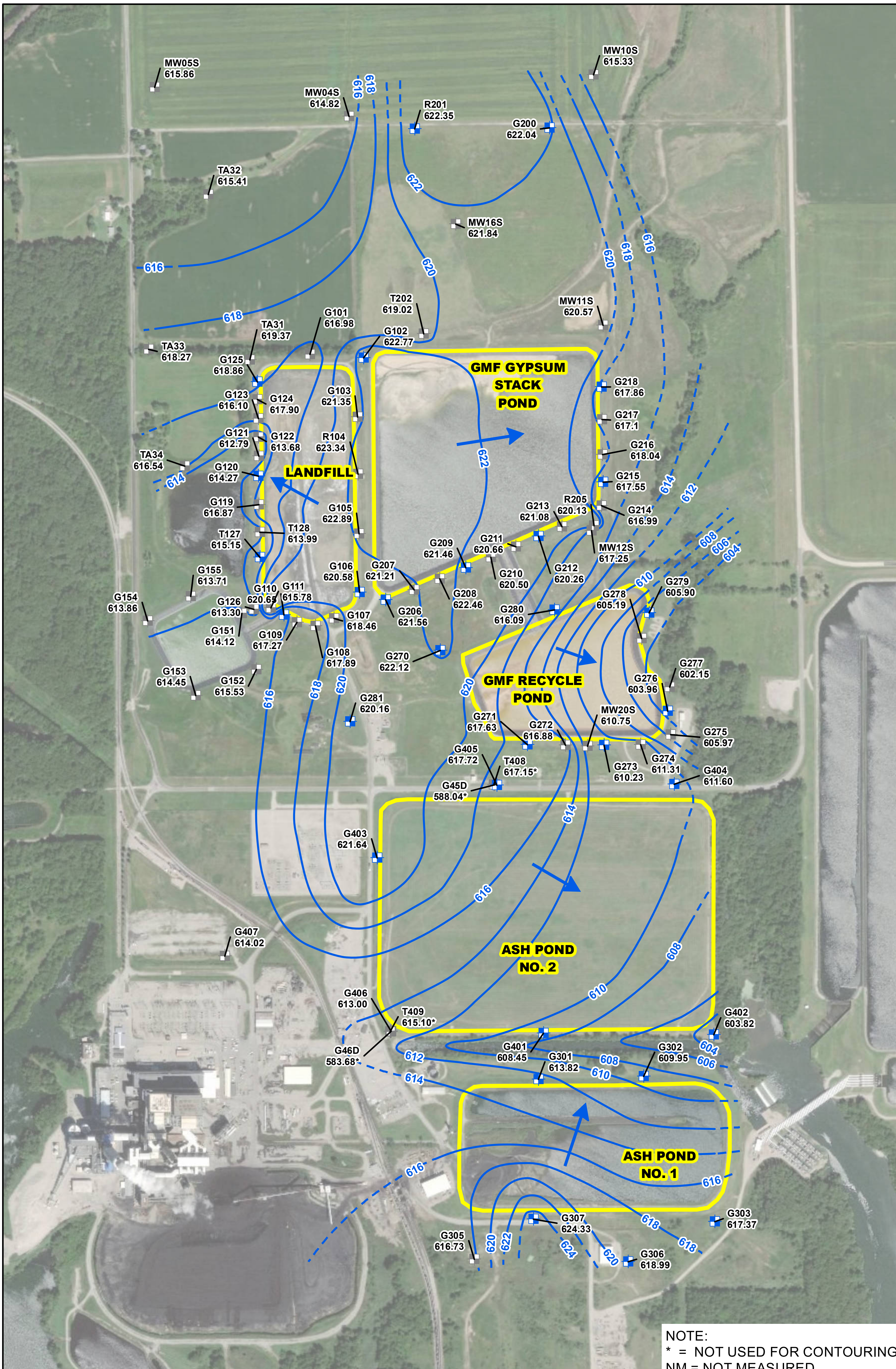
COFFEEN ASH POND NO. 1 (UNIT ID: 101), COFFEEN ASH POND NO. 2 (UNIT ID: 102), COFFEEN GMF GYPSUM STACK POND (UNIT ID: 103), COFFEEN GMF RECYCLE POND (UNIT ID: 104) AND COFFEEN LANDFILL (UNIT ID: 105)
GROUNDWATER ELEVATION CONTOUR MAP
JANUARY 15, 2019

CCR RULE GROUNDWATER MONITORING
COFFEEN POWER STATION
COFFEEN, ILLINOIS

0 150 300 600
Feet

N

O'BRIEN & GERE ENGINEERS, INC.



CCR RULE MONITORING WELL LOCATION

NON-CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

COFFEEN ASH POND NO. 1 (UNIT ID: 101), COFFEEN ASH POND NO. 2 (UNIT ID: 102), COFFEEN GMF GYPSUM STACK POND (UNIT ID: 103), COFFEEN GMF RECYCLE POND (UNIT ID: 104) AND COFFEEN LANDFILL (UNIT ID: 105)
GROUNDWATER ELEVATION CONTOUR MAP
AUGUST 5, 2019

CCR RULE GROUNDWATER MONITORING
COFFEEN POWER STATION
COFFEEN, ILLINOIS

N

0 150 300 600
Feet

O'BRIEN & GERE ENGINEERS, INC.

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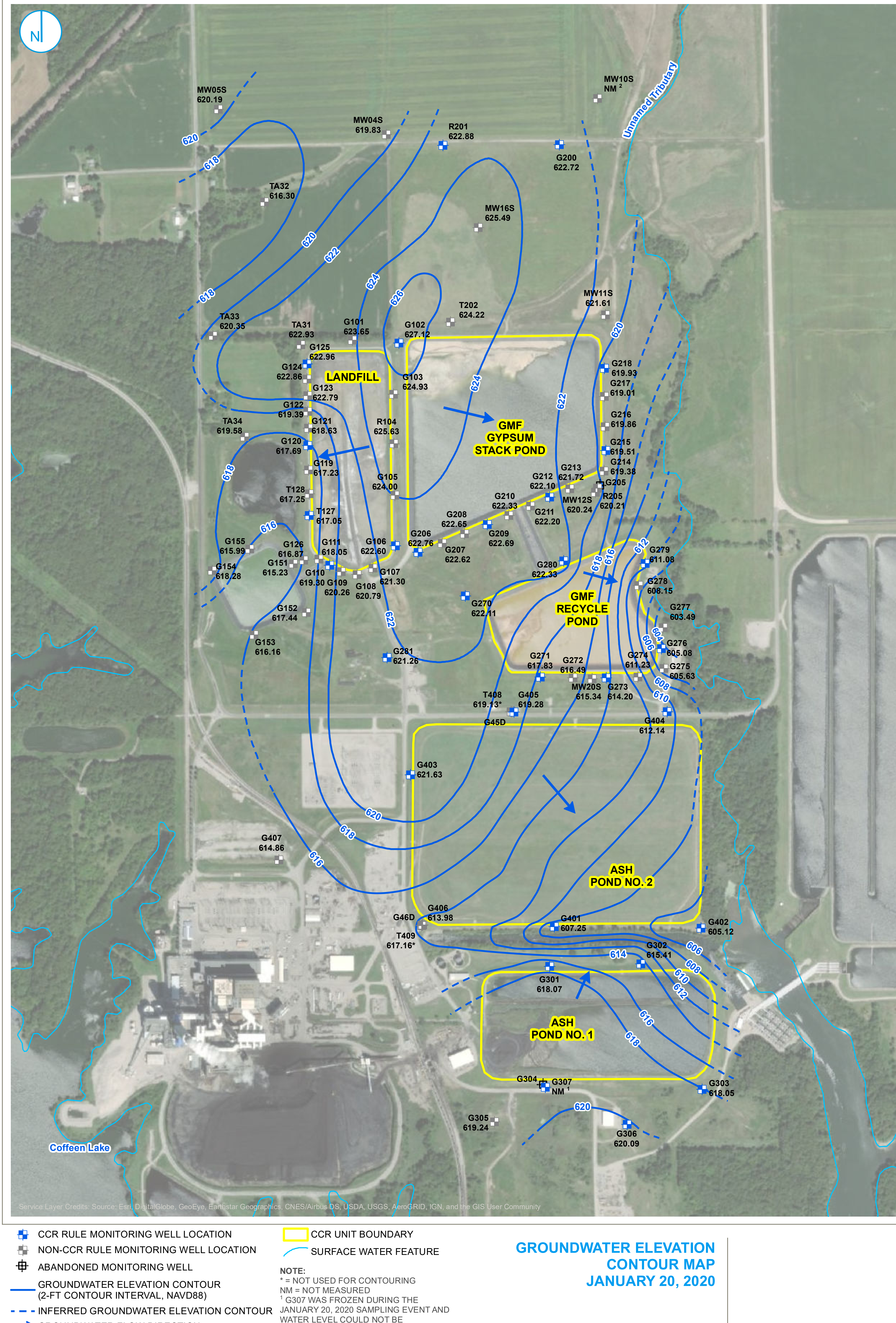

CCR RULE MONITORING WELL LOCATION
NON-CCR RULE MONITORING WELL LOCATION
ABANDONED MONITORING WELL
GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION

CCR UNIT BOUNDARY
SURFACE WATER FEATURE

NOTE:
* = NOT USED FOR CONTOURING
NM = NOT MEASURED
[1] G307 WAS FROZEN DURING THE JANUARY 20, 2020 SAMPLING EVENT AND WATER LEVEL COULD NOT BE COLLECTED.
[2] MW10S WAS DAMAGED PRIOR TO THE JANUARY 20, 2020 SAMPLING EVENT AND WATER LEVEL COULD NOT BE COLLECTED.

0 300 600 Feet

GROUNDWATER ELEVATION CONTOUR MAP
JANUARY 20, 2020

CCR RULE GROUNDWATER MONITORING
COFFEEN POWER STATION
COFFEEN, ILLINOIS

RAMBOLL US CORPORATION
A RAMBOLL COMPANY

RAMBOLL

APPENDIX C
TECHNICAL MEMORANDUM – COFFEEN ASH POND NO. 2 MONITORED NATURAL ATTENUATION (MNA) EVALUATION

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www.geosyntec.com

Geosyntec consultants

TECHNICAL MEMORANDUM

Date: November 30, 2020

To: Brian Voelker - Vistra

Copies to: Stu Cravens and Phil Morris - Vistra

From: Allison Kreinberg, Bob Glazier, and Nathan Higgerson - Geosyntec Consultants

Subject: Coffeen Ash Pond No. 2 Monitored Natural Attenuation (MNA) Evaluation

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Geosyntec is evaluating the feasibility of monitored natural attenuation (MNA), in combination with coal combustion residual (CCR) unit source control measures, as a groundwater remedy for statistically significant levels (SSLs) of cobalt and lithium above the groundwater protection standard (GWPS) at the Coffeen Ash Pond No. 2 (AP2) unit. As discussed in Section 2.3 of the Corrective Measures Assessment (CMA), SSLs of cobalt were identified at downgradient monitoring wells G-401 and G-402. An SSL of lithium was also identified at G-401. The tiered evaluation is being completed in accordance with USEPA guidance[1,2] to assess whether MNA, in combination with source control, is likely to be the viable remedy based on current and potential post-closure site conditions. The findings of the study completed to-date and the additional data collection required to develop multiple lines of evidence to support the evaluation of MNA in accordance with USEPA guidance are summarized below.

MNA EVALUATION

The selection of MNA, with source control, as a remedy for groundwater constituents will be based on a multiple lines of evidence approach, as outlined in the USEPA guidance. The multiple lines of evidence approach for AP2 will be based upon (i) source control to mitigate further loading of cobalt and lithium mass to groundwater; (ii) delineation of the nature and extent of cobalt and lithium impacts in groundwater; and (iii); a successful evaluation of favorable site conditions that result in the attenuation of cobalt and lithium in groundwater leading to stable or declining trends of cobalt in groundwater following source control implementation.

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[1] USEPA. 2007. Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume I – Technical Basis for Assessment. EPA/600/R-07/139. October.

[2] USEPA. 2015. Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites. Directive No. 9283.1-36. August.

KEY CONDITIONS

The status of key conditions which will support the selection of MNA, in combination with source control, as a groundwater remedy is summarized below. These conditions were assessed as Tier 1 of the evaluation.

Site Geology and Hydrogeology

As noted in Section 2.2 of the CMA, the uppermost aquifer at the site consists of thin, moderate to high permeability sand, silty sand, and sandy silt/clay units associated with glacial deposition. Glacial deposits often have abundant iron and manganese oxides which can provide attenuation capacity for reactive species. Thus, the geologic and hydrogeologic conditions at the site are favorable for reliable performance monitoring.

Source Control

The AP2 unit was capped in the 1980s with a two-foot thick clay and soil cap. The results of recent monitoring and investigation found that the site required additional source control measures. Illinois Environmental Protection Agency (IEPA) approved the closure and post-closure plan on January 30, 2018, which consisted of dewatering the unit and constructing a geomembrane cover system. Closure construction activities at AP2 associated with the approved closure plan were completed in November 2020. These closure measures act as improved source control and are designed to prevent future releases onsite.

Delineation of Groundwater Exceedances

Vertical delineation is not required at AP2, as the uppermost aquifer is only a few feet thick and is immediately underlain by the lower confining unit, which consist of very low permeability sandy silt till or clay till. Additional monitoring wells were not installed for horizontal delineation due to proximity of the SSLs to the discharge flume to the south and wetland restrictions adjacent to the Unnamed Creek to the east of AP2. However, a realignment of the Unnamed Creek was completed in July 2020 which will allow for further delineation efforts in the formerly restricted wetland area in 2021 as part of the Tier 1 evaluation.

Cobalt Attenuation

Cobalt readily undergoes attenuation in soils due to favorable adsorption onto clay minerals, iron and manganese oxides, and organic matter[3]. Amorphous iron oxides were found to readily remove cobalt from the aqueous phase, with minimal subsequent desorption observed[4]. Cobalt adsorption onto soils increases with increasing pH, with a marked increase above pH 7.

[3] Borggaard, O. K. 1987. Influence of iron oxides on cobalt adsorption by soils. *J. Soil Sci.*, **38**, 229-238.
[4] McLaren, R. G., Lawson, D.M., Swift, R. S. 1986. Sorption and Desorption of Cobalt by Soils and Soil Components. *J. Soil Sci.*, **37**, 413-426.

Oxidation-reduction (redox) conditions in groundwater do not appear to directly affect cobalt sorption behavior below pH 9.5; however, changes in redox conditions can affect the stability of iron oxides to which cobalt is attenuated.

G-401 (5.8-6.4 SU) and G-402 (6.5-7.0 SU) have the lowest pH of the wells within the AP2 groundwater monitoring network, as shown in the time series graph provided in Figure 1. These data suggest that the extent of low pH, which is below the favorable range for cobalt adsorption, could be resulting in greater cobalt mobility in the spatially isolated southern portion of AP2. Understanding the distribution of low pH groundwater and how it affects cobalt migration downgradient will be required to better understand the feasibility of MNA at AP2.

According to USEPA guidance, the groundwater plume should be stable or decreasing. While insufficient data points are available after initiation of closure activities in 2019 to complete statistical analysis, Mann-Kendall trend analyses were completed on all cobalt data collected under the Federal CCR rule as an initial evaluation. At G-401, cobalt concentrations have been stable over the entirety of the monitoring period (Appendix A). At G-402, cobalt concentrations are significantly decreasing (Appendix B), with reported concentrations for samples collected after the initiation of closure below the health-based screening level of 0.006 mg/L provided in 40 C.F.R. § 257.95(h)(i). Time series graphs for cobalt are provided as Figure 2. Additional statistical analysis should be completed using only data collected after source control measures were completed in November 2020 once sufficient data are available.

Lithium Attenuation

Lithium is a conservative constituent which is not readily attenuated by precipitation or adsorption processes. Instead, the primary attenuation mechanism is likely dilution and dispersion during groundwater transport downgradient. USEPA guidance notes that "Dilution and dispersion generally are not appropriate as primary MNA mechanisms because they reduce concentrations through dispersal of contaminant mass rather than destruction or immobilization of contaminant mass. Dilution and dispersion may be appropriate as a "polishing step" for distal portions of a plume when an active remedy is being used at a site, source control is complete, and appropriate land use and groundwater use controls are in place." Source control is in place via the capping efforts completed in November 2020. The lithium concentrations at G-402 are statistically decreasing (Appendix C), with recent concentrations below the health-based screening level of 0.04 mg/L provided in 40 C.F.R. § 257.95(h)(iii) (as shown in the time series graph provided in Figure 3). Given the current and anticipated future land use, there is likely limited risk of lithium exposure to the public.

These findings align with Tier 1 of the MNA evaluation in accordance with USEPA guidance. However, additional efforts will be completed in 2021 to sufficiently develop all lines of evidence and complete a full tiered evaluation.

ADDITIONAL EVALUATION

As part of the tiered evaluation, additional efforts will be completed in 2021 to support the existing findings that MNA, in combination with source control, may be an appropriate groundwater remedy at the Coffeen AP2 unit. For each tier of the remaining evaluation, the following scope of work is planned to collect sufficient additional information:

- Tier 1 (Demonstration that the groundwater plume is not expanding): Further delineation efforts in the vicinity of the former wetland area east of AP2 will be completed in 2021. Additionally, surface water sampling to support delineation efforts and an understanding of the groundwater-surface water interface will be completed in 2021 after protocols and methodologies specific to these surface water bodies are established to evaluate the extent of cobalt and lithium exceedances. Continued groundwater monitoring data from G-401 and G-402 will be collected until achievement of sufficient data points (8-10) for a Mann-Kendall statistical analysis of the trends in cobalt and lithium concentrations following closure activities.

- Tier 2 (Demonstration the attenuation mechanism and rate): For cobalt attenuation, solid phase material will be collected adjacent to G-401 and G-402 to better characterize the reactive solid phases present. Potential analytical techniques to characterize the reactive solid phases include X-ray diffraction (XRD), sequential phase extraction (SEP), analysis of total metals, and analysis of total organic carbon (TOC). Rates for cobalt are described in Tier 3, below. For lithium, groundwater hydrogeology will be reviewed to assess if dilution and dispersion will sufficiently reduce downgradient concentrations below the regulatory criteria.

- Tier 3 (Demonstration that the aquifer capacity is sufficient for attenuation and the mechanism is sufficiently irreversible): For cobalt attenuation, bench-scale adsorption isotherm and/or column tests will be run to evaluate the attenuation capacity and rate of the aquifer system. Groundwater with elevated cobalt concentrations should be exposed to unimpacted aquifer solids collected from an upgradient location in these tests. Desorption isotherm tests and/or column flushing tests should be run to evaluate the stability of the attenuation mechanism. For these tests, unimpacted site groundwater should be mixed with aquifer solids that have attenuated cobalt. Additional design considerations will be determined based on the results of the Tier 2 analyses. For lithium, additional modeling of groundwater hydrogeology may be required depending on the results of the Tier 2 analysis.

- Tier 4 (Long-Term Monitoring): Based on the results of the Tier 2 and Tier 3 tests, a performance monitoring plan will be developed to evaluate the efficacy of MNA at the site. The performance monitoring plan will also include potential supplemental remedies, if needed. These other potential remedies will be evaluated in parallel with the tiered evaluation in accordance with 40 C.F.R. § 257.97 in the performance monitoring plan.

EVALUATION CRITERIA

MNA was evaluated to assess whether it will likely meet the criteria outlined in 40 C.F.R. § 257.96(c) as a potential corrective action. This evaluation is summarized below and in Table 3 of the CMA.

MNA Performance

For cobalt, the initial evaluation described herein and cobalt's geochemical behavior suggest that MNA performance at AP2 is likely to achieve the performance criteria outlined in 40 C.F.R. § 257.97. MNA performance is best when paired with source control measures, which were completed at the site in November 2020. Completion of the tiered evaluation and assessment of cobalt concentrations under closure conditions, and stability of the attenuated cobalt, are required to fully assess MNA performance relative to the performance criteria. For lithium, the observed declining concentrations at the impacted well combined with source control suggest that MNA performance at AP2 is likely to achieve the performance criteria outlined in 40 C.F.R. § 257.97

Reliability of MNA

The reliability of MNA is dependent on site-specific conditions. For cobalt, additional investigation is required to understand the extent of low pH groundwater, which appears to increase the mobility of cobalt in the vicinity of G-401 and G-402. Additional evaluation is planned during 2021 to understand the site-specific attenuation mechanism, capacity, and rate, all of which will provide more information on the reliability of MNA. For lithium, further evaluation of site hydrogeology related to downgradient delineation is required.

Ease of implementation of MNA

MNA is relatively easy to implement compared to other potential corrective actions which require construction, earthwork, or engineering design. Additional efforts required to implement MNA include completion of the tiered investigation and implementation of the performance monitoring plan. These efforts do not require specialized equipment or contractors.

Potential impacts (including safety impacts, cross-media impacts, and control of exposure to any residual contamination)

Potential impacts are not anticipated with MNA. MNA relies on processes that are naturally occurring in the aquifer; therefore, cross-media impacts are unlikely. Large scale handling of impacted materials (such as during groundwater extraction) is not required, reducing the potential for exposure to residuals during implementation. Concentrations of lithium are already below the health-based standard provided in 40 CFR 257.95(h)(iii). The groundwater-surface water interface study will evaluate cross-media impacts. Following delineation of cobalt impacts, an evaluation of possible risk pathways should be completed.

Time required to begin and complete MNA

USEPA guidance states that "natural attenuation should achieve site-specific objections within a time frame that is reasonable compared to that offered by more active methods"[5]. When considering a reasonable time frame, USEPA recommends consideration of factors such as contaminant properties, exposure risk, classification of the protected resource, and potential for plume stability. As discussed above, source control is complete and concentrations of cobalt and lithium already exhibit stable or decreasing behavior at the impacted wells.

Additional efforts are planned for 2021 to complete the tiered MNA evaluation and assess the attenuation capacity of the aquifer to predict future stability. The collection of this additional information does not require specialized contractors and can be completed within one year. The time required to attain the groundwater protection standard at G-401 and G-402 can be estimated once additional information is developed regarding the attenuation rate and continued decline in concentrations after source control implementation was completed. Because the time to completion will depend on the source decay rate, it is anticipated that MNA would have a similar cleanup time as other potential corrective actions, such as groundwater extraction. It is anticipated that the timeframe is reasonable within the guidance provided by USEPA.

Institutional requirements, such as state or local permit requirements, that may substantially affect implementation of MNA

No institutional requirements are anticipated which would substantially affect implementation of MNA.

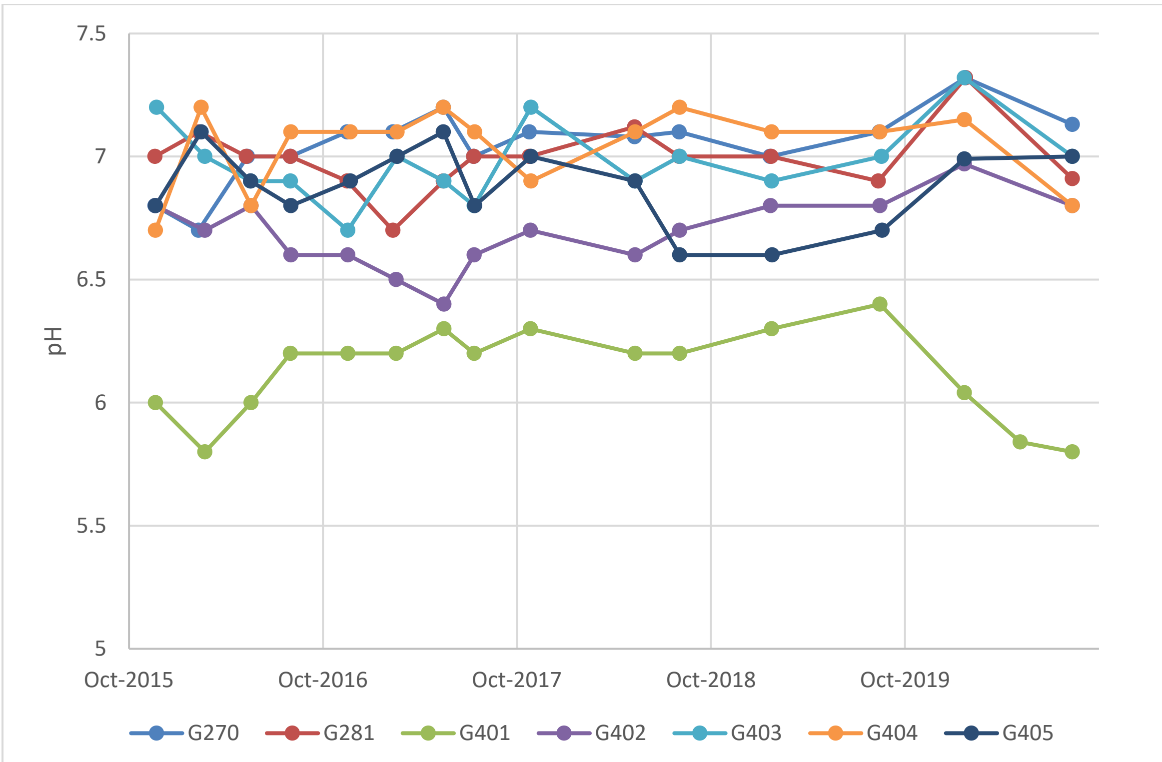
CONCLUSIONS

Based on the analysis completed to-date, MNA combined with source control appears to be a promising groundwater remedy at the Coffeen AP2 unit when reviewed against the requirements in 40 C.F.R. § 257.96(c). Further investigation will be completed in 2021 to collect sufficient

[5] USEPA. 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. OSWER Directive 9200.4-17P. April.

evidence to support the tiered MNA evaluation, which will include an analysis of the attenuation mechanism, rate, and aquifer capacity to establish multiple lines of evidence in accordance with USEPA guidance.

FIGURES



Notes: pH values were measured in the field and are reported as standard units (SU). Wells G-270 and G-281 are located upgradient of AP2.

pH Time Series Graph

Coffeen Ash Pond No. 2

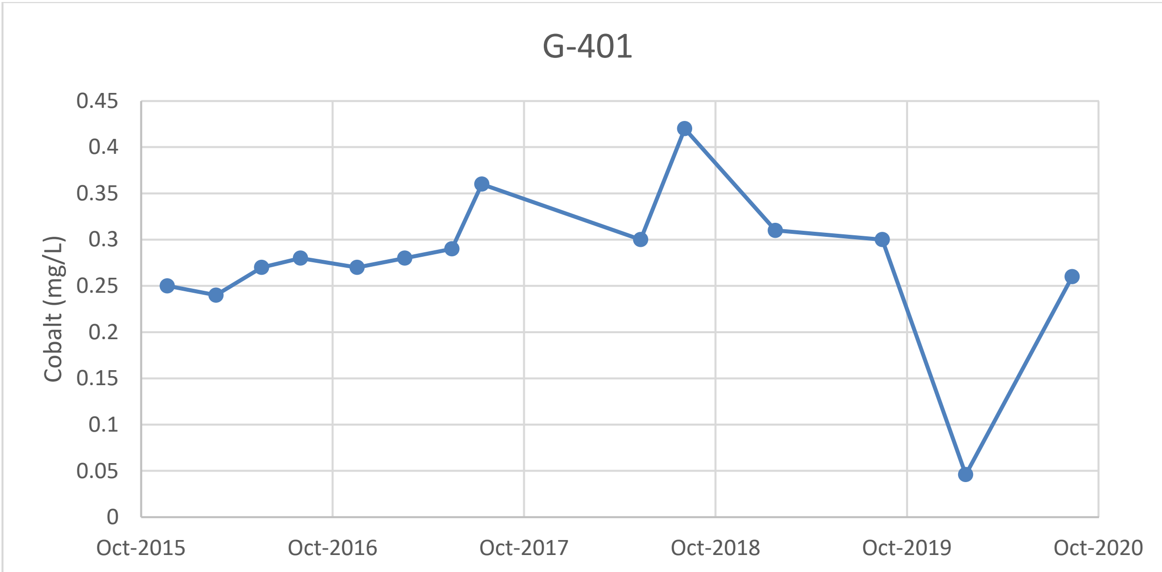
Coffeen, Illinois

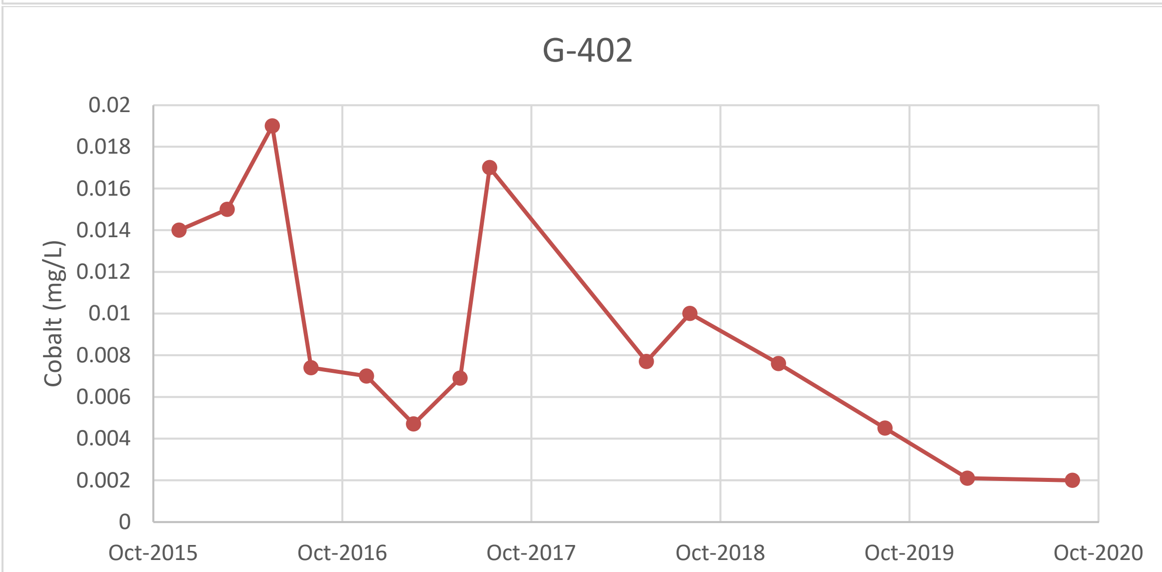
Geosyntec consultants

Figure 1

Columbus, OH | 2020/11/25

internal info: path, date revised, author





Notes: Cobalt concentrations are shown in milligrams per liter (mg/L). The y-axis of each graph varies based on the observed concentrations.

Cobalt Time Series Graph

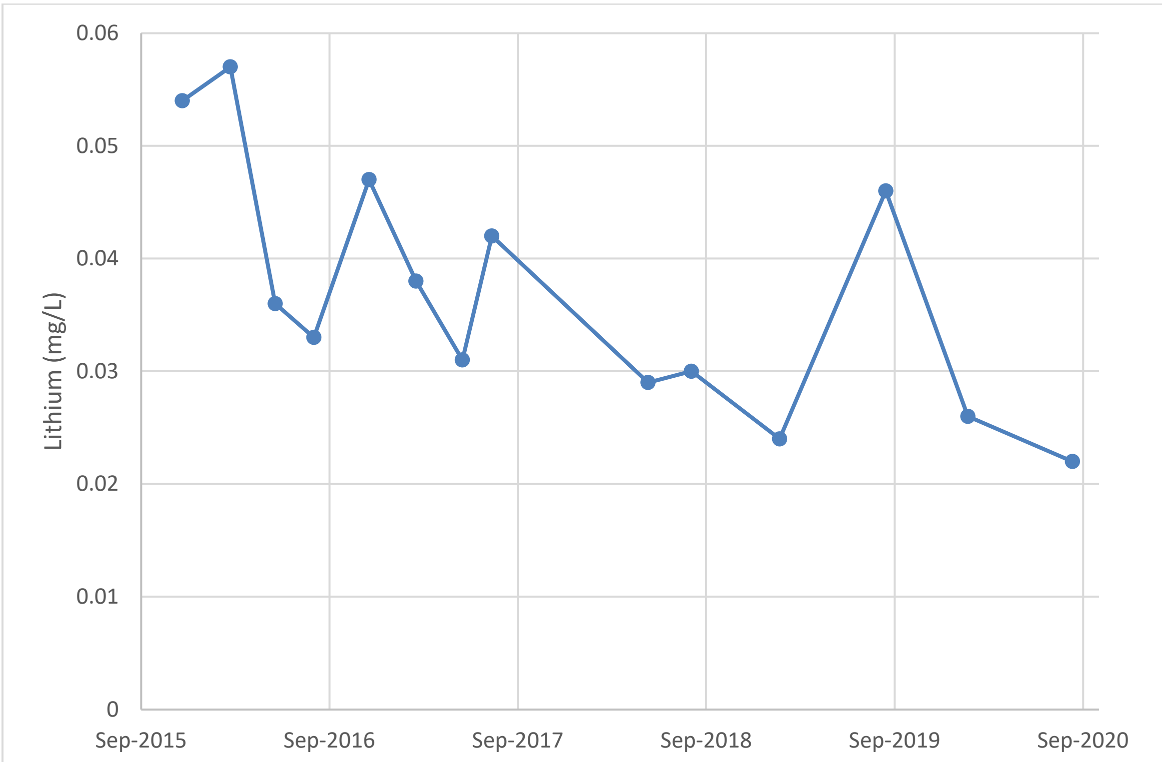
Coffeen Ash Pond No. 2
Coffeen, Illinois

Geosyntec consultants

Figure **2**

Columbus, OH | 2020/11/25

internal info: path, date revised, author



Notes: Lithium concentrations are shown in milligrams per liter (mg/L).

G-401 Lithium Time Series Graph
Coffeen Ash Pond No. 2
Coffeen, Illinois

Geosyntec consultants

Figure **3**

Columbus, OH

2020/11/25

internal info: path, date revised, author

APPENDIX A

Mann-Kendall Analysis - Cobalt Concentrations at G-401

Mann-Kendall Trend Test Analysis

User Selected Options	Value from 1/22/2020 (0.046 mg/L) removed as low outlier.
Date/Time of Computation	ProUCL 5.111/25/2020 12:38:01
From File	WorkSheet_b.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

G-401_Co

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	13
Number Values Reported (n)	13
Minimum	0.24
Maximum	0.42
Mean	0.295
Geometric Mean	0.291
Median	0.28
Standard Deviation	0.0484
Coefficient of Variation	0.164

Mann-Kendall Test

M-K Test Value (S)	39
Tabulated p-value	0.011
Standard Deviation of S	16.3
Standardized Value of S	2.331
Approximate p-value	0.00987

Insufficient evidence to identify a significant trend at the specified level of significance.

APPENDIX B

Mann-Kendall Analysis - Cobalt Concentrations at G-402

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	ProUCL 5.111/25/2020 12:35:11
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

G-402_Co

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	14
Number Values Reported (n)	14
Minimum	0.002
Maximum	0.019
Mean	0.00892
Geometric Mean	0.00732
Median	0.0075
Standard Deviation	0.00538
Coefficient of Variation	0.603

Mann-Kendall Test

M-K Test Value (S)	-45
Tabulated p-value	0.007
Standard Deviation of S	18.27
Standardized Value of S	-2.409
Approximate p-value	0.008

Statistically significant evidence of a decreasing trend at the specified level of significance.

APPENDIX C

Mann-Kendall Analysis - Lithium Concentrations at G-402

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	ProUCL 5.111/25/2020 12:35:33
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

G-402_Li

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	14
Number Values Reported (n)	14
Minimum	0.022
Maximum	0.057
Mean	0.0368
Geometric Mean	0.0353
Median	0.0345
Standard Deviation	0.011
Coefficient of Variation	0.299

Mann-Kendall Test

M-K Test Value (S)	-53
Tabulated p-value	0.002
Standard Deviation of S	18.27
Standardized Value of S	-2.847
Approximate p-value	0.00221

Statistically significant evidence of a decreasing trend at the specified level of significance.