Groundwater Monitoring System for Retrofitted Bottom Ash Pond (BAP) Cardinal Operating Company – Cardinal Power Plant 306 County Road 7E Brilliant, Ohio

January 3, 2022

Submitted to:

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Brilliant, Ohio 43913

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ENVIRONMENTAL SERVICES

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1.0 Introduction

Cox-Colvin & Associates, Inc. (Cox-Colvin) is pleased to provide Cardinal Operating Company (Cardinal) with this Groundwater Monitoring System report for the retrofitted Bottom Ash Pond (BAP) for their power plant located at 306 County Road 7E in Brilliant, Ohio (Site, Figure 1-1).

This report was prepared in accordance with the Federal Coal Combustion Residual (CCR) rules in 40 Code of Federal Regulations (CFR) 257 Subpart D. It is intended to cover recent updates associated with Cardinal's Bottom Ash Pond (BAP), which received a Permit-to-Install (PTI) from Ohio EPA on March 16, 2021, to retrofit the southern portion of the pond with a CCR compliant liner to continue receiving bottom ash (Sargent & Lundy 2020b). Upon completion of the BAP retrofit, the groundwater monitoring system described in this report will supersede the system presented in the initial Groundwater Monitoring Network Evaluation (Geosyntec 2016a).

The horizontal coordinate values provided in this report are based upon the North American Datum of 1927 (NAD27). The vertical datum used for reporting the elevations within this report is National Geodetic Vertical Datum of 1929 (NGVD 29).

2.0 Background Information

Cardinal operates a three-unit, 1,800-megawatt total capacity coal-fired generating station. Each generating unit (Units 1, 2, and 3) is equipped with an electrostatic precipitator for removal of fly ash particulate matter, a selective catalytic reduction (SCR) system for removal of nitrogen oxide, and flue gas desulphurization (FGD) systems for removal of sulfur dioxide (Geosyntec 2016a).

The retrofitted BAP, previously referred to as the South Pond of the Bottom Ash Complex (BAC), is situated along the Ohio River south of Cardinal Plant Unit 3 and will receive bottom ash sluicing discharge. An excavator placed on an "island" or "peninsula" of deposited bottom ash in the center of the pond will be used to dredge settled bottom ash from the pond for dewatering. Once dewatered, the ash will be loaded onto trucks and either beneficially used as construction material or placed in the Fly Ash Reservoir (FAR) I Solid Waste Landfill (RSW Landfill), a dry landfill disposal unit located north of the plant. Water will be recirculated for bottom ash sluicing. There will be no discharge facilities from the BAP, except for a blowdown line to the Unit 3 FGD system to control the water level in the pond and to manage water quality (Sargent & Lundy 2020b).

2.1 Construction and Operational History

The BAP, prior to the 2021 retrofit, was originally constructed in the 1960s as part of the construction of Generating Units 1 and 2. The pond was modified in 1974, including the addition of a berm separating the pond. Cardinal used these two surface impoundments to manage sluiced bottom ash, along with miscellaneous non-CCR low volume waste (LVW) streams and stormwater runoff. Together, these impoundments were referred to as the BAC, consisting of a bottom ash pond (North Pond) and a recirculation pond (South Pond). The ponds remained connected by a pipe and were, therefore, treated as a single unit monitored as the "BAP" CCR unit. The new, retrofitted BAP covers only a portion of the area of the historical BAP (refer to Figure 2-1 and Section 2.2). The base of the South Pond was constructed at an elevation of approximately 652 feet, and the north pond was constructed at approximately 648 ft. Both of the ponds were previously unlined.

In 2008, the South Pond was further divided into two areas separated by a PVC sheet pile baffle wall where water on the north side of the baffle was recirculated back to the Generating Units for ash sluicing, while the south side of the baffle was used as an area for settlement before discharging, if necessary.

2.2 Retrofit of the BAP

Cardinal has determined that the BAP, formerly South Pond of the BAC, has sufficient size to process the current loading of bottom ash and obtain target recirculation water quality. After all existing CCR and CCR-impacted materials have been removed, as well as the PVC baffle wall, the South Pond will be retrofitted with a CCR compliant liner in accordance with 40 CFR 257.102(k) and will operate as the sole CCR pond for management of Bottom Ash Transport Water. The North Pond will no longer be used to manage CCR-derived waste and will be retrofitted with a National Pollutant Discharge Elimination System (NPDES) liner to receive non-CCR LVW and stormwater runoff for discharge at a relocated Outfall 023.

The BAP will have an approximate surface area of 7 acres and volume capacity of approximately 74 acre-ft. The liner system will be composed of a geosynthetic clay over a graded and compacted native soil base in accordance with the CCR Rule permeability requirement and topped with a 60-mil textured HDPE geomembrane. The liner system will be protected by additional geotextile and natural gravel. For additional details, refer to the PTI application (Sargent & Lundy 2020b).

2.3 Historical Groundwater Monitoring

Prior to the retrofit, the BAP groundwater monitoring well network consisted of five monitoring wells: two upgradient monitor wells (MW-BAP-4 and MW-BAP-5) used to monitor background conditions and three downgradient monitor wells (MW-BAP-1, MW-BAP-2, and MW-BAP-3) used as compliance monitoring wells (Figure 2-1). The groundwater monitoring network utilized monitoring wells initially installed as part of a separate site-wide hydrogeologic investigation and was used to monitor groundwater quality in the uppermost aquifer at the Site. One of these wells (MW-BAP-3) will continue to be sampled, while the other four will be used only to collect water levels for potentiometric evaluations (Figure 2-2).

An initial eight baseline monitoring sample events were performed from June 2016 to August 2017, followed by semi-annual monitoring and statistical analysis to evaluate if CCR materials are impacting downgradient groundwater quality. The results of these have shown statistically significant increases (SSI) above background levels in groundwater downgradient of the historical BAP. However, concentrations did not reach statistically significant levels (SSL) in excess of groundwater protection standards (GWPS) that would require corrective action.

Although the former BAP is in assessment monitoring prior to the new groundwater monitoring system for the retrofitted BAP being placed into operation, the BAC will be "clean" closed (closure by removal) by removing all CCR materials at the time of closure and decontaminating all areas affected by releases (if any), in accordance with 40 CFR 257.102. The removal and decontamination activities will eliminate the potential that

contaminants from the historical BAP could result in a future exceedance of GWPS established pursuant to 40 CFR 257.95(h) (Sargent & Lundy 2020a, Sargent & Lundy 2020b).

As specified in 40 CFR 257.102(c), closure activities related to the historical BAP will be complete when all CCR has been removed and groundwater monitoring concentrations do not exceed GWPS. Furthermore, 40 CFR 257.104(a)(2) excludes the historical BAP from post-closure care criteria following removal of all CCR. Presuming that groundwater concentrations remain lower than GWPS, the historical BAP groundwater monitoring system will no longer need to be maintained following completion of closure activities. The groundwater monitoring system for the retrofitted BAP presented in this report will then constitute the entirety of required CCR groundwater monitoring at the BAP.

3.0 Hydrogeologic Setting

3.1 Climate

The 2020 average monthly temperature and precipitation values for the Brilliant, Ohio area are presented in Table 3-1 (NOAA 2021). The climatological data was collected from the weather station located in New Cumberland, West Virginia (USC00466442), which is 28 miles north of Brilliant. Although the Steubenville, Ohio weather station (USC00338025) is closer to the Site, data at that station is not collected with the same consistency as the New Cumberland weather station. Climate differences between the two stations is not expected to be significant for the purposes of this report.

Surface water in the area surrounding the BAP will be diverted so it does not enter the BAP pond. Any precipitation falling on the pond will mix with other water in the BAP and be recirculated for bottom ash sluicing. There will be no discharge facilities from the BAP, except for a blowdown line to the Unit 3 FGD system to control the water level in the pond and to manage water quality (Sargent & Lundy 2020b).

3.2 Geologic Setting

The BAP is located immediately west of the Ohio River. Regional geology is dominated by sedimentary bedrock units overlain by unconsolidated deposits (typically sand and gravel) associated with the Ohio River Valley in an area of Ohio which was unglaciated during the most recent ice age.

The unconsolidated material beneath the BAP consists of three distinct lithologies, as illustrated on the cross-sections provided in Figures 3-1A to 3-1C:

1. Fill materials. These are approximately 10-20 feet in thickness.
2. An alluvium unit consisting of silt, clay, and sand deposited by the Ohio River floodwaters that is approximately 10-20 feet in thickness.
3. A unit of glacial outwash and alluvial deposits of sand and gravel that is approximately 5- 50 feet in thickness.

The unconsolidated materials extend to the bedrock surface approximately 50-75 feet below the BAP. Bedrock is shallower on the western side of the BAP (nearer the hillside) and deeper on the eastern side of the BAP (nearer the Ohio River). Bedrock consists of interbedded shale, sandstone, coal, and limestone of the Pennsylvanian Age Conemaugh Formation.

3.3 Hydrogeologic Setting

The unconsolidated glacial outwash materials comprise the uppermost aquifer beneath the BAP. These materials are in hydraulic connection with overlying alluvium silts and clays, although the silts and clays do not have sufficient hydraulic conductivity to be considered aquifer materials. With a possible seasonal exception in the vicinity of MW-BAP-2, fill materials are fully in the vadose zone above the water table (Figure 3-1A).

3.3.1 Groundwater Use

According to an ODNR groundwater resources map, the region is largely characterized by sandstone, shale, and limestone units, all with well yields that generally do not exceed three gallons per minute (gpm). However, the area adjacent to the Ohio River, where the BAP is located, consists of thick, permeable sand and gravel deposits where yields in excess of 1000 gpm may be developed from horizontal collector wells. Wells in these valley fill areas supply much of the county through regional water systems. The ODNR groundwater resources map shows a well at the Cardinal facility, slightly north of the BAP, that is 88 feet deep in sand and gravel with a yield of 500 gpm (Walker 1990).

Based on water well records obtained from the ODNR online search tools (ODNR 2021), the nearest domestic water supply wells are located approximately one mile west of the BAP. The well records indicate well depths ranging from 30 to 110 ft below ground surface within shale and sandstone aquifers. Surface elevations at the wells are higher than those of the BAP. According to the Jefferson County Water and Sewer District, there are no surface water intakes supplying water to the town of Brilliant, Ohio. Brilliant's water source comes from two groundwater wells located near a water treatment plant approximately three miles northeast of the BAP (Geosyntec 2016b).

Water used at the Site is produced via four (4) on-site wells. These wells are located at least 1,700 feet northeast (upgradient) of the BAP. The Site production wells are screened within the sand and gravel aquifer and produce approximately 6,500 gallons per day (Ohio EPA 2003).

3.3.2 Surface Water Control

The Ohio River elevation adjacent to the Site is controlled by the Pike Island Dam, with a normal pool elevation of approximately 644.0 feet (USACE 2003). The National Weather Service (NWS) indicates that the flood stage for the Ohio River at Wellsburg, West Virginia, which is located approximately 3.7 miles upstream of the BAP, is at an elevation of 654.63 feet with a major flood stage at an elevation of 659.63 feet (NWS 2021).

The BAP is isolated from surface water flow by the pond embankments. The nearest tributary entering the Ohio River is Salt Run, located approximately 0.6 miles to the north

of the retrofitted BAP. Riddles Run and Blockhouse Run are located approximately 1.4 and 1.6 miles to the north, respectively. Groundwater in the vicinity flows towards and recharges the Ohio River. Seasonal fluctuations in the Ohio River pool stage near the BAP are expected to generally reflect seasonal precipitation values for Jefferson County, with the highest pool elevations generally in the spring and summer months.

3.3.3 Hydraulic Conductivity and Effective Porosity

Historical BAP groundwater monitoring activities (covering both the South Pond and North Pond areas) estimated hydraulic conductivity values ranging from 0.0001 cm/sec to 0.1 cm/sec (Geosyntec 2016a), with groundwater velocity calculations based upon hydraulic conductivity of 0.05 cm/sec and effective porosity of 0.36.

On March 19, 2021, slug tests were performed on three monitor wells installed in January 2021. Data and calculations are provided in Appendix A and summarized in Table 3-2.

Sand and gravel outwash materials taper out in the western area of the BAP (Figure 3-1C), and both the overlying silt/clay alluvium materials and the underlying sandstone are expected to have lower hydraulic conductivity than sand and gravel outwash materials. This is reflected in the hydraulic conductivity value for MW-BAP-1001, which is located west of the BAP and has conductivity values that are three orders of magnitude lower than other BAP wells located east of the BAP.

Slug tests were not performed on MW-BAP-3 or other monitor wells in the vicinity of the BAP. Bore logs (Appendix B) suggest that the alluvium silt and clay materials extend approximately 10-15 feet deeper at MW-BAP-3 than at MW-BAP-1002 and MW-BAP-1003 (Figure 3-1A). Materials underlying alluvium at MW-BAP-3 are mostly gravel, whereas they are mostly sand at MW-BAP-1002 and MW-BAP-1003. Based upon MW-BAP-3's location midway between MW-BAP-1002 and MW-BAP-1003, at a similar distance from the river, an average of hydraulic conductivity values at the latter two wells (as shown in Table 3-2) is considered to be a reasonable estimate of hydraulic conductivity.

3.3.4 Groundwater Flow Direction and Velocities

Potentiometric surface maps are provided as Figures 3-2A through 3-2D. Groundwater flow is from west to east across the retrofitted BAP. Based upon review of the potentiometric surface maps, geologic cross-sections, and bore logs, groundwater is most likely entering the unconsolidated aquifer west of MW-BAP-1001. This location is aligned with a stream valley located west of the highway that flows east towards the BAP. Infiltration from both the stream and bedrock strata to the west that are at a higher elevation than the BAP is possible.

Due to the proximity of the Ohio River, the groundwater elevations taken at the BAP fluctuate between 643 and 646 ft. Due to the high permeability of the aquifer, minimal differences in groundwater elevation are observed at any given time. Total elevation changes across the BAP are typically around 0.1 to 0.3 feet over 800 feet, equating to hydraulic gradients of approximately 0.000125 to 0.000375.

Potentiometric surface maps show that groundwater at the BAP generally flows east-southeast, towards the Ohio River. In 2020, the average groundwater velocity at monitor wells in the historical BAP groundwater monitoring system (including both the North Pond and South Pond areas) was 26.7 feet per year (ft/year) during the spring and 16.7 ft/year during the fall (Geosyntec 2021). Based upon the hydraulic conductivity data included in Appendix A compared to estimates used in previous reports, calculated flow velocities may be up to an order of magnitude higher at wells east of the retrofitted BAP.

Although it is typically expected that groundwater flow will be perpendicular to a river, turning downstream as it nears the river itself, (as is generally the case at the BAP) localized exceptions have been observed. These exceptions most likely relate to the following factors:

1. The difference in groundwater elevations across the BAP are very small, meaning that groundwater flow directions are sensitive to any degree of imprecision in elevation surveys and depth to water measurements.
2. The silt and clay alluvium layer extends approximately 10 feet deeper at MW-BAP-5 than it does in other areas, resulting in less sand and gravel outwash. Because the silt and clay alluvium layer has lower permeability, groundwater is expected to preferentially flow around this area. Silt and clay materials at MW-BAP-5 are generally reported as being "stiffer" than at other monitor well locations, suggesting that their permeability may be particularly low near MW-BAP-5.
3. Fill materials lying overtop native alluvium obscure the presence of any historical stream channels, and fill materials are likely to have higher permeability than underlying silts and clays due to less compaction. In the area of MW-BAP-2, fill materials extend to a depth where they are likely to intercept the water table.
4. The aquifer is in close hydraulic communication with the Ohio River. Fluctuations in river stage are likely to result in changes to groundwater flow in the aquifer.

4.0 Monitoring System Evaluation

CCR rules (40 CFR 257.53) define the term "uppermost aquifer" as "The geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary". The term "aquifer" means "a geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs." For purposes of this report, the glacial outwash materials form the uppermost aquifer beneath the BAP. The alluvium silt and clay material overlying the sand and gravel outwash materials is also saturated and in hydraulic connection with the outwash; however, usable quantities of groundwater would be obtained from the underlying sand and gravel materials that have much higher hydraulic conductivity and not the low-yielding silts and clays. The alluvial silt and clay material is, therefore, not part of the uppermost aquifer.

The following discussion provides demonstration that the groundwater monitoring system meets the requirements of 40 CFR 257.91.

4.1 Performance Standard

CCR Rule §257.91(a) specifies a performance standard that:

> *The owner or operator of a CCR unit must install a groundwater monitoring system that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that:*
>
> *(1) Accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit […]; and*
>
> *(2) Accurately represent the quality of groundwater passing the waste boundary of the CCR unit. The downgradient monitoring system must be installed at the waste boundary that ensures detection of groundwater contamination in the uppermost aquifer. All potential contaminant pathways must be monitored.*

As part of the retrofit, a new BAP groundwater monitoring system has been established (Figure 2-2). In addition to previously existing MW-BAP-3, the system includes three new monitoring wells (MW-BAP-1001, MW-BAP-1002, and MW-BAP-1003) that were installed in January 2021.

Samples collected from MW-BAP-1001 will represent background groundwater that has not been affected by leakage from a CCR unit. MW-BAP-3, MW-BAP-1002, and MW-BAP-1003 are installed along the downgradient (east) boundary of the BAP and will serve as compliance wells to ensure detection of groundwater contamination in the uppermost

aquifer. Monitor wells from the former BAP monitoring system (MW-BAP-1, MW-BAP-2, MW-BAP-4, and MW-BAP-5) will continue to be measured for water levels to distinguish potentiometric surface, but not sampled.

4.2 Site Specific Technical Evaluation

CCR Rule §257.91(b) specifies that:

> *The number, spacing, and depths of monitoring systems shall be determined based upon site-specific technical information that must include thorough characterization of:*
>
> *(1) Aquifer thickness, groundwater flow rate, groundwater flow direction including seasonal and temporal fluctuations in groundwater flow; and*
>
> *(2) Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer, including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities and effective porosities.*

The water table is separated from the BAP by at least five feet of fill materials and alluvial silt and clay. If a release from the BAP were to occur, it is anticipated that the released water would migrate vertically downward through the vadose zone fill materials and into the underlying alluvium where it would then reach saturated alluvial silt and clay materials. As noted earlier, these materials are not part of the uppermost aquifer due to their low hydraulic conductivity. The sands and gravels comprising the aquifer are encountered approximately 5 to 20 feet below the potentiometric surface. As shown on Figures 3-1A to 3-1C, monitor wells are screened near the top of aquifer.

Potentiometric surfaces presented on Figures 3-2A through 3-2D demonstrate that the location of background monitor well MW-BAP-1001 is consistently upgradient of the BAP. Hydraulic conductivity at MW-BAP-1001 is approximately three orders of magnitude less than other monitor wells in the system (Section 3.3.3), suggesting groundwater conditions at the monitor well may have greater influence from overlying alluvium and underlying bedrock materials than wells farther east. Slight geochemical differences in groundwater quality related to the environmental media could potentially increase the likelihood of falsely identifying an SSI during statistical evaluations of groundwater quality. However, due to the proximity of the BAP to the east, and areas that may have been affected by historical CCR operations farther to the northeast, background well placement in the slightly different lithology appears to be unavoidable. As shown on Figure 3-1C, MW-BAP-1001 is screened in the same outwash materials as compliance wells despite the differences in hydraulic conductivity.

MW-BAP-3, MW-BAP-1002, and MW-BAP-1003 are installed along the downgradient (east) boundary of the BAP and will serve as compliance wells to ensure detection of groundwater contamination in the uppermost aquifer. As shown on Figures 3-2A through 3-2D, monitor wells MW-BAP-3 and MW-BAP-1003 are clearly downgradient of the BAP.

Due to safety concerns related to overhead electric lines during drilling, MW-BAP-1002 was installed farther to the north than initially planned. As presented in Section 3.3.4, there has been some uncertainty regarding groundwater flow directions in the northeast portion of the retrofitted BAP. Additionally, it is possible that retrofitting of the BAP and conversion of the North Pond to an NPDES pond could result in slight changes to the potentiometric surface in this area in the future.

At this time, the location of MW-BAP-1002 appears to be down-gradient of the BAP for at least portions of the year and, therefore, representative of the quality of groundwater passing the waste boundary of the CCR unit. The location of this down-gradient well will continue to be evaluated as additional data is obtained.

4.3 Number of Wells

CCR Rule §257.91(c) specifies that:

> *The groundwater monitoring system must include the minimum number of monitoring wells necessary to meet the performance standards specified in paragraph (a) of this section, based on the site-specific information specified in paragraph (b) of this section. The groundwater monitoring system must contain:*
>
> *(1) A minimum of one upgradient and three downgradient monitoring wells; and*
>
> *(2) Additional monitoring wells as necessary to accurately represent the quality of background groundwater that has not been affected by leaking from the CCR unit and the quality of groundwater passing the waste boundary of the CCR unit.*

The groundwater monitoring system is comprised of 1 upgradient background well and 3 downgradient monitoring wells. As such, the minimum number of wells specified in the CCR Rule is met.

4.4 Multiple CCR Units

CCR Rule §257.91(d) allows multiple CCR units to be monitored in "a multiunit groundwater monitoring system instead of separate groundwater monitoring systems for each CCR unit." No other CCR units are in the immediate vicinity of the BAP, or

overlying the same uppermost aquifer as the BAP. As such, this provision of the CCR Rule is not applicable.

4.5 Monitoring Well System Construction

CCR Rule §257.91(e) requires that:

> *Monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of groundwater samples. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed to prevent contamination of samples and the groundwater.*
>
> *(1) The owner or operator of the CCR unit must document and include in the operating record the design, installation, development, and decommissioning of any monitoring wells, piezometers and other measurement, sampling and analytical devices. The qualified professional engineer must be given access to this documentation when completing the groundwater monitoring system certification required under paragraph (f) of this section.*
>
> *(2) The monitoring wells, piezometers, and other measurement, sampling, and analytical devices must be operated and maintained so that they perform to the design specification throughout the life of the monitoring program.*

4.5.1 Monitor Well Construction

Monitor well construction logs are provided in Appendix C. Wells are constructed of 2-inch diameter PVC casing and screen. Screens are surrounded with a sand pack, and the annular space above the sand pack is sealed with bentonite.

4.5.2 Groundwater Monitoring Program

In accordance with CCR rules, groundwater sampling will be performed semi-annually. Based upon flow direction and velocities observed historically at the BAP (Section 3.3.4), groundwater residence times at all monitor wells is considerably less than six months and this sampling frequency will ensure physical independence.

Groundwater elevations will be measured in each well immediately prior to purging, each time groundwater is sampled. To minimize the effects of temporal variation and allow determination of the rate and direction of groundwater flow, water levels at all wells in

the BAP groundwater monitoring system must be measured on the same day in as short a time period as is practical, even if sampling is to be conducted over multiple days.

The monitoring wells will be sampled using low flow sampling techniques based on Chapter 10 of OEPA's Technical Guidance Manual (TGM) for Hydrogeologic Investigations and Ground Water Monitoring (Ohio EPA 2020) and the Facility Groundwater Monitoring Program Plan, approved by Ohio EPA Division of Materials & Waste Management (Cardinal 2020). The monitoring well will be purged using a submersible pump. A dedicated length of disposal polyethylene tubing will be used to purge groundwater at each location, and all down-hole equipment will be decontaminated prior to use at a new sampling location.

Water will be pumped through an enclosed, flow-through cell fitted with a multi-parameter groundwater meter. Measurements of temperature, pH, specific conductance, turbidity, dissolved oxygen (DO), and oxidation reduction potential (ORP) will be measured periodically during purging. Groundwater will be purged until three consecutive readings are within the following limits for a minimum of three of the following stabilization parameters:

- Turbidity has stabilized to less than 10 nephelometric turbidity units (NTU) or ±10% if greater than 10 NTU;
- Temperature has stabilized to ±0.5 degrees Celsius (°C);
- Oxidation-reduction potential (ORP) has stabilized to ±20 millivolts (mV);
- Dissolved oxygen (DO) has stabilized to 10% or ±0.2 mg/L;
- pH has stabilized to ±0.2 standard units (SU); and
- Specific conductance has stabilized to ±3%.

Groundwater levels will be monitored during purging to confirm that drawdown is minimized. Groundwater samples will be collected following stabilization of field parameters. If stabilization is not achieved after removal of 3 well volumes, then a sample can be collected at the discretion of the field crew. Attempts should be made to avoid purging to dryness. If purging to dryness is unavoidable or inadvertent, then samples should be taken when there is a sufficient amount of water to collect a sample that best represents the ground water quality. Ideally, sampling after purging to dryness will take place within 24 hours.

Groundwater samples will be collected unfiltered, in pre-preserved sampling containers provided by the laboratory. In addition to groundwater samples discussed above, quality control blanks and field duplicates will be collected to verify that analytical data is representative of site conditions according to the Facility Groundwater Monitoring Program Plan (Cardinal 2020). Groundwater samples will be transported to a qualified laboratory in an ice-cooled chest under chain of custody.

Laboratory analysis will be conducted in accordance with 40 CFR 257.93 which includes, but is not limited to, analytical methods that accurately measure hazardous constituents listed in either Appendix III or IV of 40 CFR 257. This is further detailed in the Statistical Analysis Plan (Geosyntec 2020).

Statistical evaluation of groundwater analytical results will be performed in accordance with the Site's 2020 Statistical Analysis Plan (Geosyntec 2020) or subsequent revisions.

5.0 Professional Engineer Certification

The undersigned Professional Engineer registered in the State of Ohio is familiar with the requirements of 40 CFR part 257, subpart D and has visited and examined the facility. The undersigned Registered Engineer attests that the BAP Groundwater Monitoring System has been prepared in accordance with good engineering practice, including the design and construction to meet the requirements of §257.91, for the facility to the best of his knowledge. The minimum number of wells specified in §257.91(c)(1) has been met, as documented in Section 4.0 of this report.

This certification in no way relives the owner or operator of the facility of his duty to fully implement this Groundwater Monitoring System in accordance with the requirements of 40 CFR 257 subpart D.

Nick M. Petruzzi, PE, CPG
Principal Engineer
Registration No. E-73052 (Ohio)
Cox-Colvin & Associates, Inc.

1/3/22
Date

6.0 References

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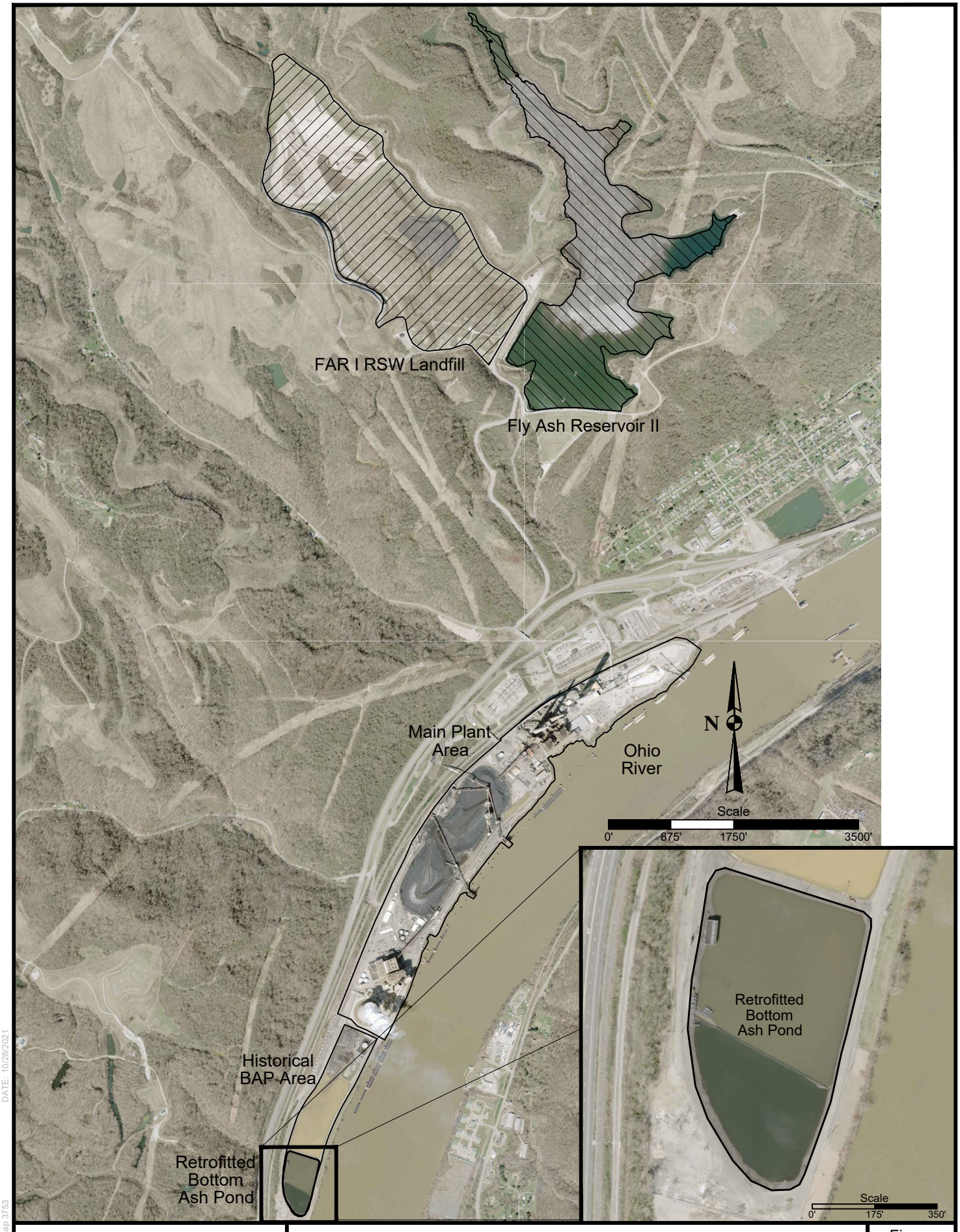
Figures



DATE: 10/28/2021

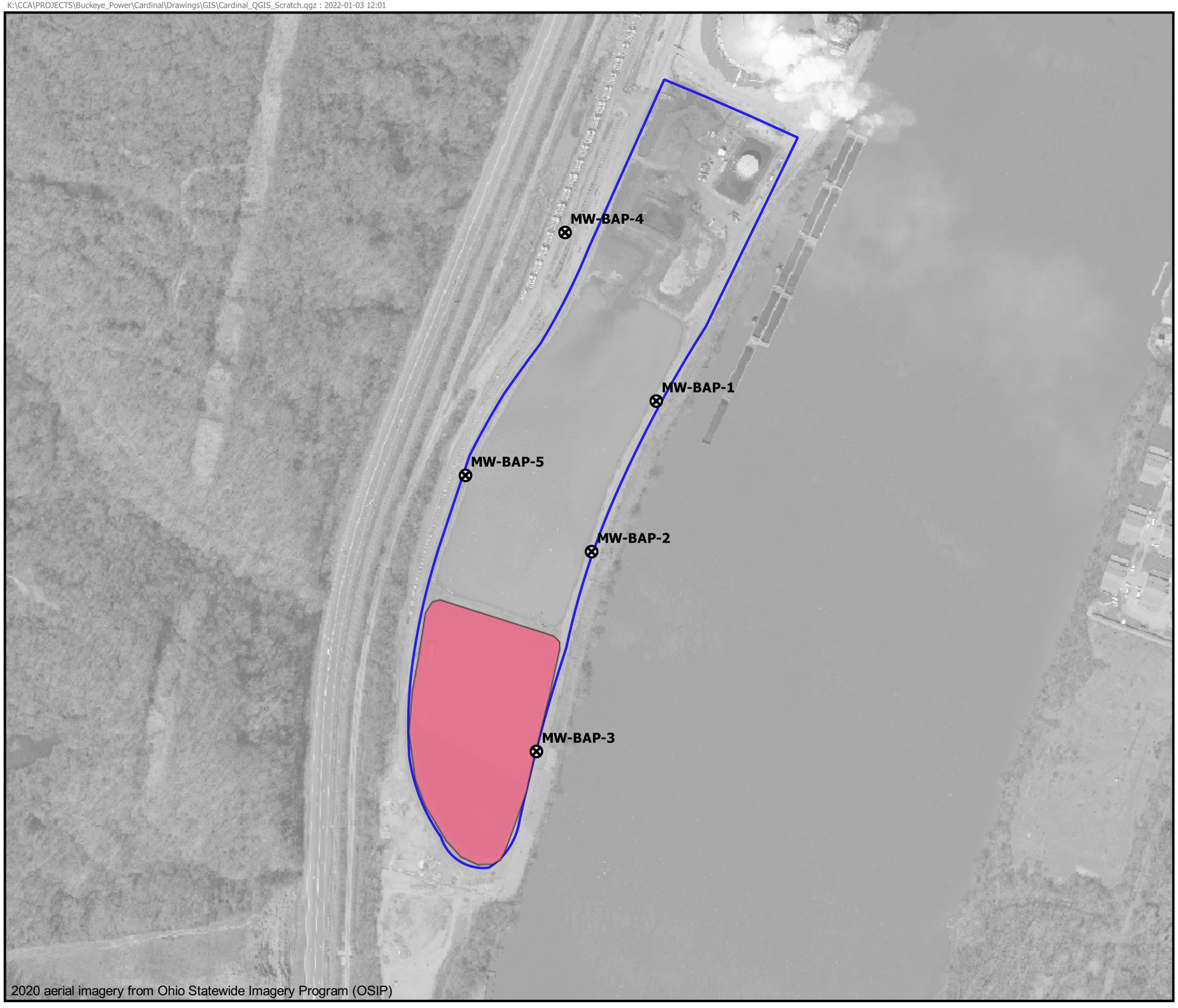
DWG NAME: Sitemap 3753

Cox-Colvin & ASSOCIATES, INC. ENVIRONMENTAL SERVICES

Facility Layout,
Cardinal Power Plant,
Brilliant, Ohio

Figure
1-1

K:\CCA\PROJECTS\Buckeye_Power\Cardinal\Drawings\GIS\Cardinal_QGIS_Scratch.qgz : 2022-01-03 12:01



Legend

- Historical BAP
- Retrofitted BAP
- Historical BAP Wells

N

0 200 400 600 800 1,000 ft

Cox-Colvin & ASSOCIATES, INC.
ENVIRONMENTAL SERVICES

Figure

2-1

Historical BAP Groundwater Monitoring Network,
Cardinal Power Plant,
Brilliant, Ohio

K:\CCA\PROJECTS\Buckeye_Power\Cardinal\Drawings\GIS\Cardinal_QGIS_Scratch.qgz : 2022-01-03 11:58

Legend

- Retrofitted BAP
- Monitor Well (Samples and Water Levels)
- Monitor Well (Water Levels Only)

N

0 200 400 600 800 1,000 ft

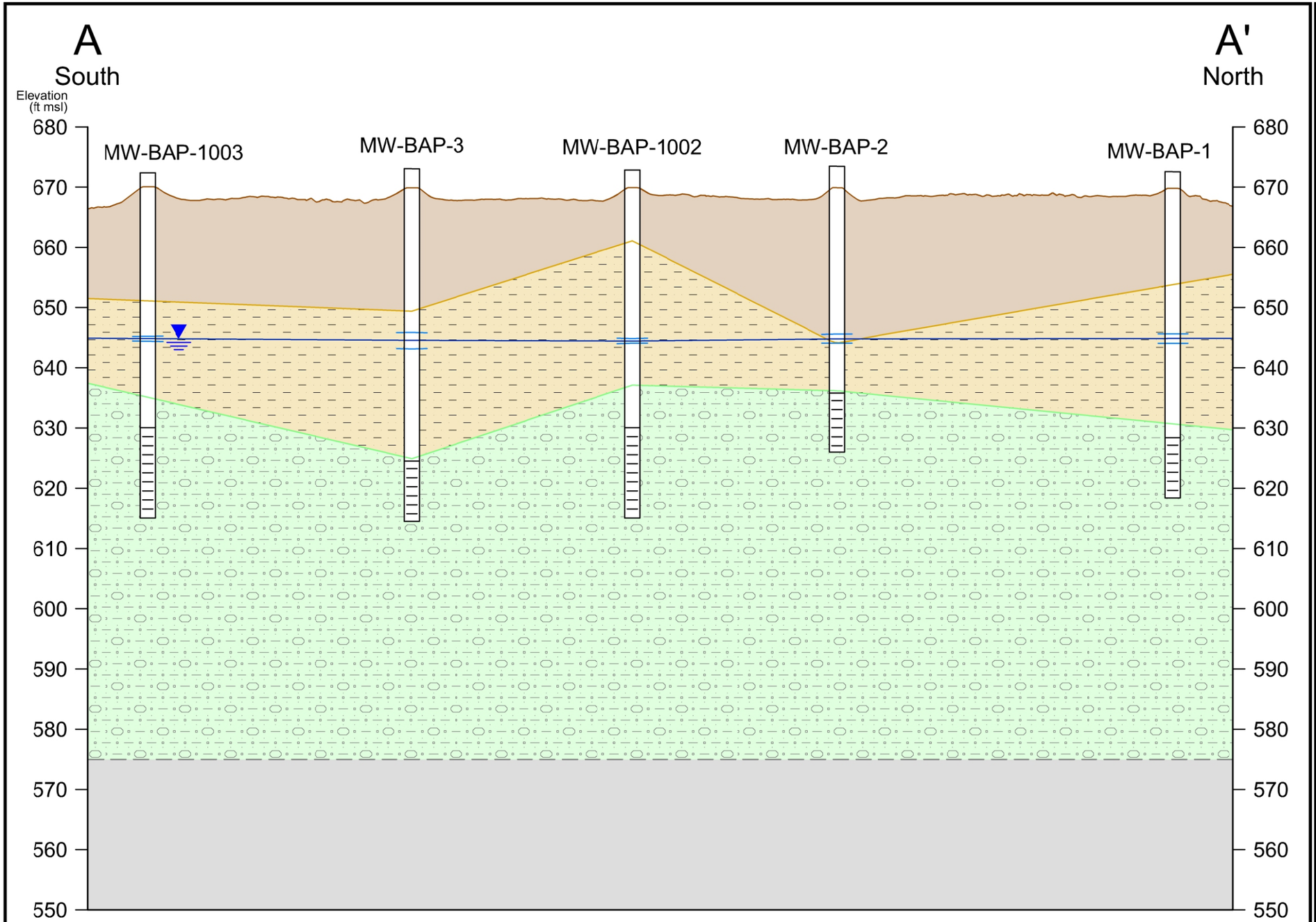
Cox-Colvin & ASSOCIATES, INC.
ENVIRONMENTAL SERVICES

Figure

2-2

Retrofitted BAP Groundwater Monitoring System,
Cardinal Power Plant,
Brilliant, Ohio

DWG NAME: Cross Section DATE: 10/20/2021



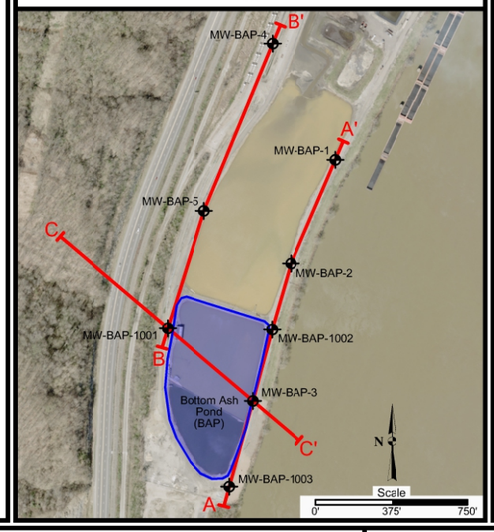
Legend

- Fill
- Alluvium (Silt/Clay)
- Glacial Outwash
- Bedrock
- Monitor Well
- Typical Groundwater Level
- Range of Observed Groundwater Elevations
- A — A' Line of Geologic Cross Section

Source of Aerial Photography: OGRIP, 2020.

Horizontal Scale
0' 87.5' 175' 350'

Vertical Exaggeration: 10x



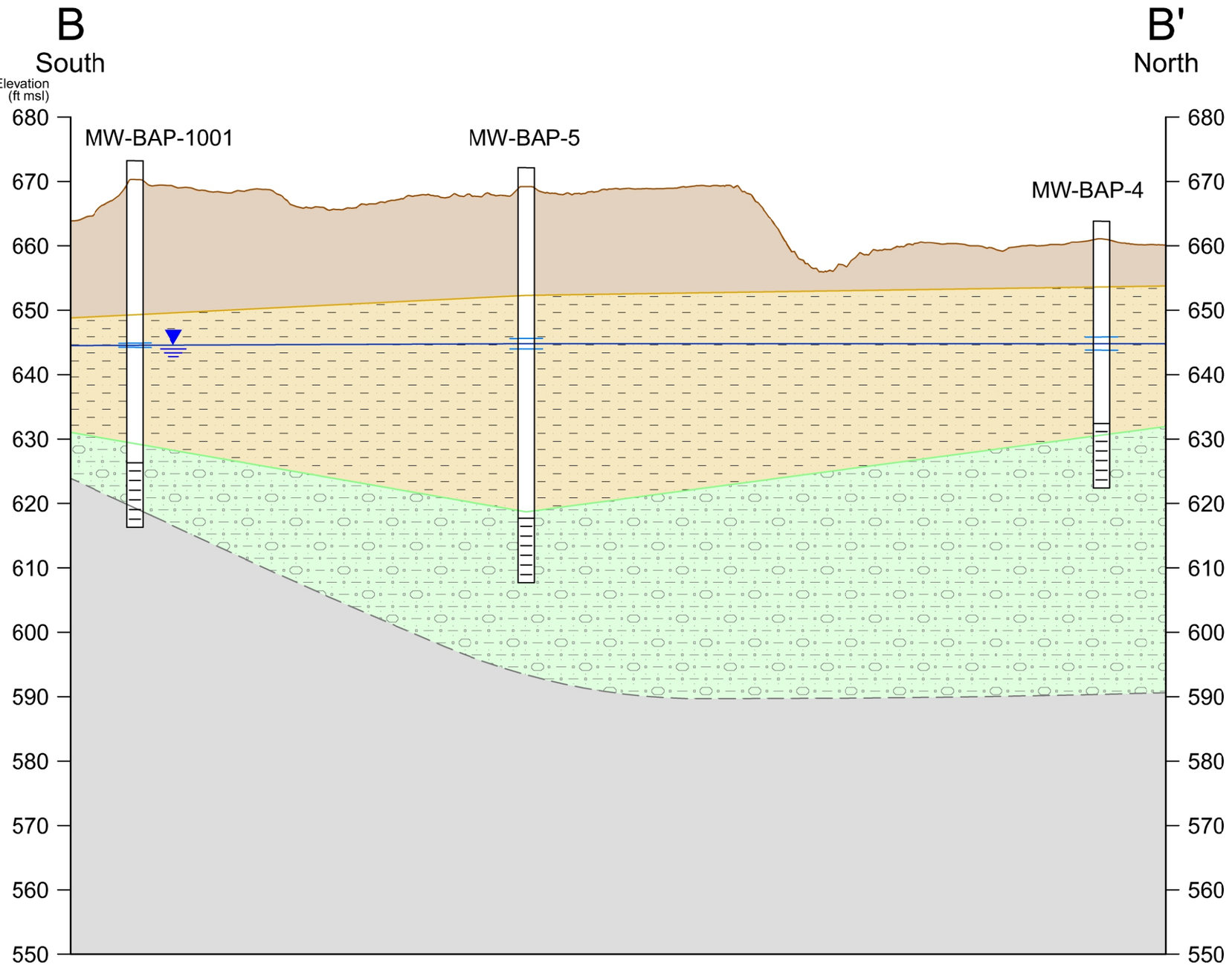
Geologic Cross-Section A - A'

Cox-Colvin & ASSOCIATES, INC. ENVIRONMENTAL SERVICES

Geologic Cross-Section A - A',
Cardinal Power Plant BAP,
Brilliant, Ohio

Figure
3-1A

DWG NAME: Cross Section DATE: 10/20/2021



Legend

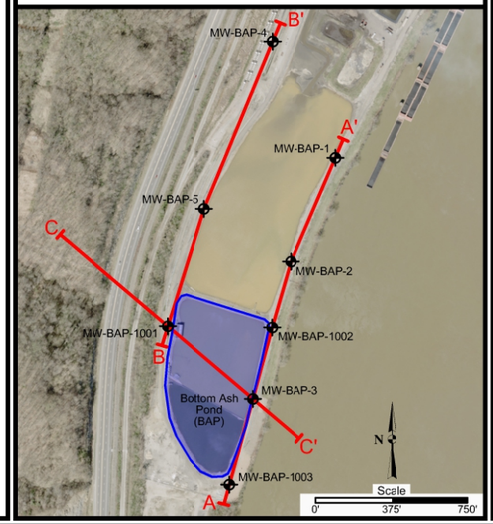
- Fill
- Alluvium (Silt/Clay)
- Glacial Outwash
- Bedrock
- Monitor Well
- Typical Groundwater Level
- Range of Observed Groundwater Elevations

B — B'
Line of Geologic Cross Section

Source of Aerial Photography: OGRIP, 2020.

Horizontal Scale
0' 87.5' 175' 350'

Vertical Exaggeration: 10x



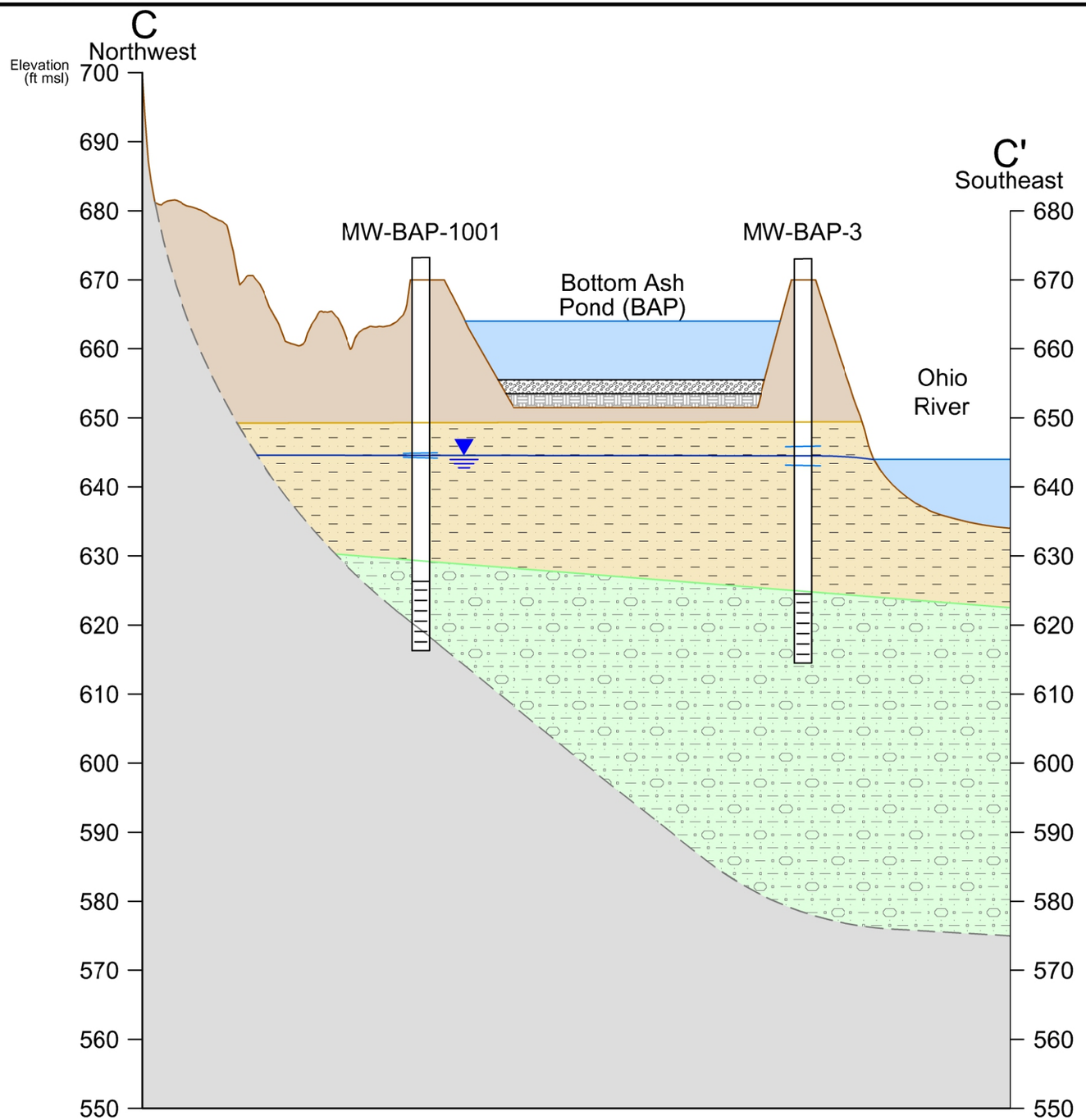
Geologic Cross-Section B - B'

Cox-Colvin & ASSOCIATES, INC. ENVIRONMENTAL SERVICES

Geologic Cross-Section B - B',
Cardinal Power Plant BAP,
Brilliant, Ohio

Figure
3-1B

DWG NAME: Cross Section DATE: 10/20/2021



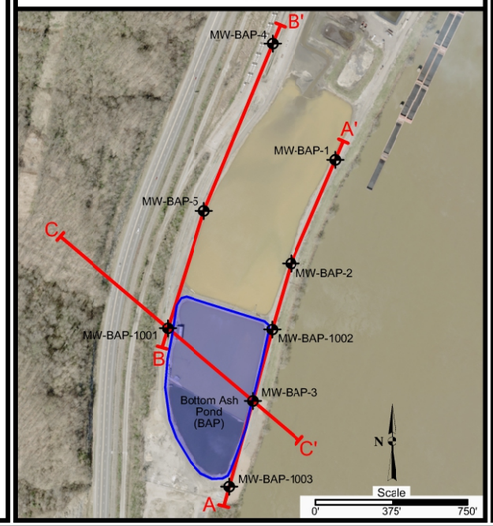
Legend

- Fill
- Alluvium (Silt/Clay)
- Glacial Outwash
- Bedrock
- Monitor Well
- Typical Groundwater Level
- Range of Observed Groundwater Elevations
- C — C' Line of Geologic Cross Section

Source of Aerial Photography: OGRIP, 2020.

Horizontal Scale
0' 90' 180' 330'

Vertical Exaggeration: 10x



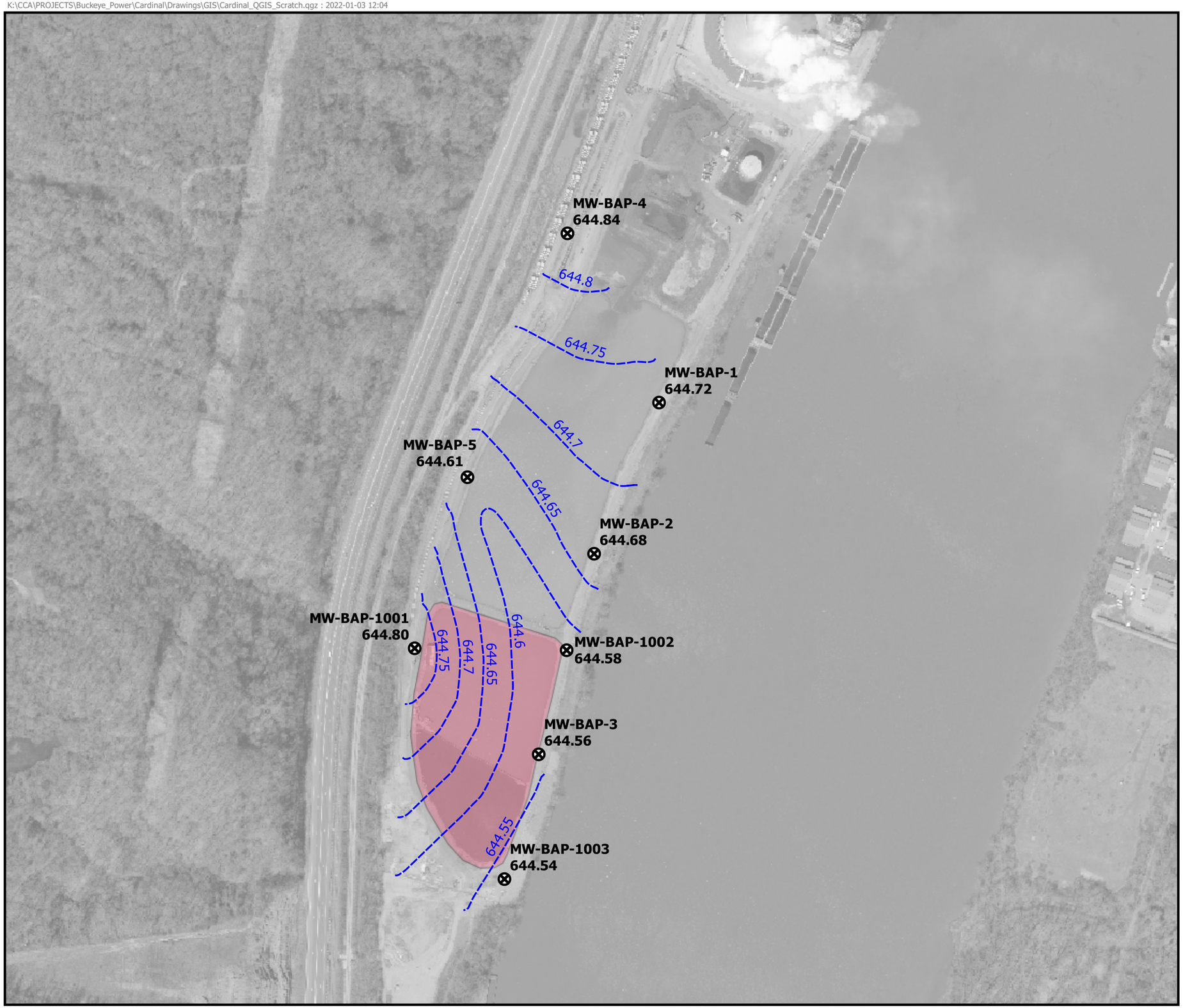
Geologic Cross-Section C - C'

Cox-Colvin & ASSOCIATES, INC. ENVIRONMENTAL SERVICES

Geologic Cross-Section C - C',
Cardinal Power Plant BAP,
Brilliant, Ohio

Figure
3-1C

K:\CCA\PROJECTS\Buckeye_Power\Cardinal\Drawings\GIS\Cardinal_QGIS_Scratch.qgz : 2022-01-03 12:04



Legend

- Retrofitted BAP
- Approximate Groundwater Elevation Contour
- Monitor Well and Groundwater Elevation

N

0 200 400 600 800 1,000 ft

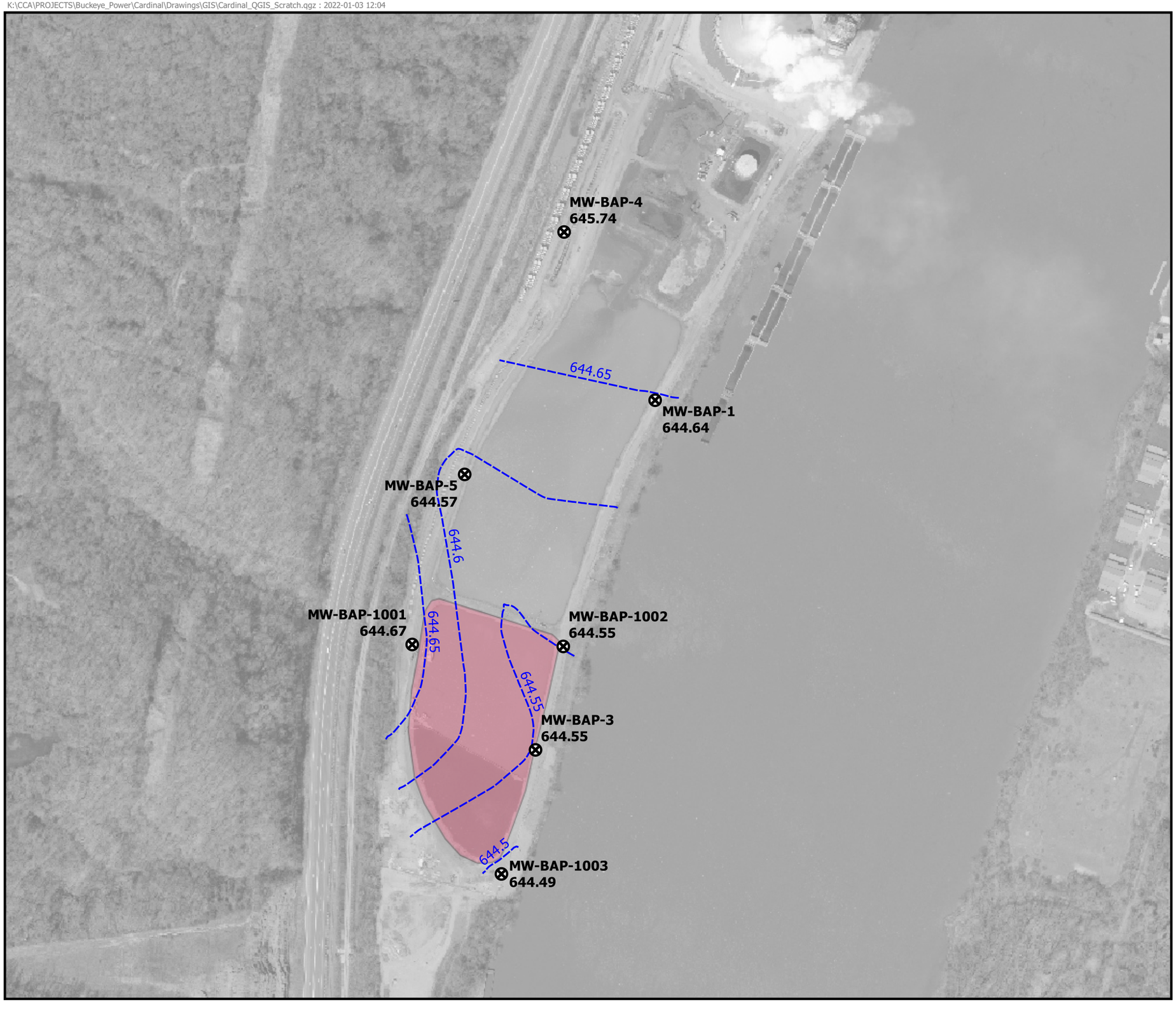
Cox-Colvin & ASSOCIATES, INC.
ENVIRONMENTAL SERVICES

Figure

3-2A

Potentiometric Surface Map - Uppermost Aquifer
Bottom Ash Pond - April 5, 2021
Buckeye Power, Cardinal Generating Plant
Brilliant, Ohio

K:\CCA\PROJECTS\Buckeye_Power\Cardinal\Drawings\GIS\Cardinal_QGIS_Scratch.qgz : 2022-01-03 12:04



Legend

- Retrofitted BAP
- Approximate Groundwater Elevation Contour
- Monitor Well and Groundwater Elevation

N

0 200 400 600 800 1,000 ft

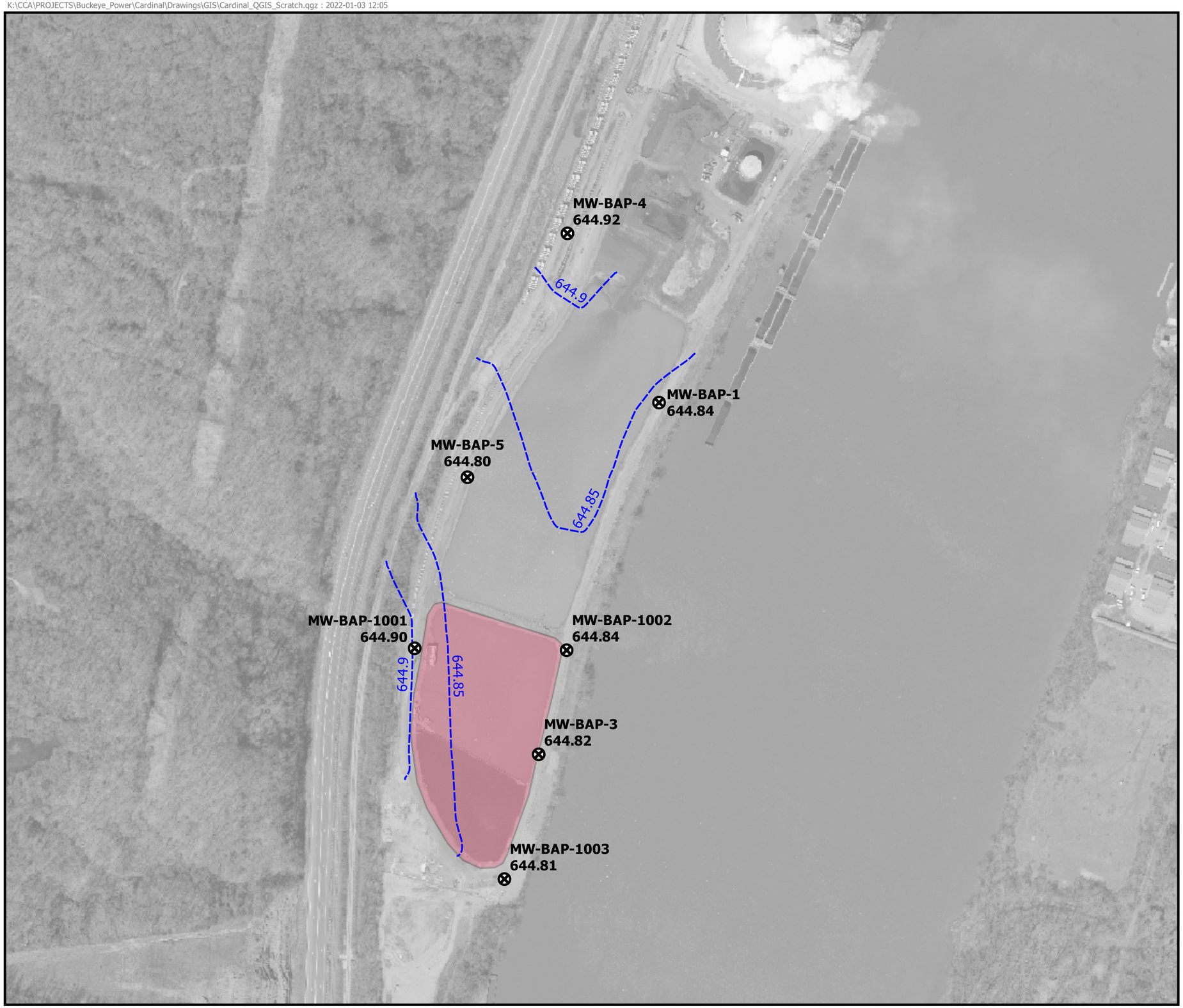
Cox-Colvin & ASSOCIATES, INC.
ENVIRONMENTAL SERVICES

Figure

3-2B

Potentiometric Surface Map - Uppermost Aquifer
Bottom Ash Pond - July 29, 2021
Buckeye Power, Cardinal Generating Plant
Brilliant, Ohio

K:\CCA\PROJECTS\Buckeye_Power\Cardinal\Drawings\GIS\Cardinal_QGIS_Scratch.qgz : 2022-01-03 12:05



Legend

- Retrofitted BAP
- Approximate Groundwater Elevation Contour
- Monitor Well and Groundwater Elevation

N

0 200 400 600 800 1,000 ft

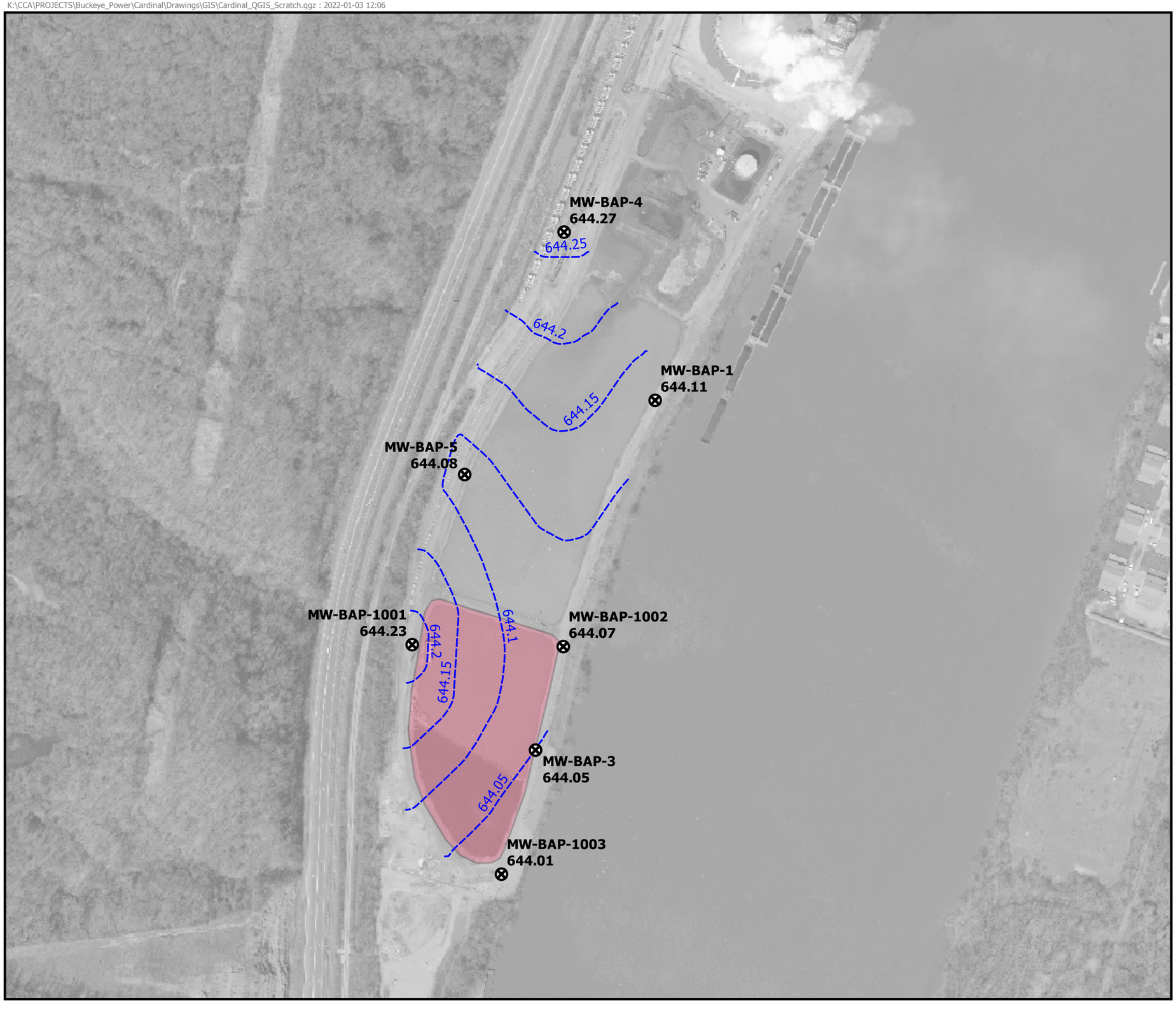
Cox-Colvin & ASSOCIATES, INC.
ENVIRONMENTAL SERVICES

Figure

3-2C

Potentiometric Surface Map - Uppermost Aquifer
Bottom Ash Pond - August 12, 2021
Buckeye Power, Cardinal Generating Plant
Brilliant, Ohio

K:\CCA\PROJECTS\Buckeye_Power\Cardinal\Drawings\GIS\Cardinal_QGIS_Scratch.qgz : 2022-01-03 12:06



Legend

- Retrofitted BAP
- Approximate Groundwater Elevation Contour
- Monitor Well and Groundwater Elevation

N

0 200 400 600 800 1,000 ft

Cox-Colvin & ASSOCIATES, INC.
ENVIRONMENTAL SERVICES

Figure

3-2D

Potentiometric Surface Map - Uppermost Aquifer
Bottom Ash Pond - September 15, 2021
Buckeye Power, Cardinal Generating Plant
Brilliant, Ohio

Tables

Table 3-1. 2020 NOAA Climatological Summary for New Cumberland, West Virginia

Month	Average Temperature (°F)	Precipitation (Inches)
January	34.7	3.67
February	33.6	3.94
March	43.9	7.24
April	46.6	4.79
May	57.5	3.42
June	68.3	2.66
July	76.4	3.87
August	73.1	3.48
September	64.6	2.66
October	54.7	3.29
November	46.6	2.69
December	34	3.59

K:\CCA\PROJECTS\Buckeye_Power\Cardinal\BAP\CCR Groundwater Monitoring Network Plan\2021 BAP Retrofit Proposed GW Network\Tables\[Table 3-1 NOAA Climatological Summary.xlsx]Table

Table 3-2. Hydraulic Conductivity, Retrofitted BAP, Cardinal Power Plant, Brilliant, Ohio

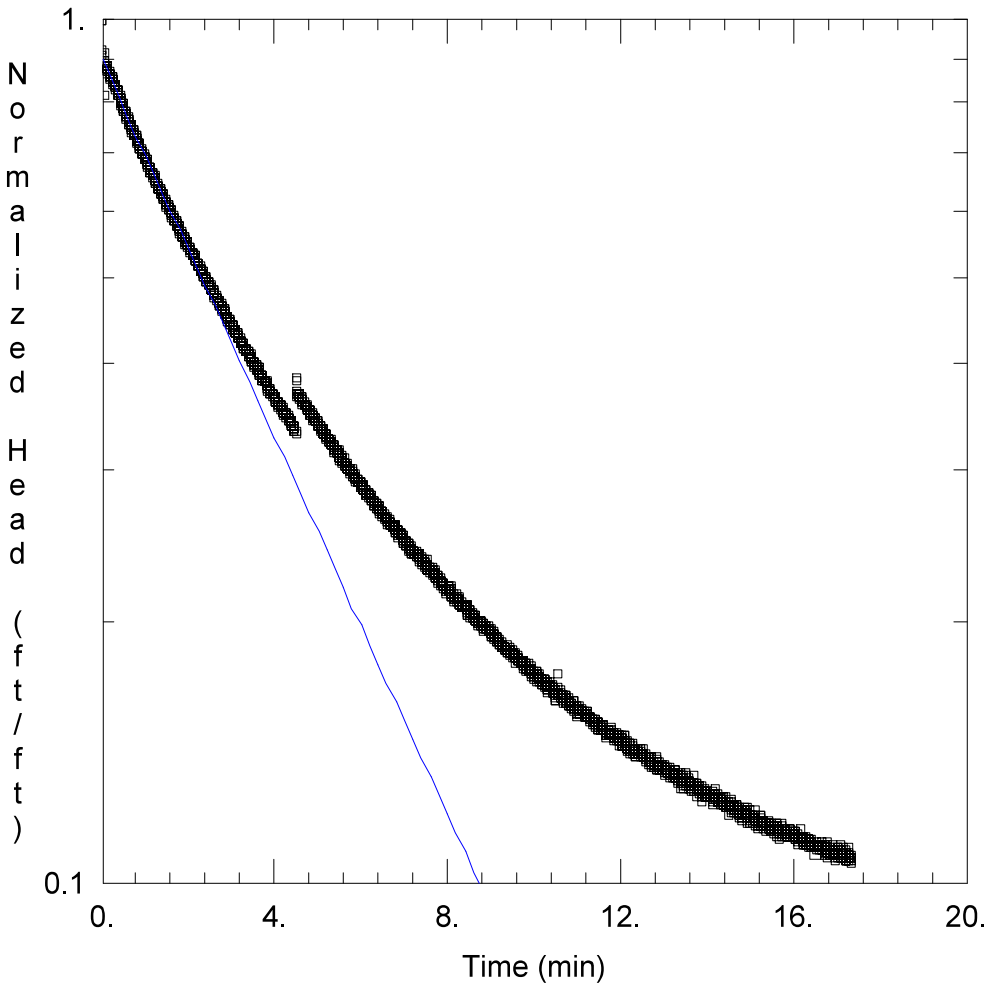
	Hydraulic Conductivity	
	ft/day	cm/sec
MW-BAP-1001	0.6606	0.000233
MW-BAP-1002	836.4	0.295063
MW-BAP-1003	797.6	0.281376
MW-BAP-3 *	817	0.288219

K:\CCA\PROJECTS\Buckeye_Power\Cardinal\BAP\CCR Groundwater Monitoring Network Plan\2022 BAP Retrofit Proposed GW Network\Tables\[Table 3-2 Hydraulic Conductivity.xlsx]Sheet1

* MW-BAP-3 hydraulic conductivity is estimated by averaging values at MW-BAP-1002 and MW-BAP-1003

Appendix A

Slug Test Results



WELL TEST ANALYSIS

Data Set: C:\...\MW-BAP-1001 (ft-day).aqt
Date: 04/09/21 Time: 15:41:07

PROJECT INFORMATION

Company: Hull
Test Well: MW-BAP-1001
Test Date: 3-19-2021

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 1.

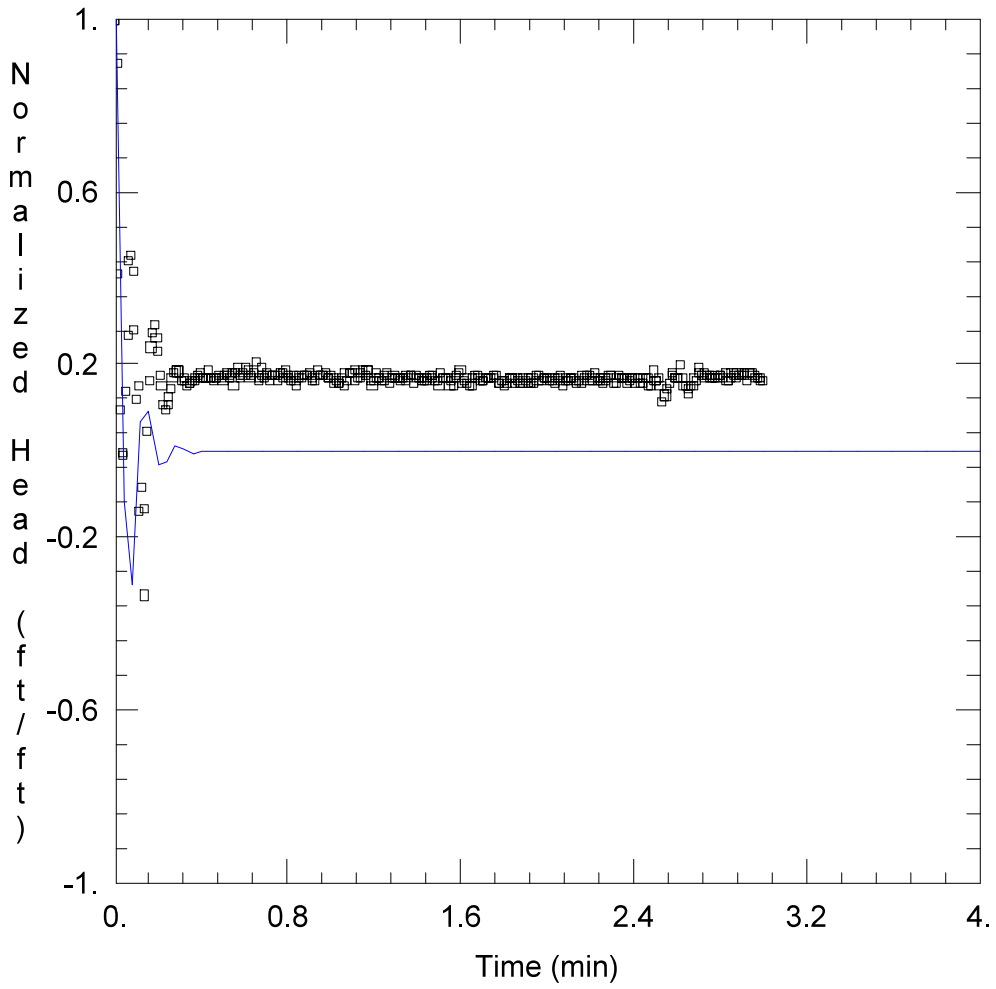
WELL DATA (MW-BAP-1001)

Initial Displacement: 2.898 ft
Total Well Penetration Depth: 54. ft
Casing Radius: 0.083 ft
Static Water Column Height: 28.65 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.6606 ft/day y0 = 2.597 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-BAP-1002 (ft-day).aqt
Date: 04/09/21 Time: 15:42:13

PROJECT INFORMATION

Company: Hull
Test Well: MW-BAP-1001
Test Date: 3-19-2021

AQUIFER DATA

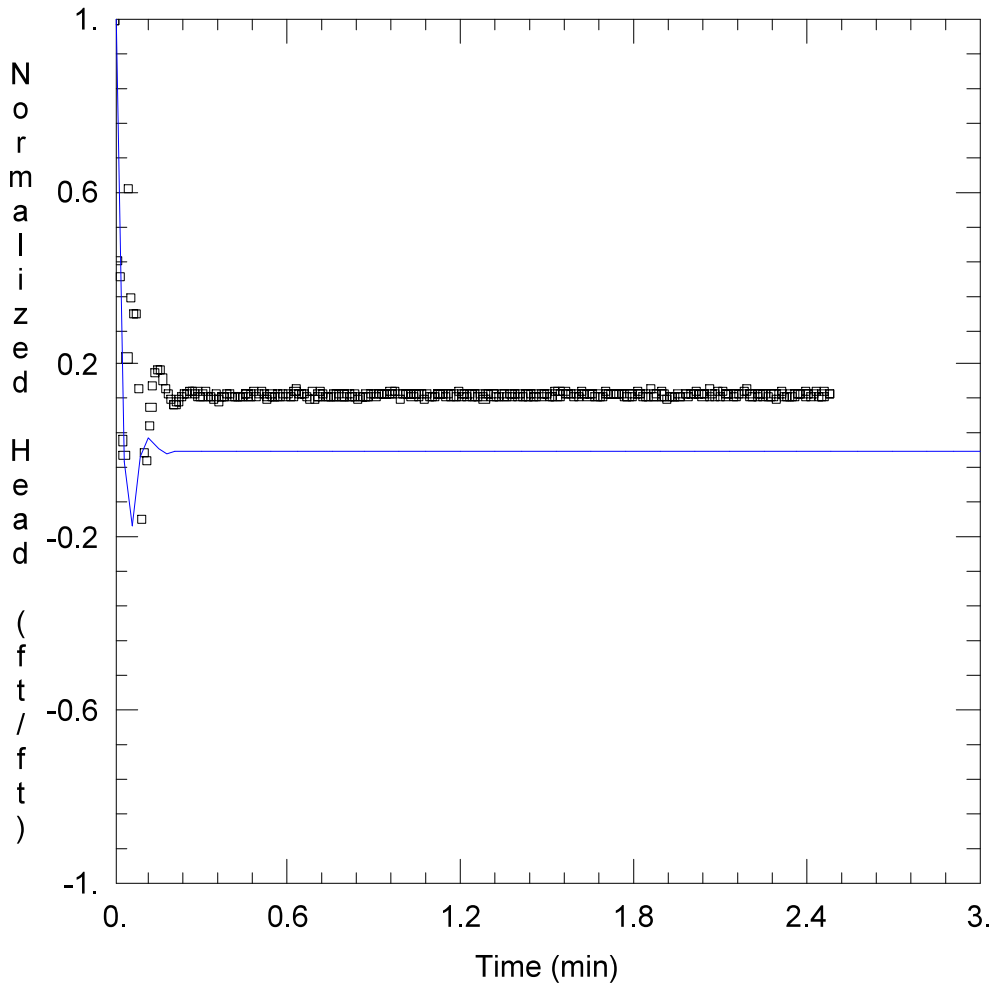
Saturated Thickness: 15. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-BAP-1002)

Initial Displacement: 0.503 ft
Total Well Penetration Depth: 55. ft
Casing Radius: 0.08 ft
Static Water Column Height: 25.2 ft
Screen Length: 15. ft
Well Radius: 0.08 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Confined Solution Method: Butler
K = 836.4 ft/day Le = 8.523 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-BAP-1003 (ft-day).aqt
Date: 04/09/21 Time: 15:41:25

PROJECT INFORMATION

Company: Hull
Test Well: MW-BAP-1001
Test Date: 3-19-2021

AQUIFER DATA

Saturated Thickness: 15. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-BAP-1003)

Initial Displacement: 0.618 ft
Total Well Penetration Depth: 55. ft
Casing Radius: 0.08 ft
Static Water Column Height: 24.94 ft
Screen Length: 15. ft
Well Radius: 0.08 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Confined Solution Method: Butler
K = 797.6 ft/day Le = 4.319 ft

Appendix B

Boring Logs

EXPLANATION OF SYMBOLS AND TERMS USED ON BORING LOGS FOR SAMPLING AND DESCRIPTION OF SOIL

SAMPLING DATA

 - Blocked-in "SAMPLES" column indicates sample was attempted and recovered within this depth interval.

 - Sample was attempted within this interval but not recovered.

2/5/9 - The number of blows required for each 6-inch increment of penetration of a "Standard" 2-inch O.D. split-barrel sampler, driven a distance of 18 inches by a 140-pound hammer freely falling 30 inches. Addition of one of the following symbols indicates the use of a split-barrel other than the 2" O.D. sampler:

2S - 2½"O.D. split-barrel sampler

3S - 3" O.D. split-barrel sampler

P - Shelby tube sampler, 3" O.D., hydraulically pushed.

R - Refusal of sampler in very-hard or dense soil, or on a resistant surface.

50-2" - Number of blows (50) to drive a split-barrel sampler a certain number of inches (2), other than the normal 6-inch increment.

S/D - Split-barrel sampler (S) advanced by weight of drill rods (D),

S/H - Split-barrel sampler (S) advanced by combined weight of rods and drive hammer (H).

SOIL DESCRIPTIONS

All soils have been classified basically in accordance with the Unified Soil Classification System, but this system has been augmented by the use of special adjectives to designate the approximate percentages of minor components as follows:

Adjective	Percent by Weight
trace	1 to 10
little	11 to 20
some	21 to 35
"and"	36 to 50

The following terms are used to describe density and consistency of soils:

Term (Granular Soils)	Blows per foot
Very-loose	Less than 5
Loose	5 to 10
Medium-dense	11 to 30
Dense	31 to 50
Very-dense	Over 50

Term (Cohesive Soils)	Qu (tsf)
Very-soft	Less than 0.25
Soft	0.25 to 0.5
Medium-stiff	0.5 to 1.0
Stiff	1.0 to 2.0
Very-stiff	2.0 to 4.0
Hard	Over 4.0

Sampled Monitor Wells

LOG OF BORING NO. MW-BAP-3
BOTTOM ASH POND MONITORING WELL INSTALLATION
CARDINAL PLANT, BRILLIANT, OH

S&ME

LOCATION: **N. 819,111, E. 2,513,519** ELEVATION: **669.9** DATE: **11/11/15 - 11/12/15**

DRILLING METHOD: **4-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **55.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT (PLASTIC LIMIT — LIQUID LIMIT)	TEST RESULTS
	0						AGGREGATE - 12 INCHES	10 20 30 40	
668.9									
		1		20/12/10	28	87	FILL: Medium-dense to dense gray and brown fine to coarse gravel, some to "and" fine to coarse sand, little to some silt or silty clay (variers), contains pockets of fine to coarse sand, dry.		H=3.5
		2		10/13/18	39	80			H=4.0
	5	3		10/14/20	43	67			
		4		3/22/13	44	100			
661.4		5		9/11/9	25	67			
659.9	10	6		3/10/13	29	100	FILL: Hard gray and brown silty clay, some fine to coarse and, little fine to coarse gravel, damp.		H=4.5+
658.4		7		11/27/30	71	67	FILL: Very-dense fine to coarse black and gray sand, some fine to coarse gravel, damp.		
		8		6/6/9	19	100	FILL: Very-stiff brown silty clay, some to "and" fine to coarse sand, some fine to coarse gravel, damp.		H=3.5
655.4		9		6/14/14	35	87			H=3.5-4.0
	15	10		4/5/6	14	80	FILL: Loose to medium-dense brown fine to coarse gravel, some to "and" fine to coarse sand, some silty clay, damp to moist.		
		11		6/6/5	14	80	- Contains zones of hard silty clay at 16.0'.		H=4.5
		12		2/4/6	13	93			
649.4	20	13		1/4/2	8	67			
		14		2/3/4	9	53	Medium-stiff to stiff brown clayey silt, "and" fine to coarse sand, some fine to coarse gravel, wet.		H=1.0-2.0
647.3		15A		2/2/3	6	100			H=0.5
		15B					Loose gray fine to medium sand, trace coarse sand, trace fine gravel, little silt, wet.		
		16		1/3/1	5	100			
644.4	25								
		17		1/1/SH	0	100	Very-loose gray silt, little fine to medium sand, wet.		
641.9									
		18		1/2/	8	100	Soft to stiff dark-brown mottled with dark-gray slithly organic to organic clayey silt, little to some fine to medium sand, contains silt seams, fine		H=1.0-1.5
	30								

2010 NEW DEFAULT BORING LOG-W/ N60

WATER LEVEL: ▽ 28.2 ▼
WATER NOTE: Inside Well
DATE: 12/11/15

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. (See Separate Curves)

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.75
Last Calibration Date : 8/2/2013
Drill Rig Number : S&ME

JOB: 7217-15-007B

-CONTINUED-

ATV 550-2

PLATE 7

LOG OF BORING NO. MW-BAP-3
BOTTOM ASH POND MONITORING WELL INSTALLATION
CARDINAL PLANT, BRILLIANT, OH

S&ME

LOCATION: **N. 819,111, E. 2,513,519** ELEVATION: **669.9** DATE: **11/11/15 - 11/12/15**

DRILLING METHOD: **4-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **55.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT (PLASTIC LIMIT — LIQUID LIMIT; 10 20 30 40)	TEST RESULTS
	30						sand seams and roots, wet.		
		19		1 / 2 / 4	5	100	Soft to stiff dark-brown mottled with dark-gray slithly organic to organic clayey silt, little to some fine to medium sand, contains silt seams, fine sand seams and roots, wet.		
		20		SH / 2 / 1	4	100			
634.4	35								
		21		SH / 2 / 1	4	100	Soft to medium-stiff dark-brown mottled with gray slightly organic to organic clayey silt, some to "and" fine to medium sand, wet.		
		22		SH / 1 / 2	4	100			
629.4	40								
		23		SH / 2 / 1	4	100	Soft to medium-stiff gray mottled with brown silty clay, trace to some fine to coarse sand, slightly organic, contains fine sand seams, wet.		
		24		SH / 4 / 7	14	100			
624.9	45								
		25		6 / 11 / 17	35	80	Medium-dense to very-dense brown fine to coarse gravel, some to "and" fine to coarse sand, trace to little silt, wet. - Contains zones of fine to coarse sand at 49.0'.		
		26		22 / 35 / 25	75	53			G
	50								
		27		21 / 8 / 8	20	33			
614.9	55						- Encountered seepage at 16.0'. - Encountered water at 20.5'. - Borehole converted to monitoring well upon completion - See separate well completion diagram. - Datum: Ohio State Plane South. NAD		
	60								

2010 NEW DEFAULT BORING LOG-W/ N60

WATER LEVEL: ▽ **28.2** ▼
WATER NOTE: **Inside Well**
DATE: **12/11/15**

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. (See Separate Curves)

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.75
Last Calibration Date : 8/2/2013
Drill Rig Number : S&ME

JOB: 7217-15-007B

-CONTINUED-

ATV 550-2

PLATE 8

LOG OF BORING NO. MW-BAP-3
BOTTOM ASH POND MONITORING WELL INSTALLATION
CARDINAL PLANT, BRILLIANT, OH

S&ME

LOCATION: **N. 819,111, E. 2,513,519** ELEVATION: **669.9** DATE: **11/11/15 - 11/12/15**

DRILLING METHOD: **4-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **55.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT (PLASTIC LIMIT — LIQUID LIMIT)	TEST RESULTS
	60						27/NAVD 29 (Plant Grid).	10 20 30 40	
	65								
	70								
	75								
	80								
	85								
	90								

WATER LEVEL: ▽ **28.2** ▼
WATER NOTE: **Inside Well**
DATE: **12/11/15**

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. (See Separate Curves)

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.75
Last Calibration Date : 8/2/2013
Drill Rig Number : S&ME

JOB: 7217-15-007B

ATV 550-2

PLATE 9

2010 NEW DEFAULT BORING LOG-W/ N60

TEST BORING LOG

PROJECT: CARDINAL BOTTOM ASH POND WELL INSTALLATION
LOCATION: BRILLIANT, OH

BORING	**MW-BAP-1001**
G.S. ELEV.	670.31
FILE	415532
SHEET	1 OF 2

GROUNDWATER DATA			
FIRST ENCOUNTERED NR			
DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE				
d	FROM	0.0 '	TO	52.3 '

DRILLER	HAD
HELPER	
INSPECTOR	K. FOWLER
DATE STARTED	01/06/2021
DATE COMPLETED	01/06/2021

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
5	S-1	2 2 4 6		***Sandy Fill*, hydroexcavated from 0-5 feet**		
				7.0 663.3		
	S-2	4 8 6 6				
10	S-3	3 9 9 6		***Light brown, brown and gray Silty Clay, stiff to very stiff, dry***		
	S-4	7 4 5 7				
15	S-5	2 4 6 4		15.0 655.3		
	S-6	2 3 3 3		***Brown and gray Sand and Rock Fragments, loose to medium dense, wet***		
	S-7	40 22 8 6				
20	S-8	4 7 4 3		21.0 649.3		
	S-9	3 3 5 8				
25	S-10	2 6 4 6				
	S-11	2 6 4 6		***Brown and light brown Clayey Silt, some rock fragments, soft to stiff, damp to moist***		
	S-12	1 2 2 5			23.6	mottled from 29 feet to 31 feet with some black organics
30	S-13	1 2 2 2				
	SH-14			33.0 637.3		
	S-15	1 2 2 4		***Black and greenish gray Lean Clay, soft to medium stiff, dry, (CL)***	23.8	
35						

DRN. SAP
CKD. SDM

NEW PROJECTS TEST BORING LOG 415532_CARDINAL BOTTOM ASH POND WELL INSTALLATION.GPJ SITE BLAUVELT.GDT 3/8/21

TEST BORING LOG

PROJECT: CARDINAL BOTTOM ASH POND WELL INSTALLATION
LOCATION: BRILLIANT, OH

BORING	**MW-BAP-1001**
G.S. ELEV.	670.31
FILE	415532
SHEET	2 OF 2

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
	SH-16				28	some gravel from 37 feet to 39 feet
	S-17	2 3 3 4		***Black and greenish gray <u>Lean Clay</u>, soft to medium stiff, dry, (CL)***	27.1	
40	SH-18			41.0 629.3		
	S-19	1 1 2 2		***Gray <u>Silty Sand</u>, with clay, some organics, very soft to soft (SM)***		some organics from 43 feet to 45 feet
45	S-20	WH WH 1 3		45.0 625.3		
	S-21	WH WH WH 2		***Greenish gray <u>Silty Sandy Clay</u>, organics, very soft to medium stiff, dry***		
	S-22	2 2 3 3				
50	S-23	1 3 2 1		51.0 619.3		
	S-24	16 25 50/0.3		52.3 ***<u>Sandstone</u>*** 618.0		Monitoring well installed at boring completion; see monitoring well installation log
				END OF BORING AT 52.3'		
55						
60						
65						
70						
75						

NEW PROJECTS TEST BORING LOG 415532_CARDINAL BOTTOM ASH POND WELL INSTALLATION.GPJ SITE BLAUVELT.GDT 3/8/21

TEST BORING LOG

PROJECT: CARDINAL BOTTOM ASH POND WELL INSTALLATION
LOCATION: BRILLIANT, OH

BORING	**MW-BAP-1002**
G.S. ELEV.	670.06
FILE	415532
SHEET	1 OF 2

GROUNDWATER DATA			
FIRST ENCOUNTERED NR			
DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE				
d	FROM	0.0 '	TO	54.0 '

DRILLER	HAD
HELPER	
INSPECTOR	K. FOWLER
DATE STARTED	01/05/2021
DATE COMPLETED	01/06/2021

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
5				***Sandy Fill*, hydroexcavated from 0-5 feet**		
				5.0 / 665.1		
	S-1	2 7 11 11		***Brown and gray Sand*, with clay and gravel, medium dense, dry (FILL)**		
	S-2	4 7 7 9		9.0 / 661.1		
10	S-3	5 20 14 9				
	S-4	6 9 9 13				
15	S-5	9 9 8 9				orange mottling from 15 feet to 19 feet
	S-6	5 3 3 4				
	S-7	1 1 3 3				organics present from 19 feet to 21 feet. slight odor from 19 feet to 21 feet.
20	S-8	1 1 3 1		***Orange Clayey Silt*, some rock fragments, very soft to very stiff, dry to wet (ML)**		
	S-9	2 2 2 2			27.5	
25	SH-10					
	S-11	1 1 2 3			26.3	
	SH-12					
30	S-13	1 1 1 1			42.5	
	SH-14			33.0 / 637.1		
35	S-15	WH WH WH WH		***Gray and brown Sand very loose to dense, moist to wet (SW)**		

DRN.	SAP
CKD.	SDM

NEW PROJECTS TEST BORING LOG 415532_CARDINAL BOTTOM ASH POND WELL INSTALLATION.GPJ SITE BLAUVELT.GDT 3/8/21

TEST BORING LOG

PROJECT: CARDINAL BOTTOM ASH POND WELL INSTALLATION
LOCATION: BRILLIANT, OH

BORING	**MW-BAP-1002**
G.S. ELEV.	670.06
FILE	415532
SHEET	2 OF 2

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
	S-16	1 1 1 1				
	S-17	1 3 5 5				
40	S-18	1 2 1 2				
	S-19	5 8 11 13				
45				***Gray and brown <u>Sand</u> very loose to dense, moist to wet (SW)***		
	S-20	2 5 8 10				Coarse gravel from 49.5 feet to 50 feet
50	S-21	11 9 10 8				Monitoring well installed at boring completion; see monitoring well installation log
	S-22	7 12 10 9				
55				55.0 615.1 ***END OF BORING AT 55'***		
60						
65						
70						
75						

NEW PROJECTS TEST BORING LOG 415532_CARDINAL BOTTOM ASH POND WELL INSTALLATION.GPJ SITE BLAUVELT.GDT 3/8/21

TEST BORING LOG

PROJECT: CARDINAL BOTTOM ASH POND WELL INSTALLATION
LOCATION: BRILLIANT, OH

BORING	**MW-BAP-1003**
G.S. ELEV.	670.08
FILE	415532
SHEET	1 OF 2

GROUNDWATER DATA			
FIRST ENCOUNTERED NR			
DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE				
d	FROM	0.0 '	TO	55.0 '

DRILLER	HAD
HELPER	
INSPECTOR	K. FOWLER
DATE STARTED	01/04/2021
DATE COMPLETED	01/05/2021

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
5	S-1	4 3 2 4		***Sandy Fill*, hydroexcavated from 0-5 feet**		
				5.0		
				***Brown Clay*, and rock fragments, medium stiff (FILL)**		
	S-2	2 2 3 5		7.0		
10	S-3	7 6 8 11		***Brown and gray Clayey Silt*, medium stiff to very stiff, dry**		
	S-4	8 50/0.5		11.0		
15	S-5	7 7 5 6		***Brown Shale Rock Fragments* with clay, stiff to hard, dry**		
	S-6	1 1 5 5		15.0		
	S-7	1 3 3 4		***Gray and brown Silty Clay*, medium stiff to stiff, dry**		
20	S-8	1 2 2 5		19.0		wood organics from 19 feet to 21 feet
	SH-9				25.1	
25	S-10	1 4 4 7		***Dark gray Silt*, with wood organics, low plasticity, soft to stiff, dry to moist (ML/OL)**	28.9	
	SH-11				30.9	
	S-12	3 4 5 6				
30	SH-13			31.0		
	S-14	WH WH WH WH		***Gray and light brown Lean Clay*, very soft, damp to moist**	43.6	
35	S-15	WH WH WH WH		35.0		

DRN.	SAP
CKD.	SDM

NEW PROJECTS TEST BORING LOG 415532_CARDINAL BOTTOM ASH POND WELL INSTALLATION.GPJ SITE BLAUVELT.GDT 3/8/21

TEST BORING LOG

BORING	**MW-BAP-1003**
G.S. ELEV.	670.08
FILE	415532
SHEET	2 OF 2

PROJECT: CARDINAL BOTTOM ASH POND WELL INSTALLATION
LOCATION: BRILLIANT, OH

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
	S-16	1 2 2 4				
	S-17	9 12 8 9				
40	S-18	10 17 16 20				
	S-19	10 15 12 20				
45	S-20	8 12 15 16		***Light brown Sand, fine to coarse grained, loose to dense, moist to wet***		
	S-21					
	S-22	10 11 13 10				
50	S-23	10 16 19 20				
	S-24	10 16 15 20				
55	S-25	9 14 16 16		55.0		Monitoring well installed at boring completion; see monitoring well installation log
				END OF BORING AT 55'		
60						
65						
70						
75						

NEW PROJECTS TEST BORING LOG 415532_CARDINAL BOTTOM ASH POND WELL INSTALLATION.GPJ SITE BLAUVELT.GDT 3/8/21

Water Level Only Monitor Wells

Cox-Colvin & Associates, Inc.

LOG OF BORING NO. MW-BAP-1
BOTTOM ASH POND MONITORING WELL INSTALLATION
CARDINAL PLANT, BRILLIANT, OH

S&ME

LOCATION: **N. 820,305, E. 2,513,927** ELEVATION: **669.8** DATE: **12/4/15 - 12/10/15**

DRILLING METHOD: **4-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **52.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT (PLASTIC LIMIT — LIQUID LIMIT)	TEST RESULTS
	0						AGGREGATE - 34 INCHES	10 20 30 40	
		1		47/34/26	75	100			
667.0									
		2		4/21/30	64	100	FILL: Hard brown silty clay, some fine to coarse sand, some fine to coarse gravel, cobbles, moist.		H=3.0
665.3									
	5	3		15/6/8	18	27	FILL: Medium-dense gray fine to coarse grave, little to some fine to coarse sand, trace silt to some silty clay, cobbles, dry.		
		4		7/40/7	59	67			
662.8									
		5		7/4/5	11	87	FILL: Stiff to very-stiff brown silty clay, some to "and" fine to coarse sand, some fine to coarse gravel, contains fine to coarse sand seams and sandstone fragments, damp.		H=2.5
		6		8/11/4	19	100			H=3.0
	10								
		7		6/8/5	16	100			H=2.5-3.5
658.3									
		8		10/8/7	19	67	FILL: Medium-dense fine to coarse gravel, some to "and" fine to coarse sand, some clayey silt, damp becoming moist.		
		9		3/3/6	11	100	- 3" pocket of sand at 14.5'.		
	15								
		10		5/3/7	13	53			H=1.25
653.8									
		11		4/3/3	8	67	Stiff gray clayey silt, "and" fine to coarse sand, little to some fine gravel, moist.		H=1.25
652.3									
		12		3/2/4	8	53	Loose brown fine to coarse sand, "and" silty clay, some fine to coarse gravel, moist.		H=1.0
650.6									
	20	13		7/8/5	16	93	Loose to medium-dense brown fine to coarse gravel, some to "and" fine to coarse sand, some silty clay, damp to moist.		H=4.5
		14		4/6/5	14	80			
		15		5/8/4	15	67			
		16		6/3/2	6	80			
	25								
643.8									
		17		4/4/5	11	73	Hard brown mottled with gray and dark-gray silty clay, little fine to coarse sand, trace fine to coarse gravel (shale fragments), slightly organic, damp.		H=3.0-4.0
641.0									
		18		2/2/	4	100	Stiff dark-brown clayey silt, little to some fine to medium sand, slightly organic, damp.		H=1.25-2.25
	30								

2010 NEW DEFAULT BORING LOG-W/ N60

WATER LEVEL: ▽ 31.0 ▼ 27.5
WATER NOTE: Inside HSA Inside Well
DATE: 12/7/15 12/15/15

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. (See Separate Curves)

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.75
Last Calibration Date : 8/2/2013
Drill Rig Number : S&ME

JOB: 7217-15-007B

-CONTINUED-

ATV 550-2

PLATE 3

LOG OF BORING NO. MW-BAP-1
BOTTOM ASH POND MONITORING WELL INSTALLATION
CARDINAL PLANT, BRILLIANT, OH

S&ME

LOCATION: **N. 820,305, E. 2,513,927** ELEVATION: **669.8** DATE: **12/4/15 - 12/10/15**

DRILLING METHOD: **4-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **52.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
	30							
638.8		▽						
		19		SH / SH / SH 1	0	100	Very-soft to medium-stiff brown, gray and dark-gray organic clayey silt, little fine sand, contains silt seams and lenses, contains seams of fine to coarse sand, wet.	H=0.0-0.25
		20		SH / SH / SH	0	100		H=0.0-0.75
	35	21		SH / SH / SH	0	100		H=0.0-0.75
630.7		22A 22B 22C		SH / SH / 1	0	100		H=1.0-1.5
	40						Very-loose gray fine to coarse sand, interbedded with silty clay seams, wet.	
628.8		23		1 / 2 / 3	6	60	Loose brown fine to coarse sand, trace fine gravel, trace silt, wet.	
626.8							Dense brown fine to coarse gravel, some to "and" fine to coarse sand, trace silt.	
	45	24		13 / 17 / 23	50	47		G
		25		19 / 14 / 18	40	67		
	50							
618.8								
		26		9 / 7 / 8	19	47	Medium-dense brown fine to coarse sand, trace fine gravel, trace clay.	
617.3								
	55						- Encountered water at 31.0'. - Encountered cobbles at 4.4 and 18.2'. - Borehole converted to monitoring well upon completions. See separate well completion diagram. - Boring locations and elevation surveyed by AEP. - Datum: Ohio State Plane South. - NAD 27/NAVD 29 (Plant Grid).	
	60							

NATURAL CONSISTENCY INDEX
NATURAL MOISTURE CONTENT
PLASTIC LIMIT — LIQUID LIMIT
10 20 30 40

2010 NEW DEFAULT BORING LOG-W/ N60

WATER LEVEL: ▽ **31.0** ▼ **27.5**
WATER NOTE: **Inside HSA** **Inside Well**
DATE: **12/7/15** **12/15/15**

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. (See Separate Curves)

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.75
Last Calibration Date : 8/2/2013
Drill Rig Number : S&ME

JOB: 7217-15-007B

ATV 550-2

PLATE 4

LOG OF BORING NO. MW-BAP-2
BOTTOM ASH POND MONITORING WELL INSTALLATION
CARDINAL PLANT, BRILLIANT, OH

S&ME

LOCATION: **N. 819,792, E. 2,513,707** ELEVATION: **669.9** DATE: **12/2/15 - 12/4/15**

DRILLING METHOD: **4-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **45.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT (PLASTIC LIMIT — LIQUID LIMIT)	TEST RESULTS
	0						AGGREGATE - 23 INCHES	10 20 30 40	
668.0		1		19/11/25	45	87	FILL: Dense to very-dense dark-gray fine to coarse sand, trace to little fine gravel, trace to little silt, moist.		
666.3		2		25/33/30	79	47	FILL: Stiff to hard brown and dark-brown silty clay, some to "and" fine to coarse sand, little to some fine to coarse gravel, few pockets of gravel, dry becoming damp.		
	5	3		33/11/8	24	60			H=2.0
		4		11/9/15	30	67			H=4.5
		5		8/9/13	28	80			
		6		4/6/9	19	60			
	10	7		7/5/5	13	87			
		8		4/10/8	23	80			H=2.0-4.5
		9		2/8/3	14	53			H=2.5
655.4									
	15	10		3/6/5	14	67	FILL: Medium-stiff to very-stiff brown mottled with gray silty clay, some fine to coarse sand, little fine to coarse gravel, moist.		H=3.5
		11		2/3/4	9	87			H=1.0-2.25
		12		3/3/5	10	67			H=0.75-1.5
650.3									
	20	13		3/3/4	9	87	FILL: Very-loose to loose dark-gray fine to coarse sand, trace to little fine gravel, little silt, moist becoming wet.		H=2.0
		14		3/4/3	9	67			
		15		SH/SH/1	0	100	- Contains sand seams at 20.0' to 20.3'.		
		16		SH/1/1	3	100			
644.7	25	17		1/1/1	3	100			H=0.5
643.9							FILL: Very-loose dark-gray silt, trace fine to coarse sand, slightly organic, wet.		
		18		SH/SH/3	0	53	Stiff gray mottled with brown silty clay, some fine sand, trace medium to coarse sand, slightly organic, silt seams, damp.		H=2.0
641.9									
		19		SH/SH/	0	100	Medium-stiff dark-gray organic clayey silt, little fine sand, damp.		H=1.0
	30								

2010 NEW DEFAULT BORING LOG-W/ N60

WATER LEVEL: ▽ **29.2** ▼
WATER NOTE: **Inside Well**
DATE: **12/15/15**

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. } See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.75
Last Calibration Date : 8/2/2013
Drill Rig Number : S&ME

JOB: 7217-15-007B

-CONTINUED-

ATV 550-2

PLATE 5

LOG OF BORING NO. MW-BAP-2
BOTTOM ASH POND MONITORING WELL INSTALLATION
CARDINAL PLANT, BRILLIANT, OH

S&ME

LOCATION: **N. 819,792, E. 2,513,707** ELEVATION: **669.9** DATE: **12/2/15 - 12/4/15**

DRILLING METHOD: **4-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **45.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT (PLASTIC LIMIT — LIQUID LIMIT)	TEST RESULTS
639.4	30							10 20 30 40	
		20		SH / 2 / 2	5	100	Stiff gray mottled with brown silty clay, little fine sand, trace medium to coarse sand, slightly organic, damp.		H=1.5
636.2									
		21		1 / 3 / 3	8	100	Loose fine to coarse sand, trace fine gravel, little to some silt, slightly organic, moist.		H=1.5
634.4	35								
		22		1 / 4 / 4	10	53	Loose brown fine to coarse sand, trace fine gravel, trace to little silt.		
		23		2 / 2 / 2	5	67			G
	40								
		24		2 / 2 / 3	6	100			
		25		2 / 2 / 2	5	100			
624.9	45								
							- Encountered water at 14.5'. to 16.0'. - Borehole converted to monitoring well upon completion - See separate well completion digram. - Boring location and elevation surveyed by AEP. - Datum: Ohio State Plane South - NAD 27/NAVD 29 (Plant Grid).		
	50								
	55								
	60								

WATER LEVEL: ▽ **29.2** ▼

WATER NOTE: **Inside Well**

DATE: **12/15/15**

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. (See Separate Curves)

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.75
Last Calibration Date : 8/2/2013
Drill Rig Number : S&ME

JOB: 7217-15-007B

ATV 550-2

PLATE 6

2010 NEW DEFAULT BORING LOG-W/ N60

LOG OF BORING NO. MW-BAP-4
BOTTOM ASH POND MONITORING WELL INSTALLATION
CARDINAL PLANT, BRILLIANT, OH

S&ME

LOCATION: **N. 820,880, E. 2,513,617** ELEVATION: **661.1** DATE: **11/20/15 - 11/23/15**

DRILLING METHOD: **4-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **40.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT (PLASTIC LIMIT — LIQUID LIMIT)	TEST RESULTS
	0						AGGREGATE - 12 INCHES	10 20 30 40	
660.1		1		4 / 15 / 16	39	87	FILL: Medium-dense to dense gray and brown fine to coarse gravel, some to "and" fine to coarse sand, little to some silt, dry.		H=4.25-4.5
		2		10 / 9 / 5	18	53			
655.8	5	3		6 / 9 / 7	20	67			
655.3		4		35 / 13 / 12	31	87	FILL: Very-soft brown and gray silty clay, "and" fine to coarse sand, little fine to coarse gravel.		G
653.6		5		50-3"R	20		FILL: Dense brown fine to coarse sand, little fine to coarse gravel, "and" clayey silt, cobbles, moist.		
		6		2 / 3 / 4	9	87	Stiff to very-stiff dark-brown mottled with dark-gray silty clay, little fine to coarse sand, trace fine gravel, slightly organic, damp.		H=2.0-3.0
	10								
				P					H=1.25-2.5
	15								
644.9		7		3 / 5 / 6	14	87	Very-stiff brown mottled with gray silty clay, little fine to medium sand, trace coarse sand, few cobbles, contains silt seams near top of stratum, damp.		H=2.0-3.5
		8		7 / 7 / 7	18				
	20	2S		10		100			H=2.25-3.25
		9		3 / 5 / 6	14	100			H=3.0
		10		3 / 5 / 6	14	100			H=3.25
	25								
634.4		11A		1 / 3 / 4	9	100			H=2.5
		11B					Medium-stiff to stiff brown clayey silt, "and" fine to medium sand, trace coarse sand, includes sand seams, moist.		H=0.5-1.5
		12		1 / 2 /	4	100			
	30								

2010 NEW DEFAULT BORING LOG-W/ N60

WATER LEVEL: ▽ **18.7** ▼
WATER NOTE: **Inside Well**
DATE: **12/15/15**

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. } See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.75
Last Calibration Date : 8/2/2013
Drill Rig Number : S&ME

JOB: 7217-15-007B

-CONTINUED-

ATV 550-2

PLATE 10

LOG OF BORING NO. MW-BAP-4
BOTTOM ASH POND MONITORING WELL INSTALLATION
CARDINAL PLANT, BRILLIANT, OH

S&ME

LOCATION: **N. 820,880, E. 2,513,617** ELEVATION: **661.1** DATE: **11/20/15 - 11/23/15**

DRILLING METHOD: **4-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **40.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT (PLASTIC LIMIT — LIQUID LIMIT; 10 20 30 40)	TEST RESULTS
630.6	30						Medium-stiff to stiff brown clayey silt, "and" fine to medium sand, trace coarse sand, includes sand seams, moist.		
		13		SH / SH / 1 1	0	100	Very-loose brown and gray fine to medium sand, little to "and" silt (percent varies), contains zones with a trace of coarse sand, wet.		G
		14		SH / SH / 1	0	67			
	35	15		SH / 1 / 1	3	67			
		16		SH / SH / 1	0	100			G
621.1	40						- Encountered water at 5.5'. - Encountered cobbles at 18.5'. - Borehole converted to monitoring well upon completion - See separate well completion diagram. - Boring location and elevation surveyed by AEP. - Datum: Ohio State Plane South, NAD 27/NAVD 29 (Plant Grid).		
	45								
	50								
	55								
	60								

2010 NEW DEFAULT BORING LOG-W/ N60

WATER LEVEL: ▽ **18.7** ▼
WATER NOTE: **Inside Well**
DATE: **12/15/15**

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. } See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.75
Last Calibration Date : 8/2/2013
Drill Rig Number : S&ME

JOB: 7217-15-007B

ATV 550-2

PLATE 11

LOG OF BORING NO. MW-BAP-5
BOTTOM ASH POND MONITORING WELL INSTALLATION
CARDINAL PLANT, BRILLIANT, OH

S&ME

LOCATION: **N. 820,052, E. 2,513,277** ELEVATION: **669.2** DATE: **11/24/15 - 11/25/15**

DRILLING METHOD: **4-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **62.5'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT (PLASTIC LIMIT — LIQUID LIMIT)	TEST RESULTS
	0						AGGREGATE - 12 INCHES	10 20 30 40	
668.2		1		6 / 8 / 11	24	60	FILL: Medium-dense brown fine to coarse sand, some fine to coarse gravel, some to "and" silty clay, dry.		
		2		16 / 5 / 5	13	60			
663.7	5	3		4 / 4 / 6	13	73			G
		4		5 / 9 / 32	51	87	FILL: Hard gray and brown silty clay, "and" fine to coarse sand, little to some fine to coarse gravel, damp.		H=4.5
660.7		5		16 / 15 / 16	39	80			H=4.5
659.2		6		10 / 13 / 11	30	87	FILL: Medium-dense brown and gray fine to coarse sand, little fine to coarse gravel, some silty clay, damp.		
	10			P			FILL: Hard brown silty clay, some fine to coarse sand, some fine to coarse gravel (shale fragments), damp.		H=4.5
		7		3 / 5 / 10	19	80			H=4.5
655.7		8		10 / 11 / 25	45	80	FILL: Medium-dense to dense brown fine to coarse gravel, some fine to coarse sand, some silty clay becoming trace silt at bottom of stratum, damp.		H=3.0
	15	9		11 / 7 / 6	16				
652.3		10A		4 / 6 / 10	20	100	Medium-stiff to stiff gray mottled with dark-gray and brown silty clay, trace fine to coarse sand, trace fine gravel, few roots, few silt seams, slightly organic, moist.		
		10B		P					
	20								
		11		SH / 1 / 3	5	100			G H=0.5-1.25
646.2									
		12		2 / 2 / 4	8	100	Medium-stiff to very-stiff brown mottled with gray silty clay, trace to little fine to coarse sand, damp.		H=3.5
	25			P					
				P					
	30								

2010 NEW DEFAULT BORING LOG-W/ N60

WATER LEVEL: 27.1
WATER NOTE: Inside Well
DATE: 12/15/15

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. (See Separate Curves)

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.75
Last Calibration Date : 8/2/2013
Drill Rig Number : S&ME

JOB: 7217-15-007B

-CONTINUED-

ATV 550-2
PLATE 12

LOG OF BORING NO. MW-BAP-5
BOTTOM ASH POND MONITORING WELL INSTALLATION
CARDINAL PLANT, BRILLIANT, OH

S&ME

LOCATION: **N. 820,052, E. 2,513,277** ELEVATION: **669.2** DATE: **11/24/15 - 11/25/15**

DRILLING METHOD: **4-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **62.5'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT (PLASTIC LIMIT — LIQUID LIMIT; 10 20 30 40)	TEST RESULTS
	30						Medium-stiff to very-stiff brown mottled with gray silty clay, trace to little fine to coarse sand, damp.		
		13		2 / 4 / 6	13	100			H=2.0-3.5
		14		3 / 4 / 5	11	100			H=2.5-3.0
	35								
		15		2 / 5 / 6	14	100			H=2.5
		16		2 / 3 / 5	10	100			H=2.5
	40								
		17		SH / 2 / 3	6	100			H=1.25
		18		SH / SH / SH	0	100			H=1.25
623.7	45								
621.2		19		SH / SH / 1	0	100	Stiff gray mottled with brown and dark-gray silty clay, trace fine to coarse sand, slightly organic, damp.		H=0.75
		20		SH / SH / SH	0	100	Medium-stiff to stiff gray and dark-gray organic clayey silt, trace fine to coarse sand, damp.		H=0.75-1.25
618.7	50								
		21		6 / 9 / 9	23	87	Medium-dense to dense fine to coarse gravel, some to "and" fine to coarse sand, trace to little silt, wet.		G
		22		8 / 21 / 34	69	87			
613.8	55								
		23		14 / 20 / 14	43	80	Medium-dense to dense gray and brown fine to coarse sand, "and" fine to coarse gravel, little silt, wet.		
		24		7 / 12 /	35	60			G
	60								

WATER LEVEL: ▽ **27.1** ▼

WATER NOTE: **Inside Well**

DATE: **12/15/15**

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. (See Separate Curves)

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.75
Last Calibration Date : 8/2/2013
Drill Rig Number : S&ME

JOB: 7217-15-007B

-CONTINUED-

ATV 550-2

PLATE 13

2010 NEW DEFAULT BORING LOG-W/ N60

LOG OF BORING NO. MW-BAP-5
BOTTOM ASH POND MONITORING WELL INSTALLATION
CARDINAL PLANT, BRILLIANT, OH

S&ME

LOCATION: **N. 820,052, E. 2,513,277** ELEVATION: **669.2** DATE: **11/24/15 - 11/25/15**

DRILLING METHOD: **4-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **62.5'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT (PLASTIC LIMIT — LIQUID LIMIT)	TEST RESULTS
	60							10 20 30 40	
606.7		25		8 / 4 / 16 / 5	11	60	Medium-dense to dense gray and brown fine to coarse sand, "and" fine to coarse gravel, little silt, wet.		
	65						- Encountered water at 17.0'. - Borehole converted to monitoring well upon completion. See separate well completion diagram. - Boring location and elevation surveyed by AEP. - Datum: Ohio State Plane South NAD 27/NAVD 29 (Plant Grid).		
	70								
	75								
	80								
	85								
	90								

2010 NEW DEFAULT BORING LOG-W/ N60

WATER LEVEL: ▽ **27.1** ▼
WATER NOTE: **Inside Well**
DATE: **12/15/15**

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. (See Separate Curves)

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.75
Last Calibration Date : 8/2/2013
Drill Rig Number : S&ME

JOB: 7217-15-007B

ATV 550-2

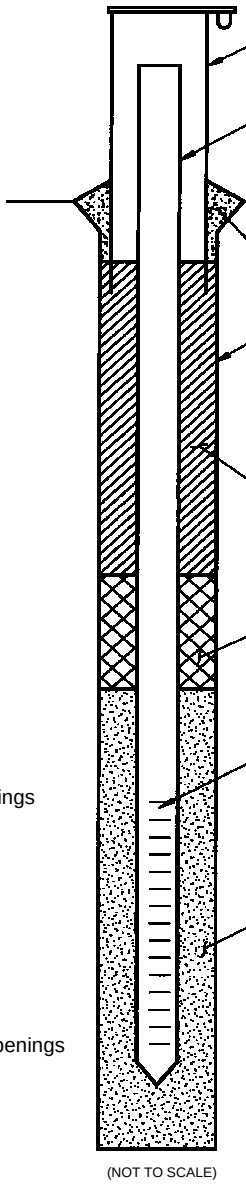
PLATE 14

Appendix C

Monitor Well Construction Logs

Sampled Monitor Wells

Elevation (Feet above MSL)	Depth Below Ground Surface (Feet)	
673.26	**-3.33**	Top of Cover
672.84	**-2.91**	Top of PVC
669.93	**0.0**	Ground Surface
667.4	**2.5**	Top of Grout
632.5	**37.4**	Top of Bentonite
626.5	**43.4**	Top of Filter Pack
624.5	**45.4**	Top of Screen Openings
614.5	**55.4**	Bottom of Screen Openings
613.9	**56.0**	Bottom of Well
613.9	**56.0**	Bottom of Boring



(NOT TO SCALE)

4 - Inch Diameter Protective Steel Casing

2 - Inch Diameter Flush-Thread PVC Casing

Ground Surface

Concrete

Boring Diameter (in inches)

8 " **0.0** to **56.0**

" to

" to

Grout: **Portland & Quick Gel**

Bentonite Seal: **3 - 5 gallon buckets (15 gal.) bentonite pellets**

10 - Slot Screen

Filter Pack: **5 - 50 lb. bags (250 lb.) #5 quartz sand**

Depth to Static Water:	28.2	28.0	28.2		
Static Water Elevation:	638.8	639.1	638.8		
Date:	**11/29/15**	**12/8/15**	**12/11/15**		

Well Development:

11/17 - Bailed 62.5 gallons of water (approx. 15 well volumes) out of well via submersible pump, water level stayed steady.
-Water level measurement on 12/8 was immediately before slug testing.
-Top cover set in 3'x3' concrete pad. Protective steel bollards placed around concrete pad.

Water Quality Readings (Horiba U-52)

Cumulative Gallons	NTU	C	ms/cm	PH	ORPmV
62.5	4.7	18.09	0.7	6.92	50

Location: N. 819,112.0' E. 2,513,519.4'
Datum: NAD27/NGVD29 OH S

WELL COMPLETION DIAGRAM

Project Name:
AEP CD Bottom Ash Pond Monitoring Wells

Project Location:
Cardinal Plant / Brilliant, Ohio

Project Number:
7217-15-007A

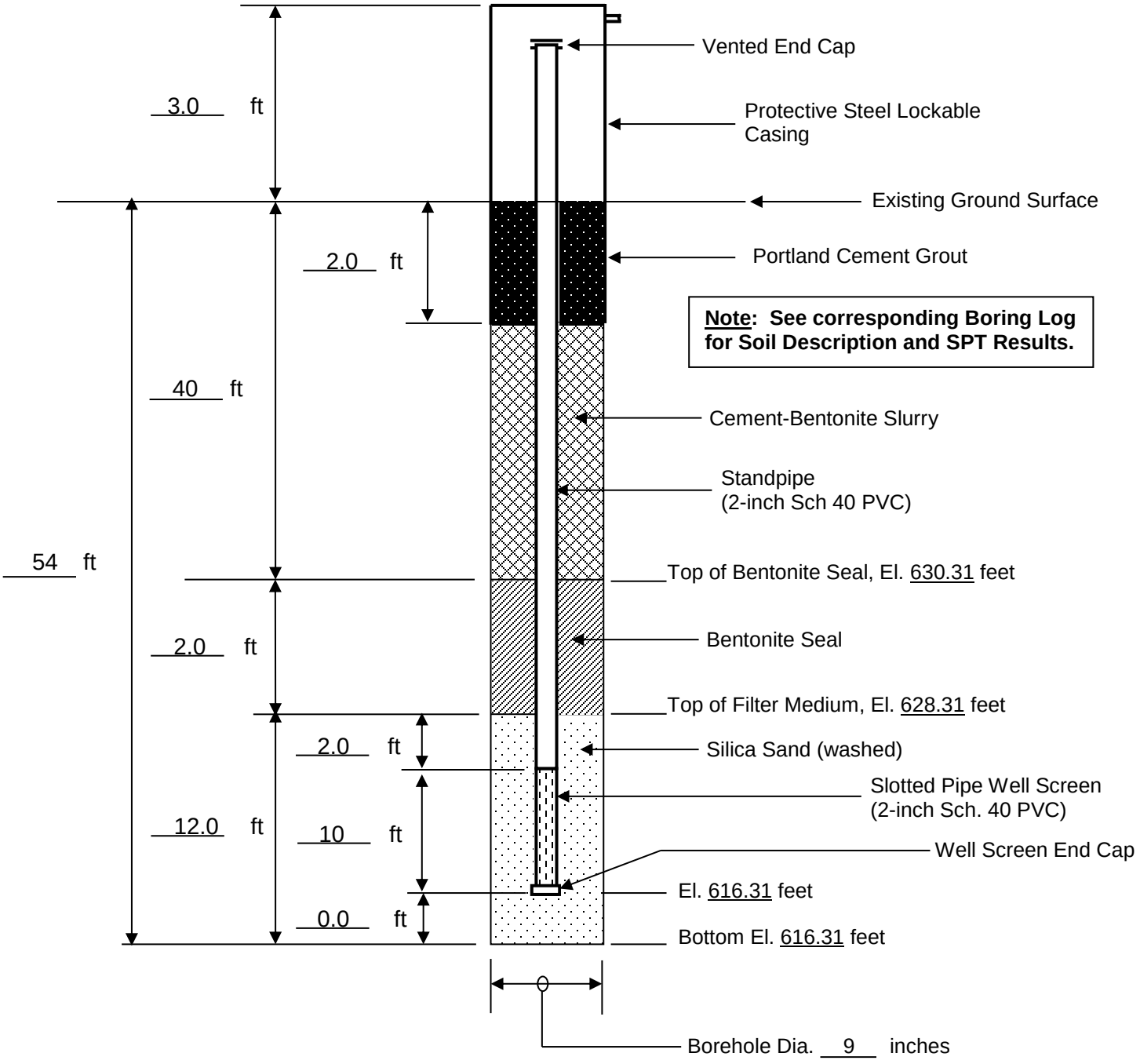
Boring Number:
MW-BAP-3

Date Well Installed:
11/13/2015

MONITORING WELL INSTALLATION LOG

Date Started: 1/6/2021 Date Completed: 1/6/2021
Coordinate: 819474.75 / 2513096.16 TOC Elev: 673.34
Driller: HAD Field Inspector: Kenton Fowler

Well Number MW-BAP-1001
G.S Elev 670.31
Sheet 1 of 1



Remarks: 10 ft long screen used due to location of clay organic layer.

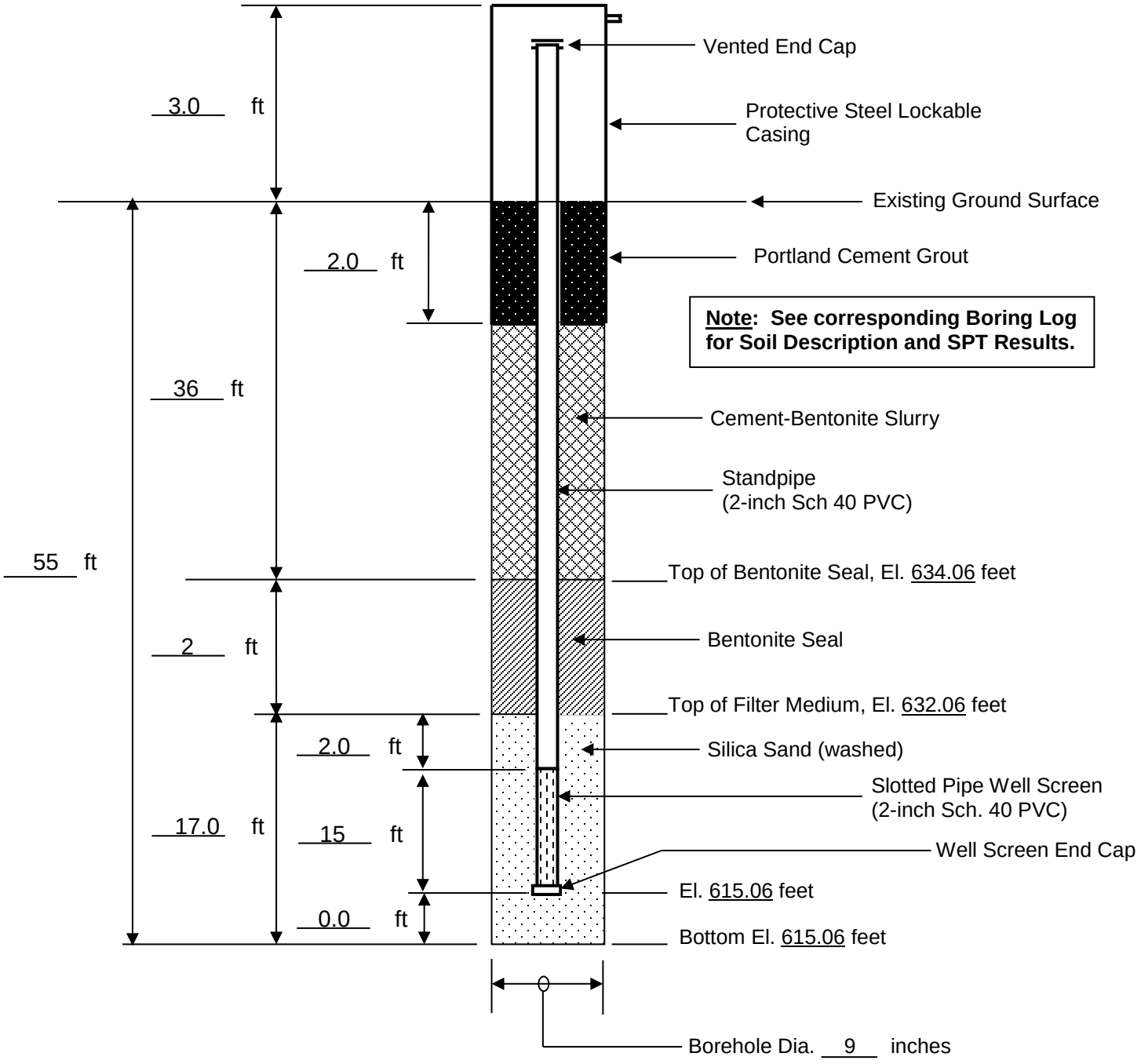
Horizontal Datum: NAD 27 Ohio State Plane (South Zone)

Vertical Datum: NGVD 29

Buckeye Power Inc.
Cardinal BAP Monitoring Well Install
Brilliant, Ohio
Drawing Not to Scale

MONITORING WELL INSTALLATION LOG

Date Started: 1/5/2021 Date Completed: 1/6/2021	Well Number MW-BAP-1002
Coordinate: 819468.12 / 2513611.82 TOC Elev: 673.15	G.S Elev 670.06
Driller: HAD Field Inspector: Kenton Fowler	Sheet 1 of 1



Remarks:

Horizontal Datum: NAD 27 Ohio State Plane (South Zone)

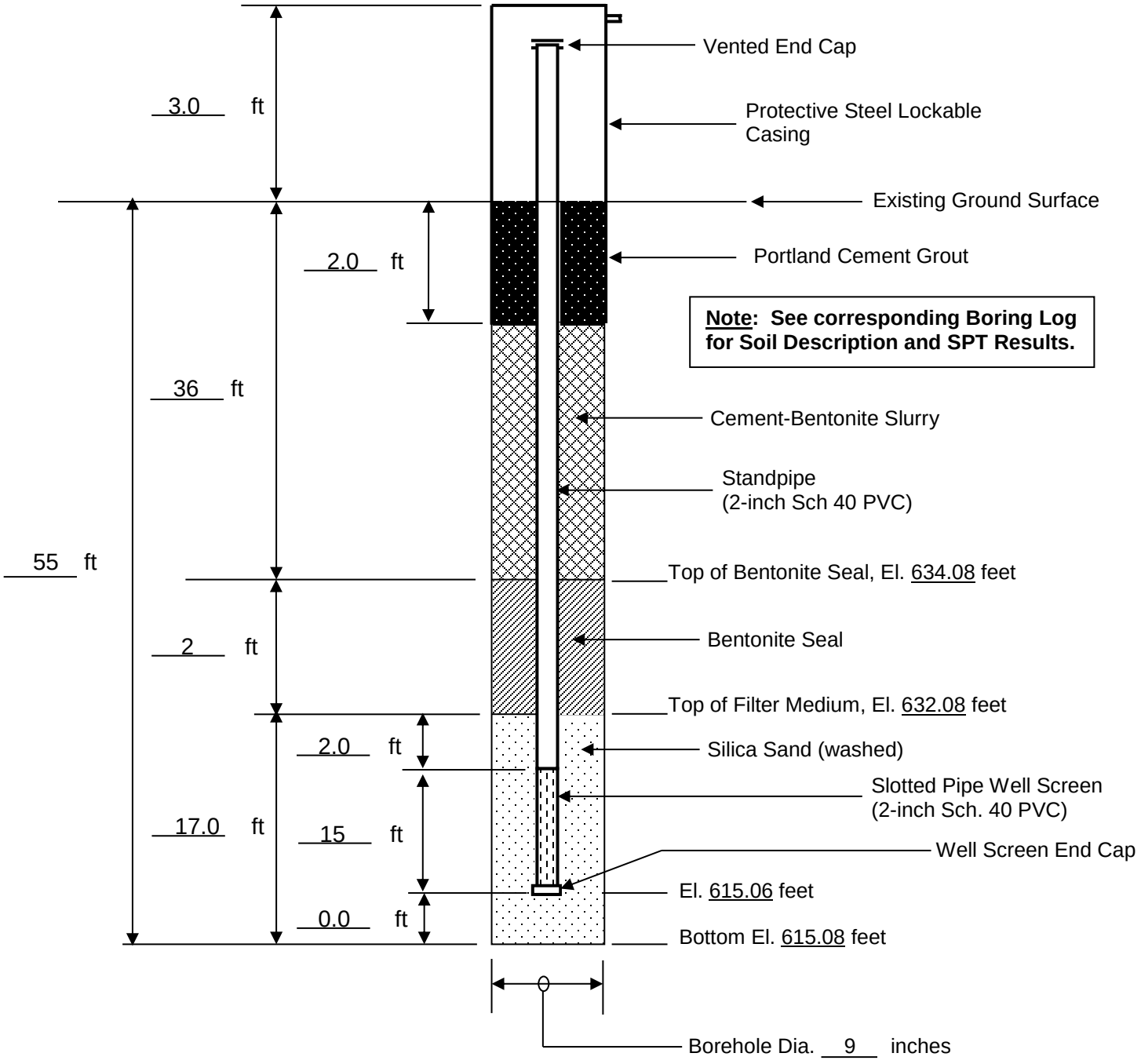
Vertical Datum: NGVD 29

Buckeye Power Inc.
Cardinal BAP Monitoring Well Install
Brilliant, Ohio
Drawing Not to Scale

MONITORING WELL INSTALLATION LOG

Date Started: 1/4/2021 Date Completed: 1/5/2021
Coordinate: 818691.63 / 2513400.83 TOC Elev: 672.87
Driller: HAD Field Inspector: Kenton Fowler

Well Number MW-BAP-1003
G.S Elev 670.08
Sheet 1 of 1



Remarks:

Horizontal Datum: NAD 27 Ohio State Plane (South Zone)

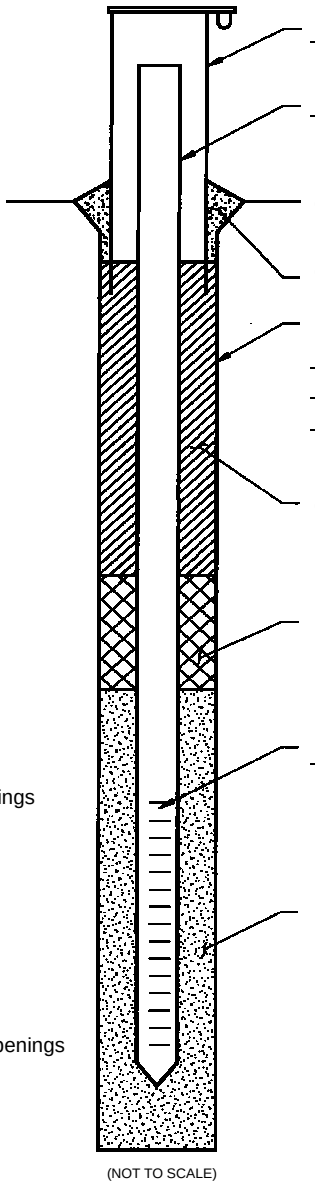
Vertical Datum: NGVD 29

Buckeye Power Inc.
Cardinal BAP Monitoring Well Install
Brilliant, Ohio
Drawing Not to Scale

Water Level Only Monitor Wells

Cox-Colvin & Associates, Inc.

Elevation (Feet above MSL)	Depth Below Ground Surface (Feet)	
672.65	**-2.86**	Top of Cover
672.29	**-2.50**	Top of PVC
669.79	**0.0**	Ground Surface
667.2	**2.6**	Top of Grout
638.9	**30.9**	Top of Bentonite
632.2	**37.6**	Top of Filter Pack
628.2	**41.6**	Top of Screen Openings
618.4	**51.4**	Bottom of Screen Openings
617.8	**52.0**	Bottom of Well
617.8	**52.0**	Bottom of Boring



(NOT TO SCALE)

4 - Inch Diameter Protective Steel Casing

2 - Inch Diameter Flush-Thread PVC Casing

Ground Surface

Concrete

Boring Diameter (in inches)

8 " **0.0** to **52.0**

" to

" to

Grout: **Portland & Quick Gel**

Bentonite Seal: **3 - 5 gallon buckets (15 gal.) bentonite pellets**

10 - Slot Screen

Filter Pack: **4 - 50 lb bags (200 lb.) #5 quartz sand**

Depth to Static Water:	28.7	27.5			
Static Water Elevation:	638.6	639.8			
Date:	**12/11/15**	**12/15/15**			

Well Development:

12/10 - Bailed 175 gallons of water (approx. 41 well volumes) via submersible pump. Water level stayed steady during pumping. NTU = 7 at 155 gallons, but increased to NTU = 12 upon terminating pump. Bailed additional 20 gallons during which initial NTU readings were intially high but decreased to NTU = 25.4.
-Water level measurement on 12/15 was immediately before slug testing.
-Top cover set in 3'x3' concrete pad. Protective steel bollards placed around concrete pad.

Water Quality Readings (Horiba U-52)

Cumulative Gallons	NTU	C	ms/cm	PH	ORPmV
175	25.4	18.09	1.31	7.15	-6

Location: N. 820,305.3' E. 2,513,927.4' Datum: NAD27/NGVD29 OH S

WELL COMPLETION DIAGRAM

Project Name:
AEP CD Bottom Ash Pond Monitoring Wells

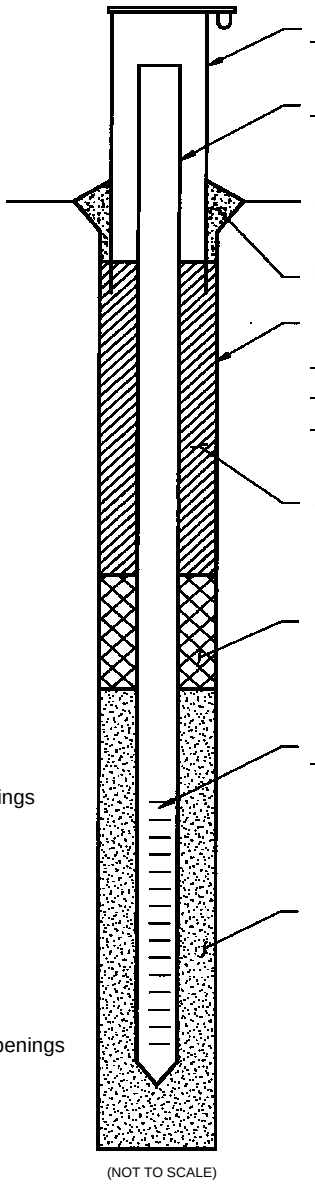
Project Location:
Cardinal Plant / Brilliant, Ohio

Project Number:
7217-15-007A

Boring Number:
MW-BAP-1

Date Well Installed:
12/10/2015

Elevation (Feet above MSL)	Depth Below Ground Surface (Feet)	
673.47	**-3.55**	Top of Cover
673.24	**-3.32**	Top of PVC
669.92	**0.0**	Ground Surface
667.3	**2.7**	Top of Grout
644.2	**25.7**	Top of Bentonite
638.2	**31.7**	Top of Filter Pack
635.8	**34.1**	Top of Screen Openings
626.0	**43.9**	Bottom of Screen Openings
625.4	**44.5**	Bottom of Well
624.9	**45.0**	Bottom of Boring



(NOT TO SCALE)

4 - Inch Diameter Protective Steel Casing

2 - Inch Diameter Flush-Thread PVC Casing

Ground Surface

Concrete

Boring Diameter (in inches)

8 " **0.0** to **44.5**

" to

" to

Grout: **Portland & Quick Gel**

Bentonite Seal: **3 - 5 gallon buckets (15 gal.) bentonite pellets**

10 - Slot Screen

Filter Pack: **9 - 50 lb. bags (450 lb.) #5 quartz sand**

Depth to Static Water:	29.5	29.2			
Static Water Elevation:	637.2	637.4			
Date:	**12/11/15**	**12/15/15**			

Well Development:

12/10 - Bailed 60 gallons of water (approx. 20 well volumes) out of well via submersible pump, water level stayed steady.
-Water level measurement on 12/15 was immediately before slug testing.
-Top cover set in 3'x3' concrete pad. Protective steel bollards placed around concrete pad.

Water Quality Readings (Horiba U-52)

Cumulative Gallons	NTU	C	ms/cm	PH	ORPmV
60	0	17.25	0.99	6.97	47

*Note: NTU readings were variable, water appeared visibly clear

Location: N. 819,792.3' E. 2,513,707.1'
Datum: NAD27/NGVD29 OH S

WELL COMPLETION DIAGRAM

Project Name:
AEP CD Bottom Ash Pond Monitoring Wells

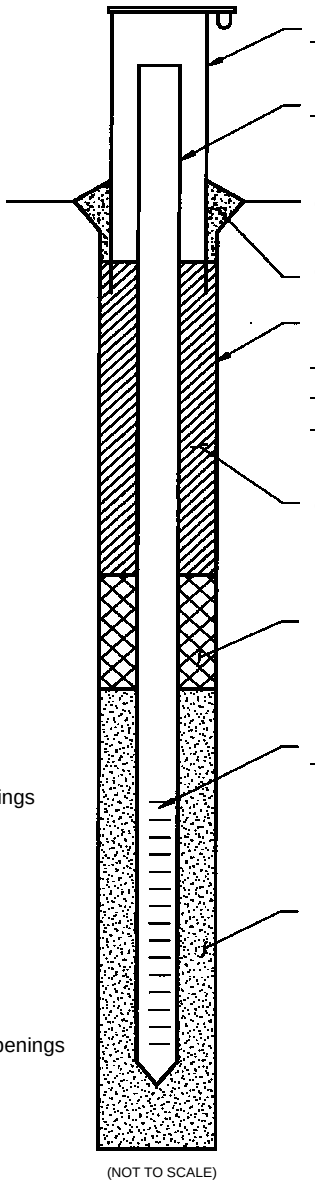
Project Location:
Cardinal Plant / Brilliant, Ohio

Project Number:
7217-15-007A

Boring Number:
MW-BAP-2

Date Well Installed:
12/2/2015

Elevation (Feet above MSL)	Depth Below Ground Surface (Feet)	
663.80	**-2.75**	Top of Cover
663.54	**-2.49**	Top of PVC
661.05	**0.0**	Ground Surface
658.4	**2.7**	Top of Grout
639.5	**21.6**	Top of Bentonite
634.2	**26.9**	Top of Filter Pack
632.2	**28.9**	Top of Screen Openings
622.4	**38.7**	Bottom of Screen Openings
621.8	**39.3**	Bottom of Well
621.1	**40.0**	Bottom of Boring



(NOT TO SCALE)

4 - Inch Diameter Protective Steel Casing

2 - Inch Diameter Flush-Thread PVC Casing

Ground Surface

Concrete

Boring Diameter (in inches)

8 " **0.0** to **39.3**

" to

" to

Grout: **Portland & Quick Gel**

Bentonite Seal: **3 - 5 gallon buckets (15 gal.) bentonite pellets**

10 - Slot Screen

Filter Pack: **7 - 50 lb. bags (350 lb.) #5 quartz sand**

Depth to Static Water:	18.8	18.7			
Static Water Elevation:	639.8	639.9			
Date:	**12/11/15**	**12/15/15**			

Well Development:

12/3 - Bailed 67.5 gallons of water (approx. 18 well volumes) out of well via submersible pump, water level stayed steady.
-Measurement on 12/15 was immediately before slug testing.
-Top cover set in 3'x3' concrete pad. Protective steel bollards placed around concrete pad.

Water Quality Readings (Horiba U-52)

Cumulative Gallons	NTU	C	ms/cm	PH	ORPmV
67.5	8.8	16.7	1.78	6.36	-7

Location: N. 820,879.5' E. 2,513,616.9'
Datum: NAD27/NGVD29 OH S

WELL COMPLETION DIAGRAM

Project Name:
AEP CD Bottom Ash Pond Monitoring Wells

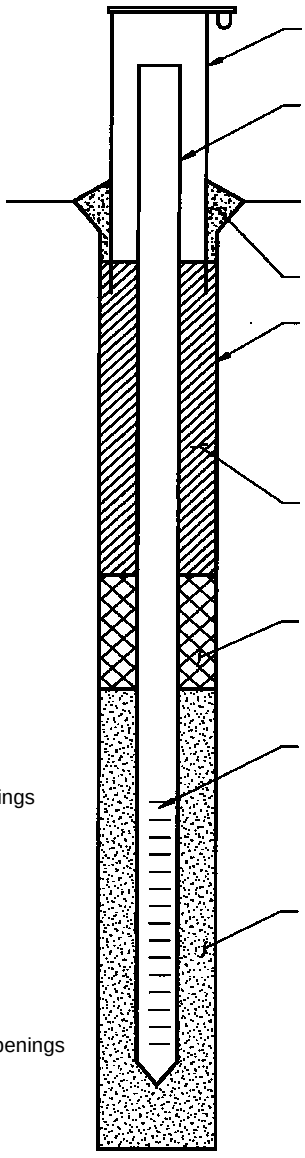
Project Location:
Cardinal Plant / Brilliant, Ohio

Project Number:
7217-15-007A

Boring Number:
MW-BAP-4

Date Well Installed:
11/23/2015

Elevation (Feet above MSL)	Depth Below Ground Surface (Feet)	
672.28	**-3.10**	Top of Cover
672.00	**-2.82**	Top of PVC
669.18	**0.0**	Ground Surface
662.6	**6.6**	Top of Grout
625.0	**44.2**	Top of Bentonite
619.5	**49.7**	Top of Filter Pack
617.5	**51.7**	Top of Screen Openings
607.7	**61.5**	Bottom of Screen Openings
607.1	**62.1**	Bottom of Well
606.7	**62.5**	Bottom of Boring



4 - Inch Diameter Protective Steel Casing

2 - Inch Diameter Flush-Thread PVC Casing

Ground Surface

Concrete

Boring Diameter (in inches)

8 " **0.0** to **62.1**

" to

" to

Grout: **Portland & Quick Gel**

Bentonite Seal: **3 - 5 gallon buckets (15 gal.) bentonite pellets**

10 - Slot Screen

Filter Pack: **7 - 50 lb. bags (350 lb.) #5 quartz sand**

(NOT TO SCALE)

Depth to Static Water:	27.3	27.6	27.2	27.1	
Static Water Elevation:	639.1	638.8	639.2	639.2	
Date:	**11/29/15**	**12/7/15**	**12/11/15**	**12/15/15**	

Well Development:

12/10 - Bailed 61.5 gallons of water (approx. 13 well volumes) out of well via submersible pump, water level stayed steady.
-Measurement on 12/15 was immediately before slug testing.
-Top cover set in 3'x3' concrete pad. Protective steel bollards placed around concrete pad.

Water Quality Readings (Horiba U-52)

Cumulative Gallons	NTU	C	ms/cm	PH	ORPmV
61.5	24.3	15.08	1.46	6.86	-56

Location: N. 820,052.1' E. 2,513,277.5'
Datum: NAD27/NGVD29 OH S

WELL COMPLETION DIAGRAM

Project Name:
AEP CD Bottom Ash Pond Monitoring Wells

Project Location:
Cardinal Plant / Brilliant, Ohio

Project Number:
7217-15-007A

Boring Number:
MW-BAP-5

Date Well Installed:
11/25/2015