REPORT

40 CFR PART 257 GROUNDWATER MONITORING PLAN

RCPA - Rush Island Energy Center

Jefferson County, Missouri, USA

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1.0 INTRODUCTION

This Groundwater Monitoring Plan (GMP) presents information on the design of the groundwater monitoring system, groundwater sampling and analysis procedures, and groundwater statistical analysis methods for the Ameren Missouri (Ameren) Rush Island Energy Center (Facility) in Jefferson County, Missouri (see location on **Figure 1**). The Facility manages Coal Combustion Residuals (CCR) at an on-site surface impoundment known as the RCPA Surface Impoundment. The RCPA is approximately 104 acres in size and is located in the south-southeast portion of the Facility.

This GMP was developed to meet the requirements of United States Environmental Protection Agency (USEPA) 40 CFR Part 257 "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule" (the CCR Rule). The CCR Rule requires owners or operators of an existing CCR Surface Impoundment to install a groundwater monitoring system and develop a sampling and analysis program (§§ 257.90 - 257.94). Ameren Missouri has determined that the RCPA Surface Impoundment is subject to the requirements of the CCR Rule. For this GMP, the Rush Island Energy Center generating plant is referred to as the RIEC and the RIEC and its surrounding facilities, including the Surface Impoundment, are referred to as the Facility or Site.

2.0 SITE SETTING

Ameren owns and operates the Facility in Jefferson County, Missouri located approximately 40 miles south of downtown St. Louis. **Figure 1** depicts the location of the Facility and property boundaries referenced to local topographic features and the Mississippi River. **Figure 2** depicts Facility structures relative to site property boundaries and the Mississippi River. The Facility encompasses approximately 960 acres and is located within the Mississippi River Valley and the adjacent upland areas to the west. The property is bounded to the east by the Mississippi River, to the south by Isle Du Bois Creek, to the north by Muddy Creek and extends into the bluffs to the west.

The Surface Impoundment is bounded to the north by the RIEC, which is at an elevation of approximately 410 feet above mean sea level (MSL). Directly to the east, south and west of the Surface Impoundment are low-lying floodplain areas, which have a lower topographic relief ranging from approximately 390 to 400 feet MSL. The eastern portion of the property contains approximately 300 to 400 feet of forested area in a narrow strip between the Surface Impoundment and the Mississippi River during normal river water levels. The southern portion of the property is forested and contains the Isle Du Bois Creek, which is as close as approximately 100 feet away from the Surface Impoundment. The western side of the property is bounded by a small drainage creek that is approximately 100 to 300 feet away from the Surface Impoundment. Approximately 300 to 500 feet west of the Surface Impoundment are bedrock bluffs that rise to elevations exceeding 700 feet MSL.

2.1 Coal Combustion Residuals (CCR) Surface Impoundment (RCPA)

The Surface Impoundment is located in the floodplain of the Mississippi River on the south-southeastern portion of the Facility to the south of the coal-fired plant and is constructed with perimeter berms at an elevation of approximately 410 feet MSL, which is above the 100-year flood event elevation of 406 feet MSL (FEMA, 2006). Both fly ash and bottom ash have been historically managed and stored in this unlined Surface Impoundment. Based on borings and piezometers previously completed by Natural Resource Technology, Inc. (NRT) the thickness of ash within the Surface Impoundment ranges from approximately 30 feet below ground surface (bgs) near the perimeter to approximately 109 feet bgs near the center of the impoundment (NRT, 2015). Based on NRT's findings, typical base elevations of ash in the Surface Impoundment are approximately 310 feet MSL.

2.2 Geology

2.2.1 Physiographic setting and Regional Geology

The Facility lies in the eastern margin of the Salem Plateau, a subsection of the Ozark Plateau Physiographic Province (USGS, 1994). The Ozark Plateau is described as a geological uplift or dome that has risen above the surrounding lowlands. The highpoint of this plateau or dome is located in the St. Francois Mountains. In the region of the Facility, the Salem Plateau portion of the Ozark Plateau is

comprised of Mississippian and Ordovician-aged dolostones, limestones and sandstones. This portion of the Ozark Plateau consists of bedrock cliffs along the major river channels. Bedrock in the area around the Facility dips approximately 3 to 7 degrees towards the east-northeast with occasional east-northeast trending syncline-anticline pairs located in the bluffs to the west of the Mississippi River Valley (Baker, 2001a, 2001b, 2001c).

2.2.2 Local Geology

The geology immediately surrounding the Facility is comprised of two distinctly different geological terrains; (1) floodplain deposits of the Mississippi River Valley and (2) older sedimentary bedrock formations. Most of the Facility, including all of the plant infrastructure and the Surface Impoundment, lies within the Mississippi River Valley on floodplain and alluvial soil deposits. The Mississippi River Valley in this region is an approximately 4- to 5-mile wide area of floodplain with alluvial deposits that are the result of the water flow and deposition from the Mississippi River. Based on boring logs from NRT (NRT 2014a, NRT 2014b, and NRT 2015) and Golder (**Appendix A**), the alluvial deposits are typically comprised of sands and gravels with lesser amounts of silts and clays, with an overall fining upward sequence. With depth, silt and clay deposits are less abundant and the sands and gravels typically coarsen. The depth of the alluvial deposits near the Surface Impoundment ranges from approximately 56 to 147 feet bgs (255 to 331 feet MSL).

Beneath the alluvial deposits of the Mississippi River Valley lie bedrock deposits from the lower part of the Ordovician-aged Plattin group. Based on the borings completed by NRT, this bedrock unit is comprised of massive, gray to brown, micritic, fossiliferous limestone with shale interbeds. The depth to bedrock typically increases towards the Mississippi River and bedrock beneath the Surface Impoundment dips towards the east-northeast at approximately 3 to 7 degrees. The Plattin group is stratigraphically underlain by the Joachim Dolomite. The higher portions of the bluffs to the west of the facility are comprised of Mississippian-age limestone and shales, which are exposed along the eastern portions of the bluffs.

2.3 Site Hydrogeology

Site hydrogeology has been characterized based on information obtained from 45 soil borings and 90 piezometer installations completed at the site by NRT (NRT 2014a, NRT 2014b, and NRT 2015), as well as the 9 CCR Rule groundwater monitoring well installations completed by Golder. **Figure 3** provides a generalized west-east depiction of the Surface Impoundment referenced to local geology, groundwater, and the Mississippi River.

2.3.1 Uppermost Aquifer

The CCR Rule requires that a groundwater monitoring system be completed in the uppermost aquifer around each Surface Impoundment (§257.91(a)). As shown on **Figure 3** and in the cross-sections located in **Appendix B,** the uppermost aquifer is the alluvial sand and gravel deposits associated with the Mississippi River Valley alluvium. These alluvial deposits (alluvium) overly Ordovician-age limestone of the

Plattin group. As generally described above these alluvial deposits exhibit a fining-upward sequence with some silts and clays present within the shallow zones and mostly coarse sands and gravels present at depth.

2.3.2 Surface Water and Groundwater Elevations

2.3.2.1 CCR Surface Impoundment Pore-Water

Groundwater surface elevations were recorded within the Surface Impoundment by NRT from January 2013 through March 2015 and ranged from 383 to 403 feet MSL with an average elevation of approximately 397 feet MSL. Groundwater elevations within the Surface Impoundment are generally higher than those in the surrounding alluvial aquifer. The coal ash pore-water is mounded generally highest in the middle areas of the impoundment and where a pond water surface is present, with the mounding effect diminishing toward the edge of the impoundment as indicated by exterior well water level data. Data show water mounding regardless of the Mississippi River elevation; however, the mounding is less pronounced at times of high river level.

2.3.2.2 Alluvial Aquifer

NRT (2015) obtained groundwater elevation measurements from January 2013 through March 2015 within the alluvial aquifer in the area in and around the Surface Impoundment. A total of 39 piezometers were used for the groundwater elevation measurements in the shallow zone of the aquifer with well depths ranging from 4.5 to 61.0 feet BGS and 340.5 to 393.8 feet MSL. Groundwater elevations were also measured within deeper depths (as deep as approximately 325 feet MSL) of the alluvial aquifer adjacent to the Surface Impoundment (deeper zone).

Golder obtained groundwater elevation measurements from March 2016 through June 2017 within the alluvial aquifer for the CCR monitoring wells. For each of the 8 background sampling events (baseline events), groundwater elevations were measured at monitoring wells within a 24-hour timeframe and a potentiometric map was generated from these data (**Appendix C and Table 1)**. Groundwater elevations ranged from approximately 369 to 384 feet MSL.

2.3.3 Groundwater Flow Directions

Groundwater flow within the alluvial aquifer is dynamic and is influenced by seasonal changes in the water level in the adjacent Mississippi River. River water levels measured at the Facility display large seasonal changes in the elevation of the Mississippi River water surface. For example, in 2013 and 2014, river water levels fluctuated between approximately 355 to 401 feet MSL. Water flows into and out of the alluvial aquifer as a result of fluctuating river water levels that produce “bank recharge” and “bank discharge” conditions. Under normal aquifer conditions, groundwater flow in the alluvial aquifer would be expected to

have a flow direction component parallel to the river and a flow component away from the bluffs, with a likely net flow direction generally to the east.

Although the movement of groundwater within the alluvial aquifer at the Facility is complex, the movement has been characterized by frequent groundwater elevation measurements and the generation of potentiometric surface maps generated by NRT and Golder (**Appendix B**, **Appendix C and Table 1**). Groundwater movement in the alluvial aquifer has been assessed by measuring water elevations in the Surface Impoundment itself (coal ash pore-water), and different depths of the alluvial aquifer in the general vicinity of the Facility. NRT obtained groundwater elevation measurements and generated potentiometric surface maps in order to complete a Detailed Site Investigation, a preliminary Pond Closure Groundwater Monitoring and Sampling Plan (NRT, 2014a), and a Proposed Utility Waste Landfill Baseline Groundwater Monitoring Plan (NRT, 2014b).

Horizontal and vertical groundwater flow within the uppermost aquifer has been locally influenced by operation of the Surface Impoundment. Ponding of water in the Surface Impoundment at elevations greater than the static water levels in the underlying alluvial aquifer create a localized “mounding” effect, resulting in downward gradients and radial groundwater flow downward and outward from the impoundment.

Groundwater flow direction and hydraulic gradient were estimated for the CCR wells using the EPA’s On-line Tool for Site Assessment calculation for hydraulic gradient (magnitude and direction) (USEPA, 2016). Estimated results from this analysis are provided in **Table 2**. These results indicate that while groundwater flow direction is variable, overall net groundwater flow during the baseline sampling period was generally toward the east/northeast (toward the river).

Based on the potentiometric surface maps, a general flow direction from the west (bluffs area) to the east (Mississippi River) under normal river conditions is expected. However, during periods of high river levels, groundwater flow can temporarily reverse and flow westward. During these times of high river stage and temporary flow direction changes, horizontal groundwater gradients generally tend to decrease and little net movement of groundwater to the west or north occurs.

2.3.3.1 Horizontal Gradients

Horizontal groundwater gradients in the alluvial aquifer are typically low and flat. The gradients are very dependent on river water levels (bank recharge and bank discharge conditions described earlier). NRT data displayed typical horizontal gradients ranging from <0.001 to 0.005 feet/foot.

Site wide horizontal gradients were also calculated for each of the baseline sampling events and the results of these are displayed on **Table 2**. The horizontal groundwater gradients are very low, ranging from 0.0002 to 0.0008 feet/foot.

A review of the potentiometric surface maps confirms the gradient estimates for a larger scale, but also demonstrates that localized horizontal gradients can be higher especially in areas near the Mississippi River.

2.3.3.2 Vertical Gradients

A review of downward gradients observed in piezometers was completed by comparing groundwater elevations obtained by NRT (NRT 2015) between shallow and intermediate/deep zone piezometers from January 2013 through March 2015 in locations where the piezometers are nested (two or more piezometers within the same borehole, screened at different elevations). From the review of these data, areas outside of the Surface Impoundment show relatively low downward gradients, with the difference in groundwater elevations between the shallow and intermediate/deep groundwater zone typically less than 1 foot and illustrate that the shallow and deeper zones are hydraulically interconnected.

Downward gradients between the pore-water in the Surface Impoundment ash and the underlying deep alluvial groundwater zone are much greater, based on a review of water elevation measurements from nested piezometers (NRT, 2015). This downward gradient changes seasonally based on river levels and fluctuating alluvial aquifer groundwater levels. During high river level conditions, the difference in groundwater elevation between the pore-water in the Surface Impoundment and the deeper alluvial groundwater zone is less than the average, as low as approximately 4 feet during the study period. During low river level conditions, the difference in groundwater elevation has been shown to be as much as approximately 37 feet between the deeper alluvial groundwater zone and the pore-water in the Surface Impoundment ash.

2.3.3.3 Hydraulic Conductivities

The hydraulic conductivity of the alluvial aquifer has been investigated by NRT through the use of slug tests (NRT 2015). The hydraulic conductivity is highly dependent of the geology present within the screened interval of the piezometer/well. The hydraulic conductivity has been characterized for three distinct areas including:

- The Surface Impoundment itself (coal ash pore-water)
- The shallow alluvial groundwater zone
- Intermediate to deep alluvial groundwater zone

Four slug tests were completed in two separate piezometers within the Surface Impoundment and all four tests determined a hydraulic conductivity of 1×10^{-4} cm/sec. Within the shallow alluvial groundwater zone, 43 slug tests were completed at 20 separate piezometers. Results from this testing demonstrate an average hydraulic conductivity of 1.58×10^{-3} cm/sec with a maximum of 7.00×10^{-3} cm/sec and a minimum of 3.00×10^{-5} cm/sec. Within the deep alluvial groundwater zone, 40 slug tests were completed at 14

separate piezometers. Results from this testing demonstrate an average hydraulic conductivity of 2.84 x 10^{-2} cm/sec with a maximum of 2.00 x 10^{-1} cm/sec and a minimum of 2.00 x 10^{-4} cm/sec.

NRT's findings for Hydraulic conductivities values for the three groundwater zones are summarized in **Table 3.**

Table 3: Summary of Hydraulic Conductivities (NRT)

Groundwater Component	Minimum Hydraulic Conductivity (cm/sec)	Average Hydraulic Conductivity (cm/sec)	Maximum Hydraulic Conductivity (cm/sec)
Surface Impoundment Pore-water	-	1.00 x 10^{-4}	-
Shallow Alluvial Groundwater	3.0 x 10^{-5}	1.58 x 10^{-3}	7.00 x 10^{-3}
Deep Alluvial Groundwater	2.00 x 10^{-4}	2.84 x 10^{-2}	2.00 x 10^{-1}

The results of the slug testing program completed by NRT show that the average hydraulic conductivity of the Surface Impoundment ash is significantly lower than the surrounding alluvial aquifer. The highest hydraulic conductivities were reported for the deep alluvial zone, which has an average hydraulic conductivity one order of magnitude higher than the shallow zone as tested by NRT. Additionally, the higher hydraulic conductivity and variable graded nature of the alluvial aquifer is expected to lead to relatively high dispersivity potential that will likely increase with depth. This is due to the prevalence of coarser particles (gravel, cobbles, etc.) at depth and relatively higher groundwater flow velocities stemming from higher hydraulic conductivities in the deep alluvial groundwater zone.

Golder also performed rising head hydraulic conductivity tests on the 9 newly installed CCR monitoring wells in order to estimate the hydraulic conductivities in December 2015. The tests were conducted using a pneumatic slug (Hi-K slug) and a downhole pressure transducer. The results of Golder's hydraulic conductivity testing estimated the geometric mean of hydraulic conductivity to be approximately 2 x 10^{-2} cm/sec. Golder's findings for hydraulic conductivity values are summarized in **Table 4** and are consistent with the conductivities calculated by NRT.

Table 4: CCR Monitoring Well Hydraulic Conductivities

Well ID	Total Depth (feet BTOC)	Well Screen Interval (feet BTOC)	Well Screen interval (feet MSL)	Estimated Hydraulic Conductivity (feet/day)	Estimated Hydraulic Conductivity (cm/sec)
RCPA Surface Impoundment Monitoring Wells					
MW-1	85.1	74.9 - 84.7	308.8 - 318.6	88	3.10E-02
MW-2	84.6	74.4 - 84.2	307.5 - 317.3	64	2.26E-02
MW-3	82.5	72.3 - 82.1	307.1 - 316.9	44	1.55E-02
MW-4	92.1	81.9 - 91.7	299.1 - 308.9	56	1.98E-02
MW-5	62.6	57.4 - 62.2	325.8 - 330.6	92	3.26E-02
MW-6	61.5	56.3 - 61.1	340.0 - 344.8	37	1.30E-02
MW-7	100.1	89.9 - 99.7	306.4 - 316.2	37	1.32E-02
Background Monitoring Wells					
MW-B1	102.0	91.8 - 101.6	307.9 - 317.7	54	1.92E-02
MW-B2	89.8	79.6 - 89.4	306.5 - 316.3	45	1.60E-02

Notes:
1. feet BTOC - feet below top of casing
2. feet MSL - feet above mean sea level.
3. cm/sec - centimeters per second.
4. Slug tests were completed by Golder Associates on December 7, 2015 using a Pneumatic Hi-K Slug®.

2.3.4 Porosity and Effective Porosity

Porosities were estimated based on the grain size distributions of aquifer soil samples collected during monitoring well drilling. A representative grain size distributions were collected from the screen intervals at MW-7 and MW-B2 using the ASTM D6912 Method B and the results are provided in **Appendix D**. The samples from MW-7 and MW-B2 were similar in field classification to other well drilling samples and the results indicate that the screened interval of the alluvial aquifer are mostly comprised of sand (at least 90%) with lesser amounts of gravel, silt and clay. Also, the typical grain size of the sand ranges from fine to medium sand. Textbook values of porosities for sands and sand/gravel mixes range from 25-50% (Fetter, 2000 and Freeze and Cherry, 1979) and fine sands typically range from 29-46%, whereas coarse sands typically range from 26-43% (Das, 2008). An average porosity of 35% is estimated for the alluvial aquifer based on the site data.

Effective porosity is the porosity that is available for fluid flow. Studies completed in unconsolidated sediments have determined that water molecules pass through all pores and the effective porosity is approximately equal to the total porosity (Fetter, 2000). Therefore, the effective porosity of the alluvial aquifer is also estimated to be 35%.

3.0 GROUNDWATER MONITORING NETWORK

3.1 Monitoring Network Design Criteria

§257.91 of The CCR Rule sets out the requirements for development of a groundwater monitoring system for both new and existing CCR landfills and Surface Impoundments. The performance standard in The CCR Rule (§257.91(a)) states that the groundwater monitoring system must consist of a sufficient number of wells at appropriate locations to yield groundwater samples in the uppermost aquifer that accurately represent:

- The quality of background groundwater
- The quality of groundwater passing the waste boundary of the CCR unit

3.2 Design of the Groundwater Monitoring System

The detection monitoring well network for the Facility is depicted on **Figure 2**. The network consists of 9 monitoring wells screened in the uppermost aquifer for the purpose of monitoring the RCPA Surface Impoundment. The monitoring well network includes 2 background groundwater monitoring wells (MW-B1 and MW-B2) that are located approximately 3,500 to 4,500 feet north of the surface Impoundment in areas unaffected by CCR disposal. Seven (7) of the groundwater monitoring wells are placed ringing the RCPA and are considered to be the downgradient wells. The groundwater monitoring well locations were selected based on site-specific information presented in section 2.0 of this document, as well as the preferential migration pathway analysis below.

3.2.1 Preferential Migration Pathway Analysis

After detailed review of the information outlined in section 2.0 of this document, a preferential migration pathway for potential groundwater impacts coming from the Surface Impoundment was determined. The preferential migration pathway is a result of downward gradients created by the water level in the Surface Impoundment and high pore-water levels in the ash. The movement of constituents from within the Surface Impoundment ash will be downward and outward from the impoundment, and generally move in the overall downgradient direction toward the Mississippi River. The groundwater gradient and the rate of groundwater movement will be variable depending on the river water elevations.

Ash within the Surface Impoundment extends down to an average base elevation of approximately 310 feet MSL. Subsurface materials beneath and around the ash consist of a thick deposit of mostly alluvial sand and gravel (see **Figure 3**) that comprise the alluvial aquifer, which is more permeable than the ash. Migration of potential CCR impacts from the ash into the uppermost aquifer will follow the path of least resistance and the generally coarser sediments in the deeper alluvial aquifer zone with its potential for

higher hydraulic conductivity and the downward gradient beneath the pond presents the highest potential for migration of impacts.

3.3 Groundwater Monitoring Well Placement

3.3.1 Background/Upgradient Monitoring Well Locations

As described above, the flow of groundwater in the alluvial aquifer is generally from the bluffs area located west of the site toward the Mississippi River, however, alluvial aquifer flow is locally influenced by water levels in the RCPA and the Mississippi River level. The CCR Rule (§257.91(a)(1)) requires that background groundwater samples from the uppermost aquifer:

"Accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit."

The CCR Rule also allows for sampling of background monitoring wells that are not hydraulically upgradient where hydrogeological conditions do not allow wells that are hydraulically upgradient and/or where sampling at other monitoring wells will provide an indication of background groundwater quality that is as representative as, or more representative than, that provided by upgradient monitoring wells. At the Facility, the alluvial aquifer terminates at the bluff and does not significantly extend westward past the edge of the Surface Impoundment, so collection of background samples is not feasible to the west of the Surface Impoundment. Two background sampling locations are located north of the RCPA, outside of the influence of the Surface Impoundment and upstream relative to the flow of the Mississippi River.

As shown in **Figure 2**, background monitoring well MW-B1 is north of the Surface Impoundment at a location relatively close to the Mississippi River. This well provides background groundwater quality representative of upgradient Mississippi River influences on the alluvial aquifer. The second background monitoring well location (MW-B2) is located away nearer to the bluffs, allowing monitoring of groundwater which originates from upgradient to the west and north.

3.3.2 Downgradient Monitoring Well Locations

As discussed above, downgradient monitoring wells are located ringing the RCPA to monitor potential migration pathways. **Figure 2** shows that the downgradient well network consists of seven (7) groundwater monitoring wells (MW-1, MW-2, MW-3, MW-4, MW-5, MW-6, and MW-7) around the RCPA at locations that are located as close to the waste boundary as practical.

3.3.1 Groundwater Monitoring Well Screen Intervals

The system of monitoring wells ringing the Surface Impoundment are screened in the alluvial aquifer zone near the base elevation of the CCR. Details on the construction of the groundwater monitoring wells are provided in **Table 5** and **Appendix E**.

Screen intervals range from approximately 301 to 346 feet MSL in sandy alluvial deposits except when, (1) bedrock was encountered prior reaching the target depth of 310 feet MSL, and (2) when the geological conditions at the desired depth were not consistent with the other groundwater monitoring wells within the network. Monitoring wells MW-1, MW-2, MW-3, MW-7, MW-B1 and MW-B2 were all installed with 10-foot well screens located at approximate elevations of 310 to 320 feet MSL. MW-4 was installed slightly deeper at approximately 300 to 310 feet MSL because a series of fine-grained soil units were encountered between 310 to 320 feet MSL. MW-5 and MW-6 located near the bedrock bluffs were installed using 5-foot screens at higher elevations because bedrock was encountered in both wells prior to reaching the target well screen zone of 310 to 320 feet MSL in the alluvial aquifer. For MW-5 and MW-6, screen intervals were placed 5 feet above the top of bedrock, within the alluvial aquifer.

4.0 INSTALLATION OF THE GROUNDWATER MONITORING SYSTEM

The CCR Rule Groundwater Monitoring System for the RCPA was installed in October-November 2015 as described in the following subsections.

4.1 Drilling Methods and Monitoring Well Constructions

Cascade Drilling LP installed the monitoring wells using a rotosonic drill rig (Mini Sonic CDD 1415) under direct supervision of a Golder Geologist or Engineer. Continuous soil core samples were obtained at each well borehole location and were logged in the field by Golder. Soils were classified according to the Unified Soil Classification System. Boring logs and well construction diagrams are provided in **Appendix A**, and **Appendix E**, respectively.

Groundwater monitoring wells were installed in accordance with Missouri Department of Natural Resources (MDNR) Well Construction Rules (10 CSR 23-4.060 Construction Standards for Monitoring Wells). All groundwater monitoring wells were installed with 2-inch diameter PVC well riser pipes and 5 or 10-foot long, 0.010-inch machine slotted well screens. Wells were installed with a sand filter pack, bentonite seal, and annular space in accordance with MDNR Well Construction Rules. Details on the construction of the groundwater monitoring wells are provided in **Table 5** and **Appendix E**.

Monitoring wells were completed with an aluminum protective cover with a locking lid that extends approximately 2 to 3 feet above ground surface and a small concrete pad. Yellow protective posts (concrete filled steel bollards) have been installed around each monitoring well.

4.2 Groundwater Monitoring Well Development

After well construction, a Golder geologist or engineer developed the groundwater monitoring wells using surging and purging techniques. During development, field parameters (pH, conductivity, temperature, and turbidity) were recorded and development was complete once a minimum of three well-bore volumes of water were purged, turbidity was typically less than 20 nephelometric turbidity units (NTU) or ± 10% and consecutive measurements of field parameter values were within 10 percent difference. Groundwater monitoring wells were developed using an inertial pump with a surge block ring attached to a foot valve to surge and purge the well. Well development forms are attached in **Appendix F**.

4.3 Dedicated Pump Installation

A dedicated pump was installed in each groundwater monitoring well after development and hydraulic conductivity testing. The dedicated pumps provide a consistent, repeatable sampling method to reduce likelihood of cross contamination, reduce water sample turbidity, and expedite sampling. For the purposes of this groundwater monitoring network, low-flow QED brand PVC MicroPurge bladder pumps with Dura-Flex Teflon bladders were installed in each well.

4.4 Surveying and Well Registration

Zahner and Associates, Inc., a Professional Land Surveyor licensed in Missouri, surveyed the location and top of casing elevation of the monitoring wells. A drawing showing the location of the groundwater monitoring wells is shown in **Figure 2** and a summary of survey information is provided in **Table 5**. Upon completion of monitoring well installation and surveying, MDNR Well Construction Registration Forms were prepared for each well and submitted to MDNR. Copies of these forms are provided in **Appendix G**.

5.0 GROUNDWATER MONITORING PROGRAM

The groundwater monitoring program for the RCPA Surface Impoundment is described in the following sections.

5.1 Baseline Sampling Events

In accordance with section 257.94(b) of the CCR Rule, before starting detection monitoring, eight baseline (or background) samples were collected for all Appendix III and Appendix IV parameters at all downgradient and upgradient/background monitoring wells prior to October 17, 2017. These samples establish initial baseline datasets that are used for the statistical evaluation of groundwater results.

5.2 Detection Monitoring

The Detection Monitoring Program is defined in the CCR Rule in section 257.94 and the following sections outline the procedures for the detection monitoring program.

5.2.1 Sampling Constituents and Monitoring Frequency

Detection monitoring should be completed at a minimum of semi-annually (approximately every 6 months) for all Appendix III constituents (**Table 6**)**,** unless a demonstration that the need for an alternative monitoring schedule is required. **Table 7** lists the analytical methods and practical quantitation limits used for the monitoring program.

5.2.2 Data Evaluation and Response

As required in the CCR Rule, a statistical evaluation of the groundwater data must be completed within 90 days of receiving data from the laboratory. The data will be analyzed using the methods and procedures outlined in the statistical analysis plan (**Appendix H**).

5.3 Assessment Monitoring

Assessment monitoring is outlined in section 257.95 of the CCR Rule and is initiated after a confirmed Statistically Significant Increase (SSI) has been identified and no alternate source demonstration has been completed. In accordance with the CCR Rule, a notification must be prepared and placed within the Facility operating record and on the publically available website stating that an Assessment Monitoring program has been initiated. The purpose of Assessment Monitoring is to determine whether or not groundwater concentrations are at a Statistically Significant Level (SSL) compared to Groundwater Protection Standards (GWPS). Detection Monitoring sampling continues during Assessment Monitoring.

5.3.1 Sampling Constituents and Monitoring Frequency

As outlined in section 257.95 of the CCR rule, Assessment Monitoring groundwater sampling must begin within 90 days of a confirmed SSI determination. Sampling must be completed at all monitoring wells used in the detection monitoring program, for all Appendix IV analytes (**Table 6**). Within 90 days of receiving

data from this initial Assessment Monitoring sampling event, a second sampling event must be completed analyzing the Appendix IV constituents detected in groundwater during the initial sampling event.

Following this initial phase of the Assessment Monitoring Program, the CCR Rule requires sampling of the full list of Appendix IV constituents on an annual basis (Annual Assessment Event). During the other semi-annual Assessment Sampling Event, only those Appendix IV constituents that are detected during the annual sampling event are to be analyzed and reported. Additionally, verification resampling will be performed within 90 days of receiving data from the laboratory for all detected Appendix IV constituents for each event.

5.3.2 Data Evaluation and Response

As required in the CCR Rule, a statistical evaluation of the groundwater data must be completed within 90 days of receiving data from the laboratory. The data will be analyzed using the methods and procedures outlined in the Statistical Analysis Plan (**Appendix H**).

A GWPS is required for each Appendix IV constituent and must be included in the annual report. The GWPS will be either the MCL or a value based on background data, whichever is higher. The generation of the GWPS is discussed in more detail in the Statistical Analysis Plan (**Appendix H**). Statistical analysis must be completed within 90 days of receiving data from the laboratory. The statistical analysis will determine if any constituents are SSLs greater than the GWPS.

In order to discontinue Assessment Monitoring and return to Detection Monitoring, the concentration of all Appendix III and Appendix IV constituents for all compliance wells must be at levels statistically lower than background levels for two consecutive sampling events (257.95(e)). If any constituent is present at a statistical level above background levels, but below the GWPS, then Assessment Monitoring continues.

5.3.2.1 Responding to a SSL

If the Assessment Monitoring statistical evaluations demonstrate that a SSL has been triggered, then the owner/operator of the CCR unit must complete the following four actions as described in 257.95(g):

1. Prepare a notification identifying the constituents in Appendix IV that have exceeded a CCR Unit specific GWPS. This notification must be placed in the facility operating record within 30 days of identifying the SSL (257.95(g)) and 257.105(h)). Additionally, within 30 days of placing the notification in the operating record, the notification must be posted to the internet site (257.107(h)).
2. Define the character and extent of the release and any relevant site conditions that may affect the corrective action remedy that is ultimately selected. The characterization must be sufficient to support a complete and accurate assessment of the corrective measures necessary to effectively clean up releases from the CCR Unit and must include at least the following: (No timeframe is specified in the CCR Rule for this action)

A. Installation of additional monitoring wells that are necessary to define the contaminant plume

B. Collect data on the nature and estimated quantity of the material released

C. Install and sample at least one additional monitoring well at the facility boundary in the direction of the contaminant plume migration

3. Notify off-site property owners if the contamination plume has migrated offsite on to their property within 30 days of this determination.

4. If possible, provide an alternate source demonstration that determines that the SSL is not caused by a release at the facility within 90 days of completing the statistical evaluation. If no alternate source demonstration can be made and the plume is determined to have originated from the CCR Unit, then proceed to corrective action steps in the CCR Rule.

D. If no alternate source demonstration is made, and the CCR Unit is an unlined surface impoundment, the closure or retrofit must be initiated.

Actions 1-3 must be completed regardless of whether or not an alternate source demonstration can be made.

5.3.3 Annual Reporting Requirements

In addition to the periodical reporting listed above, an annual groundwater monitoring report will be prepared according to the requirements of 40 CFR §257.90(e). At a minimum, the annual groundwater monitoring report will contain the following information:

- The current status of the groundwater monitoring program
- A projection of key activities planned for the upcoming year
- A map showing the CCR unit and all background (or upgradient) and downgradient monitoring wells included in this monitoring plan
- A discussion of any monitoring wells that were installed or decommissioned during the preceding year or any other changes made to the groundwater monitoring system
- Analytical results from groundwater sampling
- The monitoring data obtained under §§ 257.90 through 257.98, including a summary of the number of groundwater samples that were collected for analysis for each background and downgradient well, the dates the samples were collected, and whether the sample was required by the detection monitoring or assessment monitoring programs
- A narrative discussion of any transition between monitoring programs (e.g., the date and circumstances for transitioning from detection monitoring to assessment monitoring in addition to identifying the constituent(s) detected at a statistically significant increase over background levels)
- If required, an alternate source demonstration that is certified by a professional engineer
- If required, a demonstration that an alternate sampling frequency is needed
- If assessment monitoring is required, a listing of GWPS for each Appendix IV constituent

6.0 GROUNDWATER SAMPLING METHODOLOGY

Sampling will be performed in accordance with generally accepted practices within the industry and with the provisions of Missouri regulations. The following sections provide details regarding procedures that will be used to collect groundwater samples. Although this section provides reference to specific forms, the use of other equivalent forms to record the necessary data is permissible.

6.1 Equipment Calibration

Equipment used to record field water quality parameters will be calibrated each day prior to use following manufacturers' recommendations. Calibration solutions for standardization materials will be freshly prepared or from non-expired stock. In the absence of manufacturer or regulatory guidance, field equipment should be calibrated to within +/- 10 percent of the standard (or 0.1 standard units for pH meters). Equipment that fails calibration may not be used. Calibration records will be maintained. A sample field Instrument Calibration Form is included in **Appendix I**.

6.2 Monitoring Well Inspection

Prior to performing any water purging or sampling, each monitoring well will be inspected to assess its integrity. The condition of each monitoring well will be evaluated for any physical damage or other breach of integrity. The security of each monitoring well will be assessed in order to confirm that no outside source constituents have been introduced to the monitoring well.

6.3 Water Level Measurement

To meet the requirements of §257.93(c), water level measurements will be taken at all monitoring wells and prior to the start of any groundwater purging. These measurements will be taken within a 24 hour period and will be recorded on the Record of Water Level Readings form or Groundwater Sample Collection Form (included in **Appendix I**). Static water levels will be measured in each monitoring well prior to purging using an electric meter accurate to 0.01 foot. The measuring probe will be rinsed with distilled or deionized water before and after use at each well.

6.4 Monitoring Well Purging

Prior to collecting samples, each monitoring well will be purged. Purging will be accomplished using either:

- Low-flow (a.k.a., minimal drawdown, or Micropurge) techniques
- Traditional purging techniques where at least three well volumes are evacuated before samples are collected

6.4.1 Low-Flow Sampling Technique

Low-flow groundwater sampling procedures will be used for purging and sampling monitoring wells that are equipped with dedicated pumps and will sustain a pumping rate of at least 100 milliliters per minute (ml/min).

Water will be purged from these wells at low rates in order to minimize drawdown in the well during purging and sampling. Depth to water measurements and field water quality parameters (temperature, pH, turbidity, and conductivity) recorded during purging will be used as criteria to determine when purging has been completed. Sample collection will be initiated immediately after purging at each well.

During water purging, wells will be pumped at rates that minimize drawdown in the well. Purging rates in the range of 100-500 ml/min typically will be used; however, higher rates may be used if sustained by the well. Stabilization of the water column will be considered achieved when three consecutive water level measurements vary by 0.3 foot or less at a pumping rate of no less than 100 ml/min.

At a minimum, field water quality parameter measurements of temperature, pH, turbidity, and conductivity, will be measured during purging at each well. Prior to collecting the initial set of field water quality parameters, the water in the sampling pump and discharge tubing (i.e., pump system volume) remaining from the previous sampling event will be removed.

After evacuating the water in the pump system, collecting field measurements will begin. Depth to water measurements and field water quality parameter measurements will be made during purging. If a field meter equipped with a flow cell is used, an amount of water equal to the volume of the flow cell should be allowed to pass through the flow cell between individual field stabilization measurements. Stabilization will be attained and purging considered complete when three consecutive measurements of each field parameter vary within the following limits:

- ± 0.2 for pH
- ± 3% for Conductivity
- ± 10% for Temperature
- Less than 10 nephelometric turbidity units (NTU) or ± 10% for Turbidity

All data gathered during monitoring well purging will be recorded on a form, an example of which is included in **Appendix I**.

6.4.2 Traditional Purge Techniques

If low-flow sampling is not performed, wells will be purged a minimum of 3 well volumes before collecting a sample. Purging procedures will generally follow those for low-flow sampling including measurement of the field parameters listed above with two exceptions:

- Higher flow rate may be used during purging
- Purging is completed after a minimum of 3 well volumes have been removed (see below)

Even where low-flow sampling is not performed, the sampling goals are to:

- Stabilize field parameters (listed in previous section) prior to collecting samples
- Minimize drawdown in the well

When traditional purge techniques are used, field stabilization measurements will be collected at the beginning of purging and between each well volume purged. The stability criteria will be those described above for low-flow sampling.

6.4.3 Low Yielding Wells

If a monitoring well purges dry, it will be allowed to recover up to 24 hours before samples are collected. No additional purging will be performed after initially purging the monitoring well dry. If recharge is insufficient to fill all necessary sample bottles, samplers will note this on the field form, and fill as many sample bottles as possible.

6.5 Sample Collection

Sampling should take place immediately after purging is complete. Samples will be transferred directly from field sampling equipment into containers supplied by the analytical laboratory appropriate for the constituents being monitored **(Table 7)**. Sample containers will be kept closed until the time each set of sample containers is filled.

6.6 Equipment Decontamination

All non-dedicated field equipment that is used for purging or sample collection shall be cleaned with a phosphate-free detergent and triple-rinsed, inside and out, with deionized or distilled water prior to use and between each monitoring well. Decontamination water shall be disposed of at an Ameren approved location. Any disposable tubing used with non-dedicated pumps should be discarded after use at each monitoring well. Clean latex gloves will be worn by sampling personnel during monitoring well purging and sample collection.

6.7 Sample Preservation and Handling

In accordance with §257.93 of The CCR Rule, groundwater samples collected as part of the monitoring program will not be filtered prior to analysis. Once groundwater samples have been collected and preserved in laboratory supplied containers, they will be packed into insulated, ice-filled coolers to be maintained at a temperature as close as possible to 4 degrees Celsius. Groundwater samples will be collected in the designated size and type of containers required for specific parameters. Sample containers will be filled in such a manner as not to lose preservatives by spilling or overfilling. Samples will be delivered to the laboratory or sent via overnight courier following chain-of-custody procedures.

6.8 Chain-of-Custody Program

The chain-of-custody (COC) program will allow for tracing sample possession and handling from the time of field collection through laboratory analysis. The COC program includes sample labels, sample seals,

field Groundwater Sample Collection Forms, and COC record. A sample Chain-of-Custody (COC) form is provided in **Appendix I**.

Each sample will be assigned a unique sample identification number to be recorded on the sample label. The sample identification number for all samples will be designated differently based on the nature of the samples. Each sample identification number and description will be recorded on the field Groundwater Sample Collection Form and on the COC document.

6.8.1 Sample Labels

Sample labels sufficiently durable to remain legible when wet will contain the following information, written with indelible ink:

- Site and sample identification number
- Monitoring well number or other location
- Date and time of collection
- Name of collector
- Parameters to be analyzed
- Preservative, if applicable

6.8.2 Sample Seal

The shipping container will be sealed to prevent the samples from being disturbed during transport to the laboratory.

6.8.3 Field Forms

All field information must be completely and accurately documented to become part of the final report for the groundwater monitoring event. Example field forms are included in **Appendix I**. The field forms will document the following information:

- Identification of the monitoring well
- Sample identification number
- Field meter calibration information
- Static water level depth
- Purge volume
- Time monitoring well was purged
- Date and time of collection
- Parameters requested for analysis
- Preservative used
- Field water quality parameter measurements

- Field observations on sampling event
- Name of collector(s)
- Weather conditions including air temperature and precipitation

6.8.4 Chain-of-Custody Record

The COC record is required for tracing sample possession from time of collection to time of receipt at the laboratory. The National Enforcement Investigations Center (NEIC) of USEPA considers a sample to be in custody under any of the following conditions:

- It is in the individual's possession
- It is in the individual's view after being in his possession
- It was in the individual's possession and he locked it up
- It is in a designated secure area

All environmental samples will be handled under strict COC procedures beginning in the field. The field team leader will be the field sample custodian and will be responsible for ensuring that COC procedures are followed. A COC record will accompany each individual shipment. The record will contain the following information:

- Sample destination and transporter
- Sample identification numbers
- Signature of collector
- Date and time of collection
- Sample type
- Identification of monitoring well
- Number of sample containers in shipping container
- Parameters requested for analysis
- Signature of person(s) involved in the chain of possession
- Inclusive dates of possession

A copy of the completed COC form will be placed in a water resistant bag and accompany the shipment and will be returned to the shipper after the shipping container reaches its destination. The COC record will also be used as the analysis request sheet. When shipping by courier, the courier does not sign the COC record: copies of shipping forms are retained to document custody.

6.9 Temperature Control and Sample Transportation

After collection, sample preservation, and labeling, sample containers will be placed in coolers containing water-ice with the goal of reducing the groundwater samples to a temperature of approximately 4°C or less.

All samples included in the shipping container will be packed in such a manner to minimize the potential for container breakage. Samples will be either hand-delivered or shipped via commercial carrier to the certified analytical laboratory. Custody seals will be placed on the shipping containers if a third party courier is used.

7.0 ANALYTICAL AND QUALITY CONTROL PROCEDURES

7.1 Data Quality Objectives

As part of the evaluation component of the Quality Assurance (QA) program, analytical results will be evaluated for precision, accuracy, representativeness, completeness, and comparability (PARCC). These are defined as follows:

- Precision is the agreement or reproducibility among individual measurements of the same property, usually made under the same conditions
- Accuracy is the degree of agreement of a measurement with the true or accepted value
- Representativeness is the degree to which a measurement accurately and precisely represents a characteristic of a population, parameter, or variations at a sampling point, a process condition, or an environmental condition
- Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected to be obtained under correct normal conditions
- Comparability is an expression of the confidence with which one data set can be compared with another data set in regard to the same property

The accuracy, precision and representativeness of data will be functions of the sample origin, analytical procedures and the specific sample matrices. Quality Control (QC) practices for the evaluation of these data quality indicators include the use of accepted analytical procedures, adherence to hold time, and analysis of QC samples (e.g., blanks, replicates, spikes, calibration standards and reference standards).

Quantitative QA objectives for precision and accuracy, along with sensitivity (detection limits) are established in accordance with the specific analytical methodologies, historical data, laboratory method validation studies, and laboratory experience with similar samples. The Representativeness of the analytical data is a function of the procedures used to process the samples.

Completeness is a qualitative characteristic which is defined as the fraction of valid data obtained from a measurement system (e.g., sampling and analysis) compared to that which was planned. Completeness can be less than 100 percent due to poor sample recovery, sample damage, or disqualification of results which are outside of control limits due to laboratory error or matrix-specific interferences. Completeness is documented by including sufficient information in the laboratory reports to allow the data user to assess the quality of the results. The overall completeness goal for each task is difficult to determine prior to data acquisition. For this project, all reasonable attempts will be made to attain 90% completeness or better (laboratory).

Comparability is a qualitative characteristic which allows for comparison of analytical results with those obtained by other laboratories. This may be accomplished through the use of standard accepted methodologies, traceability of standards to the National Bureau of Standards (NBS) or USEPA sources,

use of appropriate levels of quality control, reporting results in consistent, standard units of measure, and participation in inter-laboratory studies designed to evaluate laboratory performance.

Data quality and the standard commercial report package will be evaluated with respect to PARCC criteria using the laboratory's QA practices, use of standard analytical methods, certifications, participation in inter-laboratory studies, temperature control, adherence to hold times, and COC documentation (also called Data Validation).

7.2 Quality Assurance/Quality Control Samples

This section describes the various Quality Assurance/Quality Control (QA/QC) samples that will be collected in the field and analyzed in the laboratory and the frequency at which they will be performed.

7.2.1 Field Equipment Rinsate Blanks

In cases where sampling equipment is not dedicated or disposable, an equipment rinsate blank will be collected. The equipment rinsate blanks are prepared in the field using laboratory-supplied analyte-free water. The water is poured over and through each type of sampling equipment following decontamination and submitted to the laboratory for analysis of target constituents. **One rinsate blank will be collected for every 10 samples.**

7.2.2 Field Duplicates

Field duplicates are collected by sampling the same location twice, but the field duplicate is assigned a unique sample identification number. Samplers will document which location is used for the duplicate sample. **One field duplicate will be collected for every 10 samples.**

7.2.3 Field Blank

Field blanks are collected in the field using laboratory-supplied analyte-free water. The water is poured directly into the supplied sample containers in the field and submitted to the laboratory for analysis of target constituents. **One field blank will be collected for every 10 samples.**

7.2.4 Laboratory Quality Control Samples

The laboratory will have an established QC check program using procedural (method) blanks, laboratory control spikes, matrix spikes, and duplicates. Details of the internal QC checks used by the laboratory will be found in the laboratory QAP and the published analytical methods. These QC samples will be used to determine if results may have been affected by field activities or procedures used in sample transportation or if matrix interferences are an issue. **One (1) Matrix Spike (MS)/ Matrix Spike Duplicate (MSD) set** (i.e. one sample plus one MS, and one MSD sample at one location) **will be collected per 20 samples.** MS/MSD samples will have a naming convention as follows:

- Sample: MW-1D
- MS: MW-1D-MS
- MSD: MW-1D-MSD

8.0 DATA EVALUATION AND STATISTICAL ANALYSIS

The following sections describe the evaluation and analysis procedures that are followed upon receipt of the analytical report.

8.1 Evaluation of Rate and Direction of Groundwater Flow

Groundwater elevations will be determined for each sampling event and will be used to develop a groundwater elevation contour map that will be submitted with reports. The direction of groundwater flow will be determined from up-and downgradient relationships as depicted on the potentiometric surface map. Based on these maps, groundwater flow velocities will be estimated for each event.

8.2 Data Validation

Before the data are used for statistical analysis, they will be evaluated by examining the quality control data accompanying the data report from the laboratory. Relevant quality control data could include measures of accuracy (percent recovery), precision (relative percent difference, RPD), and sample contamination (blank determinations). Data that fail any of these checks will be flagged for further evaluation. A Data Quality Review (DQR) may be initiated with the laboratory for any anomalous data.

8.3 Statistical Analysis

Upon completion of the data validation, the data will be submitted for statistical analysis in compliance with 40 CFR §257.93. The detailed statistical analysis plan for the Facility will be included in **Appendix I**.

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TABLES

Table 1
Groundwater Level Data
RCPA Surface Impoundment
Rush Island Energy Center, Jefferson County, MO

Well ID	Location[6]		Top of Casing[7]	Ground Surface[7]	Background Event 1 3/10/2016		Background Event 2 5/2/2016		Background Event 3 7/14/2016		Background Event 4 9/6/2016		Background Event 5 11/15/2016		Background Event 6 1/19/2017		Background Event 7 3/6/2017		Background Event 8 6/8/2017	
	Northing	Easting	Feet MSL[5]	Feet MSL[5]	DTW[3]	GWE[4]	DTW[3]	GWE[4]	DTW[3]	GWE[4]	DTW[3]	GWE[4]	DTW[3]	GWE[4]	DTW[3]	GWE[4]	DTW[3]	GWE[4]	DTW[3]	GWE[4]
MW-1	835384.2	889832.5	395.52	393.5	21.63	373.89	12.23	383.29	22.09	373.43	17.52	378.00	24.97	370.55	25.79	369.73	20.35	375.17	8.48	387.04
MW-2	834261.5	890364.1	393.87	391.7	20.23	373.64	10.46	383.41	20.80	373.07	15.10	378.77	23.64	370.23	23.97	369.90	18.74	375.13	7.13	386.74
MW-3	833178.4	890892.7	391.38	389.2	18.02	373.36	7.97	383.41	18.70	372.68	12.89	378.49	21.51	369.87	21.73	369.65	16.37	375.01	4.87	386.51
MW-4	831647.5	890830.5	392.78	390.8	19.16	373.62	9.80	382.98	19.67	373.11	14.16	378.62	22.44	370.34	23.20	369.58	17.78	375.00	6.19	386.59
MW-5	831994.9	889984.5	390.36	388.0	16.17	374.19	7.21	383.15	16.54	373.82	11.29	379.07	19.27	371.09	19.99	370.37	14.96	375.40	3.52	386.84
MW-6	833111.0	888977.0	402.71	401.1	27.25	375.46	19.05	383.66	27.78	374.93	23.35	379.36	30.46	372.25	30.52	372.19	26.52	376.19	15.71	387.00
MW-7	834476.8	888483.3	407.95	406.1	33.25	374.70	25.93	382.02	32.86	375.09	28.33	379.62	35.90	372.05	38.11	369.84	32.86	375.09	20.33	387.62
MW-B1	837602.1	887903.9	411.61	409.6	37.38	374.23	29.77	381.84	37.20	374.41	32.50	379.11	40.15	371.46	42.41	369.20	36.88	374.73	24.34	387.27
MW-B2	837801.7	885337.2	397.85	395.9	22.57	375.28	16.91	380.94	22.20	375.65	17.79	380.06	25.00	372.85	28.44	369.41	22.95	374.90	10.45	387.40
Mississippi River	888823*	837705*	NA	NA	NA	372.47	NA	382.23	NA	371.84	NA	380.61	NA	371.92	NA	371.33	NA	377.01	NA	386.60

Notes:
1.) Groundwater monitoring wells surveyed by Zahner & Associates, Inc. on December 1, 2015.
2.) * - Mississippi River gauge location is estimated.
3.) DTW - Depth to water measured in feet below top of casing.
4.) GWE - Groundwater elevation measured in feet above mean sea level.
5.) MSL - Feet above mean sea level.
6.) Horizontal Datum: State Plane Coordinates NAD83 (2000) Missouri East Zone feet.
7.) Vertical Datum: NAVD88 feet.
8.) Mississippi River gage elevation provided by Ameren
9.) NA - Not Applicable

Prepared JSI
Check JS/RJF
Reviewed MNH

Generalized Hydraulic Properties of Uppermost Aquifer
RPCA Surface Impoundment
Rush Island Energy Center, Jefferson County, MO

RCPA Compliance Wells Only (MW-1, MW-2, MW-3, MW-4, MW-5, MW-6, MW-7)							
Baseline Sampling Event	Baseline Sampling Event Date	Average Groundwater flow Direction (Azimuth)	Estimated Hydraulic Gradient (Feet/Foot)	Mean Hydraulic Conductivity (Feet/Day)	Mean Hydraulic Conductivity (cm/sec)	Estimated Effective Porosity	Estimated Velocity (Feet/Day)
1	3/10/2016	76.8	0.0008	56.22	2.0E-02	0.35	0.14
2	5/2/2016	265.9	0.0003	56.22	2.0E-02	0.35	0.05
3	7/14/2016	80.0	0.0011	56.22	2.0E-02	0.35	0.18
4	9/6/2016	67.5	0.0006	56.22	2.0E-02	0.35	0.10
5	11/15/2016	77.2	0.0011	56.22	2.0E-02	0.35	0.18
6	1/19/2017	67.0	0.0008	56.22	2.0E-02	0.35	0.12
7	3/6/2017	68.3	0.0003	56.22	2.0E-02	0.35	0.05
8	6/8/2017	98.3	0.0004	56.22	2.0E-02	0.35	0.06

Estimated Results (USEPA Tool)	
Resultant Groundwater Flow Direction (Azimuth)	75
Estimated Annual Net Movement (Feet/Year)	33

Prepared By: JSI
Checked By: AC
Reviewed By: MNH

Notes:
1. Azimuth and Hydraulic Gradient calculated using the United States Environmental protection agency (USEPA) On-Line Tools for Site Assessment Calculation for Hydraulic Gradient (magnitude and direction) available at https://www3.epa.gov/ceampubl/learn2model/part-two/onsite/gradient4plus-ns.html
2. Hydraulic conductivity value is the geometric mean of slug test results for the RCPA compliance wells.
3. An effective porosity of 0.35 was used based on grain size distributions and published values (Fetter 2000, Cohen 1953, and Johnson 1967) .
4. Azimuth is measured clockwise in degrees from north.
5. cm/sec - centimeters per second.

Table 5
Monitoring Well Construction Details
RCPA Surface Impoundment
Rush Island Energy Center, Jefferson County, MO

Well ID	Date Installed	Location[4]		Top of Casing Elevation	Ground Surface Elevation	Top of Screen	Bottom of Screen	Base of Well	Total Depth
		Northing	Easting	(FT MSL)[5]	(FT MSL)[5]	(FT MSL)[5]	(FT MSL)[5]	(FT MSL)[5]	(FT BGS)[5]
MW-1	10/31/2015	835384.2	889832.5	395.52	393.5	320.7	310.9	310.5	83.0
MW-2	11/1/2015	834261.5	890364.1	393.87	391.7	319.5	309.7	309.3	82.4
MW-3	10/31/2015	833178.4	890892.7	391.38	389.2	319.1	309.3	308.9	80.3
MW-4	10/30/2015	831647.5	890830.5	392.78	390.8	310.9	301.1	300.7	90.1
MW-5	10/29/2015	831994.9	889984.5	390.36	388.0	333.0	328.2	327.8	60.2
MW-6	10/28/2015	833111.0	888977.0	402.71	401.1	346.4	341.6	341.2	59.8
MW-7	10/28/2015	834476.8	888483.3	407.95	406.1	318.1	308.3	307.9	98.2
MW-B1	10/28/2015	837602.1	887903.9	411.61	409.6	319.8	310.0	309.6	100.0
MW-B2	10/27/2015	837801.7	885337.2	397.85	395.9	318.3	308.5	308.1	87.9

Notes:
1.) All elevations and coordinates were surveyed on December 1, 2015 by Zahner and Associates, Inc.
2.) FT MSL = Feet Above Mean Sea Level.
3.) FT BGS = Feet Below Ground Surface.
4.) Horizontal Datum: State Plane Coordinates NAD83 (2000) Missouri East Zone Feet.
5.) Vertical Datum: NAVD88 Feet.

Prepared By: JS
Checked By: JSI
Reviewed By: MNH

Table 6

Groundwater Quality Monitoring Parameters

RCPA Surface Impoundment

Rush Island Energy Center, Jefferson County, MO

Monitoring Parameter		Background[2]	Detection[3]	Assessment[4]
Field Parameters	Temperature, pH, Conductivity and Dissolved Oxygen	X	X	X
Appendix III[1]	Boron	X	X	X
	Calcium	X	X	X
	Chloride	X	X	X
	Fluoride	X	X	X
	Sulfate	X	X	X
	pH	X	X	X
	Total Dissolved Solids (TDS)	X	X	X
Appendix IV[1]	Antimony	X		X
	Arsenic	X		X
	Barium	X		X
	Beryllium	X		X
	Cadmium	X		X
	Chromium	X		X
	Cobalt	X		X
	Fluoride	X		X
	Lead	X		X
	Lithium	X		X
	Mercury	X		X
	Molybdenum	X		X
	Selenium	X		X
	Thallium	X		X
	Radium 226 & 228	X		X

Notes:

1.) Analyte lists match requirements for monitoring from USEPA Rule 40 CFR parts 257 and 261.

2.) Background will be performed through October 2017 until at least 8 samples are collected.

3.) Approximately 6 months will separate each semi-annual sampling event.

4.) If necessary, assessment monitoring will be performed in accordance with USEPA Rule.

Prepared By: JS

Checked By: MWD

Reviewed By: MNH

Table 7
Analytical Methods and Practical Quantitation Limits
RCPA Surface Impoundment
Rush Island Energy Center, Jefferson County, MO

Analyte	Method Reference	Preservative	Hold Times	PQL (µg/L)	MCL (mg/L)
Appendix III - Detection Monitoring					
Boron	SW-846 6010/MCAWW 200.7	HNO3	6 months	20.0	NA
Calcium	SW-846 6010/MCAWW 200.7	HNO3	6 months	500.0	NA
Chloride	EPA 300.0/325.5/MCAWW 300/SW846 9251/9056	NA	28 days	500.0	NA
Fluoride	EPA 300.0, 300.1	NA	28 days	-	4
pH	4500 H+B-2000	NA	NA	-	NA
Sulfate	EPA 300.0/SW846 300	NA	28 days	2000.0	NA
Total Dissolved Solids (TDS)	2540 C-1997/SM18-20 2540 C	NA	7 days	10000.0	NA
Appendix IV - Assessment Monitoring					
Antimony	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	1.0	0.006
Arsenic	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	1.0	0.01
Barium	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	2.0	2
Beryllium	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	1.0	0.004
Cadmium	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	0.5	0.005
Chromium	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	1.5	0.1
Cobalt	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	4.0	NP
Fluoride	EPA 300.0	N/A	28 days	-	4
Lead	SW-846 6020	HNO3	6 months	0.005	0.015
Lithium	SW-846 6010	HNO3	6 months	-	NA
Mercury	SW-846 7470	HNO3	28 days	-	0.002
Molybdenum	SW-846 6010	HNO3	6 months	-	NP
Selenium	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	1.0	0.05
Thallium	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	0.2	0.002
Radium 226 & 228	SW-846 903.1/SM 6500 904	-	-	1.0 (pCi/L)	5.0 (pCi/L)

Notes:
1.) NA - not applicable.
2.) Analyte lists matches requirements for detection and assessment monitoring from United States Environmental Protection Agency (USEPA) Rule 40 CFR parts 257 and 261.
3.) SW-846 denotes Test Methods for Evaluating Solid Waste, Physical- Chemical Methods, EPA publication SW-846, 3rd edition, and subsequent updates.
4.) MCAWW denotes Methods for the Chemical Analysis of Water and Wastes (MCAWW), United States Environmental Protection Agency (USEPA) published in the 1983.
5.) EPA 300 denotes Methods for the Determination of Organic Compounds in Drinking Water Environmental Monitoring Systems Laboratory, Office of Research and Development, USEPA, Cincinnati, Ohio 45268. EPA-300/4-88/039, December 1988 (Revised July 1991).
6.) SM18-20 denotes Standard Methods for the Examination of Water and Wastewater, 18th, 19th, and 20th Editions, published by the American Public Health Association, Water Environment Federation, and the American Water Works Association.
7.) Other industry-used or agency-approved methods may be used provided that they produce the necessary level of precision and accuracy for data use and reporting.
8.) Updates to the methods listed here are approved for use.
9.) PQL - Practical Quantitation Limit.
10.) MCL - Maximum Contaminant Level from USEPA 2014 Edition of the Drinking Water Standards and Health Advisories. October 2014. http://water.epa.gov/drink/contaminants/index.cfm.
11.) Dash (-) - Indicates no information available.
12.) µg/L - Micrograms per liter.
13.) pCi/L - Picocuries per liter.
14.) NP - Not Promulgated.
15.) mg/L - Milligrams per liter.

Prepared By: JS
Checked By: MWD
Reviewed By: MRS

FIGURES

Rush Island Energy Center

RCPA Surface Impoundment

Tailings Pond

Service Layer Credits: Copyright:© 2013 National Geographic Society, i-cubed

LEGEND

- Rush Island Energy Center Property Boundary
- RCPA Surface Impoundment

KEY MAP

NOTES

1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.

REFERENCES

1.) AMEREN MISSOURI RUSH ISLAND ENERGY CENTER, RUSH ISLAND PROPERTY CONTROL MAP, JANUARY 2012.
2.) COORDINATE SYSTEM: NAD 1983 STATE PLANE MISSOURI EAST FIPS 2401 FEET.

0 500 1,000 2,000 3,000 Feet

CLIENT
AMEREN MISSOURI
RUSH ISLAND ENERGY CENTER

PROJECT
GROUNDWATER MONITORING PROGRAM

TITLE
SITE LOCATION TOPOGRAPHIC MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-07-17
PREPARED	JSI
DESIGN	JSI
REVIEW	MWD
APPROVED	MNH

PROJECT No. 153-1406 | PHASE 0002A | Rev. 0.0 | FIGURE 1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 11in

Path: G:\Projects\153\Projects\153-1406 - Ameren GW Monitoring Program - MO\Phase 0002 - Rush Island Energy\800 - FIGURES-DRAWINGS\PRODUCTION\GMP Figures\Figure 1 - Topographic Map\Figure 1 - Topographic Map.mxd

LEGEND

- Rush Island Energy Center Property Boundary
- RCPA Surface Impoundment
- RCPA Monitoring Well

KEY MAP

NOTES

1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) WELLS WERE SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON DECEMBER 1ST, 2015.

REFERENCES

1.) AMEREN MISSOURI RUSH ISLAND ENERGY CENTER, RUSH ISLAND PROPERTY CONTROL MAP, JANUARY 2012.
2.) COORDINATE SYSTEM: NAD 1983 STATE PLANE MISSOURI EAST FIPS 2401 FEET.

0 500 1,000 2,000 3,000 Feet

CLIENT
AMEREN MISSOURI
RUSH ISLAND ENERGY CENTER

PROJECT
GROUNDWATER MONITORING PROGRAM

TITLE
SITE LOCATION AERIAL MAP AND MONITORING WELL LOCATIONS

CONSULTANT
Golder Associates

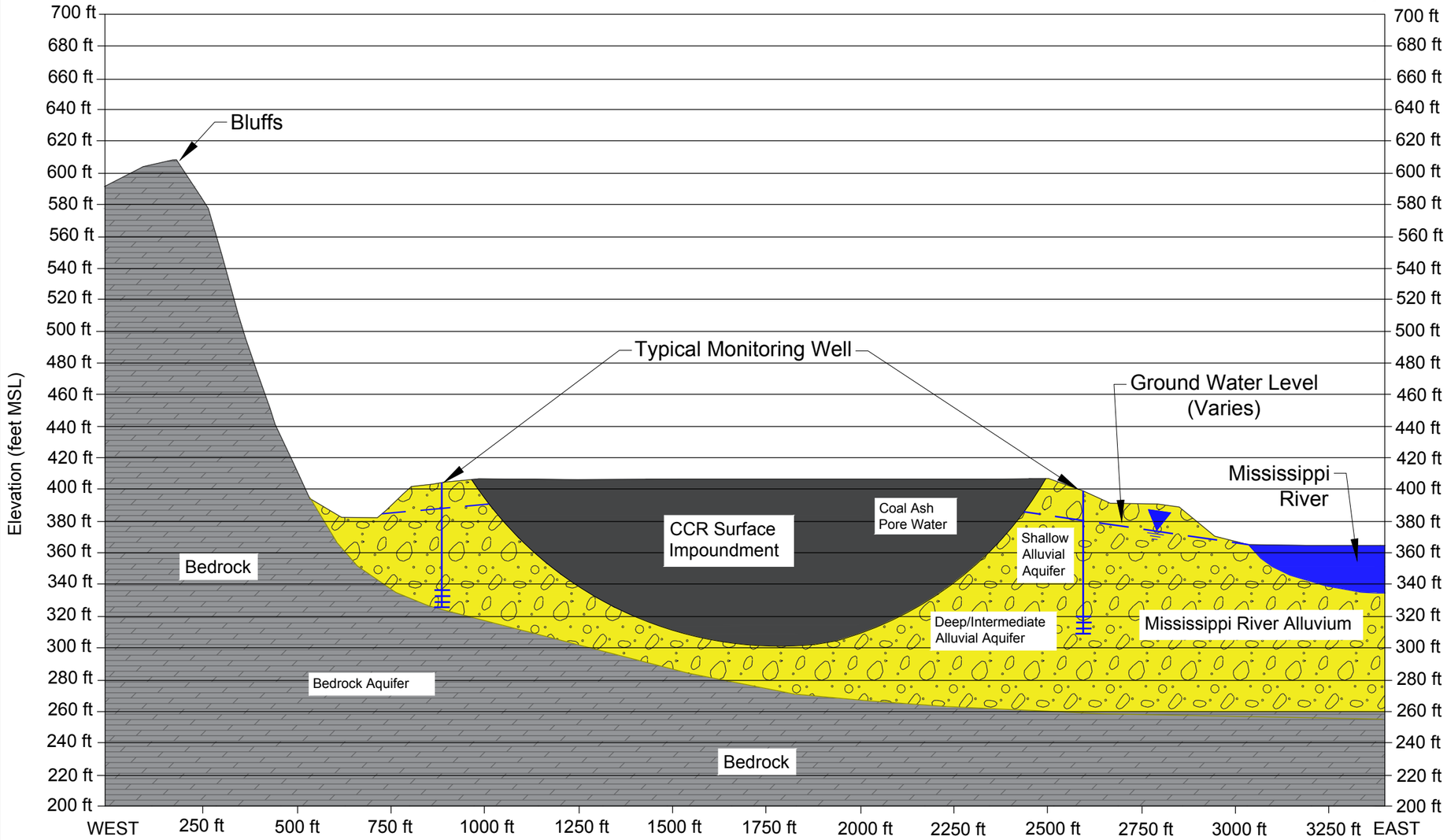
YYYY-MM-DD	2017-10-10
PREPARED	JSI
DESIGN	JSI
REVIEW	MWD
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0002A	0.0	2

Path: G:\Projects\153 Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0002 - Rush Island Energy\900 - FIGURES-DRAWINGS\PRODUCTION\GMP Figures\Figure 2 - Monitoring Well Locations\Figure 2 - Site Location Aerial Map.mxd

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 11in

Generalized Cross-Section



NOT TO SCALE

Overview Map

NOTES
1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) CROSS-SECTION BASED ON BORINGS AND PIEZOMETERS FROM NATURAL RESOURCE TECHNOLOGIES (NRT).
3.) CROSS-SECTION IS NOT TO SCALE AND IS ONLY A VISUAL REPRESENTATION OF THE SUBSURFACE GEOLOGY.
4.) MSL - MEAN SEA LEVEL.

REFERENCES

1.) AMEREN MISSOURI RUSH ISLAND ENERGY CENTER, RUSH ISLAND PROPERTY CONTROL MAP, JANUARY 2012.
2.) NRT 2014. RUSH ISLAND IMPOUNDMENT POND CLOSURE GROUNDWATER MONITORING AND SAMPLE PLAN.
3.) NRT 2014. PROPOSED UTILITY WASTE LANDFILL, BASELINE GROUNDWATER MONITORING PLAN. AMEREN MISSOURI RUSH ISLAND ENERGY CENTER.

CLIENT
AMEREN MISSOURI
RUSH ISLAND ENERGY CENTER

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-09-01
DESIGNED	JSI
PREPARED	JSI
REVIEWED	MWD
APPROVED	MNH

PROJECT
GROUNDWATER MONITORING PROGRAM

TITLE
GENERALIZED CROSS-SECTION

PROJECT NO.	Phase	REV.	Figure
153-1406	0002A	0.0	3

AMEREN_00000217

APPENDIX A
CCR Monitoring Well Boring Logs

RECORD OF BOREHOLE MW-1

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/31/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 835,384.16 E: 889,832.52

ELEVATION: 393.50
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-6.0) (CL) SILTY CLAY, low to medium plasticity fines, trace fine sand, trace organics (roots); moderate yellowish brown (10YR 5/4); cohesive, w<PL, soft	CL		393.5 0.0	1	SO	5.0 / 5.0	
		(3.0) SAA (Same As Above) except, medium plasticity fines; dark yellowish brown (10YR 4/2); w~PL			390.5 3.0				
5					387.5	2	SO	3.7 / 5.0	
		(6.0-13.5) (CL-ML) SILTY CLAY to SILT, low plasticity fines, some fine sand; medium dark gray (N4) to brownish gray (5YR 4/1); cohesive, w<PL, firm	CL-ML		6.0				
10						3	SO	3.2 / 5.0	
					380.0				
		(13.5-24.8) (SP-SM) SAND, fine sand, some non-plastic fines; moderate yellowish brown (10YR 4/2); non-cohesive, dry, compact	SP-SM		13.5				
15		(15.0) SAA except, some non-plastic fines, trace low plasticity fines; moist			378.5 15.0	4	SO	4.5 / 5.0	
20		(20.0) SAA except, some <2 inch layers of medium plasticity fines seams; medium gray (N5)			373.5 20.0	5	SO	2.7 / 5.0	
					368.7				
25		(24.8-30.0) (SW) SAND, fine to coarse sub-rounded sand, some fine to coarse sub-rounded to sub-angular gravel; dark yellowish orange (10YR 6/6); non-cohesive, wet, compact	SW		24.8	6	SO	3.9 / 5.0	Run #6, Sluff in run which added recovery. Measured field recovery: 4.7/5.0. Estimated actual recovery: 3.9/5.0.
									▽ Water Level 28.89 ft bgs 11/5/15
30					363.5				

Log continued on next page

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-1

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center
DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/31/2015
DRILL RIG: Mini Sonic (CDD 1415)
DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 835,384.16 E: 889,832.52
ELEVATION: 393.50
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(30.0-32.4) (SP) SAND, fine to medium sub-rounded sand; dark yellowish orange (10YR 6/6); non-cohesive, wet, compact	SP		30.0 361.1				
		(32.4-36.5) (SW) SAND, fine to coarse sub-rounded sand, some fine to coarse sub-rounded to sub-angular gravel; medium gray (N5); non-cohesive, wet, compact	SW		32.4 357.0	7	SO	9.0 10.0	
35		(36.5-38.8) (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; medium gray (N5); cohesive, w>PL, firm	CL		36.5 354.7				
		(38.8-40.0) (SP) SAND, fine to medium sub-rounded sand, trace fine sub-rounded gravel; medium gray (N5); non-cohesive, wet, compact	SP		38.8 353.5				
40		(40.0-60.0) (SW) SAND, fine to coarse sand, some sub-rounded to sub-angular gravel, trace low plasticity fines; medium gray (N5); non-cohesive, wet, compact	SW		40.0	8	SO	3.5 10.0	Run #8, Driller notes that poor recovery likely due to soft saturated sands which pushed sand out of the way instead of into the sampler. Driller changes bit to try to get better recovery.
45									
50						9	SO	8.6 10.0	
55									
60		Log continued on next page			333.5				

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-1

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/31/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 835,384.16 E: 889,832.52

ELEVATION: 393.50
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
60	6" Sonic	(60.0-70.0) (SP) SAND, fine to medium sub-rounded sand, some sub-rounded gravel, trace non-plastic fines; medium gray (N5); non-cohesive, wet, compact	SP		60.0	10	SO	6.0 / 10.0	
65									
70					323.5				
		(70.0-83.0) (SW) SAND, fine to coarse, sub-rounded sand, some sub-rounded gravel; medium gray (N5); non-cohesive, wet, compact	SW		70.0	11	SO	8.7 / 10.0	Run #11, poor recovery on the first sample run, most of sample fell out. Driller re-deploys sampler and collects remaining sample. Driller notes sample is likely mixed up after multiple attempts.
75									
80					310.5	12	SO	4.6 / 5.0	
		(83.0-85.0) (SP-SM) SAND, fine to medium sand, some non-plastic fines; medium dark gray (N4); non-cohesive, wet, compact	SP-SM		83.0				
85		BORING TERMINATED AT 85.0 FT BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-1			308.5 85.0				
90									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-2

SHEET 1 of 3

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 11/1/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 834,261.51 E: 890,364.13

ELEVATION: 391.70
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-0.3) (CL) SILTY CLAY, medium plasticity fines, some fine sand; light brown (5YR 5/4) to dark yellowish brown (10YR 4/2); cohesive, w~PL, firm	CL		391.4 0.3				Run #1, Silty clay swells after being brought to the surface which caused over-recovery. Measured field recovery: 5.4/5.0. Estimated actual recovery: 5.0/5.0.
		(0.3-6.7) (CL) SILTY CLAY, medium plasticity fines, trace fine sand; dark yellowish brown (10YR 4/2); cohesive, w~PL firm	CL			1	SO	5.0 5.0	
5		(5.0) SAA (Same As Above) except, some organics (roots and wood fragments); moderate brown (5YR 4/4)			386.7 5.0	2	SO	4.7 5.0	
		(6.7-21.3) (SP-SM) SAND, fine sand, some non-plastic fines; moderate yellowish brown (10YR 5/4); non-cohesive, dry, compact	SP-SM		385.0 6.7				
10						3	SO	4.0 5.0	Run #3, Sample appears to be compacted while being extruded into sample bags. Measured field recovery: 3.1/5.0. Estimated actual recovery: 4.0/5.0.
15		(15.0) SAA except, some very low plasticity fines, wet			376.7 15.0	4	SO	5.0 5.0	
20					370.4				
		(21.3-22.6) (SP) SAND, fine to medium sub-rounded sand, trace non-plastic fines; medium dark gray (N4); non-cohesive, wet, compact	SP		21.3 369.1				
		(22.6-25.3) (SP-SM) SAND, fine sand, some non-plastic to very low plasticity fines; medium dark gray (N4); non-cohesive, wet, compact	SP-SM		22.6 366.4	5	SO	8.9 10.0	
25		(25.3-28.1) (SP) SAND, fine to medium sub-rounded sand, trace non-plastic fines, trace organics (wood fragments); medium dark gray (N4); non-cohesive, wet, compact	SP		25.3 363.6				▽ Water Level 26.89 ft bgs 11/9/15
		(28.1-29.1) (SC) CLAYEY SAND, fine sand, low plasticity fines; medium dark gray (N4); non-cohesive, wet	SC		28.1 362.6				
			SP		29.1 361.7				
30		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-2

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center
DRILLING METHOD: 6" Sonic
DRILLING DATE: 11/1/2015
DRILL RIG: Mini Sonic (CDD 1415)
DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 834,261.51 E: 890,364.13
ELEVATION: 391.70
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(29.1-36.9) (SP) SAND, fine to medium sub-rounded sand, trace non-plastic fines; medium dark gray (N4); non-cohesive, wet, compact *(Continued)* (30.0) SAA except, trace fine sub-rounded gravel; medium gray (N5)	SP		30.0 / 354.8	6	SO	9.3 / 10.0	
		(36.9-40.0) (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; medium gray (N5); cohesive, w>PL, stiff	CL		36.9 / 351.7				
40		(40.0-85.0) (SW) SAND, fine to coarse sub-rounded sand, trace non-plastic fines, trace sub-rounded gravel; medium gray (N5); non-cohesive, wet, compact	SW		40.0	7	SO	8.8 / 10.0	
50						8	SO	9.1 / 10.0	
60		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek
LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-2

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 11/1/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 834,261.51 E: 890,364.13

ELEVATION: 391.70
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
60	6" Sonic	(40.0-85.0) (SW) SAND, fine to coarse sub-rounded sand, trace non-plastic fines, trace sub-rounded gravel; medium gray (N5); non-cohesive, wet, compact *(Continued)*	SW			9	SO	4.7 / 10.0	Run #9, Sample appears to be compacted while being extruded into sample bags. Measured field recovery: 4.7/10.0. Estimated actual recovery: 6.0/10.0.
65									
70		(70.0) SAA except, some fine to coarse sub-rounded gravel			321.7 / 70.0	10	SO	7.0 / 10.0	
75		(77.0) SAA except, less coarse sand			314.7 / 77.0				
80		(80.0) SAA except, more coarse sand			311.7 / 80.0	11	SO	5.0 / 5.0	
85		BORING TERMINATED AT 85.0 FT BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-2.			306.7 / 85.0				
90									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-3

SHEET 1 of 3

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/31/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 833,178.44 E: 890,892.65

ELEVATION: 389.18
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	Sonic	(0.0-3.3) (CL) SILTY CLAY, medium plasticity fines, trace fine sand, trace sub-angular gravel, some organics (roots); dark yellowish brown (10YR 4/4); cohesive, w<PL, firm	CL		385.9	1	SO	5.0 / 5.0	
		(3.3-6.5) (CL-ML) SILTY CLAY, low plasticity fines, some fine sand; dark yellowish brown (10YR 5/4); cohesive, w<PL, firm	CL-ML		3.3 382.7				
5		(6.5-11.7) (ML) sandy SILT, non-plastic fines, fine sand; moderate yellowish brown (10YR 5/4); non-cohesive, dry, loose	ML		6.5 377.5	2	SO	3.7 / 5.0	
10		(11.7-12.4) (CL) sandy SILTY CLAY, low to medium plasticity fines, fine sand; dark yellowish brown (10YR 4/2) to medium gray (N5); cohesive, w~PL, soft	CL		11.7 376.8	3	SO	4.4 / 5.0	
		(12.4-15.0) (ML) sandy SILT, non-plastic fines, fine sand; light brownish gray (5YR 6/1) to medium gray (N5); non-cohesive, moist, compact	ML		12.4 374.2				
15		(15.0-18.3) (ML) sandy CLAYEY SILT, low plasticity fines, fine sand; brownish gray (5YR 4/1) to medium gray (N5); cohesive, w<PL, soft	ML		15.0 370.9	4	SO	5.0 / 5.0	
		(18.3-19.6) (CL) SILTY CLAY, medium plasticity fines, some fine sand; medium gray (N5); cohesive, w~PL, soft	CL		18.3 369.6				
		(19.6-20.0) (ML) sandy SILT, non-plastic fines, fine sand; medium gray (N5); non-cohesive, wet, compact	ML		19.6 369.2				
20		(20.0-21.3) (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; brownish gray (5YR 4/1); cohesive, w>PL, stiff	CL		20.0 367.9				
		(21.3-22.3) (ML) sandy CLAYEY SILT, low to non-plastic fines, fine sand; medium gray (N5); cohesive, w<PL, soft	ML		21.3 366.9				
		(22.3-25.0) (CL) SILTY CLAY, low plasticity fines, trace fine sand; medium gray (N5); cohesive, W<PL, soft	CL		22.3 364.2	5	SO	8.9 / 10.0	
25		(25.0-25.6) (SP-SM) SAND, fine to medium sub-rounded sand, non-plastic fines, trace organics (wood fragments); medium gray (N5); non-cohesive, wet, loose	SP-SM		25.0 363.6				▽ Water Level 25.96 ft bgs 11/4/15
			CL		25.6 363.0				
		(25.6-26.2) (CL) SILTY CLAY, low plasticity fines, trace fine sand; medium gray (N5); cohesive, w<PL, soft	SP-SM		26.2 362.5				
		(26.2-26.7) (SP-SM) SAND, fine sand, non-plastic fines; medium gray (N5) to brownish gray (5YR 4/1); non-cohesive, wet, compact	CL		26.7 362.2				
		(26.7-29.5) (CL) SILTY CLAY, low to medium plasticity fines, trace fine sand; medium gray (N5); cohesive, w~PL, soft (27.0-27.2) - 2 inch silty SAND seam			27.0 359.7				
30		(29.5-30.0) (SP) SAND, fine sand, some non-plastic	SP		29.5				
		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-3

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center
DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/31/2015
DRILL RIG: Mini Sonic (CDD 1415)
DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 833,178.44 E: 890,892.65
ELEVATION: 389.18
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	Sonic	\ fines; medium gray (N5); non-cohesive, wet, compact / (30.0-80.3) (SW) SAND, fine to coarse sub-rounded sand, trace non-plastic fines, trace sub-rounded gravel; medium gray (N5); non-cohesive, wet, compact	SW		359.2 30.0	6	SO	8.0 / 10.0	Run #6, Sample appears to be compacted while being extruded into sample bags. Measured field recovery: 6.5/10.0 Estimated actual recovery: 8.0/10.0.
40						7	SO	8.5 / 10.0	Run #7, Sample appears to be compacted while being extruded into sample bags. Measured field recovery: 7.5/10.0 Estimated actual recovery: 8.5/10.0.
50						8	SO	8.5 / 10.0	
60		Log continued on next page			329.2				

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek
LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-3

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/31/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 833,178.44 E: 890,892.65

ELEVATION: 389.18
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
60	Sonic	(30.0-80.3) (SW) SAND, fine to coarse sub-rounded sand, trace non-plastic fines, trace sub-rounded gravel; medium gray (N5); non-cohesive, wet, compact *(Continued)* (60.0) SAA (Same as Above) except, some fine to coarse sub-rounded to sub-angular gravel			60.0				
65						9	SO	6.7 / 10.0	
70		(70.0) SAA except, less coarse sand, trace sub-rounded gravel	SW		319.2 / 70.0				
75						10	SO	9.5 / 10.3	
80		BORING TERMINATED AT 80.3 FT BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-3.			308.9 / 80.3				
85									
90									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-4

SHEET 1 of 4

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/30/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 831,647.50 E: 890,830.51

ELEVATION: 390.82
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-1.2) (CL-ML) SILTY CLAY to SILT, low plasticity fines, trace fine sand, some organics (roots); dusky brown (5YR 2/2); cohesive, w<PL, soft	CL-ML		389.6				
		(1.2-1.9) (CL) sandy SILTY CLAY, medium plasticity fines, fine sand; grayish brown (5YR 3/2); cohesive, w<PL, soft	CL		1.2 388.9 1.9				
		(1.9-5.0) (CL) SILTY CLAY, medium plasticity fines, fine sand; dark yellowish brown (10YR 4/2); cohesive, w<PL, soft	CL			1	SO	4.6 5.0	
5		(5.0-14.0) (SM) SILTY SAND, fine sand, non-plastic fines; moderate yellowish brown (10YR 5/4); non-cohesive, dry, loose	SM		385.8 5.0	2	SO	3.3 5.0	
10						3	SO	4.2 5.0	
		(14.0-29.6) (CL) sandy SILTY CLAY, low plasticity fines, fine sand; medium gray (N5) to light brownish gray (5YR 6/1); cohesive, w<PL, soft			376.8 14.0				
15									
20		(20.0) SAA (Same as Above) except, some (~10%) fine sand seams up to ~4 inches thick	CL		370.8 20.0	4	SO	10.0 10.0	
25									▽ Water Level 26.06 ft bgs 11/9/15
		(27.3) SAA except, medium gray (N5)			363.5 27.3	5	SO	5.0 5.0	
			SP		361.2 29.6				
30		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-4

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center
DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/30/2015
DRILL RIG: Mini Sonic (CDD 1415)
DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 831,647.50 E: 890,830.51
ELEVATION: 390.82
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(29.6-43.0) (SP) SAND, fine sand, trace non-plastic fines; olive gray (5Y 3/2); non-cohesive, wet, compact *(Continued)*	SP			6	SO	8.0 / 10.0	
35									
40									Run #7, Sample appears to be compacted while being extruded into sample bags. Measured field recovery: 6.0/10.0 Estimated actual recovery: 9.0/10.0.
					347.8				
		(43.0-70.0) (SW) SAND, fine to coarse sub-rounded sand, trace non-plastic fines, trace fine sub-rounded gravel; medium gray (N5); non-cohesive, wet, compact.			43.0	7	SO	9.0 / 10.0	
45									
50			SW						Run #8, Sample appears to be compacted while being extruded into sample bags. Measured field recovery: 6.0/10.0 Estimated actual recovery: 8.0/10.0.
55						8	SO	8.0 / 10.0	
60		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek
LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

RECORD OF BOREHOLE MW-4

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center
DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/30/2015
DRILL RIG: Mini Sonic (CDD 1415)
DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 831,647.50 E: 890,830.51
ELEVATION: 390.82
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
60	6" Sonic	(43.0-70.0) (SW) SAND, fine to coarse sub-rounded sand, trace non-plastic fines, trace fine sub-rounded gravel; medium gray (N5); non-cohesive, wet, compact. *(Continued)*	SW			9	SO	2.0 / 10.0	Run #9, Driller notes that poor recovery is likely caused by the sands being pushed out and not coming into the sampler. Driller swithes bit to try to fix the problem.
65									
70					320.8				
		(70.0-73.8) (CL) SILTY CLAY, medium plasticity fines, some fine sand; medium gray (N5); cohesive, w<PL, firm	CL		70.0 / 317.0				
75		(73.8-76.0) (CL & SP) SILTY CLAY and SAND, medium plasticity fines and fine sand; medium gray (N5); cohesive, w<PL, soft	CL & SP		73.8 / 314.8	10	SO	9.0 / 10.0	
		(76.0-78.1) (SC) CLAYEY SAND, fine sand, low plasticity fines; medium gray (N5); cohesive, w<PL, soft	SC		76.0 / 312.7				
		(78.1- 82.0) (SP-SM) SAND, fine sand, some non-plastic to low plasticity fines; medium gray (N5); non-cohesive, wet, loose	SP-SM		78.1 / 308.8				
80									
		(82.0-90.1) (SW) SAND, fine to coarse sub-rounded sand, trace fine to coarse sub-rounded gravel, trace low plasticity fines seams (up to ~2 inches thick); medium gray (N5); non-cohesive, wet, compact	SW		82.0	11	SO	8.0 / 10.1	
85									
90		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek
LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-4

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/30/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 831,647.50 E: 890,830.51

ELEVATION: 390.82
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
90		BORING TERMINATED AT 90.1 FT BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-4.			300.7 90.1				
95									
100									
105									
110									
115									
120									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-5

SHEET 1 of 3

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/29/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 831,994.91 E: 889,984.54

ELEVATION: 388.00
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-1.5) (ML) sandy SILT, non to low plasticity fines, fine sand; dark yellowish brown (10YR 4/2); non-cohesive, loose, dry	ML		386.5				
		(1.5-7.5) (ML) sandy CLAYEY SILT, low plasticity fines, fine sand, trace organics (roots); brownish gray (5YR 4/1) mottled with light brown (5YR 5/6); cohesive, w<PL, soft	ML		1.5	1	SO	2.9 / 5.0	
5					380.5	2	SO	3.4 / 5.0	
		(7.5-12.0) (CL) SILTY CLAY, medium plasticity fines, trace fine sand, trace organics (roots); brownish gray (5YR 4/1) to medium gray (N5); cohesive, w~PL, firm	CL		7.5				
10					376.0	3	SO	4.5 / 5.0	
		(12.0-12.4) (SM) SILTY SAND, fine sand, non-plastic fines; brownish gray (5YR 4/1); non-cohesive, wet, compact	SM		12.0				
			CL		375.6				
		(12.4-13.2) (CL) SILTY CLAY, medium plasticity fines, trace fine sand, trace organics (roots); brownish gray (5YR 4/1) to medium gray (N5); cohesive, w~PL, firm	SM		12.4 374.8				
			CL		13.2 374.4				
		(13.2-13.6) (SM) SILTY SAND, fine sand, non-plastic fines; brownish gray (5YR 4/1); non-cohesive, wet, compact			13.6 373.5				
15		(13.6-14.5) (CL) SILTY CLAY, medium plasticity fines, trace fine sand; brownish gray (5YR 4/1) to medium gray (N5); cohesive, w~PL, firm	SM		14.5				
					371.6	4	SO	4.6 / 5.0	
		(14.5-16.4) (SM) SILTY SAND, fine sand, non-plastic fines; brownish gray (5YR 4/1); non-cohesive, wet, compact			16.4				
		(16.4-18.8) (ML) sandy SILT, non-plastic fines, fine sand; brownish gray (5YR 4/1); non-cohesive, wet, compact	ML		369.2				
		(18.8-20.0) (CL) SILTY CLAY, low to medium plasticity fines, some fine sand; medium gray (N5); cohesive, w<PL, soft	CL		18.8 368.0				
20		(20.0-22.0) (SM) SILTY SAND, fine sand, non-plastic fines; light brownish gray (5YR 6/1); non-cohesive, wet, loose	SM		20.0 366.0				
		(22.0-26.5) (ML) sandy CLAYEY SILT, low plasticity fines, fine sand; medium gray (N5); cohesive, w<PL, soft	ML		22.0				▽ Water Level 23.01 ft bgs 11/10/15
25					361.5	5	SO	8.4 / 10.0	
		(26.5-40.0) (SP-SM) SAND, fine sand, some non-plastic fines; medium gray (N5); non-cohesive, wet, compact	SP-SM		26.5				
30					358.0				

Log continued on next page

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-5

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/29/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 831,994.91 E: 889,984.54

ELEVATION: 388.00
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(26.5-40.0) (SP-SM) SAND, fine sand, some non-plastic fines; medium gray (N5); non-cohesive, wet, compact *(Continued)* (30.0) SAA (Same As Above), trace low plasticity fines	SP-SM		30.0	6	SO	8.2 / 10.0	
40		(40.0-41.8) (SM) SILTY SAND, fine sand, non-plastic fines; medium gray (N5); non-cohesive, wet, compact	SM		348.0 40.0 346.2				
		(41.8-43.4) (CL) SILTY CLAY, medium plasticity fines, some fine sand; medium gray (N5); cohesive, w~PL, firm	CL		41.8 344.6				
45		(43.4-50.0) (SP) SAND, fine sand, trace non-plastic fines; medium gray (N5); non-cohesive, wet, compact	SP		43.4 338.0	7	SO	9.3 / 10.0	
50		(50.0-64.0) (SW) SAND, fine to coarse sub-rounded sand, trace fine sub-rounded gravel; medium gray (N5); non-cohesive, wet, compact	SW		50.0	8	SO	9.2 / 10.0	
55									
60					328.0				

Log continued on next page

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

RECORD OF BOREHOLE MW-5

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center
DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/29/2015
DRILL RIG: Mini Sonic (CDD 1415)
DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 831,994.91 E: 889,984.54
ELEVATION: 388.00
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
60	6" Sonic	(50.0-64.0) (SW) SAND, fine to coarse sub-rounded sand, trace fine sub-rounded gravel; medium gray (N5); non-cohesive, wet, compact *(Continued)* (60.0) SAA except, some fine to coarse sub-rounded gravels	SW		60.0 / 324.0	9	SO	3.2 / 4.0	When done drilling, pull up sampling rod up to 60.2 ft bgs and only push outer casing to 60.2 ft bgs in order to set the bottom of the well at 60.2 ft bgs. below 60.2 ft bgs is natural cave in.
		BORING TERMINATED AT 64.0 FT BELOW GROUND SURFACE. BEDROCK ENCOUNTERED AT 64.0 FEET BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-5.			64.0				
65									
70									
75									
80									
85									
90									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek
LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-6

SHEET 1 of 3

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/28/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 833,110.97 E: 888,976.95

ELEVATION: 401.08
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-0.3) (OL) ORGANIC SILT, non-plastic fines, organics (roots, etc.), some fine to medium sand; black (N1); non-cohesive, dry, loose	OL		400.8 / 0.3				
		(0.3-2.0) FILL - (SP) SAND, fine sand, trace non-plastic fines; brownish gray (5YR 4/1); non-cohesive, dry, compact	SP		399.1 / 2.0				
		(2.0-7.0) (SM) SILTY SAND, fine sand, non-plastic fines; moderate yellowish brown (10YR 5/4); non-cohesive, dry, compact	SM			1	SO	5.0 / 5.0	
5					394.1				
		(7.0-10.0) (CL) SILTY CLAY, medium plasticity fines, trace fine sand; brownish gray (5YR 4/1); cohesive, w<PL, firm	CL		7.0 / 391.1	2	SO	3.0 / 5.0	
10		(10.0-11.5) (SP) SAND, fine sand, trace non-plastic fines; brownish gray (5YR 4/1); non-cohesive, dry, compact	SP		10.0 / 389.6				
		(11.5-20.0) (SM) SILTY SAND, fine sand, non-plastic fines; moderate yellowish brown (10YR 5/4); non-cohesive, dry, compact	SM		11.5 / 388.1	3	SO	5.0 / 5.0	
		(13.0) SAA (Same As Above), brownish gray (5YR 4/1)			13.0				
15						4	SO	4.5 / 5.0	
					381.1				
20		(20.0-21.0) (CL) SILTY CLAY, medium plasticity fines, some fine sand; brownish gray (5YR 4/1); cohesive, w~PL, soft	CL		20.0 / 380.1				
		(21.0-22.1) (SC) CLAYEY SAND, fine sand, medium plasticity fines; brownish gray (5YR 4/1); cohesive, w<PL, soft	SC		21.0 / 379.0				
		(22.1-23.6) (SP-SM) SAND, fine sand, some non-plastic fines, trace sub-rounded gravels; brownish gray (5YR 4/1); non-cohesive, moist, compact	SP-SM		22.1 / 377.5	5	SO	4.5 / 5.0	
		(23.6-25.0) (CL) SILTY CLAY, medium plasticity fines, some sub-rounded to sub-angular gravel, trace fine sand; medium dark gray (N4); cohesive, w~PL, firm	CL		23.6 / 376.1				
25		(25.0-27.5) (SC) CLAYEY SAND, fine sand, medium plasticity fines; brownish gray (5YR 4/1); non-cohesive, moist, compact	SC		25.0 / 373.6	6	SO	4.6 / 5.0	
		(27.5-30.6) (CL) SILTY CLAY, medium plasticity fines, trace fine sand; light brownish gray (5YR 4/1) to medium gray (N6); cohesive, w<PL, firm	CL		27.5				
30		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-6

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/28/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 833,110.97 E: 888,976.95

ELEVATION: 401.08
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic		CL		370.5				
		(30.6-33.5) (SM) SILTY SAND, fine sand, non-plastic fines; medium gray (N5) to light olive gray (5Y 5/2); non-cohesive, wet, compact	SM		30.6 367.6				
		(33.5-35.0) (SC) CLAYEY SAND, medium to coarse sub-rounded sand, medium to low plasticity fines; dark yellowish orange (10YR 5/4) and medium gray (N5); non-cohesive, wet, compact	SC		33.5 366.1				
35		(35.0-36.1) (CL) sandy SILTY CLAY, medium plasticity fines, fine sand; medium gray (N5); cohesive, w<PL, soft	CL		35.0 365.0	7	SO	10.0 10.0	▽ Water Level 34.96 ft bgs 11/5/15
		(36.1-37.9) (SM) SILTY SAND, fine sand, non-plastic fines; medium gray (N5); non-cohesive, wet, compact	SM		36.1 363.2				
		(37.9-41.7) (SP) SAND, fine to medium sub-rounded sand, trace non-plastic fines; medium gray (N5); non-cohesive, wet, compact	SP		37.9 359.4				
40		(41.7-50.0) (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; medium gray (N5); cohesive, w<PL, firm	CL		41.7 351.1	8	SO	10.0 10.0	
45									
50		(50.0-51.3) (SP-SM) SAND, fine to medium sub-rounded sand, some non-plastic fines; medium gray (N5); non-cohesive, wet, loose	SP-SM		50.0 349.8				
		(51.3-53.0) (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; medium gray (N5); cohesive, w~PL, soft	CL		51.3 348.1				
		(53.0-55.0) (SM) SILTY SAND, fine to medium sub-rounded sand, non-plastic fines, trace fine to coarse sub-rounded gravels, trace wood fragments; medium gray (N5), non-cohesive, wet, compact	SM		53.0 346.1				
55		(55.0-59.5) (GW) sandy GRAVEL, sub-angular to sub-rounded gravel, fine to coarse sub-rounded sand, some non-plastic fines, trace organics (wood fragments); medium gray (N5) mottled black (N1) (organics); non-cohesive, wet, loose	GW		55.0 341.6	9	SO	9.0 10.5	
60		Log continued on next page	GW		59.5				

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-6

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center
DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/28/2015
DRILL RIG: Mini Sonic (CDD 1415)
DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 833,110.97 E: 888,976.95
ELEVATION: 401.08
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
60		(59.5-60.5) (GW) sandy GRAVEL Residuum, fine to coarse sub-rounded gravel, fine to coarse sub-rounded sand, some non-plastic fines; pale yellowish brown (10YR 6/2); non-cohesive, wet, loose *(Continued)*	GW		340.6	9	SO		(60.0) Driller starts to feel gravelly residuum shaking the rods. Driller adds additonal sample rods and pushes for a 10.5 foot run down to bedrock.
		BORING TERMINATED AT 60.5 FT BELOW GROUND SURFACE. BEDROCK ENCOUNTERED AT 60.5 FT BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-6.			60.5				
65									
70									
75									
80									
85									
90									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

RECORD OF BOREHOLE MW-7

SHEET 1 of 4

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/28/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 834,476.82 E: 888,483.33

ELEVATION: 406.06
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-1.0) (OL) ORGANIC SILT, non-plastic fines, organics (roots, etc.), some fine to medium sand; black (N1); non-cohesive, dry, loose	OL		405.1				
		(1.0-1.5) FILL - (GP) GRAVEL, coarse angular gravel, some fine to coarse sand; pale yellowish brown (10YR 6/2); non-cohesive, dry, loose	GP		1.0 404.6 1.5				
		(1.5-5.0) (SM) SILTY SAND, fine sand, non-plastic fines; moderate yellowish brown (10YR 5/4); non-cohesive, dry, loose (2.5) SAA (Same As Above) except, trace medium plasticity fines layers (1 Inch thick); medium gray (N5)	SM		403.6 2.5	1	SO	2.7 5.0	
5		(5.0-10.0) (SC) CLAYEY SAND, fine sand, low to medium plasticity fines; brownish gray (5G 4/1); non-cohesive, moist, loose	SC		401.1 5.0	2	SO	2.7 5.0	
10		(10.0-32.0) (CL) SILTY CLAY, medium plasticity fines, trace fine sand, trace iron staining; brownish gray (5YR 4/1); cohesive, w~PL, firm	CL		396.1 10.0	3	SO	5.0 5.0	
		(12.5) SAA except, medium to high plasticity fines; medium dark gray (N4)			393.6 12.5				
15		(15.0) SAA, some fine sand			391.1 15.0	4	SO	5.0 5.0	
20		(20.0) SAA except, trace fine sand; medium dark gray (N4) to brownish gray (5YR 4/1)			386.1 20.0	5	SO	4.7 5.0	
25						6	SO	5.0 5.0	
30					376.1				

Log continued on next page

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-7

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/28/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 834,476.82 E: 888,483.33

ELEVATION: 406.06
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(10.0-32.0) (CL) SILTY CLAY, medium plasticity fines, trace fine sand, trace iron staining; brownish gray (5YR 4/1); cohesive, w~PL, firm *(Continued)* (30.0) SAA except, some fine sand	CL		30.0 374.1				
		(32.0-34.8) (CL & SP) SILTY CLAY and SAND, medium plasticity fines, fine sand; medium gray (N5) mottled with light brown (5YR 5/6); cohesive, w<PL, soft	CL & SP		32.0 371.3	7	SO	5.0 / 5.0	
35		(34.8-40.0) (SP) SAND, fine to medium sand, some non-plastic fines; moderate yellowish brown (10YR 5/6); non-cohesive, wet, compact	SP		34.8 366.1	8	SO	5.0 / 5.0	
40		(40.0-52.0) (SW) SAND, fine to coarse sub-rounded sand, some low plasticity fines (silty clay seams ~1 inch thick), trace fine subrounded gravels; dark yellowish orange (10YR 6/6), brownish gray (5YR 4/1) and medium dark gray (N4); non-cohesive, wet, compact	SW		40.0	9	SO	10.0 / 10.0	▽ Water Level 41.05 ft bgs 11/6/15
45									
50		(52.0-52.5) (GW) sandy GRAVEL, fine to coarse sub-rounded gravel, medium to coarse sub-rounded sand; medium dark gray (N4); non-cohesive, wet, compact	GW		354.1 52.0 353.6 52.5	10	SO	10.0 / 10.0	
		(52.5-57.0) (SP) SAND, fine sub-rounded sand, some fine sub-rounded gravel, some non-plastic fines; medium dark gray (N4); non-cohesive, wet, compact	SP						
55		(57.0-59.5) (SC) CLAYEY SAND, fine sand, medium plasticity fines, trace sub-rounded gravels; medium dark gray (N4); non-cohesive, wet, compact	SC		349.1 57.0 346.6				
60		Log continued on next page	SW		59.5				

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-7

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/28/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 834,476.82 E: 888,483.33

ELEVATION: 406.06
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
60	6" Sonic	(59.5-82.3) (SW) SAND, fine to coarse sub-rounded sand, some rounded gravels, trace non-plastic fines; medium dark gray (N4); non-cohesive, wet, compact *(Continued)*	SW			11	SO	9.0 / 10.0	
65									
70						12	SO	5.0 / 10.0	
75									
80		(82.0) SAA except, 1 inch black (N1) organic layer			324.1 / 82.0				
		(82.3-98.2) (SP) SAND, fine to medium sub-rounded sand, trace sub-rounded gravels, some non-plastic fines; medium gray (N5); non-cohesive, wet, compact	SP		323.8 / 82.3	13	SO	10.0 / 10.0	
85									
90		Log continued on next page			316.1				

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

RECORD OF BOREHOLE MW-7

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center
DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/28/2015
DRILL RIG: Mini Sonic (CDD 1415)
DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 834,476.82 E: 888,483.33
ELEVATION: 406.06
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
90	6" Sonic	(82.3-98.2) (SP) SAND, fine to medium sub-rounded sand, trace sub-rounded gravels, some non-plastic fines; medium gray (N5); non-cohesive, wet, compact *(Continued)* (90.0) SAA except, no gravel	SP		90.0	14	SO	4.5 / 8.2	
95									
		BORING TERMINATED AT 98.2 FT BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-7.			307.9 98.2				
100									
105									
110									
115									
120									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek
LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-B1

SHEET 1 of 4

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/25/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 837,602.13 E: 887,903.93

ELEVATION: 409.55
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	Sonic	(0.0-0.3) TOPSOIL - (ML) SILT, non-plastic fines, trace fine sand, trace organics (roots); medium dark gray (N4); non-cohesive, moist, very loose	ML		409.3 / 0.3				
		(0.3-19.0) FILL - (SP) SAND, fine to medium sub-rounded sand, trace non-plastic fines, trace sub-angular gravel; moderate yellowish brown (10YR 5/4); non-cohesive, dry, loose				1	SO	3.5 / 5.0	
5						2	SO	4.0 / 5.0	
10		(10.0) SAA (Same As Above) except, trace medium plasticity silty clay seams (~0.5 inches thick), no gravel	SP		399.6 / 10.0	3	SO	4.5 / 5.0	
15						4	SO	5.0 / 5.0	Run #4, not all of the sample was collected on first attempt, some of the sample likely fell out. driller re-deploys sampler to retrieve the remainder of the sample. Sample likely mixed up after multiple attempts.
					390.6				
20		(19.0-21.4) (SC) CLAYEY SAND, fine to medium sub-rounded sand, non to low plasticity fines; medium dark gray (N4); non-cohesive, moist, compact	SC		19.0 / 388.2				
		(21.4-22.5) (CL & SP) SILTY CLAY and SAND, medium plasticity fines, fine sand; medium dark gray (N4); cohesive, w~PL, soft	CL & SP		21.4 / 387.1	5	SO	4.7 / 5.0	
		(22.5-25.0) (CL) SILTY CLAY, low plasticity fines, trace fine sand; medium dark gray (N4); cohesive, w<PL, firm	CL		22.5 / 384.6				
25		(25.0-32.0) (SP & CL) SAND and SILTY CLAY, fine sand, medium to low plasticity fines; light brownish gray (5YR 6/1) (sand size particles) and medium dark gray (N4) (fines); cohesive, w<PL, firm	SP & CL		25.0	6	SO	4.0 / 10.0	
30		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-B1

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/25/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 837,602.13 E: 887,903.93

ELEVATION: 409.55
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	Sonic	(25.0-32.0) (SP & CL) SAND and SILTY CLAY, fine sand, medium to low plasticity fines; light brownish gray (5YR 6/1) (sand size particles) and medium dark gray (N4) (fines); cohesive, w<PL, firm *(Continued)*	SP & CL		377.6				
		(32.0-35.0) (SM) SILTY SAND, fine sand, non-plastic fines; light brownish gray (5YR 6/1); non-cohesive, dry, compact	SM		32.0	6	SO	4.0 / 10.0	
35		(35.0-40.0) (CL) sandy SILTY CLAY, low to medium plasticity fines, fine sand; light brownish gray (5YR 6/1); cohesive, w~PL, firm	CL		374.6 35.0				
40		(40.0-55.0) (SP) SAND, fine to medium sub-rounded sand, trace low plasticity fines; yellowish gray (5Y 7/2); non-cohesive, dry, compact			369.6 40.0	7	SO	7.0 / 10.0	
45		(45.0) SAA except, moderate yellowish brown (10YR 5/4); moist	SP		364.6 45.0	8	SO	5.0 / 10.0	(45.0) Driller notes native groundwater likely encountered. ▽ Water Level 45.63 ft bgs 11/6/15
50									
55		(55.0-100.0) (SW) SAND, fine to coarse, sub-rounded sand, trace fine to coarse sub-rounded gravel, trace non-plastic fines; medium dark gray (N4) to moderate yellowish brown (10YR 5/4); non-cohesive, wet, compact	SW		354.6 55.0	9	SO	4.0 / 10.0	
60		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

RECORD OF BOREHOLE MW-B1

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center
DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/25/2015
DRILL RIG: Mini Sonic (CDD 1415)
DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 837,602.13 E: 887,903.93
ELEVATION: 409.55
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
60	Sonic	(55.0-100.0) (SW) SAND, fine to coarse, sub-rounded sand, trace fine to coarse sub-rounded gravel, trace non-plastic fines; medium dark gray (N4) to moderate yellowish brown (10YR 5/4); non-cohesive, wet, compact *(Continued)*	SW						
					346.6 63.0	9	SO	4.0 10.0	
		(63.0) SAA except. thin layer (~2 inches) of black (N1) organics							
65									
70						10	SO	4.0 10.0	
					336.6 73.0				
		(73.0) SAA except, trace black (N1) organics							
75					334.6 75.0				
		(75.0) SAA except, no fines, light olive gray (5Y 5/2)				11	SO	0.5 5.0	Run #11, issues with recovery, driller notes that material is very soft any is likely being pushed out of the way instead of into the sampler.
80									Run #12, still issues with recovery, driller trys to switch drill bit to help improve recovery.
85						12	SO	5.0 10.0	
90					319.6				

Log continued on next page

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek
LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-B1

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/25/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 837,602.13 E: 887,903.93

ELEVATION: 409.55
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
90	Sonic	(55.0-100.0) (SW) SAND, fine to coarse, sub-rounded sand, trace fine to coarse sub-rounded gravel, trace non-plastic fines; medium dark gray (N4) to moderate yellowish brown (10YR 5/4); non-cohesive, wet, compact *(Continued)* (90.0) SAA except, trace 1 inch layers of CLAYEY SAND (SC) with medium plasticity	SW		90.0	13	SO	5.0 / 10.0	
95									
100		BORING TERMINATED AT 100.0 FT BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-B1.			309.6 100.0				
105									
110									
115									
120									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-B2

SHEET 1 of 3

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/27/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 837,801.74 E: 885,337.20

ELEVATION: 395.94
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-0.1) TOPSOIL - (ML) SILT, non-plastic fines, trace fine sand, trace organics (roots); medium dark gray (N4); non-cohesive, moist, very loose	ML		395.8 / 0.1				
		(0.1-3.5) (SP) SAND, fine to medium sand, trace non-plastic fines; moderate yellowish brown (10YR 5/4); non-cohesive, dry, loose	SP			1	SO	1.5 / 2.5	
					392.4				
		(3.5-8.8) (SP) SAND, fine to medium sand, trace non-plastic fines; medium dark gray (N4); non-cohesive, moist, loose	SP		3.5	2	SO	2.0 / 2.5	
5		(5.0) SAA (Same As Above) except, trace fine to coarse sub-rounded gravel (chert)			390.9 / 5.0	3	SO	5.0 / 5.0	
					387.1				
		(8.8-10.0) (CL-ML) SILTY CLAY to SILT, low plasticity fines, trace fine sand; medium dark gray (N4); cohesive, w<PL, soft	CL-ML		8.8 / 385.9				
10		(10.0-12.5) (SC) CLAYEY SAND, fine to medium sand, low plasticity fines; medium dark gray (N4); non-cohesive, dry, loose	SC		10.0 / 383.4	4	SO	2.8 / 5.0	
		(12.5-20.0) (SM) SILTY SAND, fine sand, non-plastic fines; light brownish gray (5YR 6/1); non-cohesive, dry, loose	SM		12.5				
15		(17.5) SAA except, some medium plasticity fines seams (>1.0 inches thick)			378.4 / 17.5	5	SO	3.7 / 5.0	
					375.9				
20		(20.0-24.0) (CL) SILTY CLAY, medium plasticity fines, some fine sand; brownish gray (5YR 4/1) to medium dark gray (N4); cohesive, w~PL, soft	CL		20.0	6	SO	4.2 / 5.0	(20.0) Driller notes native water encountered.
					371.9				
		(24.0-30.0) (SP-SM) SAND, fine sand, some non-plastic fines; brownish gray (5YR 4/1); non-cohesive, moist, compact	SP-SM		24.0	7	SO	5.0 / 5.0	
25									
30					365.9				

Log continued on next page

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-B2

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center
DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/27/2015
DRILL RIG: Mini Sonic (CDD 1415)
DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 837,801.74 E: 885,337.20
ELEVATION: 395.94
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(30.0-40) (SP) SAND, fine sand, trace non-plastic fines; light olive gray (5Y 5/2); non-cohesive, wet, compact	SP		30.0	8	SO	2.0 / 10.0	(30.0) Run #8, Driller notes silty/sandy clay may have clogged bit for run. sand was not able to push up the clay causing poor recovery. when pushing in the casing the driller noted that the material acted like a sand. ▽ Water Level 32.54 ft bgs 11/3/15
35									
40		(40.0-41.0) (SW) SAND, fine to coarse, subrounded sand; dark gray (N3); non-cohesive, wet, compact	SW		355.9 40.0				
		(41.0-43.0) (CL) SILTY CLAY, medium plasticity fines, some fine sand; medium dark gray (N4); cohesive, w~PL, firm	CL		354.9 41.0				
45		(43.0-54.5) (SP) SAND, fine to medium sub-rounded sand; medium dark gray (N4); non-cohesive, moist, compact	SP		352.9 43.0	9	SO	8.0 / 10.0	
50		(53.0) ~1 inch seam of black (N1) organic material.			342.9 53.0	10	SO	10.0 / 10.0	
55		(54.5-60.0) (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; medium dark gray (N4); cohesive, w>PL, firm	CL		341.4 54.5				
60		Log continued on next page			335.9				

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek
LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

RECORD OF BOREHOLE MW-B2

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0002A
LOCATION: Rush Island Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 10/27/2015
DRILL RIG: Mini Sonic (CDD 1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 837,801.74 E: 885,337.20

ELEVATION: 395.94
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
60	6" Sonic	(60.0-65.0) (SP) SAND, fine to medium sub-rounded sand, trace non-plastic fines; medium dark gray (N4); non-cohesive, wet, compact	SP		60.0				
65		(65.0-87.9) (SP) SAND, fine to coarse sub-rounded sand, trace non-plastic, fines; medium dark gray (N4); non-cohesive, wet, compact	SP		330.9 65.0	11	SO	8.0 10.0	
70						12	SO	7.0 10.0	(70.0) Run #11, poor recovery on the first sample run, most of sample fell out. Driller re-deploys sampler and collects remaining sample. Driller notes sample is likely mixed up after multiple attempts.
75									
80		(80.0) SAA, trace fine to medium sub-rounded gravel			315.9 80.0	13	SO	4.0 7.9	
85									
90		BORING TERMINATED AT 87.9 FT BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-B2.			308.0 87.9				

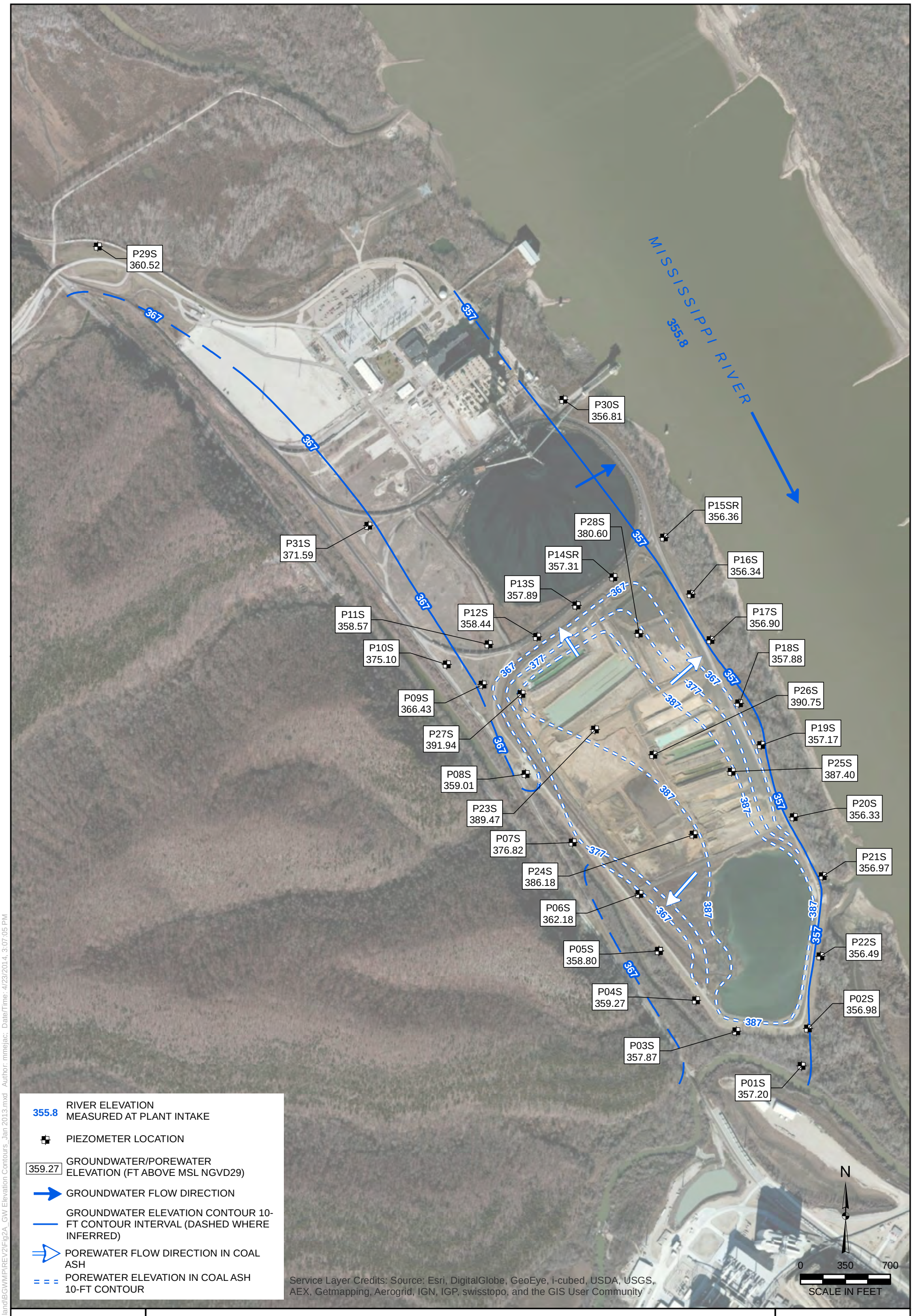
SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD RIEC LOGS.GPJ GLDR_CO.GDT 10/9/17

APPENDIX B
Historic NRT Potentiometric Surface Maps and Cross-Sections with Potentiometric Contours



DRAWN BY/DATE:
MDM 4/8/14
REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

GROUNDWATER ELEVATION CONTOURS
COAL ASH AND SHALLOW ALLUVIUM JANUARY 25, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWP
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 2A

NATURAL RESOURCE TECHNOLOGY

MISSISSIPPI RIVER
355.8

P28D
(357.22)

P23D
357.98

P26D
357.19

P25D
(356.74)

P24D
357.20

357.8

357.2

355.8 RIVER ELEVATION
MEASURED AT PLANT INTAKE

PIEZOMETER LOCATION

359.27 GROUNDWATER/POREWATER
ELEVATION (FT ABOVE MSL NGVD29)

GROUNDWATER FLOW DIRECTION

GROUNDWATER ELEVATION CONTOUR

NOTE:
LOCATIONS P25D AND P28D NOT INCLUDED FOR GROUNDWATER POTENTIOMETRIC SURFACE CONTOURS.

N

0 350 700
SCALE IN FEET

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Y:\GIS\Projects\20\2072\MXD\Rush Island\BGWMP\REV2\Fig2B_GW Pot Surface_Jan 2013.mxd Author: mmejac; Date/Time: 4/23/2014, 1:50:51 PM

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MDM 4/8/14
REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

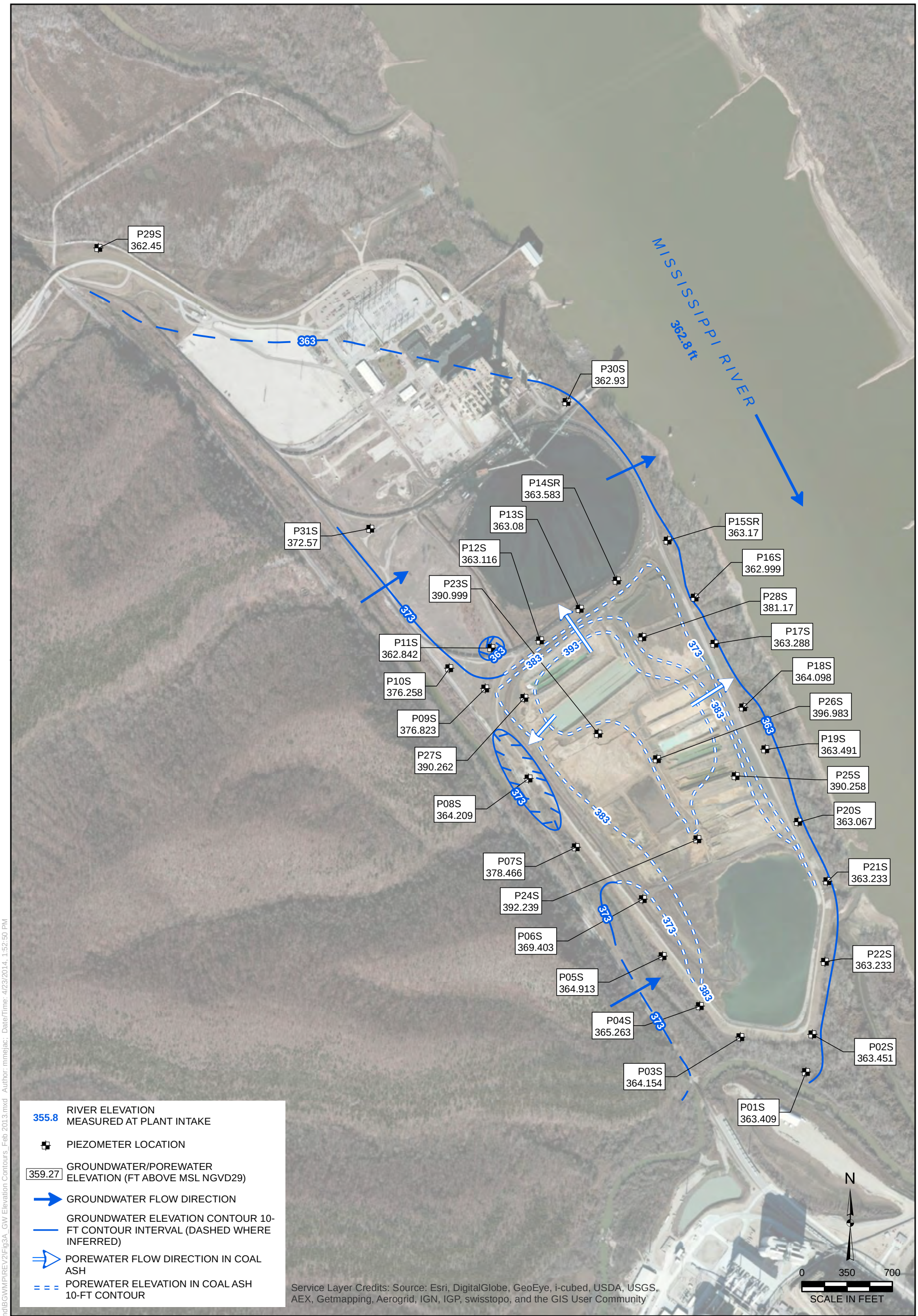
GROUNDWATER POTENTIOMETRIC SURFACE
DEEP ALLUVIAL SAND JANUARY 25, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 2B

NATURAL RESOURCE TECHNOLOGY



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MDM 4/8/14
REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

GROUNDWATER ELEVATION CONTOURS
COAL ASH AND SHALLOW ALLUVIUM FEBRUARY 20, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 3A

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000252

MISSISSIPPI RIVER
362.8 ft

P28D
(363.25)

P23D
363.59

363.4
363.6
363.8

P26D
363.33

P25D
(363.08)

P24D
363.48

355.8 RIVER ELEVATION MEASURED AT PLANT INTAKE

PIEZOMETER LOCATION

359.27 GROUNDWATER/POREWATER ELEVATION (FT ABOVE MSL NGVD29)

GROUNDWATER FLOW DIRECTION

GROUNDWATER ELEVATION CONTOUR

NOTE:
LOCATIONS P25D AND P28D NOT INCLUDED FOR GROUNDWATER POTENTIOMETRIC SURFACE CONTOURS.

N

0 350 700
SCALE IN FEET

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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MDM 4/8/14
REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

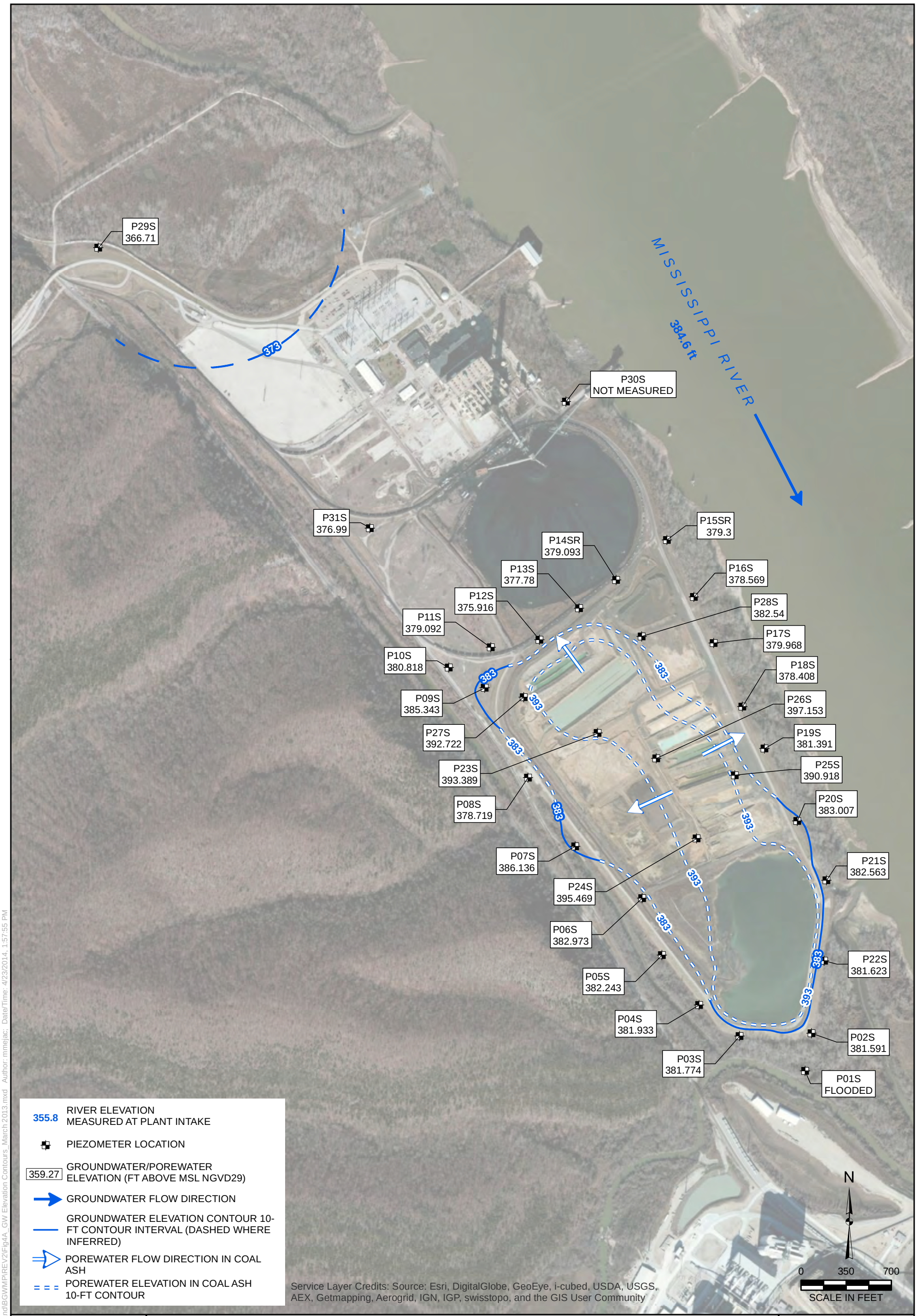
GROUNDWATER ELEVATION CONTOURS
DEEP ALLUVIAL SAND FEBRUARY 20, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 3B

NATURAL RESOURCE TECHNOLOGY



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REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

GROUNDWATER ELEVATION CONTOURS
COAL ASH AND SHALLOW ALLUVIUM MARCH 15, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 4A

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000254

MISSISSIPPI RIVER
384.6 ft

P28D
(381.24)

P23D
380.18

P26D
382.23

P25D
(382.9)

383
382
381
380

P24D
382.78

355.8 RIVER ELEVATION
MEASURED AT PLANT INTAKE

PIEZOMETER LOCATION

359.27 GROUNDWATER/POREWATER
ELEVATION (FT ABOVE MSL NGVD29)

GROUNDWATER FLOW DIRECTION

GROUNDWATER ELEVATION CONTOUR

NOTE:
LOCATIONS P25D AND P28D NOT INCLUDED FOR GROUNDWATER POTENTIOMETRIC SURFACE CONTOURS.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

N

0 350 700
SCALE IN FEET

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MDM 4/8/14
REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

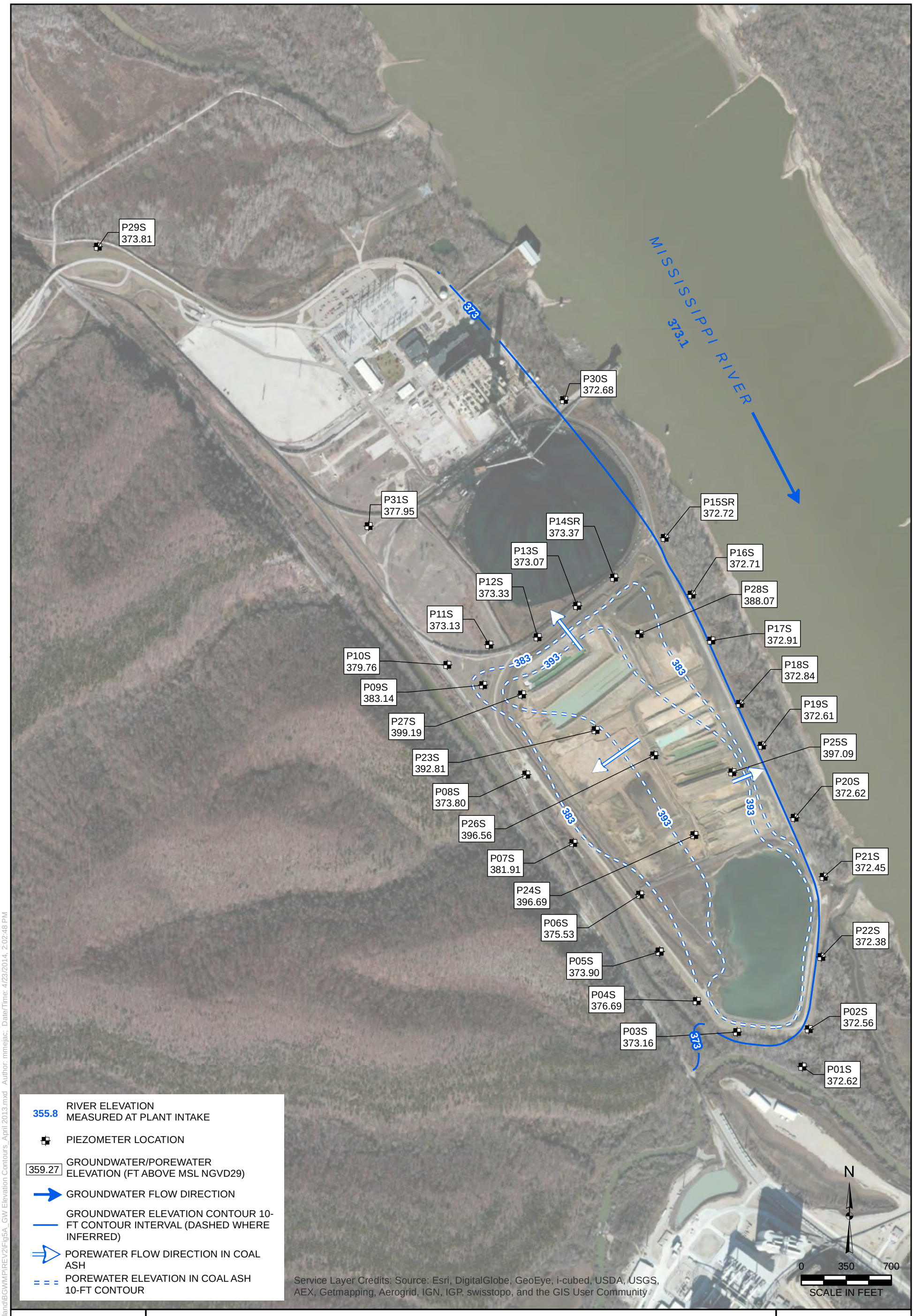
GROUNDWATER ELEVATION CONTOURS
DEEP ALLUVIAL SAND MARCH 15, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 4B

NATURAL RESOURCE TECHNOLOGY



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REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

GROUNDWATER ELEVATION CONTOURS
COAL ASH AND SHALLOW ALLUVIUM APRIL 4, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 5A

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000256

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REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

GROUNDWATER POTENTIOMETRIC SURFACE
DEEP ALLUVIAL SAND APRIL 4, 2013

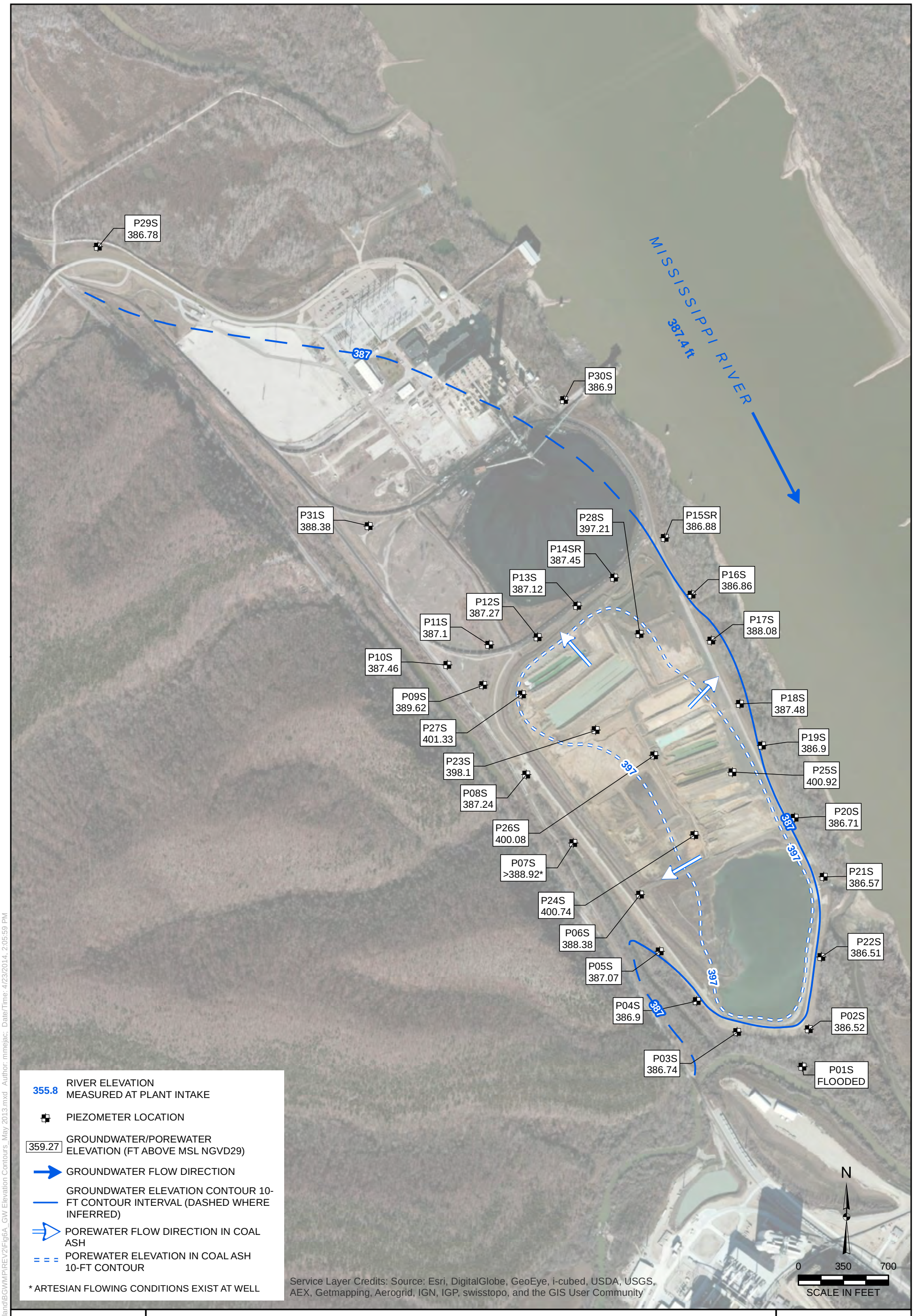
GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWP
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 5B

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000257



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REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

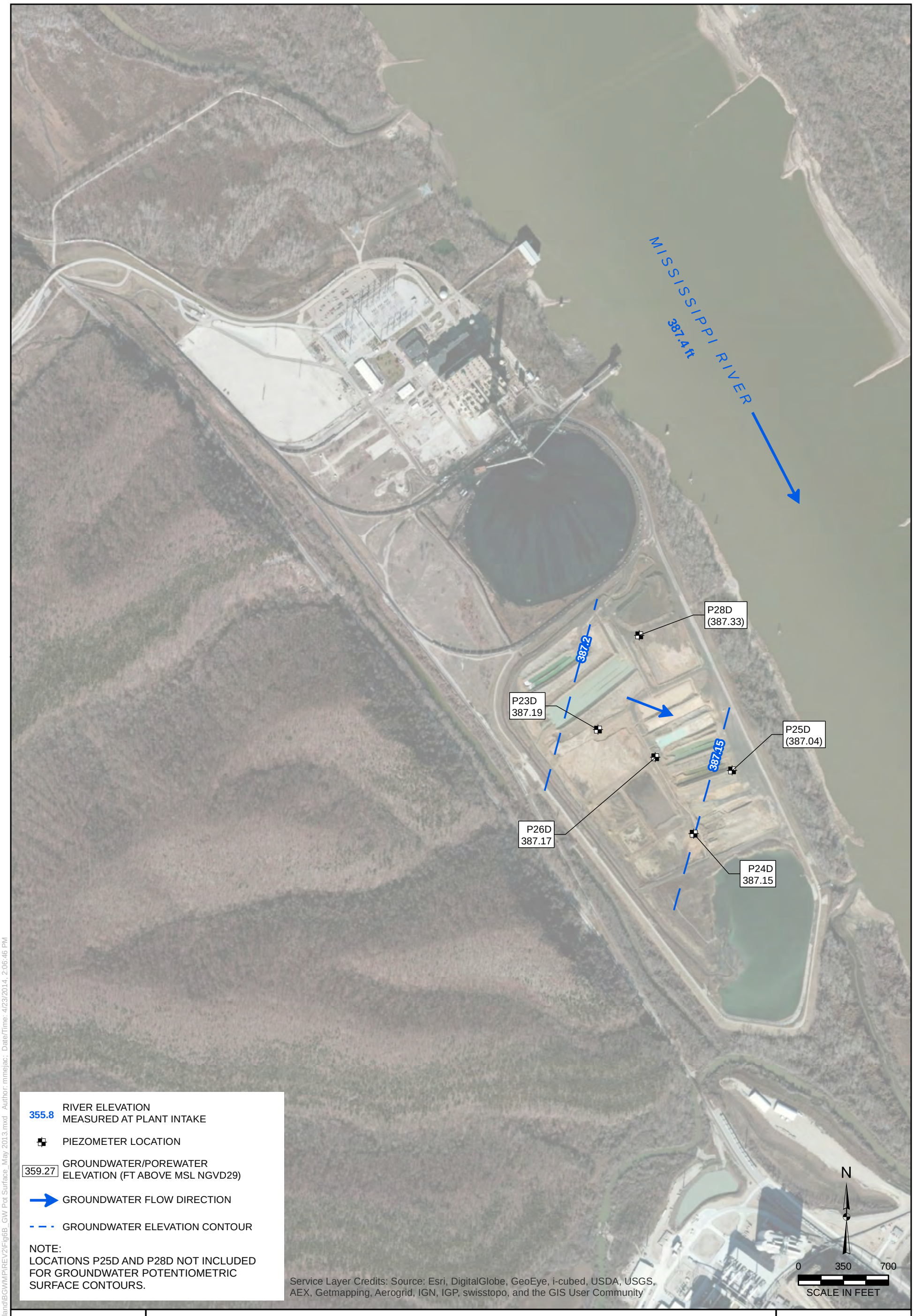
GROUNDWATER ELEVATION CONTOURS
COAL ASH AND SHALLOW ALLUVIUM MAY 23, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 6A

NATURAL RESOURCE TECHNOLOGY



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REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

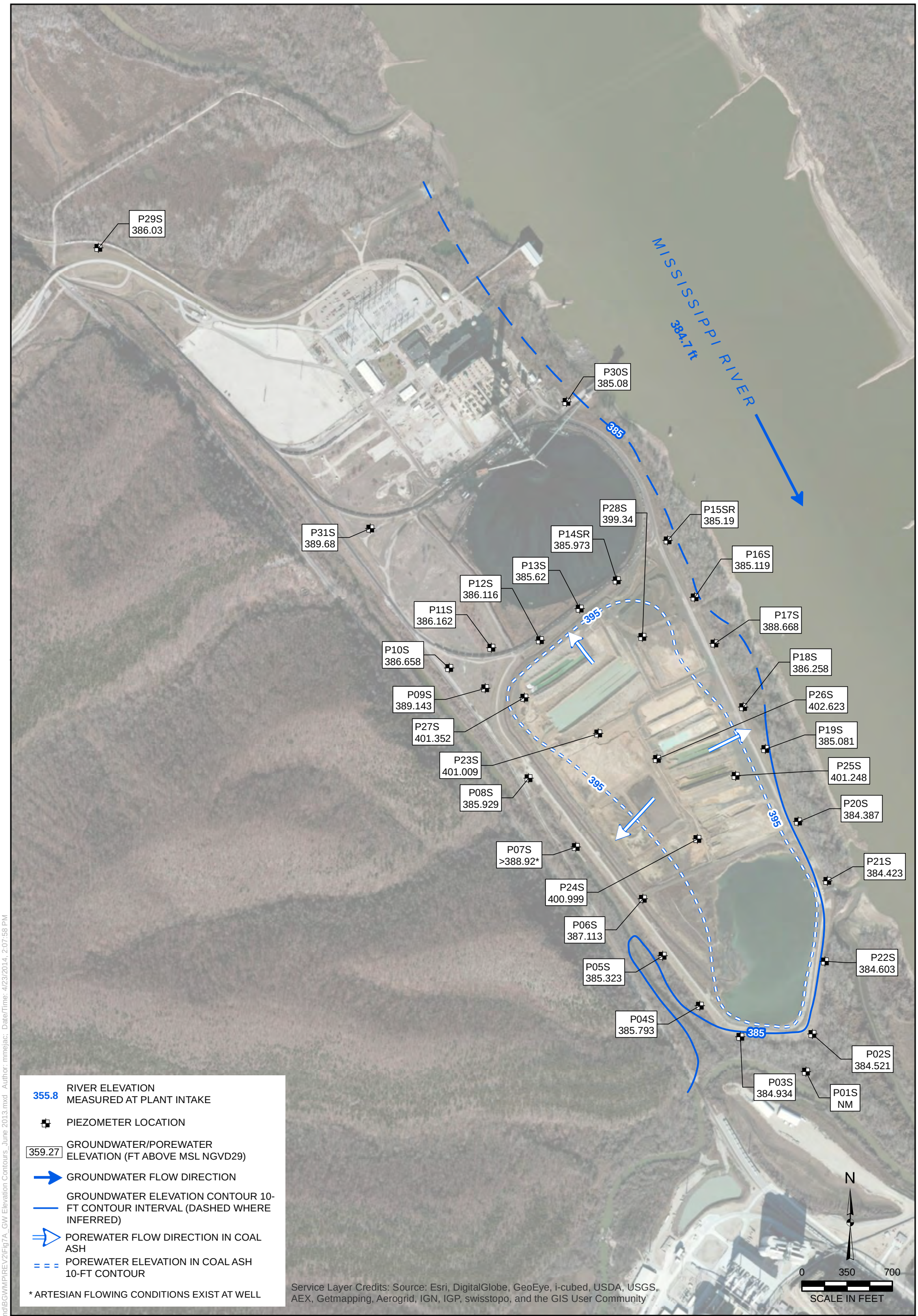
GROUNDWATER ELEVATION CONTOURS
DEEP ALLUVIAL SAND MAY 23, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 6B

NATURAL RESOURCE TECHNOLOGY



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REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

GROUNDWATER ELEVATION CONTOURS
COAL ASH AND SHALLOW ALLUVIUM JUNE 26, 2013

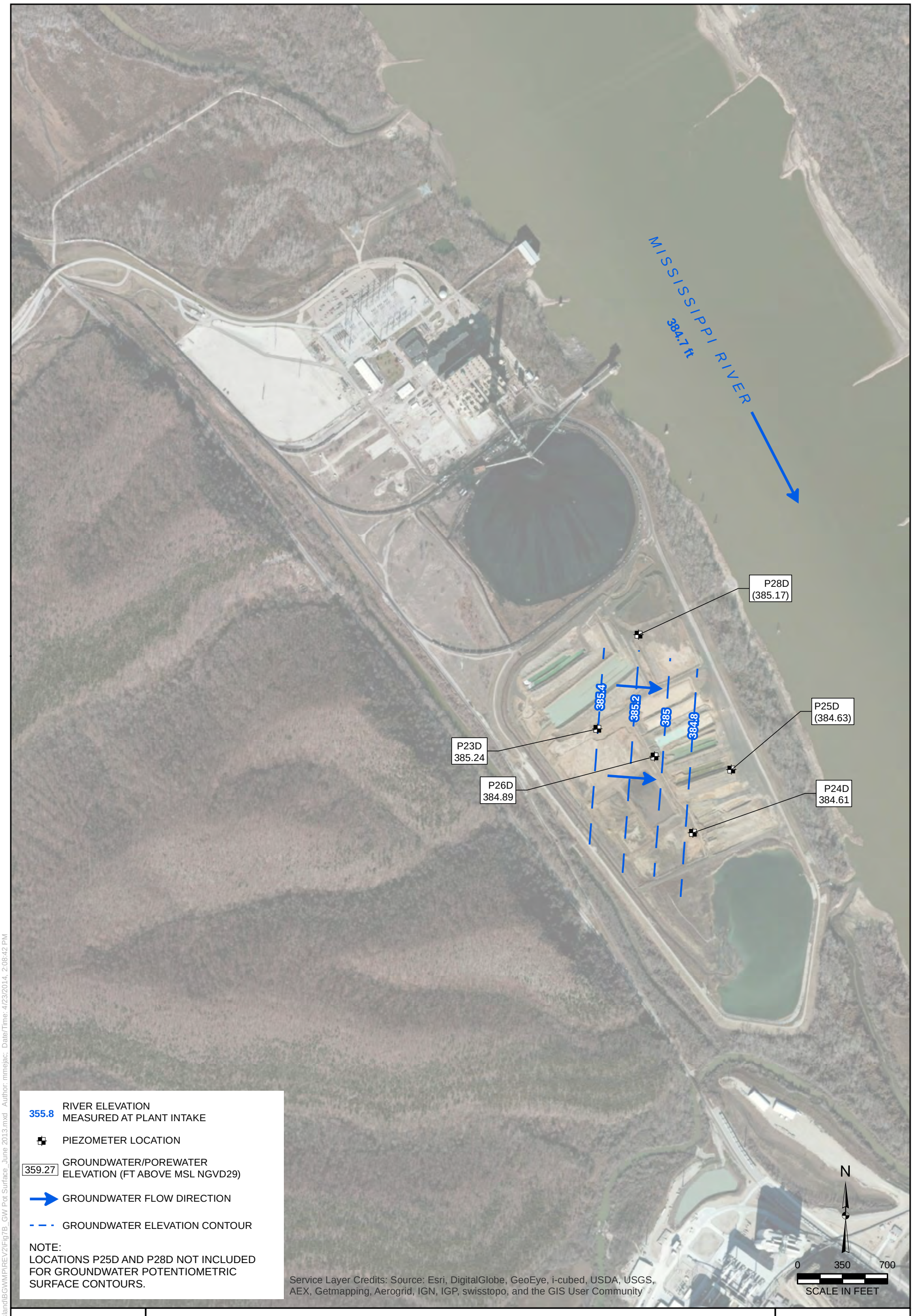
GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 7A

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000260



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BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

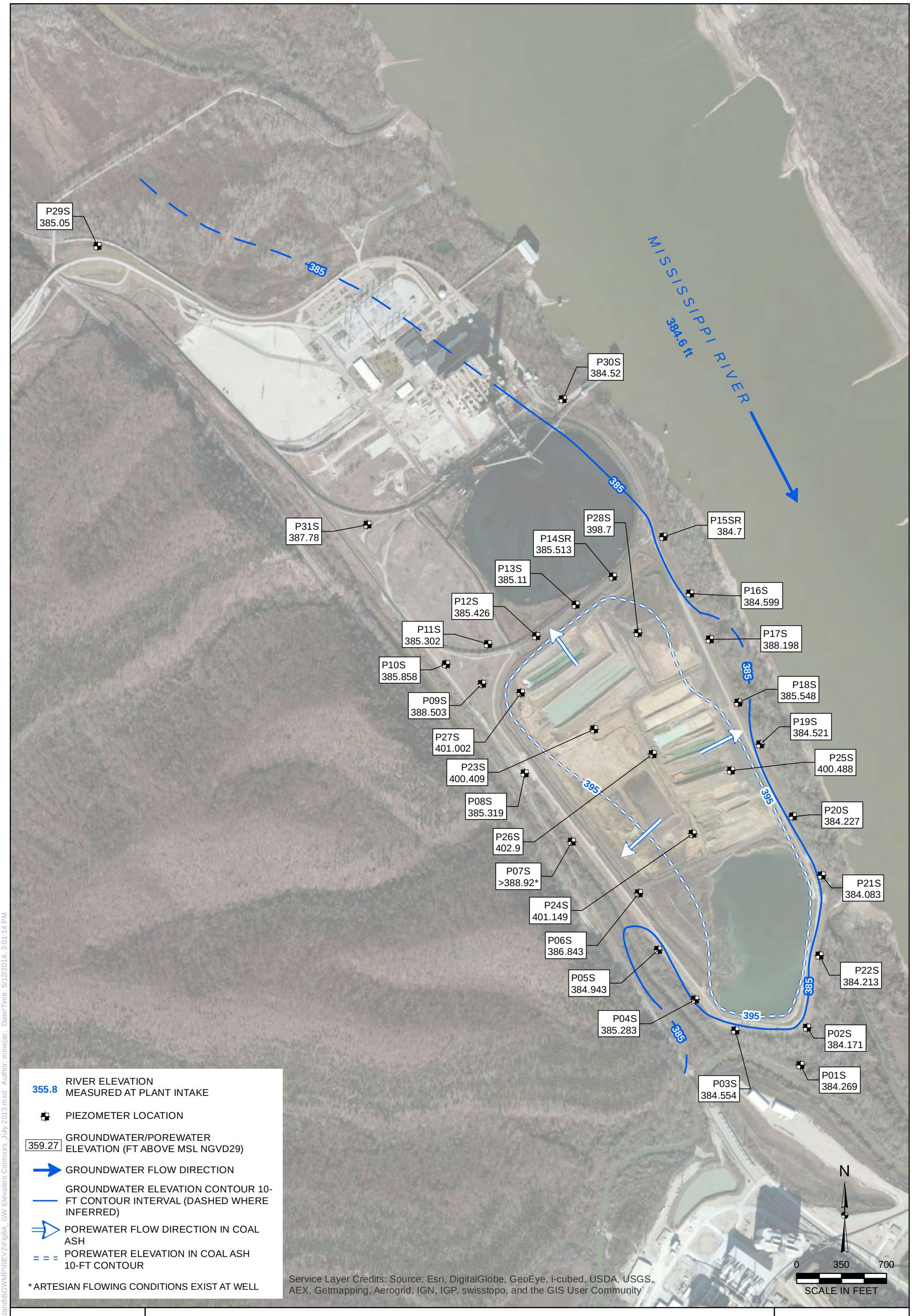
GROUNDWATER ELEVATION CONTOURS
DEEP ALLUVIAL SAND JUNE 26, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 7B

NATURAL RESOURCE TECHNOLOGY



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BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

GROUNDWATER ELEVATION CONTOURS
COAL ASH AND SHALLOW ALLUVIUM JULY 9, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 8A

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000262

MISSISSIPPI RIVER
384.6 ft

P28D
(384.82)

P23D
384.84

P26D
384.61

P25D
(384.41)

P24D
384.54

384.8

385

355.8 RIVER ELEVATION MEASURED AT PLANT INTAKE

PIEZOMETER LOCATION

359.27 GROUNDWATER/POREWATER ELEVATION (FT ABOVE MSL NGVD29)

GROUNDWATER FLOW DIRECTION

GROUNDWATER ELEVATION CONTOUR

NOTE:
LOCATIONS P25D AND P28D NOT INCLUDED FOR GROUNDWATER POTENTIOMETRIC SURFACE CONTOURS.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

N

0 350 700
SCALE IN FEET

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MDM 4/8/14
REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

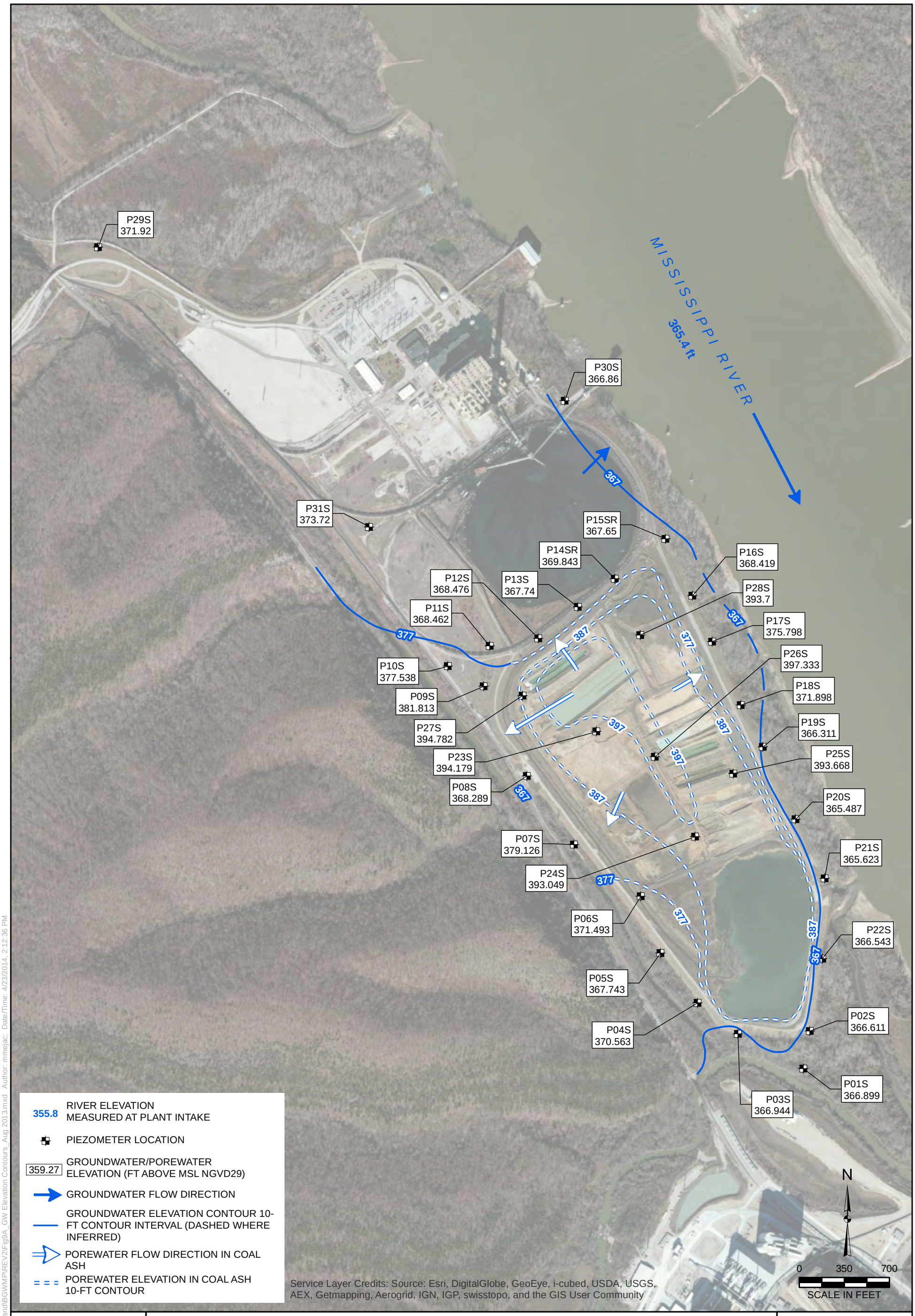
GROUNDWATER ELEVATION CONTOURS
DEEP ALLUVIAL SAND JULY 9, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 8B

NATURAL RESOURCE TECHNOLOGY



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BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

GROUNDWATER ELEVATION CONTOURS
COAL ASH AND SHALLOW ALLUVIUM AUGUST 21, 2013

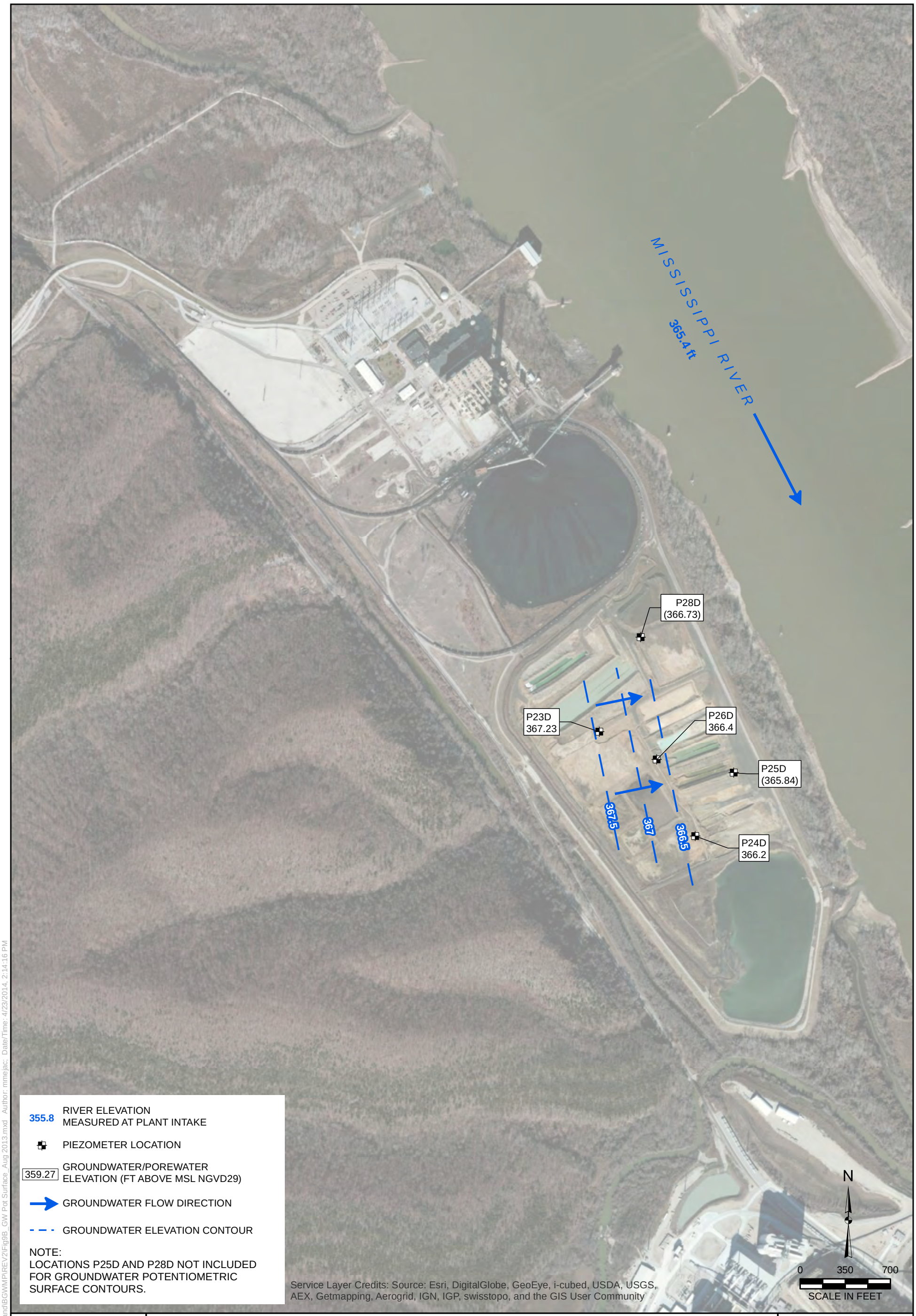
GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 9A

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000264



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BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

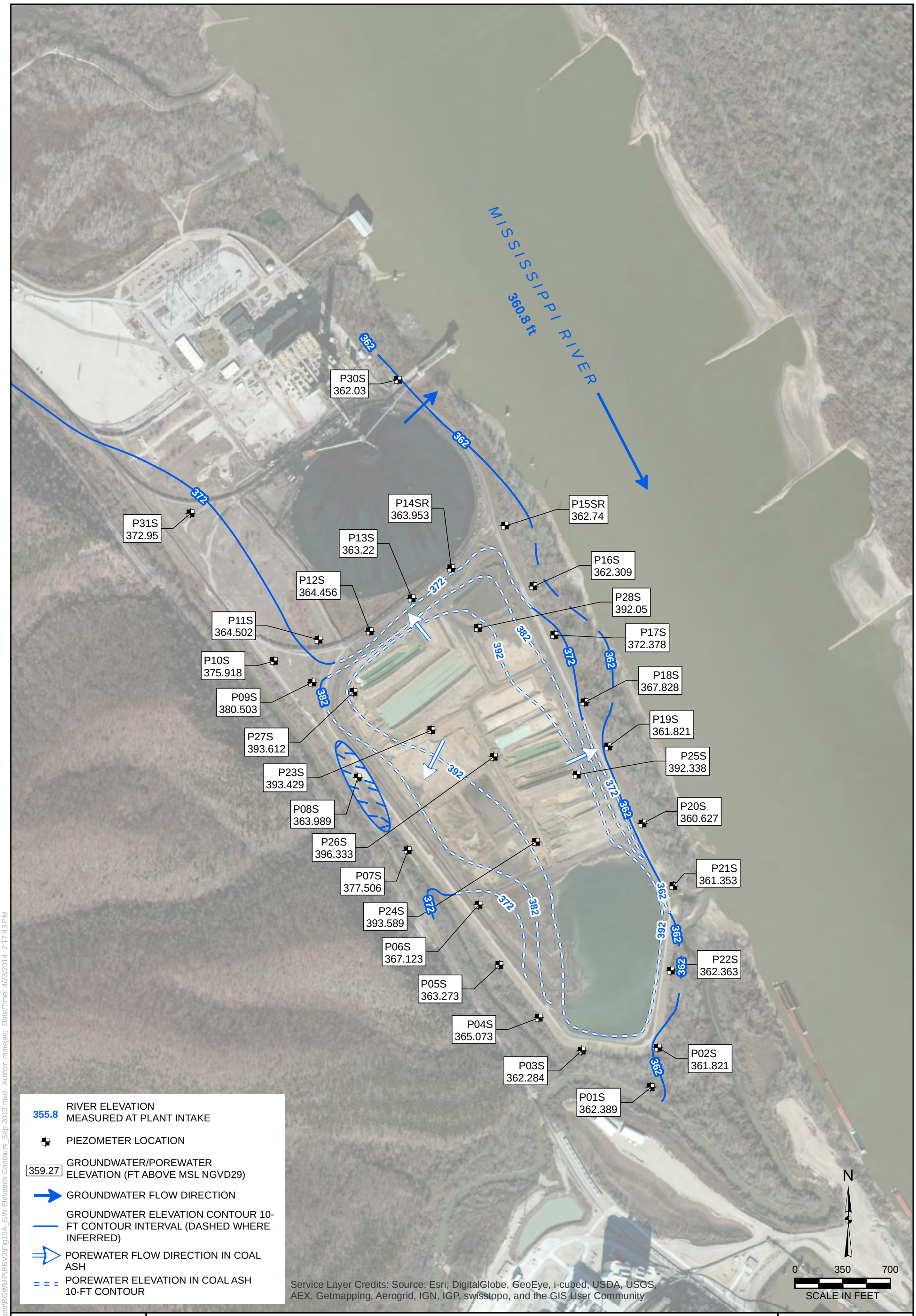
GROUNDWATER ELEVATION CONTOURS
DEEP ALLUVIAL SAND AUGUST 21, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 9B

NATURAL RESOURCE TECHNOLOGY



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REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

GROUNDWATER ELEVATION CONTOURS
COAL ASH AND SHALLOW ALLUVIUM SEPTEMBER 5, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 10A

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000266

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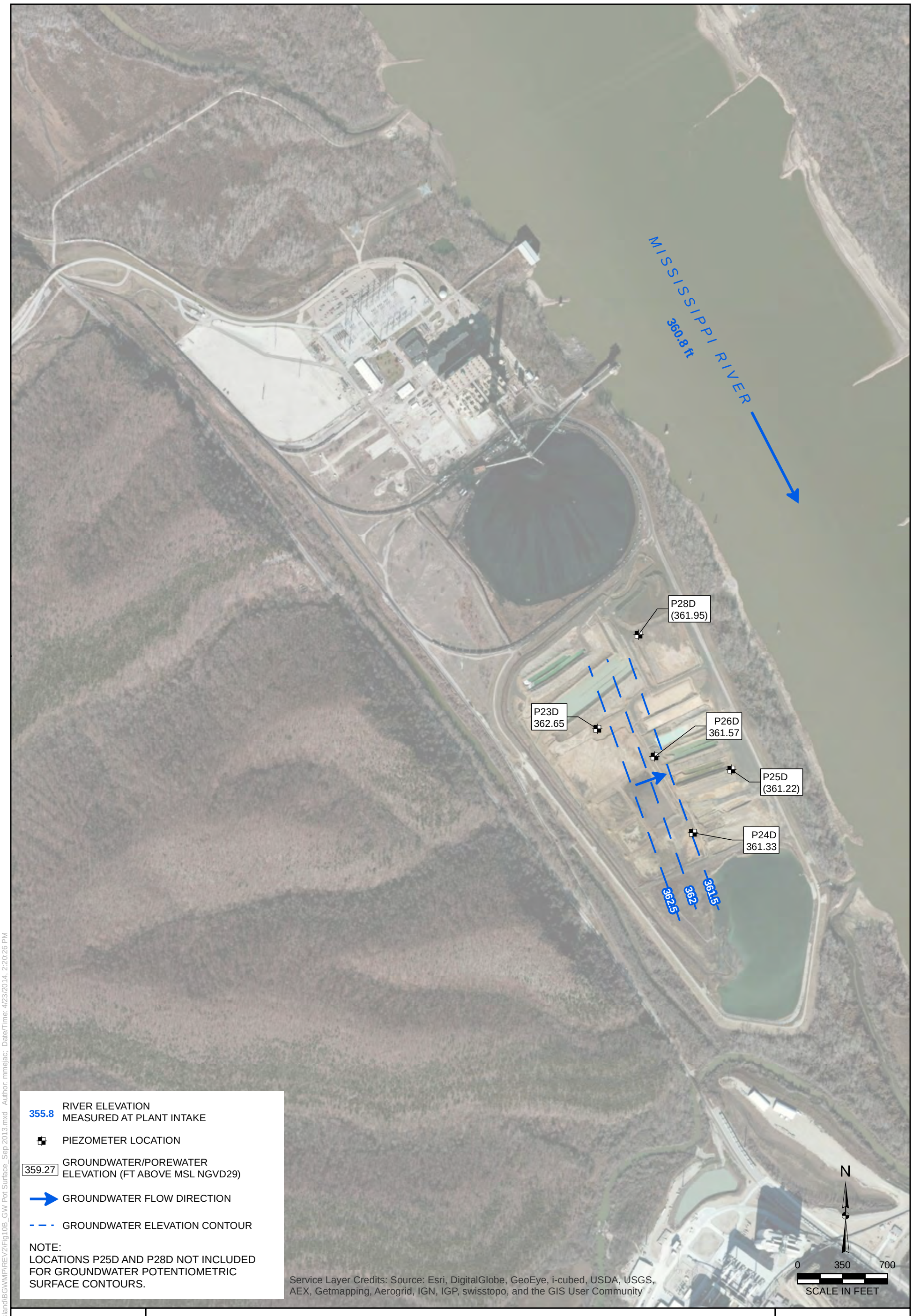

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REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

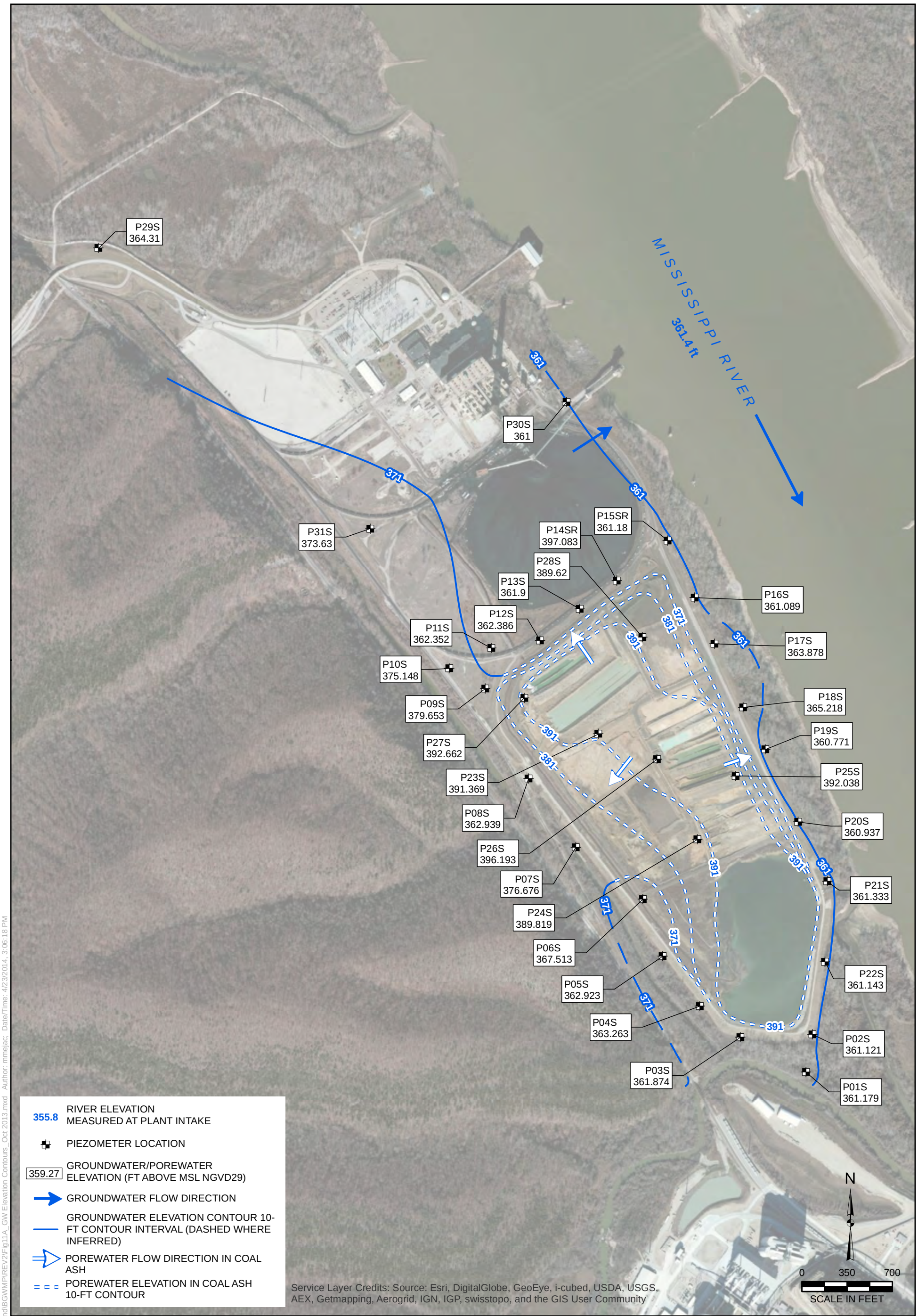
GROUNDWATER ELEVATION CONTOURS
DEEP ALLUVIAL SAND SEPTEMBER 9, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 10B

NATURAL RESOURCE TECHNOLOGY



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BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

GROUNDWATER ELEVATION CONTOURS
COAL ASH AND SHALLOW ALLUVIUM OCTOBER 10, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 11A

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000268

MISSISSIPPI RIVER
361.4ft

P28D
(361.92)

362.4
362.2
362.0

P26D
361.87

P23D
362.335

P25D
(361.47)

P24D
361.87

355.8 RIVER ELEVATION
MEASURED AT PLANT INTAKE

PIEZOMETER LOCATION

359.27 GROUNDWATER/POREWATER
ELEVATION (FT ABOVE MSL NGVD29)

GROUNDWATER FLOW DIRECTION

GROUNDWATER ELEVATION CONTOUR

NOTE:
LOCATIONS P25D AND P28D NOT INCLUDED FOR GROUNDWATER POTENTIOMETRIC SURFACE CONTOURS.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

N

0 350 700
SCALE IN FEET

Y:\GIS\Projects\2012072\MXD\Rush Island\BGWMP\REV2\Fig11B_GW Pot Surface_Oct 2013.mxd Author: mmejac; DateTime: 4/23/2014, 2:21:16 PM

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MDM 4/8/14
REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

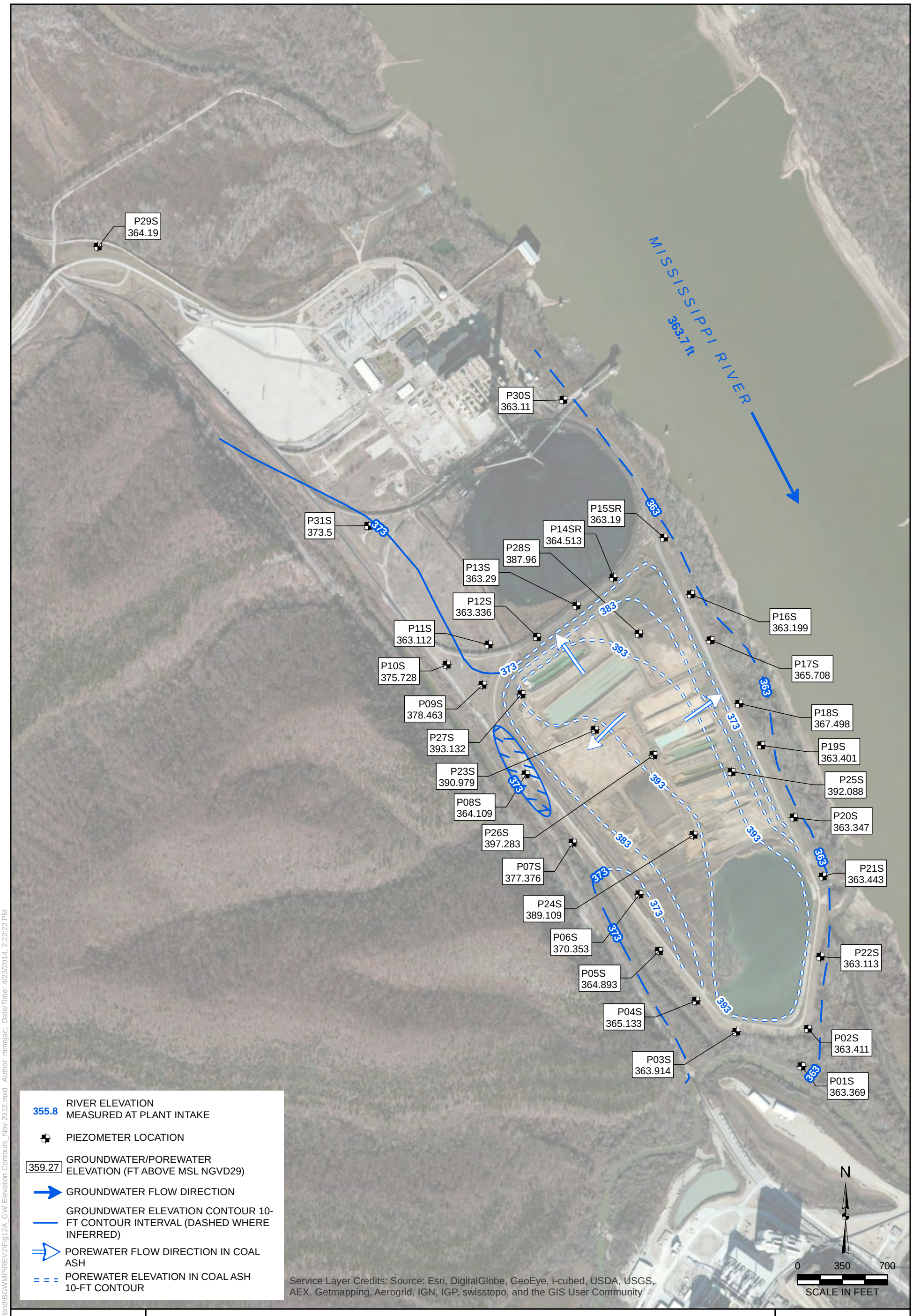
GROUNDWATER ELEVATION CONTOURS
DEEP ALLUVIAL SAND OCTOBER 10, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 11B

NATURAL RESOURCE TECHNOLOGY



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MDM 4/8/14
REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

GROUNDWATER ELEVATION CONTOURS
COAL ASH AND SHALLOW ALLUVIUM NOVEMBER 12, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 12A

NATURAL RESOURCE TECHNOLOGY

Y:\GIS\Projects\2072\MXD\Rush Island\BGWMP\REV2\Fig12B_GW Pot Surface_Nov 2013.mxd Author: mmejac; Date/Time: 4/23/2014, 2:23:05 PM

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BRH 4/11/14
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BRH 4/11/14

GROUNDWATER ELEVATION CONTOURS
DEEP ALLUVIAL SAND NOVEMBER 12, 2013

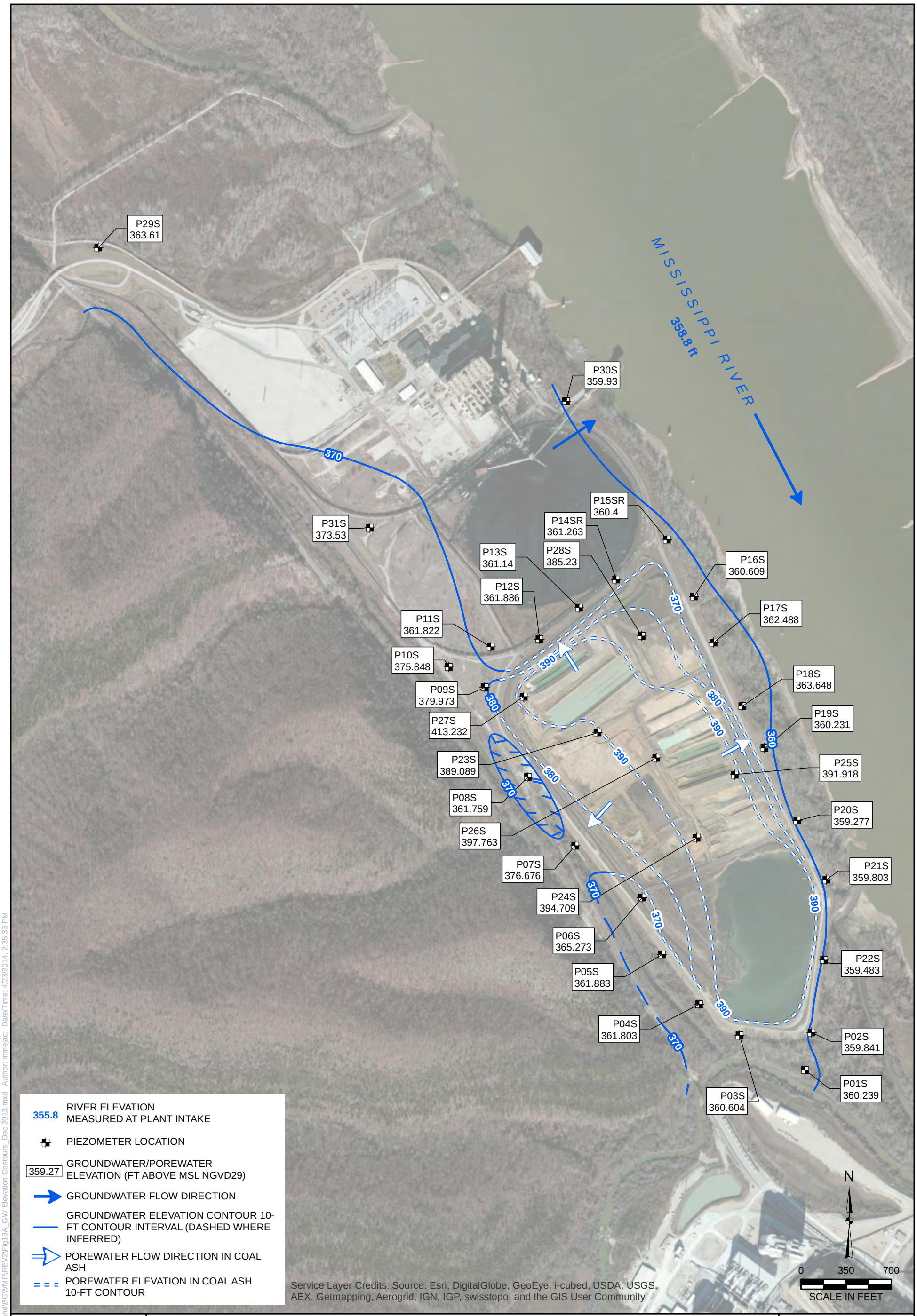
GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 12B

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000271



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MDM 4/8/14
REVIEWED BY/DATE:
BRH 4/11/14
APPROVED BY/DATE:
BRH 4/11/14

GROUNDWATER ELEVATION CONTOURS
COAL ASH AND SHALLOW ALLUVIUM DECEMBER 10, 2013

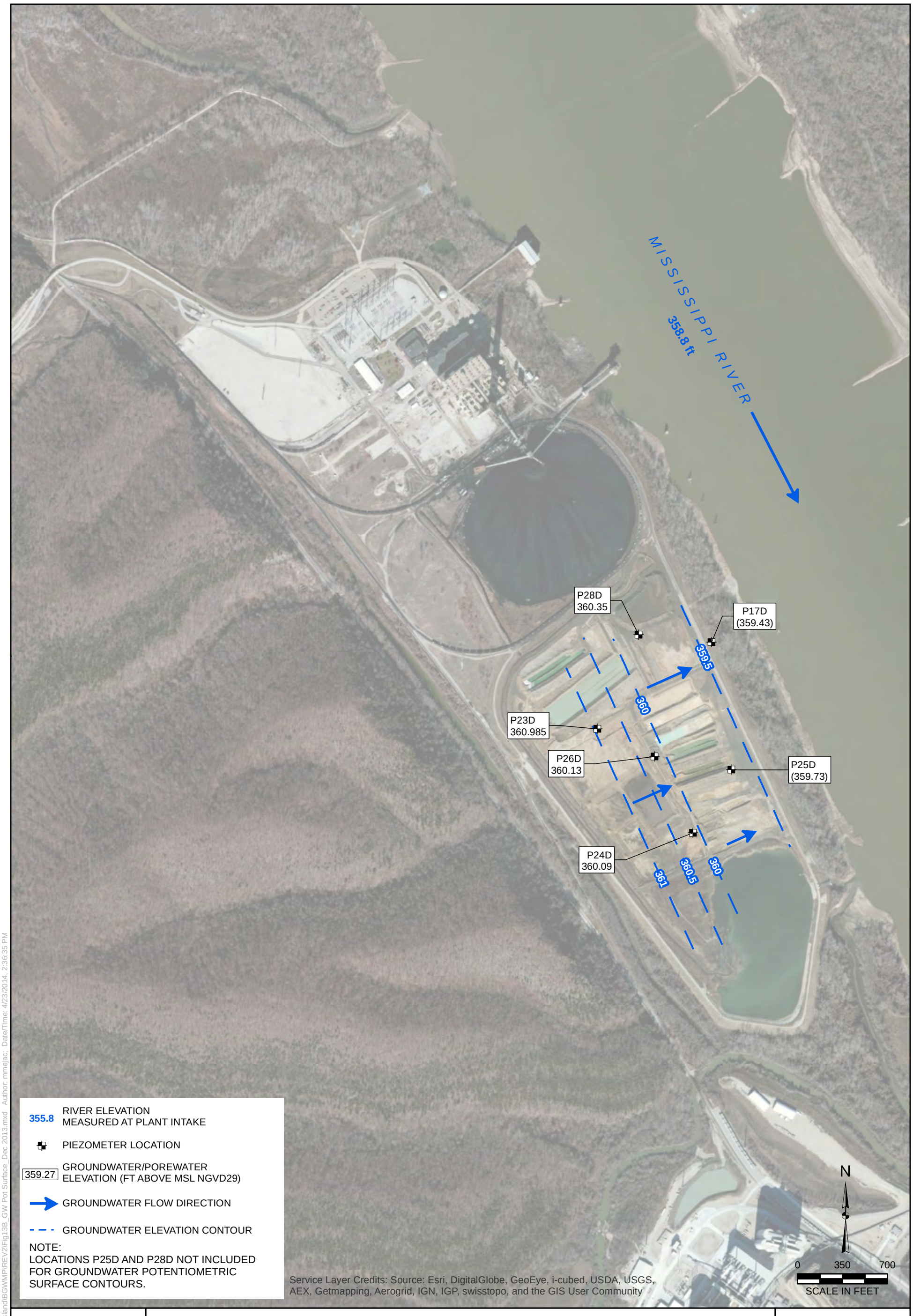
GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 13A

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000272



Y:\GIS\Projects\2072\MXD\Rush Island\BGWMP\REV2\Fig13B_GW Pot Surface_Dec 2013.mxd Author: mmejac; Date/Time: 4/23/2014, 2:36:35 PM

DRAWN BY/DATE:
MDM 4/8/14
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BRH 4/11/14
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BRH 4/11/14

GROUNDWATER ELEVATION CONTOURS
DEEP ALLUVIAL SAND DECEMBER 10, 2013

GROUNDWATER MONITORING AND SAMPLING PLAN
RUSH ISLAND ENERGY CENTER PROPOSED UWL
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1

FIGURE NO: 13B

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000273

DRAFT

P29S
367.77

P30S
369.98

P31S
375.17

MISSISSIPPI RIVER
371.0 FT

P15SR
370.37

P14SR
372.30

P13S
370.51

P16S
370.14

P12S
370.55

P10S
378.21

P11S
371.51

P28S
392.07

P17S
375.35

P09S
382.30

P27S
399.29

P23S
393.82

P18S
373.16

P08S
371.10

P26S
395.58

P19S
370.44

P25S
391.65

P07S
380.10

P20S
370.40

P24S
389.57

P06S
376.26

P21S
370.51

P05S
371.54

P22S
370.26

P04S
374.11

P02S
370.44

P03S
370.77

P01S
370.02

371.0
381.0
391.0

371.0 RIVER ELEVATION MEASURED AT PLANT INTAKE

P01S 370.02 PIEZOMETER LOCATION, GROUNDWATER ELEVATION, FEET ABOVE MEAN SEA LEVEL (NGVD29)

GROUNDWATER FLOW DIRECTION

GROUNDWATER ELEVATION CONTOUR 5-FT CONTOUR INTERVAL (DASHED WHERE INFERRED)

POREWATER ELEVATION IN COAL ASH 5-FT CONTOUR

N

0 300 600
SCALE IN FEET

PRINTED AT 22" x 34" (ANSI D)
1 INCH = 300 FT

PRINTED AT 11" x 17"
1 INCH = 600 FT

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Y:\GIS\Projects\2072\MXD\Rush Island\DSI\Fig_PS-0314 Shallow Alluvial Aquifer Groundwater Porewater Elevation Contour.mxd Author: mmeiac; Date/Time: 2/25/2015, 4:07:02 PM

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MDM 10/15/14
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APPROVED BY/DATE:
BRH 7/--/14

SHALLOW ALLUVIAL AQUIFER - GROUNDWATER / POREWATER ELEVATION CONTOUR MAP MARCH 25, 2014

DETAILED SITE INVESTIGATION
RUSH ISLAND ENERGY CENTER
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1/10.3

FIGURE NO: PS - 3/14

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000274

DRAFT

P29S
382.23

P30S
384.56

MISSISSIPPI RIVER
385.6 FT

P31S
385.08

P15SR
384.23

P14SR
386.26

385.0

P13S
384.78

P16S
383.77

P11S
384.55

P12S
384.85

385.0

P10S
385.26

P28S
394.94

P17S
384.29

P09S
388.03

P27S
401.46

P23S
395.75

P18S
383.45

P08S
384.84

P26S
396.91

395.0

P19S
384.29

385.0

P25S
396.72

395.0

P07S
387.86

P24S
395.88

P20S
384.73

P06S
386.93

P21S
384.59

385.0

385.0

P05S
384.97

395.0

395.0

P22S
384.13

P04S
384.85

P02S
384.31

P03S
384.69

P01S
NM

N

0 300 600
SCALE IN FEET

PRINTED AT 22" x 34" (ANSI D)
1 INCH = 300 FT

PRINTED AT 11" x 17"
1 INCH = 600 FT

385.6 RIVER ELEVATION MEASURED AT PLANT INTAKE

P01S NM PIEZOMETER LOCATION, GROUNDWATER ELEVATION, FEET ABOVE MEAN SEA LEVEL (NGVD29)

GROUNDWATER FLOW DIRECTION

GROUNDWATER ELEVATION CONTOUR 10-FT CONTOUR INTERVAL (DASHED WHERE

POREWATER ELEVATION IN COAL ASH 10-FT CONTOUR

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Y:\GIS\Projects\2012072\MXD\Rush Island\DSI\Fig_PS-0614 Shallow Alluvial Aquifer Groundwater Porewater Elevation Contour.mxd Author: mmeiac; Date/Time: 2/25/2015, 4:08:55 PM

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MDM 10/15/14
REVIEWED BY/DATE:
THC 7/--/14
APPROVED BY/DATE:
BRH 7/--/14

SHALLOW ALLUVIAL AQUIFER - GROUNDWATER / POREWATER ELEVATION CONTOUR MAP JUNE 15, 2014

DETAILED SITE INVESTIGATION
RUSH ISLAND ENERGY CENTER
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1/10.3

FIGURE NO: PS - 6/14

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000275

DRAFT

P29S
383.04

P30S
384.97

MISSISSIPPI RIVER
386.5 FT

P31S
384.38

P15SR
384.69

385.5

P14SR
386.22

P13S
385.14

P16S
384.29

P11S
384.75

P12S
385.01

P10S
385.71

P28S
392.52

P17S
383.61

385.5

P09S
388.75

385.5

P27S
398.51

385.5

P23S
396.64

P18S
383.02

P08S
385.41

P26S
392.53

P19S
384.82

P25S
390.99

P07S
388.21

P24S
389.81

P20S
385.55

385.5

P06S
386.75

P21S
385.20

P05S
385.54

P22S
384.64

385.5

385.5

P04S
385.40

P03S
385.28

P02S
384.95

P01S
385.25

N

0 300 600
SCALE IN FEET

PRINTED AT 22" x 34" (ANSI D)
1 INCH = 300 FT

PRINTED AT 11" x 17"
1 INCH = 600 FT

386.5 RIVER ELEVATION MEASURED AT PLANT INTAKE

P01S 385.71 PIEZOMETER LOCATION, GROUNDWATER ELEVATION, FEET ABOVE MEAN SEA LEVEL (NGVD29)

GROUNDWATER FLOW DIRECTION

GROUNDWATER ELEVATION CONTOUR 10-FT CONTOUR INTERVAL (DASHED WHERE

POREWATER ELEVATION IN COAL ASH 10-FT CONTOUR

DRAWN BY/DATE:
MDM 10/15/14
REVIEWED BY/DATE:
THC 7/--/14
APPROVED BY/DATE:
BRH 7/--/14

SHALLOW ALLUVIAL AQUIFER - GROUNDWATER / POREWATER ELEVATION CONTOUR MAP SEPTEMBER 16, 2014

DETAILED SITE INVESTIGATION
RUSH ISLAND ENERGY CENTER
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1/10.3

FIGURE NO: PS - 9/14

NATURAL RESOURCE TECHNOLOGY

DRAFT

P29S 372.01

P30S 368.46

P31S 374.57

MISSISSIPPI RIVER 368.1 FT

P15SR 368.79

P64S 368.87

P14SR 375.53

P13S 369.13

P16S 368.78

P11S 369.52

P12S 369.52

P10S 378.54

P65S 368.30

P28S 396.53

P09S 382.66

P17S 378.42

P27S 393.36

P66S 378.79

P23S 396.56

P18S 374.09

P67S 370.90

P26S 403.21

P19S 368.47

P08S 369.94

P25S 399.67

P68S 367.96

P07S 380.05

P24S 408.67

P20S 367.93

P69S 367.95

P06S 376.86

P21S 367.95

P70S 367.54

P05S 369.79

P22S 368.52

P04S 374.83

P71S 368.35

P03S 369.11

P02S 369.92

P01S 368.70

369.0 379.0 389.0 399.0

N

0 300 600

SCALE IN FEET

PRINTED AT 22" x 34" (ANSI D)
1 INCH = 300 FT

PRINTED AT 11" x 17"
1 INCH = 600 FT

368.1 RIVER ELEVATION MEASURED AT PLANT INTAKE

P01S 368.70 PIEZOMETER LOCATION, GROUNDWATER ELEVATION, FEET ABOVE MEAN SEA LEVEL (NGVD29)

GROUNDWATER FLOW DIRECTION

GROUNDWATER ELEVATION CONTOUR 10-FT CONTOUR INTERVAL (DASHED WHERE

POREWATER ELEVATION IN COAL ASH 10-FT CONTOUR

DRAWN BY/DATE:
MDM 1/12/15
REVIEWED BY/DATE:
THC 7/--/14
APPROVED BY/DATE:
BRH 7/--/14

SHALLOW ALLUVIAL AQUIFER - GROUNDWATER / POREWATER ELEVATION CONTOUR MAP DECEMBER 11, 2014

DETAILED SITE INVESTIGATION
RUSH ISLAND ENERGY CENTER
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1/10.3

FIGURE NO: PS - 12/14

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000277

DRAFT

P29D
368.72

MISSISSIPPI RIVER
371.0 FT

P13D
370.42

370.5

P28D
(370.94)

P17D
370.59

P23D
(371.04)

P08D
371.09

P26D
(371.04)

P19D
370.09

P25D
(370.82)

P24D
(371.00)

371.0

370.5

P21D
370.26

P05I
371.17

P22D
370.33

P03D
370.73

N

0 300 600
SCALE IN FEET

PRINTED AT 22" x 34" (ANSI D)
1 INCH = 300 FT

PRINTED AT 11" x 17"
1 INCH = 600 FT

371.0 RIVER ELEVATION MEASURED AT PLANT INTAKE

P03D 370.73 PIEZOMETER LOCATION, GROUNDWATER ELEVATION, FEET ABOVE MEAN SEA LEVEL (NGVD29)

GROUNDWATER FLOW DIRECTION

POTENTIOMETRIC SURFACE ELEVATION 0.5 FT CONTOUR INTERVAL (DASHED WHERE INFERRED)

NOTES:
WATER LEVELS AT PIEZOMETERS P23D, P24D, P25D, P26D AND P28D NOT USED FOR CONTOURING.

Y:\GIS\Projects\2012072\MXD\Rush Island\DSI\Fig PD-0314 Deep Alluvial Aquifer Groundwater Porewater Elevation Contour.mxd Author: mmejac; Date/Time: 2/25/2015, 4:00:25 PM

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MDM 10/16/14
REVIEWED BY/DATE:
THC 7/--/14
APPROVED BY/DATE:
BRH 7/--/14

DEEP ALLUVIAL AQUIFER - POTENTIOMETRIC SURFACE ELEVATION CONTOUR MAP MARCH 25, 2014

DETAILED SITE INVESTIGATION
RUSH ISLAND ENERGY CENTER
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1/10.3

FIGURE NO: PD - 3/14

NATURAL RESOURCE TECHNOLOGY

DRAFT

P29D
383.93

MISSISSIPPI RIVER
385.6 FT

P13D
384.81

385.0

P28D
(385.15)

P17D
385.01

385.0

P23D
(385.04)

385.0

P08D
384.84

P26D
(385.15)

P19D
384.48

P25D
(385.08)

384.5

P24D
(385.17)

385.0

P21D
384.8

P05I
384.96

P22D
384.68

P03D
384.73

N

0 300 600
SCALE IN FEET

PRINTED AT 22" x 34" (ANSI D)
1 INCH = 300 FT

PRINTED AT 11" x 17"
1 INCH = 600 FT

Service Layer Credits:

385.6 RIVER ELEVATION MEASURED AT PLANT INTAKE

P03D 384.73 PIEZOMETER LOCATION, GROUNDWATER ELEVATION, FEET ABOVE MEAN SEA LEVEL (NGVD29)

GROUNDWATER FLOW DIRECTION

POTENTIOMETRIC SURFACE ELEVATION 0.5 FT CONTOUR INTERVAL (DASHED WHERE INFERRED)

NOTES:
WATER LEVELS AT PIEZOMETERS P23D, P24D, P25D, P26D AND P28D NOT USED FOR CONTOURING.

Y:\GIS\Projects\2072\MXD\Rush Island\DSI\Fig_PD-0614 Deep Alluvial Aquifer Groundwater Porewater Elevation Contour.mxd Author: mmejac; Date/Time: 2/25/2015, 4:01:14 PM

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MDM 10/16/14
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THC 7/--/14
APPROVED BY/DATE:
BRH 7/--/14

DEEP ALLUVIAL AQUIFER - POTENTIOMETRIC SURFACE ELEVATION CONTOUR MAP JUNE 13, 2014

DETAILED SITE INVESTIGATION
RUSH ISLAND ENERGY CENTER
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1/10.3

FIGURE NO: PD - 6/14

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000279

DRAFT

P29D
384.27

MISSISSIPPI RIVER
386.5 FT

P13D
385.18

P28D
(385.77)

P17D
385.83

P23D
(385.54)

P08D
385.39

P26D
(385.82)

P19D
385.30

P25D
(385.81)

P24D
(385.84)

P21D
385.65

P05I
385.56

P22D
385.46

P03D
385.38

385.5

N

0 300 600
SCALE IN FEET

PRINTED AT 22" x 34" (ANSI D)
1 INCH = 300 FT

PRINTED AT 11" x 17"
1 INCH = 600 FT

386.5 RIVER ELEVATION MEASURED AT PLANT INTAKE

P03D 385.38 PIEZOMETER LOCATION, GROUNDWATER ELEVATION, FEET ABOVE MEAN SEA LEVEL (NGVD29)

GROUNDWATER FLOW DIRECTION

POTENTIOMETRIC SURFACE ELEVATION 0.5 FT CONTOUR INTERVAL (DASHED WHERE INFERRED)

NOTES:
WATER LEVELS AT PIEZOMETERS P23D, P24D, P25D, P26D AND P28D NOT USED FOR CONTOURING.

Y:\GIS\Projects\2012072\MXD\Rush Island\DSI\Fig PD-0914 Deep Alluvial Aquifer Groundwater Porewater Elevation Contour.mxd Author: mmeiac; Date/Time: 2/26/2015, 3:11:32 PM

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MDM 10/16/14
REVIEWED BY/DATE:
THC 7/--/14
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BRH 7/--/14

DEEP ALLUVIAL AQUIFER - POTENTIOMETRIC SURFACE ELEVATION CONTOUR MAP SEPTEMBER 16, 2014

DETAILED SITE INVESTIGATION
RUSH ISLAND ENERGY CENTER
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1/10.3

FIGURE NO: PD - 9/14

NATURAL RESOURCE TECHNOLOGY

DRAFT

P29D
370.01

MISSISSIPPI RIVER
368.1 FT

P13D
369.00

P28D
(368.90)

P17D
368.25

P23D
(369.31)

P08D
369.89

P26D
(368.81)

P19D
367.64

P25D
(368.44)

P24D
(368.73)

P21D
367.77

P05I
369.55

P22D
368.00

P03D
368.99

369.5
369.0
368.5
368.0

368.1 RIVER ELEVATION MEASURED AT PLANT INTAKE

P03D 368.99 PIEZOMETER LOCATION, GROUNDWATER ELEVATION, FEET ABOVE MEAN SEA LEVEL (NGVD29)

GROUNDWATER FLOW DIRECTION

POTENTIOMETRIC SURFACE ELEVATION 0.5 FT CONTOUR INTERVAL (DASHED WHERE INFERRED)

NOTES:
WATER LEVELS AT PIEZOMETERS P23D, P24D, P25D, P26D AND P28D NOT USED FOR CONTOURING.

N

0 300 600
SCALE IN FEET

PRINTED AT 22" x 34" (ANSI D)
1 INCH = 300 FT

PRINTED AT 11" x 17"
1 INCH = 600 FT

DRAWN BY/DATE:
MDM 1/12/15
REVIEWED BY/DATE:
THC 7/--/14
APPROVED BY/DATE:
BRH 7/--/14

DEEP ALLUVIAL AQUIFER - POTENTIOMETRIC SURFACE ELEVATION CONTOUR MAP DECEMBER 11, 2014

DETAILED SITE INVESTIGATION
RUSH ISLAND ENERGY CENTER
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1/10.3

FIGURE NO: PD - 12/14

NATURAL RESOURCE TECHNOLOGY

DRAFT

MISSISSIPPI RIVER
385.6 FT

P15SBR
(243.88)

P14SBR
385.01

P16SBR
384.76

P12SBR
(362.45)

P56SBR
384.84

P59SBR
384.73

P17SBR
384.69

384.7

385.0

P55SBR
384.84

P60SBR
384.89

P23SBR
385.02

P18SBR
384.73

385.0

P08SBR
384.99

P19SBR
(381.75)

P54SBR
(382.17)

P25SBR
384.86

P58SBR
384.70

P07SBR
384.86

385.0

P34SBR
384.77

P57SBR
384.76

P36SBR
384.97

385.0

384.7

P21SBR
384.55

P61SBR
385.02

P05SBR
384.90

P22SBR
(277.22)

P04SBR
384.87

P03SBR
(303.91)

P02SBR
(314.54)

N

0 300 600
SCALE IN FEET

PRINTED AT 22" x 34" (ANSI D)
1 INCH = 300 FT

PRINTED AT 11" x 17"
1 INCH = 600 FT

Service Layer Credits:

385.6 — RIVER ELEVATION MEASURED AT PLANT INTAKE

P04SBR 384.87 — PIEZOMETER LOCATION, GROUNDWATER ELEVATION, FEET ABOVE MEAN SEA LEVEL (NGVD29)

GROUNDWATER FLOW DIRECTION

POTENTIOMETRIC SURFACE ELEVATION 0.3 FT CONTOUR INTERVAL (DASHED WHERE INFERRED)

NOTES:
WATER LEVELS AT P02SBR, P03SBR, P12SBR, P15SBR, P19SBR, P22SBR AND P54SBR NOT USED FOR CONTOURING.

Y:\GIS\Projects\202072\MXD\Rush Island\DSI\Fig_PBR-0614 Shallow Bedrock Piezometers Potentiometric.mxd Author: mmejac; Date/Time: 2/25/2015, 3:55:26 PM

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MDM 10/16/14
REVIEWED BY/DATE:
THC 7/--/14
APPROVED BY/DATE:
BRH 7/--/14

SHALLOW BEDROCK PIEZOMETERS - POTENTIOMETRIC SURFACE ELEVATION CONTOUR MAP JUNE 13, 2014

DETAILED SITE INVESTIGATION
RUSH ISLAND ENERGY CENTER
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1/10.3

FIGURE NO: PBR - 6/14

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000282

DRAFT

MISSISSIPPI RIVER
386.5 FT

P15SBR
(248.91)

P14SBR
385.63

P16SBR
385.55

P12SBR
(375.66)

P56SBR
385.53

P59SBR
384.96

P17SBR
385.51

P55SBR
385.53

P60SBR
385.21

P23SBR
385.53

P18SBR
385.57

P08SBR
385.44

P19SBR
385.32

P54SBR
(380.85)

P25SBR
385.6

P07SBR
385.44

P58SBR
385.54

P34SBR
385.53

P57SBR
385.59

P36SBR
385.52

P21SBR
385.36

P61SBR
385.63

P05SBR
385.52

P22SBR
(281.16)

P04SBR
385.49

P03SBR
(305.03)

P02SBR
(352.73)

385.5
385.0

386.5 RIVER ELEVATION MEASURED AT PLANT INTAKE

P04SBR 385.49 PIEZOMETER LOCATION, GROUNDWATER ELEVATION, FEET ABOVE MEAN SEA LEVEL (NGVD29)

GROUNDWATER FLOW DIRECTION

POTENTIOMETRIC SURFACE ELEVATION 0.5 FT CONTOUR INTERVAL (DASHED WHERE INFERRED)

NOTES:
WATER LEVELS AT P02SBR, P03SBR, P12SBR, P15SBR, P22SBR AND P54SBR NOT USED FOR CONTOURING.

N

0 300 600
SCALE IN FEET

PRINTED AT 22" x 34" (ANSI D)
1 INCH = 300 FT

PRINTED AT 11" x 17"
1 INCH = 600 FT

Y:\GIS\Projects\2012072\MXD\Rush Island\DSI\Fig_PBR-0914 Shallow Bedrock Piezometers Potentiometric.mxd Author: mmejac: Date/Time: 2/26/2015, 3:23:04 PM

DRAWN BY/DATE:
MDM 10/16/14
REVIEWED BY/DATE:
THC 7/--/14
APPROVED BY/DATE:
BRH 7/--/14

SHALLOW BEDROCK PIEZOMETERS - POTENTIOMETRIC SURFACE ELEVATION CONTOUR MAP SEPTEMBER 16, 2014

DETAILED SITE INVESTIGATION
RUSH ISLAND ENERGY CENTER
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1/10.3

FIGURE NO: PBR - 9/14

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000283

DRAFT

MISSISSIPPI RIVER
368.1 FT

P15SBR
(254.37)

P14SBR
368.63

P16SBR
368.03

P12SBR
(371.34)

P56SBR
368.39

P59SBR
369.64

P17SBR
368.01

P55SBR
368.30

P60SBR
369.79

P18SBR
368.08

P23SBR
369.23

P08SBR
369.92

P19SBR
368.14

P54SBR
369.10

P25SBR
368.21

P58SBR
368.02

P07SBR
370.61

P34SBR
368.15

P57SBR
368.15

P36SBR
369.58

P21SBR
367.95

P61SBR
369.80

P05SBR
369.48

P22SBR
(283.72)

P04SBR
369.36

P03SBR
(306.24)

P02SBR
(359.38)

368.0
368.5
369.0
369.5
370.0

N

0 300 600
SCALE IN FEET

PRINTED AT 22" x 34" (ANSI D)
1 INCH = 300 FT

PRINTED AT 11" x 17"
1 INCH = 600 FT

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

368.11 RIVER ELEVATION MEASURED AT PLANT INTAKE

P04SBR 369.36 PIEZOMETER LOCATION, GROUNDWATER ELEVATION, FEET ABOVE MEAN SEA LEVEL (NGVD29)

GROUNDWATER FLOW DIRECTION

POTENTIOMETRIC SURFACE ELEVATION 0.5 FT CONTOUR INTERVAL (DASHED WHERE INFERRED)

NOTES:
WATER LEVELS AT P02SBR, P03SBR, P12SBR, P15SBR, AND P22SBR NOT USED FOR CONTOURING.

Y:\GIS\Projects\2012072\MXD\Rush Island\DSI\Fig_PBR-1214 Shallow Bedrock Piezometers Potentiometric.mxd Author: mmejac; Date/Time: 2/25/2015, 3:58:39 PM

DRAWN BY/DATE:
MDM 1/12/15
REVIEWED BY/DATE:
THC 7/--/14
APPROVED BY/DATE:
BRH 7/--/14

SHALLOW BEDROCK PIEZOMETERS - POTENTIOMETRIC SURFACE ELEVATION CONTOUR MAP DECEMBER 11, 2014

DETAILED SITE INVESTIGATION
RUSH ISLAND ENERGY CENTER
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO: 2072.1/10.3

FIGURE NO: PBR - 12/14

NATURAL RESOURCE TECHNOLOGY

AMEREN_00000284

DRAFT

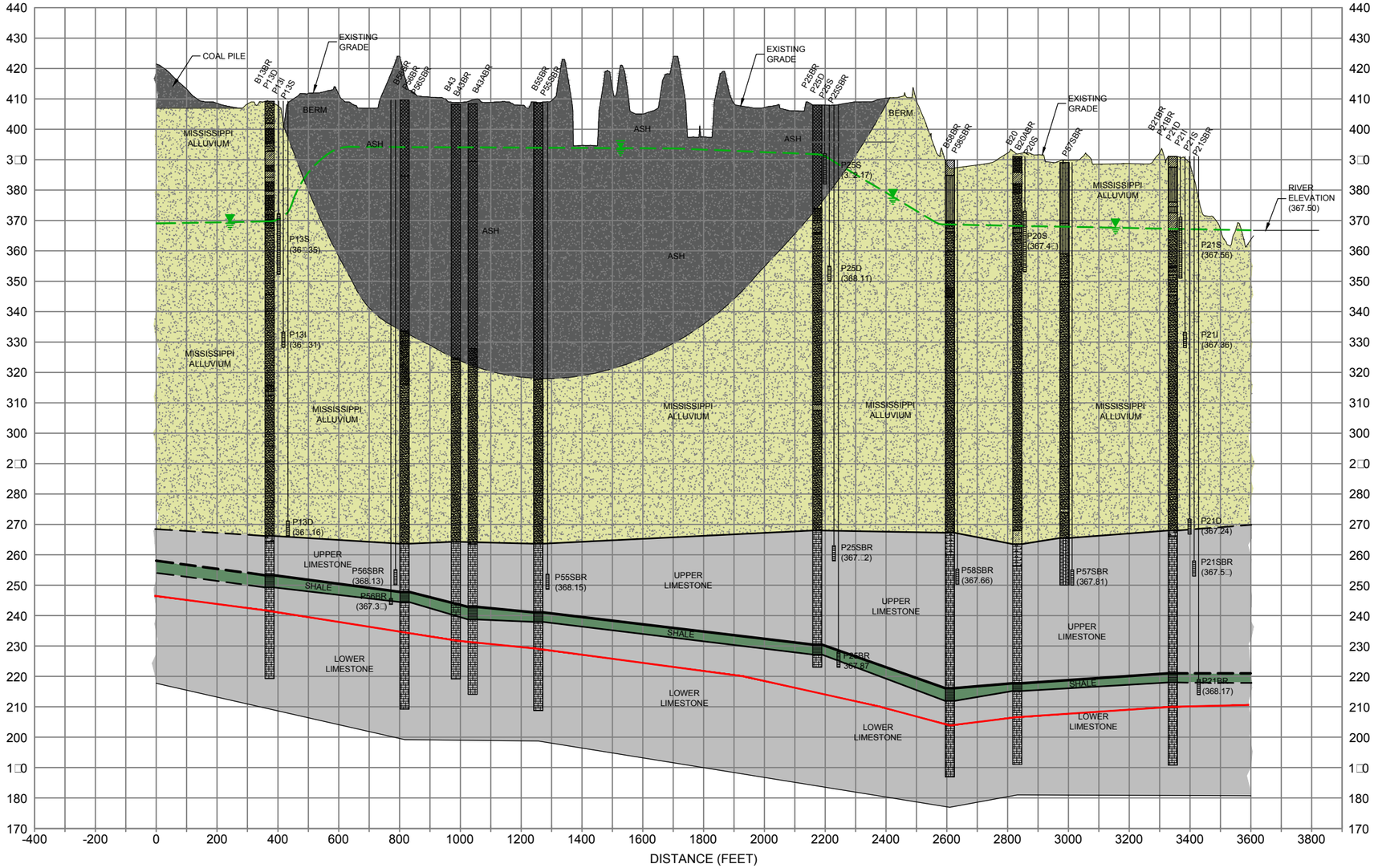
NATURAL RESOURCE TECHNOLOGY

PROJECT NO. 2072/10.3	CROSS SECTION LOCATIONS	
DRAWN BY: DMD 10/31/14	DETAILED SITE INVESTIGATION RUSH ISLAND ENERGY CENTER 100 BIG HOLLOW ROAD FESTUS, MISSOURI	
CHEC□ED BY: THC 10/31/14		
APPROVED BY: .	DRAWING NO: 2072-103-PlanView 103114.dwg	SHEET NO. 1
	REFERENCE: .	

AMEREN_00000285

Y: \ACAData\Projects\20\2072\10-3\dwg 2014 July\2072-103-PlanView 103114.dwg CROSS SECTION LAYOUT
IMAGES: Y: \ACAData\Projects\20\2072\Source\Rush Island\ESRI Aerial 103114.jpg:
XREFS:

C (NORTH) (SOUTH) C'



SECTION C-C'

- ASH (FILL)
- CLAY
- SILTY CLAY
- SILT
- CLAYEY SAND
- SILTY SAND
- POORLY GRADED SAND
- WELL GRADED SAND
- LIMESTONE
- WEATHERED LIMESTONE
- SHALE
- WATER TABLE SURFACE
- PIEZOMETER SCREEN
- (35□.01) GROUNDWATER/POREWATER ELEVATION MEASURED IN PIEZOMETERS, FT. MSL (AUG. 2014)
- PRESUMED LITHOLOGY (DASHED WHERE INFERRED)
- TOP OF CORRELATED, LATERALLY PERSISTENT CONFINING BED
- ASH
- MISSISSIPPI ALLUVIUM
- LIMESTONE
- SHALE

VERTICAL SCALE IN FEET: 20'
HORIZONTAL SCALE IN FEET: 200'
VERTICAL EXAGGERATION =10

DRAFT

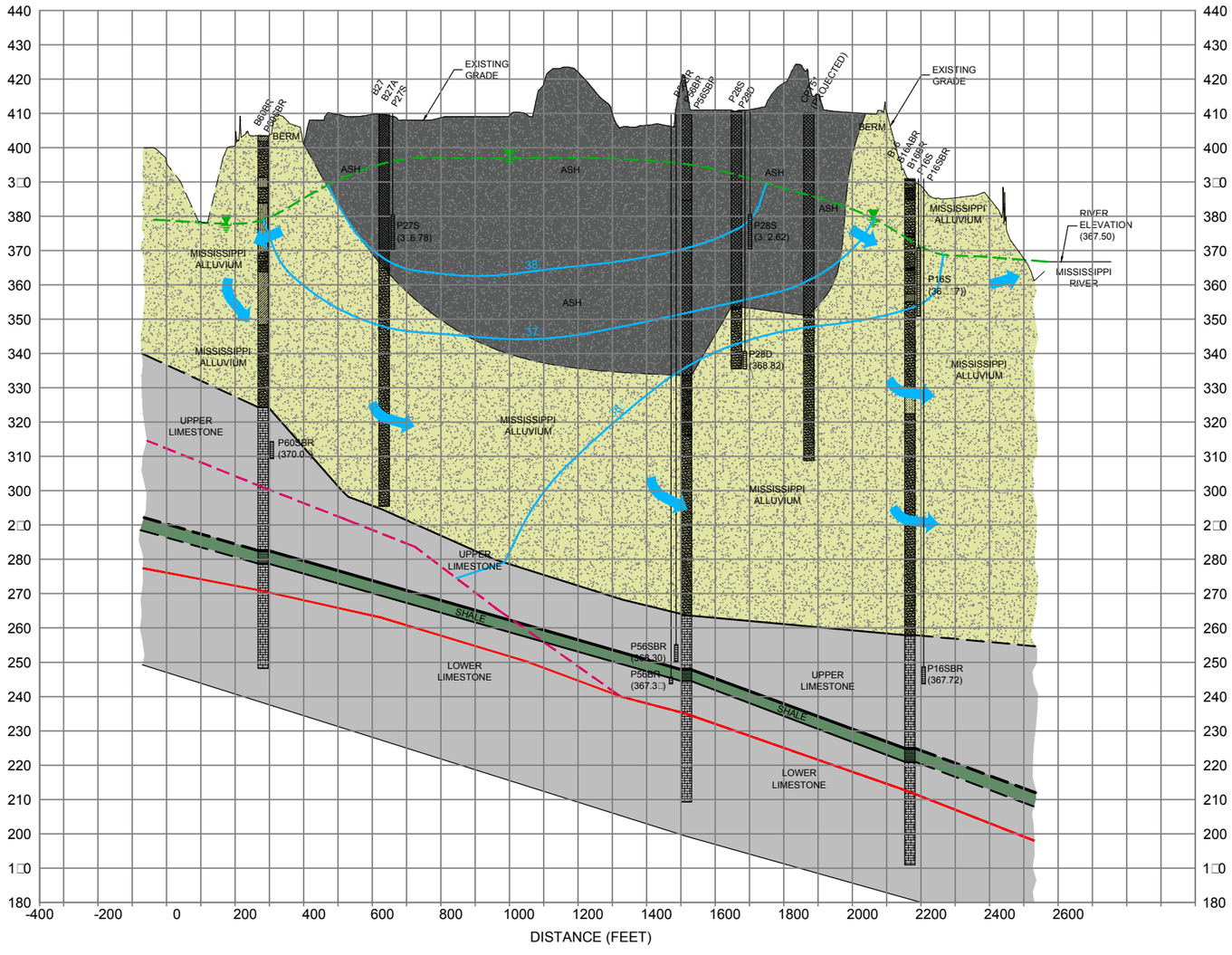
NATURAL RESOURCE TECHNOLOGY

PROJECT NO. 2072/10.3	CROSS SECTION C-C'
DRAWN BY: DMD 08/1□/14	DETAILED SITE INVESTIGATION RUSH ISLAND ENERGY CENTER 100 BIG HOLLOW ROAD FESTUS, MISSOURI
CHEC□ED BY: THC 10/21/14	
APPROVED BY: .	DRAWING NO: 2072-10-3-D01-14.DWG REFERENCE: .
	SHEET NO. 4

Y:\ACAData\Projects\20\2072\10-3\dwg 2014 July\2072-10-3-D01-14.dwg SECTION C-C
IMAGES:
XREFS:

AMEREN_00000286

F (WEST) (EAST) F'



SECTION F-F'

- ASH (FILL)
- CLAY
- SILTY CLAY
- SILT
- CLAYEY SAND
- SILTY SAND
- POORLY GRADED SAND
- WELL GRADED SAND
- LIMESTONE
- WEATHERED LIMESTONE
- SHALE

- WATER TABLE SURFACE
- PIEZOMETER SCREEN
- (35□01) GROUNDWATER/POREWATER ELEVATION MEASURED IN PIEZOMETERS, FT. MSL (AUG. 2014)
- 37□ E□UIPOTENTIAL LINES (POTENTIAL HEAD, FT. MSL)
- GROUNDWATER FLOW DIRECTION
- PRESUMED LITHOLOGY (DASHED WHERE INFERRED)
- TOP OF UPPERMOST CONFINING UNIT
- TOP OF CORRELATED, LATERALLY PERSISTENT CONFINING BED
- ASH
- MISSISSIPPI ALLUVIUM
- LIMESTONE
- SHALE

VERTICAL SCALE IN FEET 20'
HORIZONTAL SCALE IN FEET 200'
VERTICAL EXAGGERATION =10

DRAFT

NATURAL RESOURCE TECHNOLOGY

PROJECT NO. 2072/10.3	CROSS SECTION F-F'
DRAWN BY: DMD 08/1□14	DETAILED SITE INVESTIGATION RUSH ISLAND ENERGY CENTER 100 BIG HOLLOW ROAD FESTUS, MISSOURI
CHEC□ED BY: THC 10/21/14	
APPROVED BY: .	DRAWING NO: 2072-10-3-D01-14.DWG REFERENCE: .
	SHEET NO. 7

Y:\ACAData\Projects\20\2072\10-3\dwg 2014 July\2072-10-3-D01-14.dwg SECTION F-F
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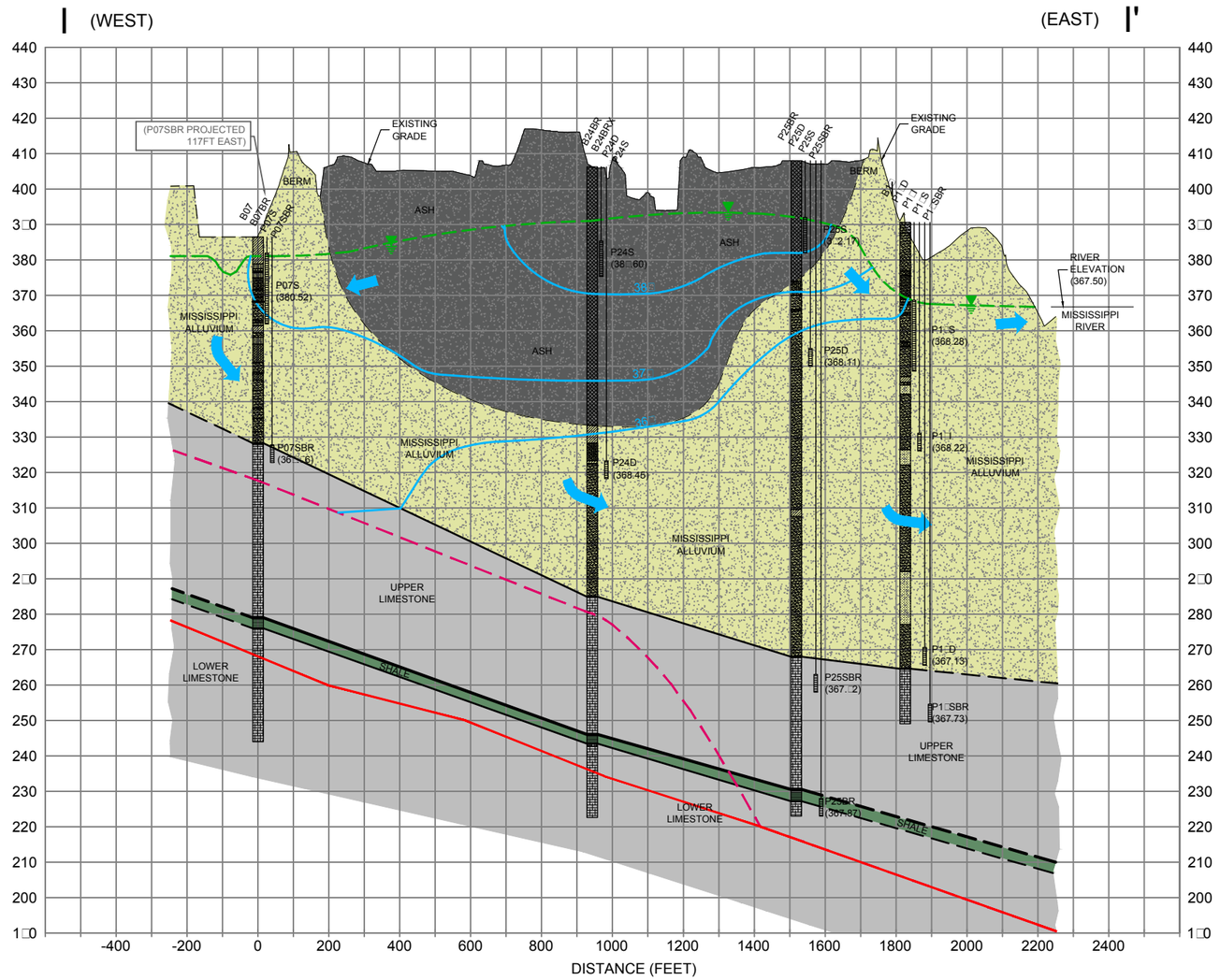
XREFS:



SECTION I-I'

ASH (FILL)
CLAY
SILTY CLAY
SILT
CLAYEY SAND
SILTY SAND
POORLY GRADED SAND
WELL GRADED SAND
LIMESTONE
WEATHERED LIMESTONE
SHALE

WATER TABLE SURFACE
PIEZOMETER SCREEN
(35□01) — GROUNDWATER/POREWATER ELEVATION MEASURED IN PIEZOMETERS, FT. MSL (AUG. 2014)
37□ — E□UIPOTENTIAL LINES (POTENTIAL HEAD, FT. MSL)
GROUNDWATER FLOW DIRECTION
PRESUMED LITHOLOGY (DASHED WHERE INFERRED)
TOP OF UPPERMOST CONFINING UNIT
TOP OF CORRELATED, LATERALLY PERSISTENT CONFINING BED

ASH
MISSISSIPPI ALLUVIUM
LIMESTONE
SHALE

VERTICAL SCALE IN FEET: 20'
HORIZONTAL SCALE IN FEET: 200'
VERTICAL EXAGGERATION =10

DRAFT

NATURAL RESOURCE TECHNOLOGY

CROSS SECTION I-I'

DETAILED SITE INVESTIGATION
RUSH ISLAND ENERGY CENTER
100 BIG HOLLOW ROAD
FESTUS, MISSOURI

PROJECT NO. 2072/10.3	
DRAWN BY: DMD 08/1□/14	
CHEC□ED BY: THC 05/20/13	
APPROVED BY: .	DRAWING NO: 2072-10-3-D01-14.DWG
	REFERENCE: .
	SHEET NO. 10

Y:\ACADdata\Projects\20\2072\10-3\dwg 2014 July\2072-10-3-D01-14.dwg SECTION I-I
IMAGES:
XREFS:

APPENDIX C
Potentiometric Surface Maps From Background CCR Sampling Events

LEGEND

- Rush Island Energy Center Property Boundary
- RCPA Surface Impoundment

Groundwater Elevation Contour (FT MSL)

- Groundwater Elevation Contour (FT MSL)
- = = = Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Groundwater Monitoring Well
- Mississippi River Gauge
- RCPA Pond Gauge
- Groundwater Flow Direction

KEY MAP

NOTES

1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON DECEMBER 1, 2015.
3.) GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
4.) GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
5.) MISSISSIPPI RIVER LEVEL PROVIDED BY AMEREN.
6.) POND LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

1.) AMEREN MISSOURI RUSH ISLAND ENERGY CENTER, RUSH ISLAND PROPERTY CONTROL MAP, JANUARY 2012.
2.) COORDINATE SYSTEM: NAD 1983 STATE PLANE MISSOURI EAST FIPS 2401 FEET.

0 500 1,000 2,000
Feet

CLIENT
AMEREN MISSOURI
RUSH ISLAND ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
RCPA - POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 1 - MARCH 10, 2016

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-03-10
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0002A	0.0	**P1**

LEGEND

Rush Island Energy Center Property Boundary

RCPA Surface Impoundment

Groundwater Elevation Contour (FT MSL)

Groundwater Elevation Contour (FT MSL)

Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

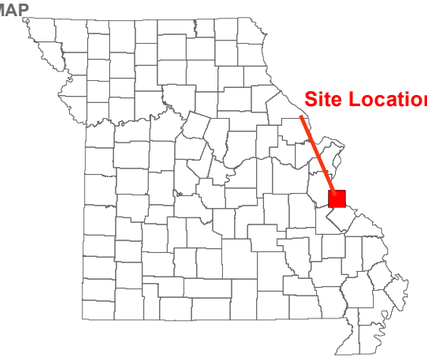
Groundwater Monitoring Well

Mississippi River Gauge

RCPA Pond Gauge

Groundwater Flow Direction

KEY MAP



NOTES

1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON DECEMBER 1, 2015.
3.) GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
4.) GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
5.) MISSISSIPPI RIVER LEVEL PROVIDED BY AMEREN.
6.) POND LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

1.) AMEREN MISSOURI RUSH ISLAND ENERGY CENTER, RUSH ISLAND PROPERTY CONTROL MAP, JANUARY 2012.
2.) COORDINATE SYSTEM: NAD 1983 STATE PLANE MISSOURI EAST FIPS 2401 FEET.

0 500 1,000 2,000 Feet

CLIENT
AMEREN MISSOURI
RUSH ISLAND ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
RCPA - POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 2 - MAY 2, 2016

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-05-24
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0002A	0.0	**P2**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 11in 0

Path: G:\Projects\153\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0002 - Rush Island Energy\800 - FIGURES-DRAWINGS\PRODUCTION\GMP Figures\Potentiometric Surface Maps\Updated Pot Maps\RCPA-E2.mxd

LEGEND

- Rush Island Energy Center Property Boundary
- RCPA Surface Impoundment

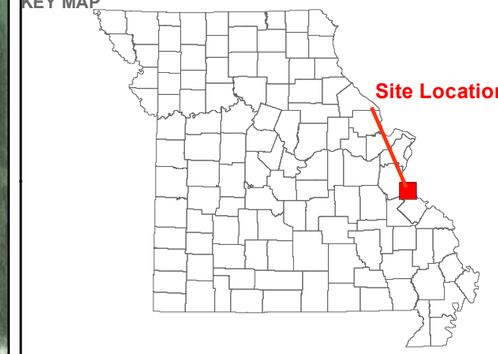
Groundwater Elevation Contour (FT MSL)

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Groundwater Monitoring Well
- Mississippi River Gauge
- RCPA Pond Gauge
- Groundwater Flow Direction

KEY MAP



NOTES

1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON DECEMBER 1, 2015.
3.) GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
4.) GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
5.) MISSISSIPPI RIVER LEVEL PROVIDED BY AMEREN.
6.) POND LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

1.) AMEREN MISSOURI RUSH ISLAND ENERGY CENTER, RUSH ISLAND PROPERTY CONTROL MAP, JANUARY 2012.
2.) COORDINATE SYSTEM: NAD 1983 STATE PLANE MISSOURI EAST FIPS 2401 FEET.

0 500 1,000 2,000
Feet

CLIENT
AMEREN MISSOURI
RUSH ISLAND ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
RCPA - POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 3 - JULY 14, 2016

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-08-16
PREPARED	JS
DESIGN	JSI
REVIEW	JSI
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0002A	0.0	**P3**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 11in 0

Path: G:\Projects\153\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0002 - Rush Island Energy\800 - FIGURES-DRAWINGS\PRODUCTION\GMP Figures\Potentiometric Surface Maps\Updated Pot Maps\RCPA-E3.mxd

LEGEND

- Rush Island Energy Center Property Boundary
- RCPA Surface Impoundment

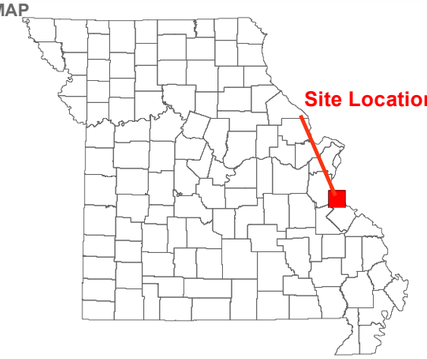
Groundwater Elevation Contour (FT MSL)

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Groundwater Monitoring Well
- Mississippi River Gauge
- RCPA Pond Gauge
- Groundwater Flow Direction

KEY MAP



NOTES

1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON DECEMBER 1, 2015.
3.) GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
4.) GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
5.) MISSISSIPPI RIVER LEVEL PROVIDED BY AMEREN.
6.) POND LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

1.) AMEREN MISSOURI RUSH ISLAND ENERGY CENTER, RUSH ISLAND PROPERTY CONTROL MAP, JANUARY 2012.
2.) COORDINATE SYSTEM: NAD 1983 STATE PLANE MISSOURI EAST FIPS 2401 FEET.

0 500 1,000 2,000
Feet

CLIENT
AMEREN MISSOURI
RUSH ISLAND ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
RCPA - POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 4 - SEPTEMBER 6, 2016

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-09-27
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0002A	0.0	**P4**

LEGEND

Rush Island Energy Center Property Boundary

RCPA Surface Impoundment

Groundwater Elevation Contour (FT MSL)

Groundwater Elevation Contour (FT MSL)

Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

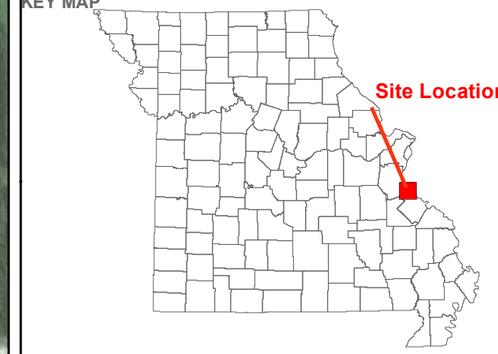
Groundwater Monitoring Well

Mississippi River Gauge

RCPA Pond Gauge

Groundwater Flow Direction

KEY MAP



NOTES

1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON DECEMBER 1, 2015.
3.) GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
4.) GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
5.) MISSISSIPPI RIVER LEVEL PROVIDED BY AMEREN.
6.) POND LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

1.) AMEREN MISSOURI RUSH ISLAND ENERGY CENTER, RUSH ISLAND PROPERTY CONTROL MAP, JANUARY 2012.
2.) COORDINATE SYSTEM: NAD 1983 STATE PLANE MISSOURI EAST FIPS 2401 FEET.

0 500 1,000 2,000 Feet

CLIENT
AMEREN MISSOURI
RUSH ISLAND ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
RCPA - POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 5 - NOVEMBER 15, 2016

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-11-15
PREPARED	JSI
DESIGN	JSI
REVIEW	MSG
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0002A	0.0	**P5**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 11in 0

Path: G:\Projects\153\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0002 - Rush Island Energy\800 - FIGURES-DRAWINGS\PRODUCTION\GMP Figures\Potentiometric Surface Maps\Updated Pot Maps\RCPA-E5.mxd

LEGEND

- Rush Island Energy Center Property Boundary
- RCPA Surface Impoundment

Groundwater Elevation Contour (FT MSL)

- Groundwater Elevation Contour (FT MSL)
- = = = Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Groundwater Monitoring Well
- Mississippi River Gauge
- RCPA Pond Gauge
- Groundwater Flow Direction

KEY MAP

NOTES

1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON DECEMBER 1, 2015.
3.) GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
4.) GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
5.) MISSISSIPPI RIVER LEVEL PROVIDED BY AMEREN.
6.) POND LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

1.) AMEREN MISSOURI RUSH ISLAND ENERGY CENTER, RUSH ISLAND PROPERTY CONTROL MAP, JANUARY 2012.
2.) COORDINATE SYSTEM: NAD 1983 STATE PLANE MISSOURI EAST FIPS 2401 FEET.

0 500 1,000 2,000
Feet

CLIENT
AMEREN MISSOURI
RUSH ISLAND ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
RCPA - POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 6 - JANUARY 19, 2016

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-01-23
PREPARED	JS
DESIGN	JSI
REVIEW	BEF
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0002A	0.0	**P6**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:
1 in
0

Path: G:\Projects\153\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0002 - Rush Island Energy\800 - FIGURES-DRAWINGS\PRODUCTION\GMP Figures\Potentiometric Surface Maps\Updated Pot Maps\RCPA-E6.mxd

MW-B2
374.90

MW-B1
374.73

Mississippi River Gauge
377.01

RUSH ISLAND
ENERGY CENTER

MISSISSIPPI RIVER

377

375

376

MW-1
375.17

MW-7
375.09

MW-2
375.13

RCPA

376

MW-6
376.19

MW-3
375.01

Pond Gauge
398.50

MW-5
375.40

MW-4
375.00

LEGEND

Rush Island Energy Center Property Boundary

RCPA Surface Impoundment

Groundwater Elevation Contour (FT MSL)

Groundwater Elevation Contour (FT MSL)

Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

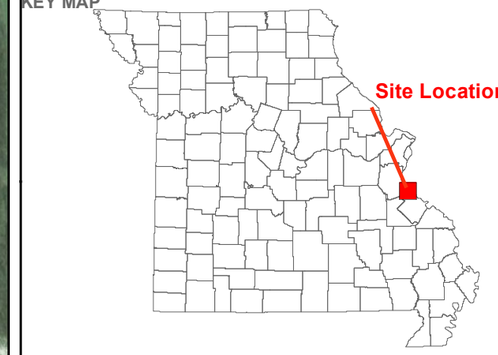
Groundwater Monitoring Well

Mississippi River Gauge

RCPA Pond Gauge

Groundwater Flow Direction

KEY MAP



NOTES

1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON DECEMBER 1, 2015.
3.) GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
4.) GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
5.) MISSISSIPPI RIVER LEVEL PROVIDED BY AMEREN.
6.) POND LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

1.) AMEREN MISSOURI RUSH ISLAND ENERGY CENTER, RUSH ISLAND PROPERTY CONTROL MAP, JANUARY 2012.
2.) COORDINATE SYSTEM: NAD 1983 STATE PLANE MISSOURI EAST FIPS 2401 FEET.

0 500 1,000 2,000
Feet

CLIENT
AMEREN MISSOURI
RUSH ISLAND ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
RCPA - POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 7 - MARCH 6, 2017

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-14
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0002A	0.0	**P7**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 11in 0

Path: G:\Projects\153\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0002 - Rush Island Energy\800 - FIGURES-DRAWINGS\PRODUCTION\GMP Figures\Potentiometric Surface Maps\Updated Pot Maps\RCPA-E7.mxd

LEGEND

- Rush Island Energy Center Property Boundary
- RCPA Surface Impoundment

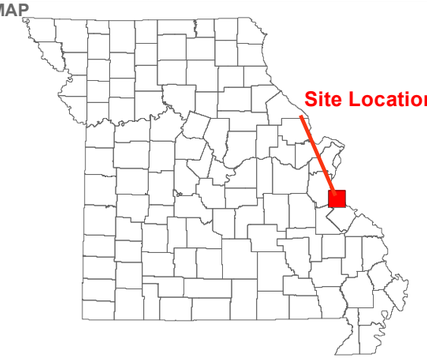
Groundwater Elevation Contour (FT MSL)

- Groundwater Elevation Contour (FT MSL)
- = = = Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Groundwater Monitoring Well
- Mississippi River Gauge
- RCPA Pond Gauge
- Groundwater Flow Direction

KEY MAP



NOTES

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4.) GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
5.) MISSISSIPPI RIVER LEVEL PROVIDED BY AMEREN.
6.) POND LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

1.) AMEREN MISSOURI RUSH ISLAND ENERGY CENTER, RUSH ISLAND PROPERTY CONTROL MAP, JANUARY 2012.
2.) COORDINATE SYSTEM: NAD 1983 STATE PLANE MISSOURI EAST FIPS 2401 FEET.

0 500 1,000 2,000
Feet

CLIENT
AMEREN MISSOURI
RUSH ISLAND ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
RCPA - POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 8 - JUNE 8, 2017

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-06-20
PREPARED	JSI
DESIGN	JSI
REVIEW	RJF
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0002A	0.0	**P8**

Path: G:\Projects\153\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0002 - Rush Island Energy\800 - FIGURES-DRAWINGS\PRODUCTION\GMP Figures\Potentiometric Surface Maps\Updated Pot Maps\RCPA-EB.mxd

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

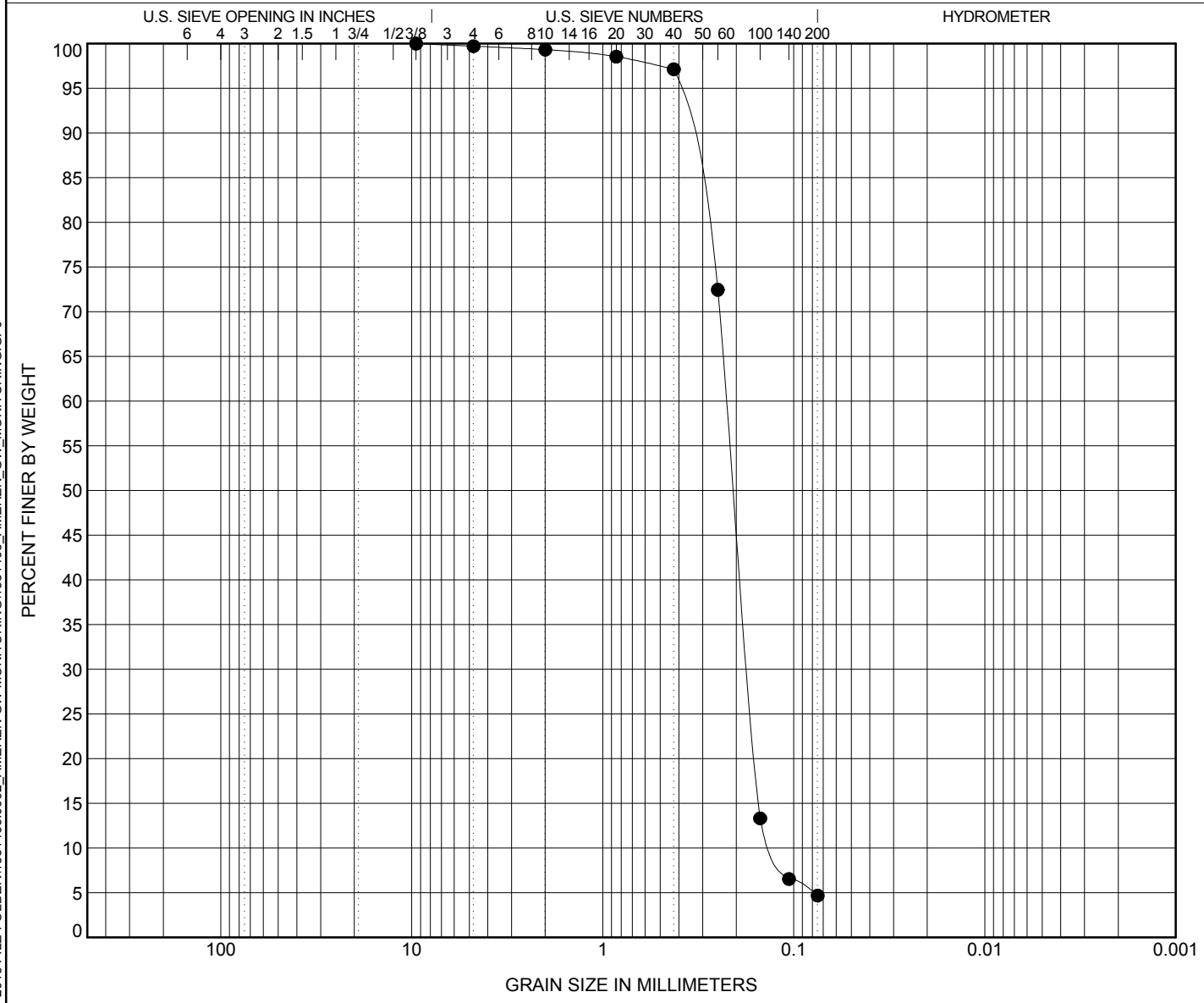
APPENDIX D
Grain Size Distribution

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

GRAIN SIZE DISTRIBUTION
ASTM D6913
Method B

CLIENT AMEREN SERVICES **PROJECT NAME** Ameren/GW Monitoring Program/MO

PROJECT NUMBER 153-1406.0002 **PROJECT LOCATION**



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI
●	MW-7	90 ft	POORLY GRADED SAND (SP)			

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	MW-7	90 ft	9.5	0.224	0.173	0.127	0.3	95.0	5	

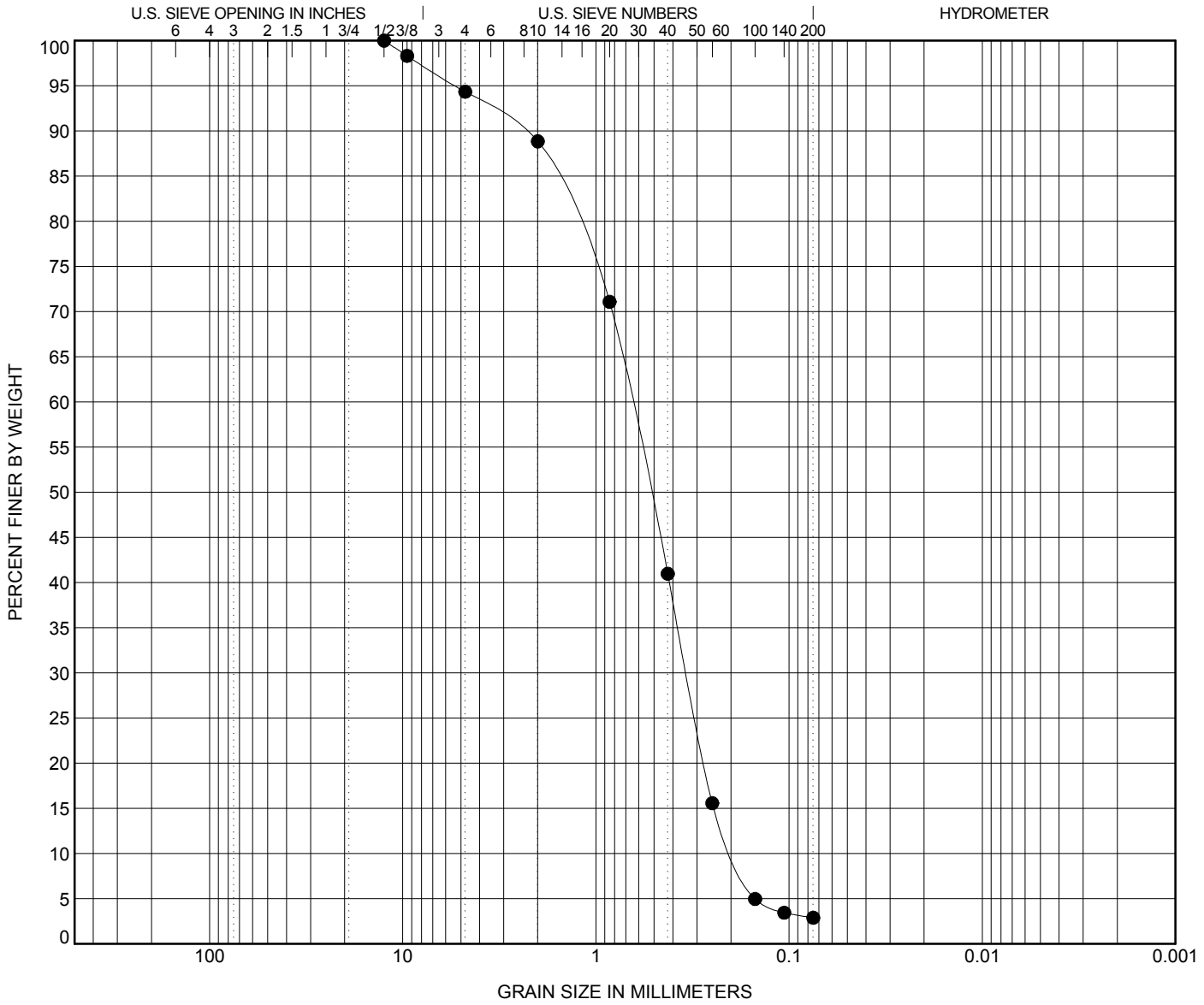
GRAIN SIZE (FULL SIEVE) - GINT STD US LAB.GDT - 11/3/15 08:51 - L:\15 - 2015 FILE FOLDER\1531406.0002_AMEREN GW MONITORING\1531405_AMEREN_GW_MONITORING.GPJ

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

GRAIN SIZE DISTRIBUTION
ASTM D6913
Method B

CLIENT AMEREN SERVICES **PROJECT NAME** Ameren/GW Monitoring Program/MO

PROJECT NUMBER 153-1406.0002 **PROJECT LOCATION**



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI
●	MW-B2	80 ft	POORLY GRADED SAND (SP)			

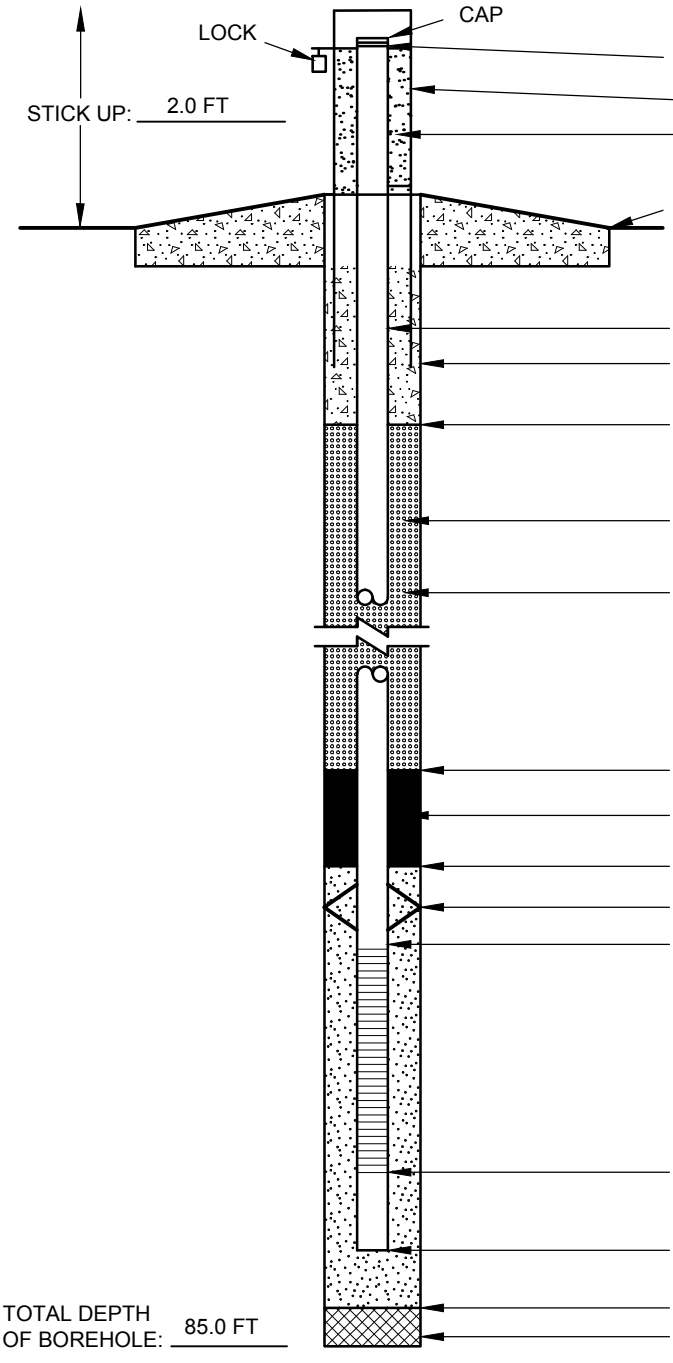
	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	MW-B2	80 ft	12.5	0.659	0.338	0.191	5.7	91.5	3	

GRAIN SIZE (FULL SIEVE) - GINT STD US LAB.GDT - 10/29/15 09:06 - L:\15 - 2015 FILE FOLDER\1531406.0002_AMEREN GW MONITORING\1531405_AMEREN_GW_MONITORING.GPJ

APPENDIX E
CCR Monitoring Well Construction Diagrams

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-1

PROJECT NAME: AMEREN CCR GW MONITORING	PROJECT NUMBER: 153-1406.0002A	
SITE NAME: RUSH ISLAND ENERGY CENTER	LOCATION: MW-1	
CLIENT: AMEREN MISSOURI	SURFACE ELEVATION: 393.5 FT MSL	
GEOLOGIST: J. INGRAM	NORTHING: 835384.2	EASTING: 889832.5
DRILLER: J. DRABEK	STATIC WATER LEVEL: 25.31 FT BTOC	COMPLETION DATE: 10/31/2015
DRILLING COMPANY: CASCADE	DRILLING METHODS: SONIC	



TOP OF CASING ELEVATION: 395.52 FT MSL

PROTECTIVE CASING (yes) / no): 4" X 5' ALUMINUM

PEA GRAVEL OR SAND

GROUND SURFACE ELEVATION: 393.5 FT MSL

DIAMETER OF RISER PIPE (in.): 2.0

DIAMETER OF BOREHOLE (in.): 6.0

CONCRETE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF ANNULAR SEAL: 3/8" BENTONITE CHIPS - 2.5 BAGS

TYPE AND AMOUNT OF ANNULAR SEAL: HIGH SOLIDS BENTONITE 4 X 50 POUND BAGS

TOP OF BENTONITE SEAL DEPTH (ft. bgs): 61.0

TYPE AND AMOUNT OF BENTONITE SEAL: 3/8" BENTONITE CHIPS - 1 BAG

TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 69.0 FINE: 67.0

CENTRALIZER ((yes) / no) - TYPE: STAINLESS STEEL (TOP + BOTTOM)

TOP OF SCREEN DEPTH (ft. bgs): 72.8

TYPE OF SCREEN: 2" X 9.8' SCHEDULE 40 PVC

SCREEN SLOT SIZE (in.): 0.010 IN

SIZE OF SAND PACK: COARSE: #1 FINE: #0

AMOUNT OF SAND: COARSE: 3 BAGS FINE: 1/2 BAG

BOTTOM OF SCREEN DEPTH (ft. bgs): 82.6

BOTTOM OF WELL DEPTH (ft. bgs): 83.0

BOTTOM OF FILTER PACK (ft. bgs): 83.0

TYPE AND AMOUNT OF BACKFILL: 2.0 FT - NATURAL CAVE IN

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
400 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FEET (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON DECEMBER 1, 2015
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

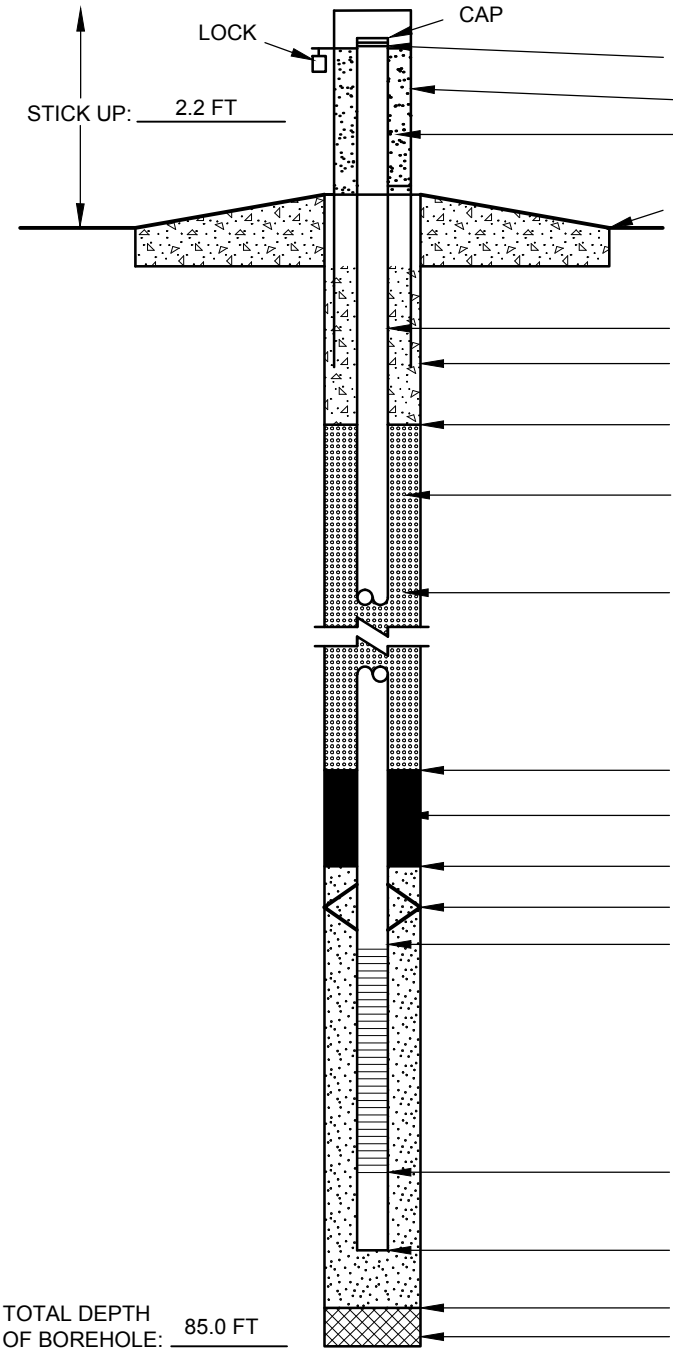
CHECKED BY: J. INGRAM

DATE CHECKED: 4/21/2016

PREPARED BY: J. SUOZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-2

PROJECT NAME: AMEREN CCR GW MONITORING	PROJECT NUMBER: 153-1406.0002A	
SITE NAME: RUSH ISLAND ENERGY CENTER	LOCATION: MW-2	
CLIENT: AMEREN MISSOURI	SURFACE ELEVATION: 391.7 FT MSL	
GEOLOGIST: J. INGRAM	NORTHING: 834261.5	EASTING: 890364.1
DRILLER: J. DRABEK	STATIC WATER LEVEL: 23.94 FT BTOC	COMPLETION DATE: 10/31/2015
DRILLING COMPANY: CASCADE	DRILLING METHODS: SONIC	



TOP OF CASING ELEVATION: 393.87 FT MSL

PROTECTIVE CASING (yes / no): 4" X 5' ALUMINUM

PEA GRAVEL OR SAND

GROUND SURFACE ELEVATION: 391.7 FT MSL

DIAMETER OF RISER PIPE (in.): 2.0

DIAMETER OF BOREHOLE (in.): 6.0

CONCRETE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF ANNULAR SEAL: 3/8" BENTONITE CHIPS - 2 BAGS

TYPE AND AMOUNT OF ANNULAR SEAL: HIGH SOLIDS BENTONITE 5 X 50 POUND BAGS

TOP OF BENTONITE SEAL DEPTH (ft. bgs): 63.0

TYPE AND AMOUNT OF BENTONITE SEAL: 3/8" BENTONITE CHIPS - 1 BAGS

TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 69.5 FINE: 69.0

CENTRALIZER (yes / no) - TYPE: STAINLESS STEEL (TOP + BOTTOM)

TOP OF SCREEN DEPTH (ft. bgs): 72.2

TYPE OF SCREEN: 2" X 9.8' SCHEDULE 40 PVC

SCREEN SLOT SIZE (in.): 0.010 IN

SIZE OF SAND PACK: COARSE: #1 FINE: #0

AMOUNT OF SAND: COARSE: 3 BAGS FINE: 1/2 BAG

BOTTOM OF SCREEN DEPTH (ft. bgs): 82.0

BOTTOM OF WELL DEPTH (ft. bgs): 82.4

BOTTOM OF FILTER PACK (ft. bgs): 82.4

TYPE AND AMOUNT OF BACKFILL: 2.6 FT - NATURAL CAVE IN

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
350 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FEET (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON DECEMBER 1, 2015
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

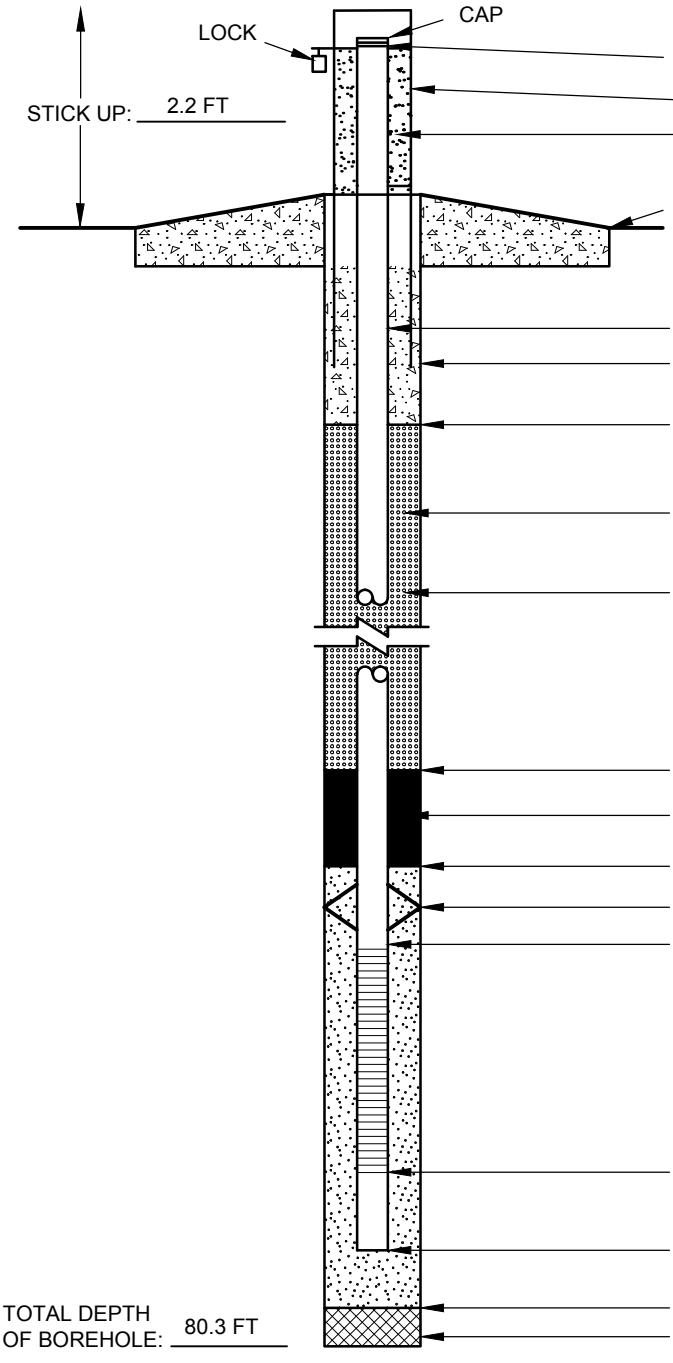
CHECKED BY: J. INGRAM

DATE CHECKED: 4/21/2016

PREPARED BY: J. SUOZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-3

PROJECT NAME: AMEREN CCR GW MONITORING		PROJECT NUMBER: 153-1406.0002A
SITE NAME: RUSH ISLAND ENERGY CENTER		LOCATION: MW-3
CLIENT: AMEREN MISSOURI		SURFACE ELEVATION: 389.2 FT MSL
GEOLOGIST: J. INGRAM	NORTHING: 833178.4	EASTING: 890892.7
DRILLER: J. DRABEK	STATIC WATER LEVEL: 21.84 FT BTOC	COMPLETION DATE: 10/31/2015
DRILLING COMPANY: CASCADE		DRILLING METHODS: SONIC



TOP OF CASING ELEVATION: 391.38 FT MSL

PROTECTIVE CASING (yes / no): 4" X 5' ALUMINUM

PEA GRAVEL OR SAND

GROUND SURFACE ELEVATION: 389.2 FT MSL

DIAMETER OF RISER PIPE (in.): 2.0

DIAMETER OF BOREHOLE (in.): 6.0

CONCRETE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF ANNULAR SEAL: 3/8" BENTONITE CHIPS - 3.5 BAGS

TYPE AND AMOUNT OF ANNULAR SEAL: HIGH SOLIDS BENTONITE 6 X 50 POUND BAGS

TOP OF BENTONITE SEAL DEPTH (ft. bgs): 61.0

TYPE AND AMOUNT OF BENTONITE SEAL: 3/8" BENTONITE CHIPS - 1 BAG

TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 66.0 FINE: 65.0

CENTRALIZER (yes / no) - TYPE: STAINLESS STEEL (TOP + BOTTOM)

TOP OF SCREEN DEPTH (ft. bgs): 70.1

TYPE OF SCREEN: 2" X 9.8' SCHEDULE 40 PVC

SCREEN SLOT SIZE (in.): 0.010 IN

SIZE OF SAND PACK: COARSE: #1 FINE: #0

AMOUNT OF SAND: COARSE: 3.25 BAGS FINE: 1/2 BAG

BOTTOM OF SCREEN DEPTH (ft. bgs): 79.9

BOTTOM OF WELL DEPTH (ft. bgs): 80.3

BOTTOM OF FILTER PACK (ft. bgs): 80.3

TYPE AND AMOUNT OF BACKFILL: NONE

TOTAL DEPTH OF BOREHOLE: 80.3 FT

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
280 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FEET (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON DECEMBER 1, 2015
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

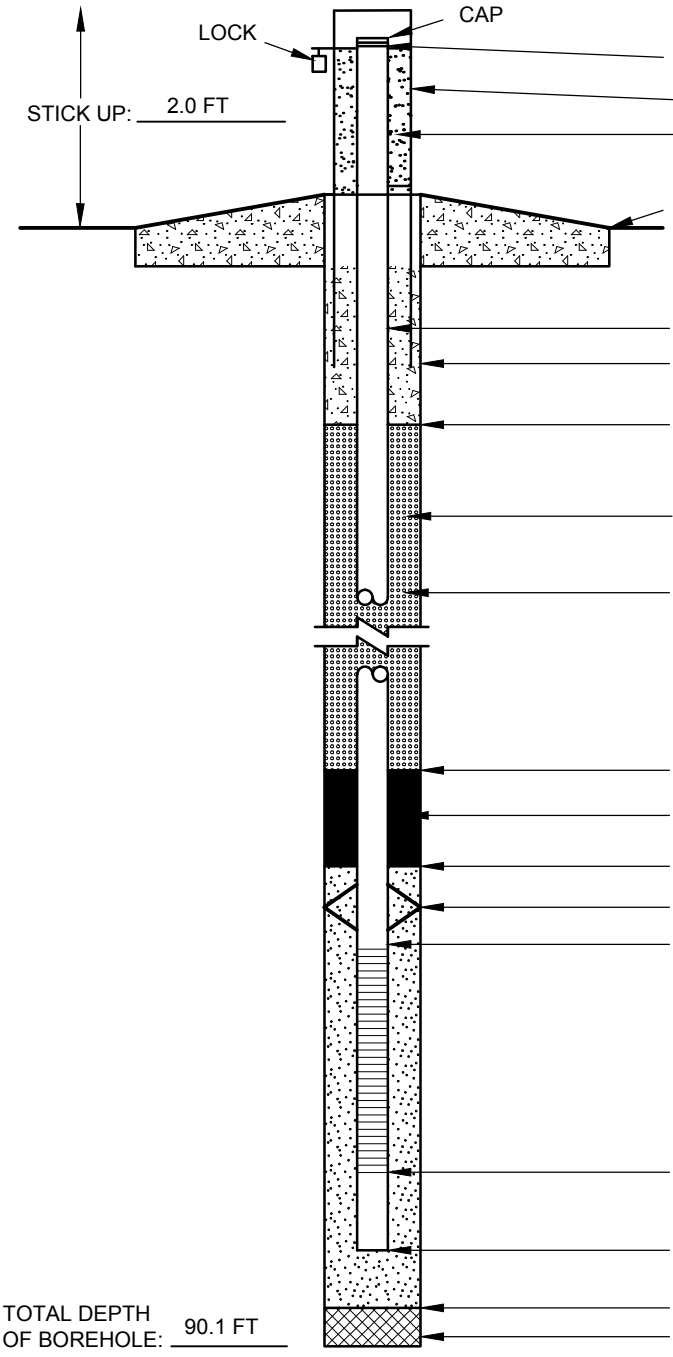
CHECKED BY: J. INGRAM

DATE CHECKED: 4/21/2016

PREPARED BY: J. SUSZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-4

PROJECT NAME: AMEREN CCR GW MONITORING	PROJECT NUMBER: 153-1406.0002A	
SITE NAME: RUSH ISLAND ENERGY CENTER	LOCATION: MW-4	
CLIENT: AMEREN MISSOURI	SURFACE ELEVATION: 390.8 FT MSL	
GEOLOGIST: J. INGRAM	NORTHING: 831647.5	EASTING: 890830.5
DRILLER: J. DRABEK	STATIC WATER LEVEL: 22.64 FT BTOC	COMPLETION DATE: 10/30/2015
DRILLING COMPANY: CASCADE	DRILLING METHODS: SONIC	



TOP OF CASING ELEVATION: 392.78 FT MSL

PROTECTIVE CASING (yes / no): 4" X 5' ALUMINUM

PEA GRAVEL OR SAND

GROUND SURFACE ELEVATION: 390.8 FT MSL

DIAMETER OF RISER PIPE (in.): 2.0

DIAMETER OF BOREHOLE (in.): 6.0

CONCRETE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF ANNULAR SEAL: 3/8 " BENTONITE CHIPS - 2.5 BAGS

TYPE AND AMOUNT OF ANNULAR SEAL: HIGH SOLIDS BENTONITE 6 X 50 POUND BAGS

TOP OF BENTONITE SEAL DEPTH (ft. bgs): 71.0

TYPE AND AMOUNT OF BENTONITE SEAL: 3/8 " BENTONITE CHIPS - 1 BAG

TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 77.0 FINE: 76.0

CENTRALIZER (yes / no) - TYPE: STAINLESS STEEL (TOP + BOTTOM)

TOP OF SCREEN DEPTH (ft. bgs): 79.9

TYPE OF SCREEN: 2" X 9.8' SCHEDULE 40 PVC

SCREEN SLOT SIZE (in.): 0.010 IN

SIZE OF SAND PACK: COARSE: #1 FINE: #0

AMOUNT OF SAND: COARSE: 4 BAGS FINE: 1/2 BAG

BOTTOM OF SCREEN DEPTH (ft. bgs): 89.7

BOTTOM OF WELL DEPTH (ft. bgs): 90.1

BOTTOM OF FILTER PACK (ft. bgs): 90.1

TYPE AND AMOUNT OF BACKFILL: NONE

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
325 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FEET (2000)
MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON DECEMBER 1, 2015
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

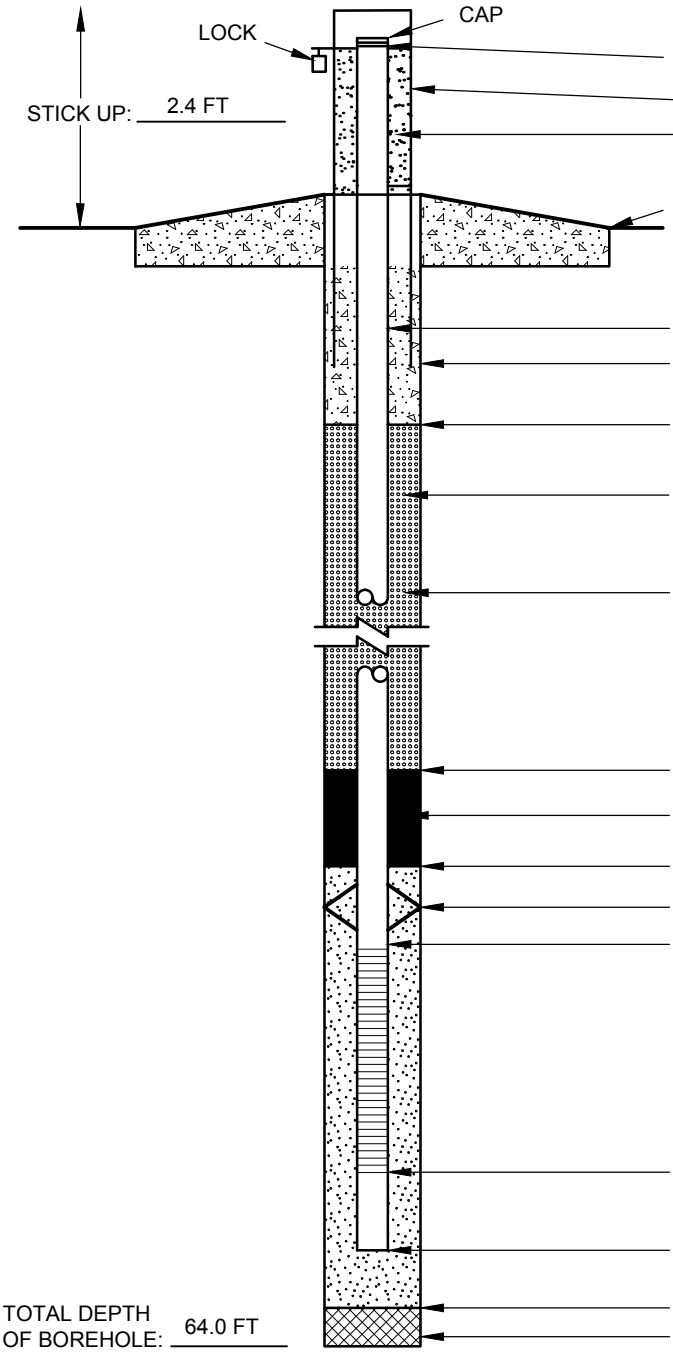
CHECKED BY: J. INGRAM

DATE CHECKED: 4/21/2016

PREPARED BY: J. SUOZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-5

PROJECT NAME: AMEREN CCR GW MONITORING	PROJECT NUMBER: 153-1406.0002A	
SITE NAME: RUSH ISLAND ENERGY CENTER	LOCATION: MW-5	
CLIENT: AMEREN MISSOURI	SURFACE ELEVATION: 388.0 FT MSL	
GEOLOGIST: J. INGRAM	NORTHING: 831994.9	EASTING: 889984.5
DRILLER: J. DRABEK	STATIC WATER LEVEL: 19.38 FT BTOC	COMPLETION DATE: 10/29/2015
DRILLING COMPANY: CASCADE	DRILLING METHODS: SONIC	



TOP OF CASING ELEVATION: 390.36 FT MSL

PROTECTIVE CASING (yes) / no): 4" X 5' ALUMINUM

PEA GRAVEL OR SAND

GROUND SURFACE ELEVATION: 388.0 FT MSL

DIAMETER OF RISER PIPE (in.): 2.0

DIAMETER OF BOREHOLE (in.): 6.0

CONCRETE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF ANNULAR SEAL: 3/8" BENTONITE CHIPS - 1.5 BAGS

TYPE AND AMOUNT OF ANNULAR SEAL: HIGH SOLIDS BENTONITE 3 X 50 POUND BAGS

TOP OF BENTONITE SEAL DEPTH (ft. bgs): 46.0

TYPE AND AMOUNT OF BENTONITE SEAL: 3/8" BENTONITE CHIPS - 1 BAG

TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 53.0 FINE: 51.5

CENTRALIZER (yes) / no) - TYPE: STAINLESS STEEL (TOP + BOTTOM)

TOP OF SCREEN DEPTH (ft. bgs): 55.0

TYPE OF SCREEN: 2" X 4.8' SCHEDULE 40 PVC

SCREEN SLOT SIZE (in.): 0.010 IN

SIZE OF SAND PACK: COARSE: #1 FINE: #0

AMOUNT OF SAND: COARSE: 2 BAGS FINE: 1/2 BAG

BOTTOM OF SCREEN DEPTH (ft. bgs): 59.8

BOTTOM OF WELL DEPTH (ft. bgs): 60.2

BOTTOM OF FILTER PACK (ft. bgs): 60.2

TYPE AND AMOUNT OF BACKFILL: 3.8 FT - NATURAL CAVE IN

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
150 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FEET (2000)
MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON DECEMBER 1, 2015
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

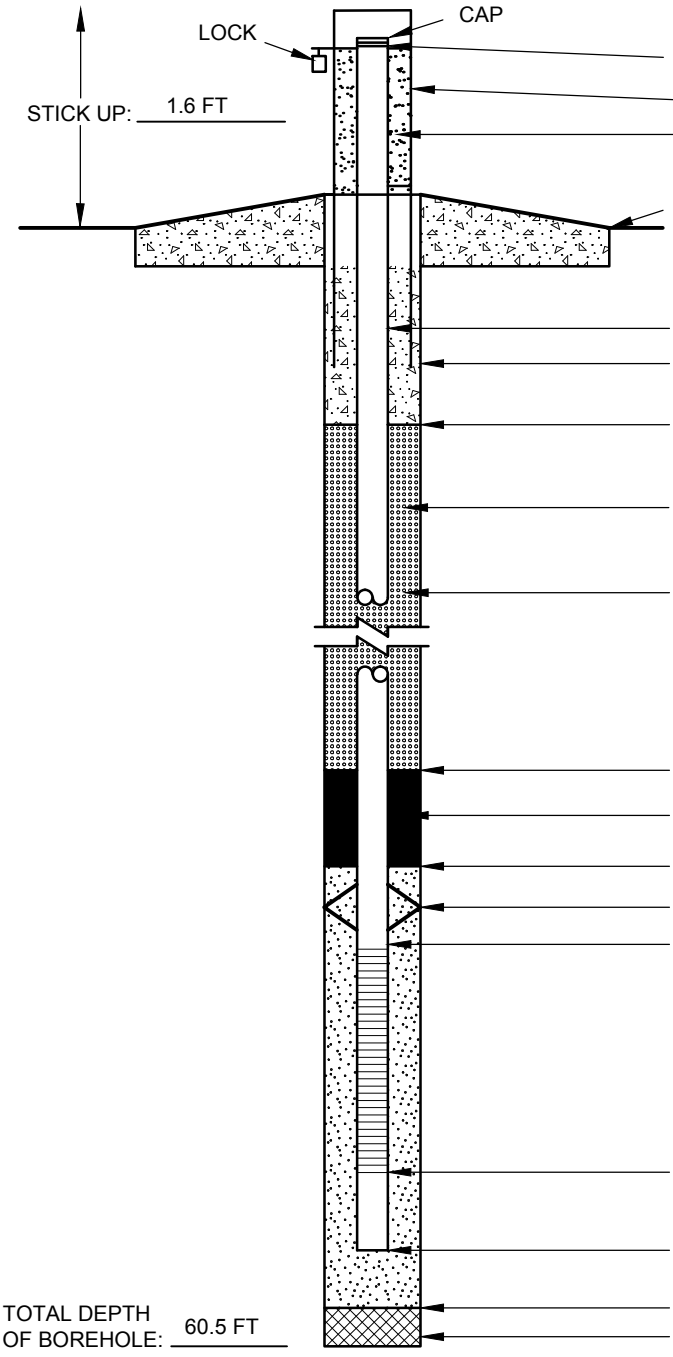
CHECKED BY: J. INGRAM

DATE CHECKED: 4/21/2016

PREPARED BY: J. SUOZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-6

PROJECT NAME: AMEREN CCR GW MONITORING	PROJECT NUMBER: 153-1406.0002A	
SITE NAME: RUSH ISLAND ENERGY CENTER	LOCATION: MW-6	
CLIENT: AMEREN MISSOURI	SURFACE ELEVATION: 401.1 FT MSL	
GEOLOGIST: J. INGRAM	NORTHING: 833111.0	EASTING: 888977.0
DRILLER: J. DRABEK	STATIC WATER LEVEL: 36.11 FT BTOC	COMPLETION DATE: 10/28/2015
DRILLING COMPANY: CASCADE	DRILLING METHODS: SONIC	



TOP OF CASING ELEVATION: 402.71 FT MSL

PROTECTIVE CASING (yes / no): 4" X 5' ALUMINUM

PEA GRAVEL OR SAND

GROUND SURFACE ELEVATION: 401.1 FT MSL

DIAMETER OF RISER PIPE (in.): 2.0

DIAMETER OF BOREHOLE (in.): 6.0

CONCRETE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF ANNULAR SEAL: 3/8" BENTONITE CHIPS - 1.75 BAGS

TYPE AND AMOUNT OF ANNULAR SEAL: HIGH SOLIDS BENTONITE
3 X 50 POUND BAGS

TOP OF BENTONITE SEAL DEPTH (ft. bgs): 46.0

TYPE AND AMOUNT OF BENTONITE SEAL: 3/8" BENTONITE CHIPS - 1 BAG

TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 52.0 FINE: 51.5

CENTRALIZER (yes / no) - TYPE: STAINLESS STEEL (TOP + BOTTOM)

TOP OF SCREEN DEPTH (ft. bgs): 54.6

TYPE OF SCREEN: 2" X 4.8' SCHEDULE 40 PVC

SCREEN SLOT SIZE (in.): 0.010 IN

SIZE OF SAND PACK: COARSE: #1 FINE: #0

AMOUNT OF SAND: COARSE: 2.5 BAGS FINE: 1/2 BAG

BOTTOM OF SCREEN DEPTH (ft. bgs): 59.4

BOTTOM OF WELL DEPTH (ft. bgs): 59.8

BOTTOM OF FILTER PACK (ft. bgs): 59.8

TYPE AND AMOUNT OF BACKFILL: 0.7 FT - NATURAL CAVE IN

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
120 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FEET (2000)
MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON DECEMBER 1, 2015
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

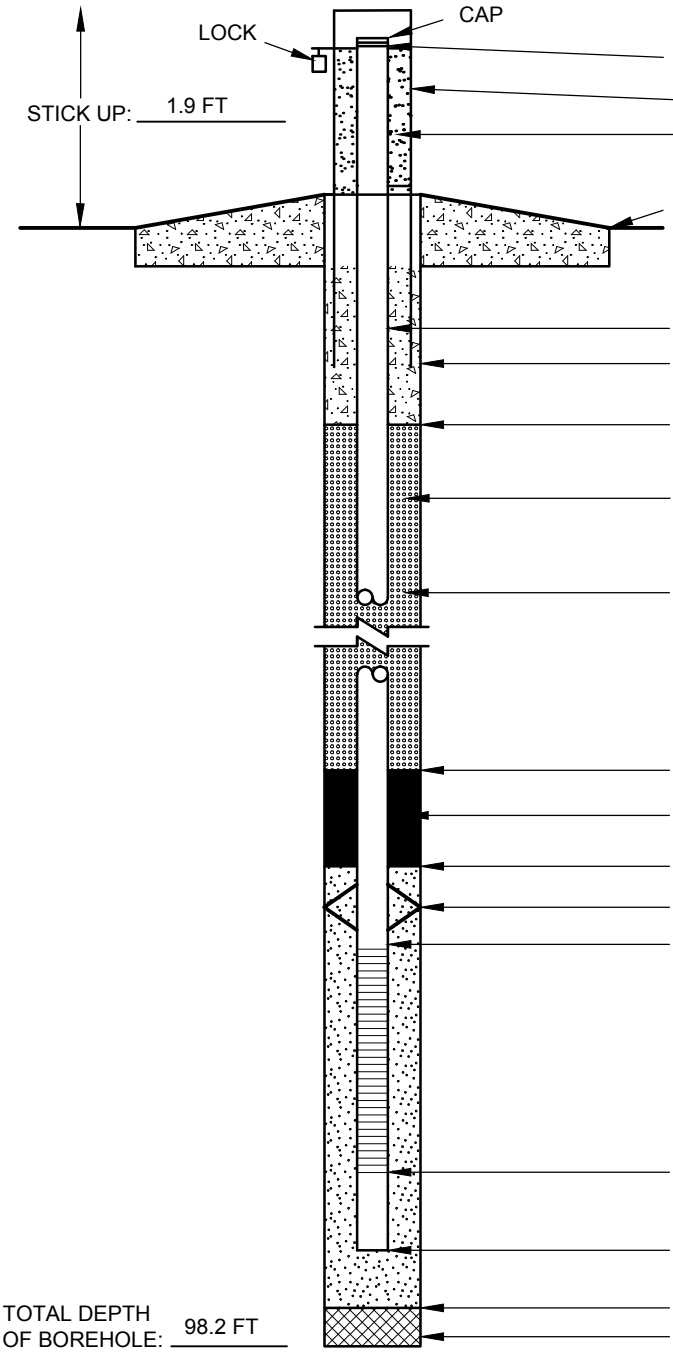
CHECKED BY: J. INGRAM

DATE CHECKED: 4/21/2016

PREPARED BY: AMEREN_0000807 J. SUOZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-7

PROJECT NAME: AMEREN CCR GW MONITORING	PROJECT NUMBER: 153-1406.0002A	
SITE NAME: RUSH ISLAND ENERGY CENTER	LOCATION: MW-7	
CLIENT: AMEREN MISSOURI	SURFACE ELEVATION: 406.1 FT MSL	
GEOLOGIST: J. INGRAM	NORTHING: 834476.8	EASTING: 888483.3
DRILLER: J. DRABEK	STATIC WATER LEVEL: 36.11 FT BTOC	COMPLETION DATE: 10/28/2015
DRILLING COMPANY: CASCADE	DRILLING METHODS: SONIC	



- TOP OF CASING ELEVATION: 407.95 FT MSL
- PROTECTIVE CASING (yes / no): 4" X 5' ALUMINUM
- PEA GRAVEL OR SAND
- GROUND SURFACE ELEVATION: 406.1 FT MSL
- DIAMETER OF RISER PIPE (in.): 2.0
- DIAMETER OF BOREHOLE (in.): 6.0
- CONCRETE SEAL DEPTH (ft. bgs): 2.5
- TYPE AND AMOUNT OF ANNULAR SEAL: 3/8" BENTONITE CHIPS - 2.5 BAGS
- TYPE AND AMOUNT OF ANNULAR SEAL: HIGH SOLIDS BENTONITE 9 X 50 POUND BAGS
- TOP OF BENTONITE SEAL DEPTH (ft. bgs): 75.0
- TYPE AND AMOUNT OF BENTONITE SEAL: 3/8" BENTONITE CHIPS - 1 BAG
- TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 84.0 FINE: 82.0
- CENTRALIZER (yes / no) - TYPE: STAINLESS STEEL (TOP + BOTTOM)
- TOP OF SCREEN DEPTH (ft. bgs): 88.0
- TYPE OF SCREEN: 2" X 9.8' SCHEDULE 40 PVC
- SCREEN SLOT SIZE (in.): 0.010 IN
- SIZE OF SAND PACK: COARSE: #1 FINE: #0
- AMOUNT OF SAND: COARSE: 3 BAGS FINE: 1/2 BAG
- BOTTOM OF SCREEN DEPTH (ft. bgs): 97.8
- BOTTOM OF WELL DEPTH (ft. bgs): 98.2
- BOTTOM OF FILTER PACK (ft. bgs): 98.2
- TYPE AND AMOUNT OF BACKFILL: NONE

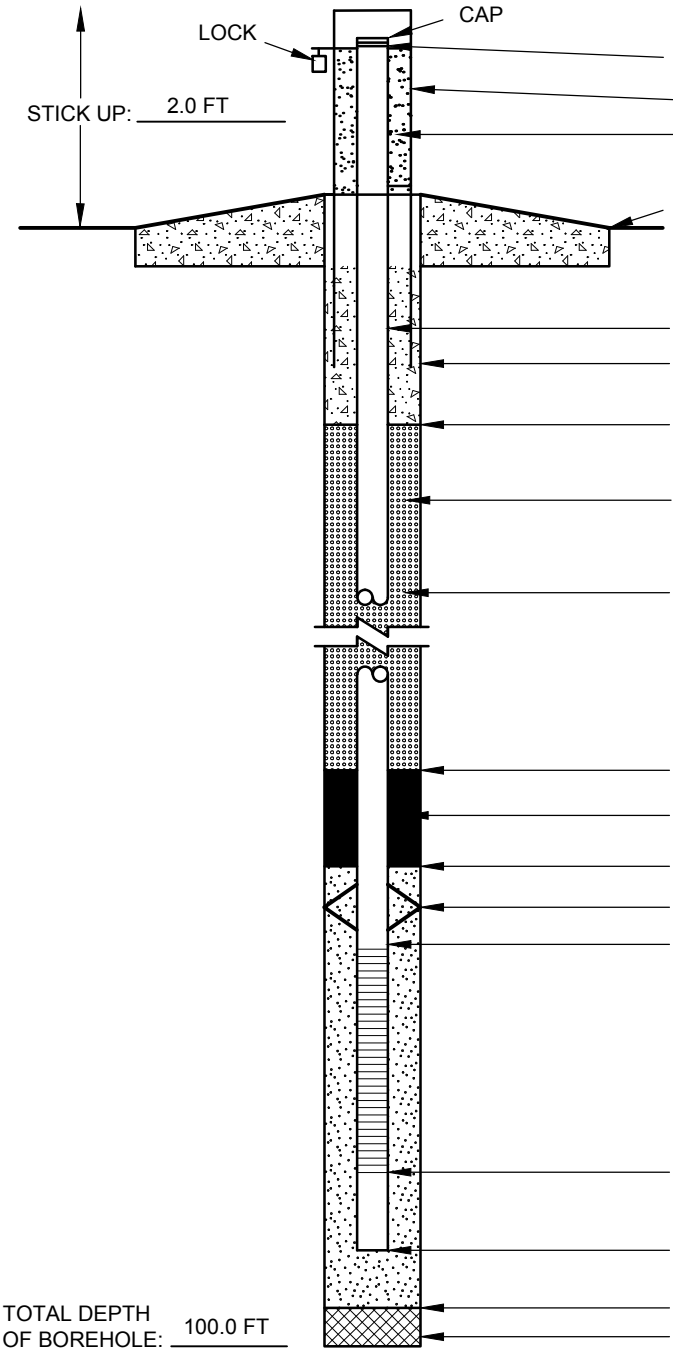
ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
400 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FEET (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON DECEMBER 1, 2015
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

CHECKED BY: J. INGRAM
DATE CHECKED: 4/21/2016

PREPARED BY: J. SUOZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-B1

PROJECT NAME: AMEREN CCR GW MONITORING	PROJECT NUMBER: 153-1406.0002A	
SITE NAME: RUSH ISLAND ENERGY CENTER	LOCATION: MW-B1	
CLIENT: AMEREN MISSOURI	SURFACE ELEVATION: 409.6 FT MSL	
GEOLOGIST: J. INGRAM	NORTHING: 837602.1	EASTING: 887903.9
DRILLER: J. DRABEK	STATIC WATER LEVEL: 40.33 FT BTOC	COMPLETION DATE: 10/28/2015
DRILLING COMPANY: CASCADE	DRILLING METHODS: SONIC	



- TOP OF CASING ELEVATION: 411.61 FT MSL
- PROTECTIVE CASING (yes / no): 4" X 5' ALUMINUM
- PEA GRAVEL OR SAND
- GROUND SURFACE ELEVATION: 409.6 FT MSL
- DIAMETER OF RISER PIPE (in.): 2.0
- DIAMETER OF BOREHOLE (in.): 6.0
- CONCRETE SEAL DEPTH (ft. bgs): 2.5
- TYPE AND AMOUNT OF ANNULAR SEAL: 3/8" BENTONITE CHIPS - 3.5 BAG
- TYPE AND AMOUNT OF ANNULAR SEAL: HIGH SOLIDS BENTONITE 6 X 50 POUND BAGS
- TOP OF BENTONITE SEAL DEPTH (ft. bgs): 79.0
- TYPE AND AMOUNT OF BENTONITE SEAL: 3/8" BENTONITE CHIPS - 1 BAG
- TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 86.0 FINE: 84.0
- CENTRALIZER (yes / no) - TYPE: STAINLESS STEEL (TOP + BOTTOM)
- TOP OF SCREEN DEPTH (ft. bgs): 89.8
- TYPE OF SCREEN: 2" X 9.8' SCHEDULE 40 PVC
- SCREEN SLOT SIZE (in.): 0.010 IN
- SIZE OF SAND PACK: COARSE: #1 FINE: #0
- AMOUNT OF SAND: COARSE: 3 BAGS FINE: 1/2 BAG
- BOTTOM OF SCREEN DEPTH (ft. bgs): 99.6
- BOTTOM OF WELL DEPTH (ft. bgs): 100.0
- BOTTOM OF FILTER PACK (ft. bgs): 100.0
- TYPE AND AMOUNT OF BACKFILL: NONE

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL. 450 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FEET (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON DECEMBER 1, 2015 FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

CHECKED BY: J. INGRAM
DATE CHECKED: 4/21/2016

PREPARED BY: J. SUGAZI

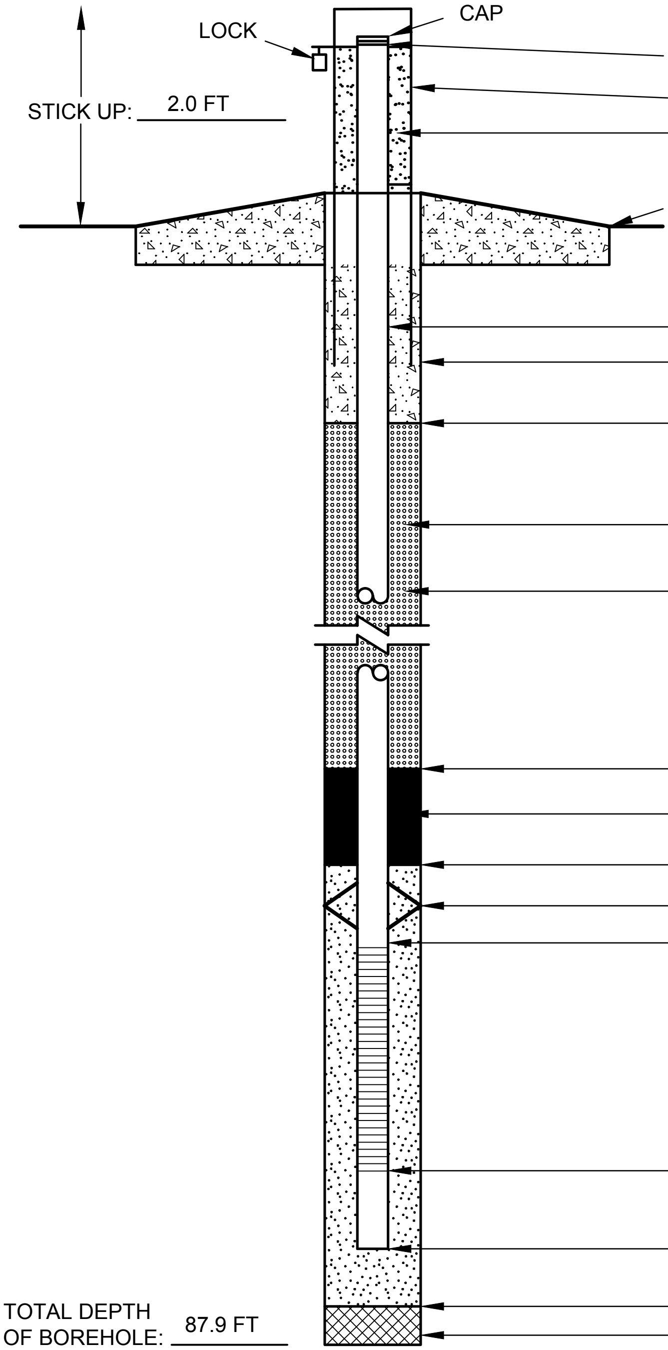
ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-B2

Golder Associates

PROJECT NAME: AMEREN CCR GW MONITORING	PROJECT NUMBER: 153-1406.0002A
SITE NAME: RUSH ISLAND ENERGY CENTER	LOCATION: MW-B2
CLIENT: AMEREN MISSOURI	SURFACE ELEVATION: 395.9 FT MSL

GEOLOGIST: J. INGRAM	NORTHING: 837801.7	EASTING: 885337.2
DRILLER: J. DRABEK	STATIC WATER LEVEL: 24.32 FT BTOC	COMPLETION DATE: 10/27/2015

DRILLING COMPANY: CASCADE	DRILLING METHODS: SONIC



STICK UP: 2.0 FT

TOP OF CASING ELEVATION: 397.85 FT MSL

PROTECTIVE CASING (yes / no): 4" X 5' ALUMINUM

PEA GRAVEL OR SAND

GROUND SURFACE ELEVATION: 395.9 FT MSL

DIAMETER OF RISER PIPE (in.): 2.0

DIAMETER OF BOREHOLE (in.): 6.0

CONCRETE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF ANNULAR SEAL: $\frac{3}{8}$" BENTONITE CHIPS - 1.5 BAGS

TYPE AND AMOUNT OF ANNULAR SEAL: HIGH SOLIDS BENTONITE 5 X 50 POUND BAGS

TOP OF BENTONITE SEAL DEPTH (ft. bgs): 65.0

TYPE AND AMOUNT OF BENTONITE SEAL: $\frac{3}{8}$" BENTONITE CHIPS - 1 BAG

TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 73.0 FINE: 72.0

CENTRALIZER (yes / no) - TYPE: STAINLESS STEEL (TOP + BOTTOM)

TOP OF SCREEN DEPTH (ft. bgs): 77.7

TYPE OF SCREEN: 2" X 9.8' SCHEDULE 40 PVC

SCREEN SLOT SIZE (in.): 0.010 IN

SIZE OF SAND PACK: COARSE: #1 FINE: #0

AMOUNT OF SAND: COARSE: 3 BAGS FINE: 1/2 BAG

BOTTOM OF SCREEN DEPTH (ft. bgs): 87.5

BOTTOM OF WELL DEPTH (ft. bgs): 87.9

TOTAL DEPTH OF BOREHOLE: 87.9 FT

BOTTOM OF FILTER PACK (ft. bgs): 87.9

TYPE AND AMOUNT OF BACKFILL: NONE

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL. 250 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FEET (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON DECEMBER 1, 2015 FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

CHECKED BY: J. INGRAM

DATE CHECKED: 4/21/2016

PREPARED BY: J. SUOZZI

APPENDIX F
Well Development Forms

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.

Location MW-1

Monitored By: JS Date 11/5/13 Time 0820

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	85.06 TOC	feet
Depth of Water (from top of PVC or ground)	28.89 TOC	feet
Radius of Casing	2"	inches
		feet
Casing Volume		cubic feet
	13.6 x 3 = 40.8	gallons

+ 400 gal from drilling
440 gal

Development / Purging Discharge Data

Purging Method: Waterra pump

Start Purging Date 11/5/13 Time 0820

Stop Purging Date 11/5/13 Time 1256

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
11/5/13	0835	35	19.34	9.25	0.866	>1000	1.06	-13.6	29.05	very muddy
	0845	50	19.31	9.64	0.857	>1000	0.66	-18.4	29.06	muddy
	0900	75	19.24	10.04	0.832	>1000	0.82	-55	28.91	muddy
	0915	120	19.33	10.16	0.843	>1000	0.62	-63.4	28.95	muddy
	0930	130	19.31	10.20	0.8	77.5	1.09	-22.0	28.91	cloudy
	0945	160	19.30	10.43	0.779	37.7	0.58	-27.5	28.97	slight cloudy
	1000	180	19.28	10.41	0.770	>1000	0.81	-29.0	28.80	cloudy
	1015	200	19.35	10.40	0.795	31.6	1.04	-28.7	28.89	slight cloud
	1035	240	—	—	—	—	—	—	—	pretty clear
	1105	260	19.14	10.03	0.789	6.78	1.57	15.1	28.90	clear
	1120	285	19.13	10.21	0.782	2.63	1.21	5.6	28.85	clear
	1135	310	19.21	10.46	0.781	3.58	0.84	-15.6	28.82	clear
	1145	340	19.23	10.48	0.780	3.49	0.75	-24.7	28.81	clear
	1200	355	19.22	10.50	0.776	4.02	0.63	-29.3	28.76	clear
	1215	370	19.21	10.92	0.786	7.84	0.85	-60.5	28.92	clear
	1230	400	19.22	10.90	0.773	2.34	0.71	-65.4	28.80	clear
	1240	430	19.22	10.90	0.773	2.28	0.72	-71.5	28.84	clear
	1245	440	19.23	10.97	0.777	2.30	0.75	-71.3	28.80	clear

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.

Location MW-2

Monitored By: JS Date 11/9/15 Time 0709

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	84.59 TOC	feet
Depth of Water (from top of PVC or ground)	76.98 TOC	feet
Radius of Casing	2	inches
		feet
Casing Volume		cubic feet
	13.8·3 = 41.5	gallons

+350 gal from drilling
392 gal total

Development / Purging Discharge Data

Purging Method: Waterra Pump

Start Purging: Date 11/9/15 Time 0738

Stop Purging: Date 11/9/15 Time 1318

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°C)	pH	Spec.Cond. (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
11/9/15	0915	180	—	—	—	71000	—	—	—	muddy
11/9/15	1116	185	17.42	10.44	0.839	71000	0.76	-87.6	27.36	muddy
	1136	240	16.71	10.46	0.834	71000	0.66	-100.9	27.56	muddy
	1146	255	16.72	10.57	0.835	71000	0.52	-110.6	28.08	muddy
	1156	270	16.78	10.65	0.836	71000	1.04	-115.0	28.20	muddy (slightly)
	1206	290	16.79	10.69	0.838	71000	1.78	-112.5	27.65	slight muddy
	1216	330	16.71	10.70	0.834	83.4	0.89	-113.5	27.47	cloudy
	1226	340	16.74	10.72	0.836	41.8	1.10	-117.9	27.62	cloudy
	1236	350	16.63	10.74	0.832	31.5	1.12	-120.6	27.60	cloudy
	1246	370	16.68	10.74	0.834	22.0	0.91	-123.3	27.64	slight cloudy
	1251	385	16.91	10.73	0.839	22.7	1.27	-126.9	27.61	slight cloudy
	1255	390	16.87	10.75	0.838	23.9	1.31	-129.7	27.16	slightly cloudy
	1305	400	16.87	10.76	0.839	23.6	1.31	-128.6	27.11	slightly cloudy
	1315	410	16.85	10.76	0.838	27.1	1.25	-126.9	27.10	slight cloudy

top of sock removed

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.

Location MW-3

Monitored By: JS Date 11/4/15 Time 0846

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground): 82.46 TOC feet

Depth of Water (from top of PVC or ground): 25.96 TOC feet

Radius of Casing: 2" inches / feet

Casing Volume: cubic feet / gallons: 13.4 gal - 3 = 40.1 gal + 280 gal drilling ≈ 320 gal development

Development / Purging Discharge Data

Purging Method: Waterra pump

Start Purging: Date 11/4/15 Time 0846

Stop Purging: Date 11/4/15 Time 1610

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
11/4/15	0856	20	16.06	9.48	1.565	>1000	1.08	-1.5	26.30	muddy
	0905	25	16.19	10.22	1.479	>1000	0.44	-31.1	26.19	muddy
	0917	45	16.20	10.44	1.369	>1000	0.41	-56.9	26.12	muddy
	0926	65	16.22	10.52	1.296	>1000	0.42	-60.7	26.10	muddy
	0935	85	16.24	10.57	1.234	>1000	0.07	-82.9	26.11	muddy
	0945	100	16.20	10.40	1.189	>1000	0.19	-93.0	26.37	muddy
	0957	115	—	—	—	—	—	—	—	—
	1023	145	16.19	9.72	1.089	>1000	0.12	-50.2	26.09	muddy
	1033	165	16.19	9.88	1.070	>1000	0.07	-44.3	26.05	muddy
	1043	185	16.21	9.94	1.070	>1000	0.05	-77.7	26.01	muddy
	1053	205	16.21	9.91	1.049	>1000	0.40	-84.7	26.0	muddy
	1141	235	16.30	10.08	1.048	>1000	1.06	-54	26.09	slightly muddy
	1151	250	16.31	10.05	1.046	>1000	0.98	-57.6	26.15	slightly muddy
	1201	270	16.34	10.07	1.055	>1000	0.67	-51.4	26.01	slight muddy
	1211	290	16.40	10.09	1.043	>1000	0.45	-57.2	26.16	slight mud
	1231	310	16.41	10.06	1.040	>1000	0.65	-58.1	26.05	slight mud
	1245	335	16.41	10.09	1.032	272	0.70	-54.6	26.04	slight mud
	1255	355	16.40	10.04	1.031	222	0.54	-39.4	26.07	cloudy
	1305	370	16.42	10.09	1.031	182	0.55	-41.7	26.05	cloudy
	1320	380	16.42	10.03	1.030	69.4	0.51	-41.9	26.09	cloudy
	1335	390	16.39	10.07	1.029	61.9	0.96	-45.6	25.91	cloudy
	1340	395	16.77	10.07	1.028	58.5	0.87	-44.2	25.66	cloudy
	1350	400	17.13	10.08	1.028	47.8	0.88	-41.3	25.55	cloudy
	1430	400	17.14	10.06	1.041	47.6	1.98	-58.5	25.31	cloudy
	1445	405	17.07	10.16	1.092	45.5	4.06	-20.4	25.25	slightly cloudy
	1455	410	17.02	10.14	1.039	31.6	3.23	-6.7	25.32	slightly cloudy
	1510	420	16.86	10.08	1.033	50.0	2.77	-16.4	25.79	slightly cloudy
	1520	430	16.71	10.14	1.030	46.7	1.25	-21.5	25.71	slight cloudy
	1530	440	16.56	10.10	1.030	38.7	1.64	-24.9	25.70	slight cloud
	1540	445	16.52	10.14	1.029	33.5	1.15	-29.0	25.58	slight cloud
	1550	450	16.51	10.12	1.029	30.0	1.30	-28.9	25.90	slight cloud
	1600	455	16.51	10.13	1.028	24.7	1.33	-29.0	25.57	slight cloudy
	1610	460	16.54	10.13	1.028	24.3	1.30	-28.0	25.61	slight cloudy

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.

Location MW-4

Monitored By: JS Date 11/9/15 Time 1400

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	92.09 TOC	feet
Depth of Water (from top of PVC or ground)	26.06 TOC	feet
Radius of Casing	2	inches
		feet
Casing Volume		cubic feet
	14.6 · 3 = 43.7	gallons

+ 325 gal from drilling
369 gal total

Development / Purging Discharge Data

Purging Method: Waterra Pump

Start Purging: Date 11/9/15 Time 1419

Stop Purging: Date 11/10/15 Time 1052

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
11/9/15	1430	30	14.48	8.55	0.632	71000	1.05	-167.7	26.74	Muddy
	1450	80	14.53	7.80	0.589	71000	0.94	-156.4	26.87	Muddy
	1510	125	14.59	7.50	0.533	71000	0.51	-139.5	27.11	Muddy
	1530	185	14.38	7.39	0.528	71000	0.87	-124.5	27.19	Muddy
	1550	220	14.76	7.33	0.526	71000	0.79	-128.5	27.20	cloudy
	1602	250	14.69	7.35	0.522	71000	0.77	-132.5	26.10	cloudy
11/10/15	0843	350	13.41	6.92	0.566	54.7	1.47	-112.4	26.54	slightly cloudy
	0853	380	14.15	6.95	0.579	104.0	0.96	-113.5	26.45	slightly cloudy
	0903	395	14.22	7.03	0.578	149.0	1.52	-116.9	26.33	slightly cloudy
	0921	410	13.34	7.11	0.576	186.0	1.32	-127.9	26.86	slightly cloudy
	0931	415	13.16	7.12	0.579	158.0	0.94	-129.0	26.28	slight cloud
	0946	420	13.35	7.18	0.572	96.3	0.91	-129.5	26.23	slight cloudy
	0956	423	13.47	7.18	0.564	52.4	0.81	-134.0	26.31	slightly cloudy
	1007	430	13.55	7.19	0.563	38.8	0.74	-134.8	26.30	clear
	1017	435	13.76	7.19	0.563	27.1	0.90	-131.9	26.29	clear
	1027	440	13.80	7.20	0.562	24.4	0.75	-135.4	26.29	clear
	1037	445	13.99	7.21	0.564	18.2	0.82	-131.2	26.28	clear
	1041	447	14.12	7.22	0.568	18.0	0.95	-132.0	26.34	clear
	1047	450	14.08	7.21	0.566	15.8	0.87	-132.3	26.30	clear

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.

Location MW-5

Monitored By: BS Date 11/10/15 Time 1140

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	62.56 TOC	feet
Depth of Water (from top of PVC or ground)	23.01 TOC	feet
Radius of Casing	2	inches
		feet
Casing Volume		cubic feet
	9.9 gal · 3 = 30 gal	gallons

+ 150 gal from drilling
180 gal total

Development / Purging Discharge Data

Purging Method: Waterra Pump

Start Purging Date 11/10/15 Time 1143

Stop Purging Date 11/10/15 Time 1330

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
11/10/15	1152	25	14.21	7.41	0.634	71000	0.41	-152.4	23.34	Very muddy
	1212	60	14.26	7.42	0.604	71000	0.60	-146.8	24.27	Muddy
	1232	85	14.27	7.33	0.595	71000	0.71	-143.3	24.18	muddy
	1252	—	—	—	—	—	—	—	—	—
	1256	130	14.27	7.28	0.598	47.2	0.75	-137.6	23.54	cloudy (slight)
	1306	140	14.32	7.26	0.601	8.92	1.01	-137.8	23.55	clear
	1316	170	14.31	7.26	0.598	6.62	1.03	-135.3	23.96	clear
	1321	180	14.30	7.25	0.598	5.35	0.72	-135.7	23.60	clear
	1326	190	14.30	7.23	0.595	6.26	0.69	-135.0	23.64	clear

remove purge blank

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.: 153-1406.**

Location MW-6

Monitored By: JS Date 11/5/2015 Time 1350

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	61.47 TOC	feet
Depth of Water (from top of PVC or ground)	34.96 TOC	feet
Radius of Casing	2"	inches
		feet
Casing Volume		cubic feet
	6.82 · 3 = 20.5	gallons

+ 120 gal from drilling
140 gal total

Development / Purging Discharge Data

Purging Method: Waterra Pump

Start Purging Date 11/5/15 Time 1416

Stop Purging Date 11/5/15 Time 1635

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
11/5/15	1440	5	15.22	7.62	0.584	>1000	6.87	184.8	35.29	muddy
	1500	80	14.23	7.53	0.592	>1000	3.81	147.4	35.26	muddy
	1515	60	13.85	7.85	0.581	71000	2.58	116.7	35.26	muddy
	1530	85	13.96	8.17	0.583	850	4.82	99.2	35.25	Very cloudy
	1545	105	14.10	8.27	0.573	276	2.64	88.0	35.27	Cloudy
	1600	115	14.08	8.15	0.576	106	2.58	78.2	35.30	Cloudy
	1615	135	14.12	8.01	0.575	76.9	3.60	70.7	35.31	slight cloudy
	1620	145	14.26	7.89	0.579	63.8	3.57	68.5	35.30	slight cloud
	1625	150	14.13	7.90	0.579	63.5	3.65	69.1	35.25	slight cloud
	1630	165	14.25	7.69	0.579	60.9	3.60	69.4	35.31	slight cloud

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.

Location MW-7

Monitored By: JS Date 11/6/15 Time 1300

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	100.05 TOC	feet
Depth of Water (from top of PVC or ground)	41.09 TOC	feet
Radius of Casing	2 in	inches
		feet
Casing Volume		cubic feet
	13.78 · 3 = 41.4	gallons

400 gal from drilling

442 gal total

Development / Purging Discharge Data

Purging Method: Waterra pump

Start Purging Date 11/6/2015 Time 1332

Stop Purging Date 11/6/2015 Time 1655

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
11/6/15	1350	50	16.54	7.77	1.383	71000	2.04	-125.9	41.75	Very muddy
	1410	110	16.50	7.78	1.114	71000	2.38	-115.0	41.72	Very muddy
	1430	145	16.36	7.78	1.006	71000	2.07	-116.5	41.74	Muddy
	1450	185	16.45	7.81	0.919	71000	1.30	-128.8	41.70	Cloudy
	1510	235	16.44	7.76	0.861	33.8	1.53	-124.4	41.73	Slightly cloudy
	1530	250	-	-	-	-	-	-	-	Dump purge water
	1550	290	16.34	7.90	0.794	9.57	1.26	-131.9	41.72	Clear
	1610	330	16.22	7.84	0.754	9.64	1.50	-135.3	41.70	Clear
	1617	370	16.55	7.69	0.750	8.60	1.43	-135.8	41.68	Clear
	1621	380	16.60	7.61	0.741	9.88	1.42	-138.9	41.73	Clear
	1630	390	16.58	7.56	0.732	8.60	1.34	-137.9	41.74	Clear
	1635	410	16.62	7.68	0.724	9.10	1.16	-142.4	41.74	Clear
	1640	425	16.47	7.65	0.726	7.80	0.98	-145.5	41.74	Clear
	1658	445	16.38	7.59	0.726	8.12	1.01	-146.2	41.71	Clear

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.

Location MW-B1

Monitored By: TS Date 11/6/15 Time 0725

Well Piezometer Data

(circle one)

Depth of Well (from ~~top of PVC~~ or ground)	102.03 TOC	feet
Depth of Water (from ~~top of PVC~~ or ground)	45.63 TOC	feet
Radius of Casing	2 in	inches
		feet
Casing Volume		cubic feet
	13.3 • 3 = 40	gallons

450 gal from drilling
490 gal total

Development / Purging Discharge Data

Purging Method: Waterra pump

Start Purging Date 11/6/15 Time 0800

Stop Purging Date 11/6/15 Time 1245

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
11/6/15	~~0840~~	70	15.22	7.71	1.443	71000	1.28	-91.5	45.77	muddy
	0900	105	15.57	7.55	1.460	71000	0.33	-106.0	45.74	muddy
	0920	145	15.67	7.34	1.437	71000	1.30	-116.1	45.66	Very cloudy
	0940	165	15.57	7.36	1.435	71000	1.22	-98.7	45.75	very cloudy
	1000	175	15.97	7.57	1.415	71000	0.90	-121.1	45.69	Very cloudy
	1020	~~225~~	15.71	7.34	1.408	71000	0.98	-107.4	45.63	Very cloudy
	1040	~~250~~	—	—	—	—	—	—	—	Dump Water
	1100	270	15.80	7.41	1.380	>1000	2.38	-102.4	45.76	cloudy
	1120	310	15.72	7.44	1.385	>1000	1.47	-113.3	45.65	cloudy
	1140	350	15.74	7.29	1.401	71000	0.66	-123.8	45.60	Muddy
Remove Surge block	1200	380	15.64	7.13	1.381	40.6	1.75	-109.8	45.65	cloudy
	1220	440	15.76	7.04	1.367	8.36	1.72	-111.3	45.55	clear
	1225	460	15.72	6.97	1.366	3.77	1.62	-110.2	45.58	clear
	1230	~~480~~	15.75	6.96	1.365	4.91	1.51	-114.4	45.55	clear
	1235	480	15.76	6.96	1.364	4.65	1.35	-114.6	45.54	clear
	1240	490	15.75	6.90	1.364	3.83	1.30	-116.0	45.54	

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406. 0002

Location MW-82

Monitored By: JS/TSL Date 11/3/15 Time 0833

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground): 89.80 TOC feet

Depth of Water (from top of PVC or ground): 32.54 TOC feet

Radius of Casing: 2.0 inches

feet

Casing Volume: cubic feet

13.5 x 3 = 40.5 gallons + 250 gall DRILLINGS = 290 gallons

Development / Purging Discharge Data

Purging Method: Watera Pump

Start Purging Date 11/3/15 Time 0934

Stop Purging Date 11/3/15 Time 1549

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°C)	pH	Spec.Cond. (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
11/3/15	0948	70	14.58	7.70	1.031	>1000	1.75	-51.6	32.74	muddy -
	0953	40	14.40	7.69	0.894	>1000	0.44	-84.6	32.70	muddy
	0959	60	14.34	7.69	0.954	71000	0.33	-116.0	32.61	muddy
	1010	80	14.41	7.25	0.915	71000	—	-91.3	32.70	muddy
	1019	100	14.31	7.35	0.881	71000	0.60	-122.7	32.65	muddy
	1031	120	14.35	7.25	0.874	71000	0.64	-115.2	32.74	muddy
	1039	140	14.31	7.31	0.852	71000	0.73	-106.4	32.60	muddy
	1047	160	14.30	7.32	0.882	567	1.04	-115.7	32.65	Slightly Cloudy
	1056	180	14.29	7.27	0.816	>1000	0.66	-122.6	32.68	slightly cloudy
	1106	200	14.33	7.31	0.793	71000	0.75	-119.1	32.62	slightly cloudy
	1111	240	14.35	7.27	0.807	71000	0.40	-126.1	32.67	slightly cloudy
	1120	260	14.42	7.34	0.804	71000	1.71	-125.6	32.71	slight cloudy
	1148	280	14.46	7.29	0.798	71000	0.84	-124.4	32.74	Slight cloudy
	1159	300	14.49	7.28	0.793	71000	0.88	-125.3	32.50	slight cloud/ EMIT Purge H2O
	1243	320	15.07	7.46	0.784	604	1.44	-129.0	32.71	muddy
	1254	340	14.84	7.39	0.787	40.4	11.81	-124.4	32.70	clear
	1304	360	14.88	7.39	0.785	13.3	1.45	-126.2	32.66	clear
	1317	380	15.20	7.58	0.784	8.41	1.19	-117.9	32.40	clear
	1330	400	15.15	7.39	0.778	221	1.09	-119.1	32.65	Slight cloudy (more pump)
	1340	420	14.93	7.34	0.782	582	1.10	-115.3	32.68	"
	1350	440	14.73	7.36	0.779	307	1.19	-116.3	32.36	BACK TO Bottom of screen
	1408	460	14.77	7.39	0.774	203	0.79	-122.7	32.63	cloudy
	1414	480	14.76	7.39	0.777	218	2.03	-121.8	32.67	Slightly cloudy
	1422	500	14.62	7.36	0.773	165	0.99	-122.4	32.49	slight cloudy
	1432	520	14.82	7.33	0.774	135	0.75	-119.8	32.59	slight cloudy / STOP - Dump Water.
	1509	530	14.64	7.35	0.775	131	0.81	-121.6	32.58	slight cloudy
	1518	540	14.51	7.26	0.771	19	0.85	-120.0	32.44	~~stop~~ clear
	1528	550	14.68	7.30	0.770	12.9	0.89	-118.8	32.62	clear
	1538	560	14.53	7.36	0.769	9.5	0.96	-121.0	32.63	clear
	1548	570	14.80	7.29	0.768	5.18	0.87	-117.9	32.58	clear

APPENDIX G
CCR MDNR Well Certification Forms

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO: 00512528	DATE RECEIVED: 12/23/2015
CR NO:	CHECK NO.: 170065
STATE WELL NO: A206103 01/04/2016	REVENUE NO.: 122315
ENTERED NRSMITK4 PH1 PH2 PH3: 12/28/2015 12/28/2015 12/28/2015	APPROVED BY:	ROUTE:

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME: AMEREN MISSOURI	CONTACT NAME: BILL KUTOSKY		VARIANCE GRANTED BY DNR NUMBER:
OWNER ADDRESS: 3700 S LINDBERGH BLVD	CITY: ST LOUIS	STATE: MO / ZIP: 63127	
SITE NAME: AMEREN MISSOURI		WELL NUMBER: MW-1	COUNTY: JEFFERSON
SITE ADDRESS: RUSH INLAND ENERGY CENTER 100 BIG HOLLOW ROAD		CITY: FESTUS	STATIC WATER LEVEL: 28.9 FT

SURFACE COMPLETION

TYPE: [X] ABOVE GROUND [ ] FLUSH MOUNT

LENGTH AND DIAMETER OF SURFACE COMPLETION: LENGTH 5.0 FT. DIAMETER 4.0 IN.

DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED: DIAMETER 12.0 IN. LENGTH 2.5 FT.

SURFACE COMPLETION GROUT: [X] CONCRETE [ ] OTHER

LOCATION OF WELL

LAT. 38 ° 7' 39.47"

LONG. 90 ° 15' 28.8"

SMALLEST 1/4 1/4 LARGEST NE 1/4

SEC. 5 TWN. 39 NORTH

RANGE 7 Direction E

MONITORING FOR:
[ ] RADIONUCLIDES [ ] PETROLEUM PRODUCTS ONLY
[ ] EXPLOSIVES [ ] METALS [ ] VOC
[ ] SVOCS [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
[ ] GAS MIGRATION WELL [X] OBSERVATION
[ ] EXTRACTION WELL [ ] OPEN HOLE
[ ] PIEZOMETERS
[ ] DIRECT PUSH

[ ] LOCKING CAP
[ ] WEEP HOLE

ELEVATION _____FT.

ANNULAR SEAL

LENGTH 59.0FT.

[ ] SLURRY [ ] CHIPS
[ ] PELLETS [ ] GRANULAR
[ ] CEMENT/SLURRY

IF CEMENT/BENTONITE MIX:

BAGS OF CEMENT USED:

%OF BENTONITE USED:

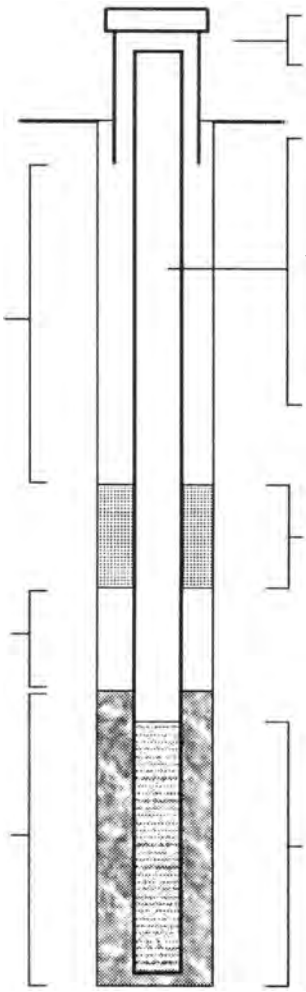
WATER USED/BAG: GAL.

SECONDARY FILTER PACK

LENGTH: 0.0FT.

DEPTH TO TOP OF PRIMARY FILTER PACK: 71.0FT.

LENGTH OF PRIMARY FILTER PACK: 14.0FT.



SURFACE COMPLETTION

[ ] STEEL [X] ALUMINUM [ ] PLASTIC

RISER

RISER PIPE DIAMETER 2.0IN.

RISER PIPE LENGTH 75.0FT.

HOLE DIAMETER 6.0IN.

WEIGHT OR SDR# SCH40

MATERIAL

[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

BENTONITE SEAL

LENGTH: 6.0

[X] CHIPS [ ] PELLETS [ ] GRANULAR
[ ] SLURRY
[ ] SATURATED ZONE [ ] HYDRATED

SCREEN

SCREEN DIAMETER: 2.0IN.

SCREEN LENGTH: 10.0FT.

DIAMETER OF DRILL HOLE: 6.0IN.

DEPTH TO TOP 75.0FT.

SCREEN MATERIAL

[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	6.0	SLTY CLY
6.0	13.5	SLTY CLY
13.5	24.5	SND
24.5	30.0	SND
30.0	32.4	SND
32.4	36.5	SND
36.5	38.8	SLTY CLY
38.8	40.0	SND
40.0	60.0	SND
60.0	70.0	SND
70.0	80.0	SND
80.0	85.0	SND
TOTAL DEPTH:		85.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR) x JEFFREY INGRAM	PERMIT NUMBER 006124	DATE WELL DRILLING WAS COMPLETED 11/01/2015
I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS		[ ] PUMP INSTALLED
SIGNATURE (WELL DRILLER) x JASON DRABEK	PERMIT NUMBER 004484	SIGNATURE (APPRENTICE) x _____ / APPRENTICE PERMIT NUMBER _____

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO	DATE RECEIVED
00512529	12/23/2015
CR NO	CHECK NO.
	170065
STATE WELL NO	REVENUE NO.
A206104 01/04/2016	122315
ENTERED NRSMITK4	APPROVED BY
PH1 PH2 PH3	ROUTE
12/28/2015 12/28/2015 12/28/2015	

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME	CONTACT NAME			VARIANCE GRANTED BY DNR
AMEREN MISSOURI	BILL KUTOSKY			
OWNER ADDRESS	CITY	STATE	ZIP	NUMBER
3700 S LINDBERGH BLVD	ST LOUIS	MO	63127	
SITE NAME		WELL NUMBER		COUNTY
AMEREN MISSOURI		MW-2		JEFFERSON
SITE ADDRESS		CITY		STATIC WATER LEVEL
RUSH INLAND ENERGY CENTER 100 BIG HOLLOW ROAD		FESTUS		27.0 FT

SURFACE COMPLETION

TYPE	LENGTH AND DIAMETER OF SURFACE COMPLETION	DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED	SURFACE COMPLETION GROUT
[X] ABOVE GROUND	LENGTH 5.0 FT.	DIAMETER 12.0 IN.	[X] CONCRETE
[ ] FLUSH MOUNT	DIAMETER 4.0 IN.	LENGTH 2.5 FT.	[ ] OTHER

LOCATION OF WELL

LAT. 38 ° 7' 26.23"
LONG. 90 ° 15' 21.11"

SMALLEST LARGEST
_____ 1/4 _____ 1/4 _____NW 1/4

SEC. 9 TWN. 39 NORTH
RANGE 7 Direction E

MONITORING FOR:
[ ] RADIONUCLIDES [ ] PETROLEUM PRODUCTS ONLY
[ ] EXPLOSIVES [ ] METALS [ ] VOC
[ ] SVOCS [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
[ ] GAS MIGRATION WELL [X] OBSERVATION
[ ] EXTRACTION WELL [ ] OPEN HOLE
[ ] PIEZOMETERS
[ ] DIRECT PUSH

[ ] LOCKING CAP
[ ] WEEP HOLE

ELEVATION _____FT.

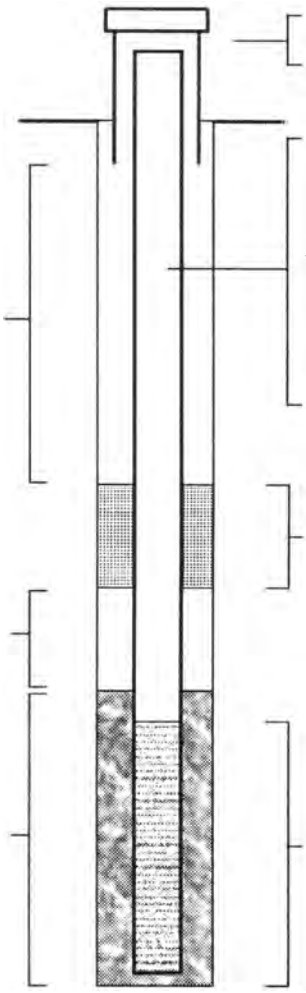
ANNULAR SEAL
LENGTH 59.0FT.
[ ] SLURRY [ ] CHIPS
[ ] PELLETS [ ] GRANULAR
[ ] CEMENT/SLURRY

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 0.0FT.

DEPTH TO TOP OF PRIMARY
FILTER PACK: 72.0FT.

LENGTH OF PRIMARY FILTER PACK: 13.0FT.



SURFACE COMPLETTION
[ ] STEEL [X] ALUMINUM [ ] PLASTIC

RISER
RISER PIPE DIAMETER 2.0IN.
RISER PIPE LENGTH 74.0FT.
HOLE DIAMETER 6.0IN.
WEIGHT OR SDR# SCH40

MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

BENTONITE SEAL
LENGTH: 6.0
[X] CHIPS [ ] PELLETS [ ] GRANULAR
[ ] SLURRY
[ ] SATURATED ZONE [ ] HYDRATED

SCREEN
SCREEN DIAMETER: 2.0IN.
SCREEN LENGTH: 10.0FT.
DIAMETER OF DRILL HOLE: 6.0IN.
DEPTH TO TOP 75.0FT.

SCREEN MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	6.7	SLTY CLY
6.7	21.3	SND
21.3	22.6	SND
22.6	25.3	SND
25.3	28.1	SND
28.1	29.1	CLY SND
29.1	36.9	SND
36.9	40.0	SLTY CLY
40.0	85.0	SND
TOTAL DEPTH:		85.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR)	PERMIT NUMBER	DATE WELL DRILLING WAS COMPLETED
x JEFFREY INGRAM	006124	10/31/2015

I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS

[ ] PUMP INSTALLED

SIGNATURE (WELL DRILLER)	PERMIT NUMBER	SIGNATURE (APPRENTICE)	APPRENTICE PERMIT NUMBER
x JASON DRABEK	004484	x _____	_____

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO	DATE RECEIVED
00512530	12/23/2015
CR NO	CHECK NO.
	170065
STATE WELL NO	REVENUE NO.
A206105 01/04/2016	122315
ENTERED NRSMITK4	APPROVED BY / ROUTE
PH1 PH2 PH3	
12/28/2015 12/28/2015 12/28/2015	

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME	CONTACT NAME			VARIANCE GRANTED BY DNR
AMEREN MISSOURI	BILL KUTOSKY			
OWNER ADDRESS	CITY	STATE	ZIP	NUMBER
3700 S LINDBERGH BLVD	ST LOUIS	MO	63127	
SITE NAME		WELL NUMBER		COUNTY
AMEREN MISSOURI		MW-3		JEFFERSON
SITE ADDRESS		CITY		STATIC WATER LEVEL
RUSH INLAND ENERGY CENTER 100 BIG HOLLOW ROAD		FESTUS		26.0 FT

SURFACE COMPLETION

TYPE	LENGTH AND DIAMETER OF SURFACE COMPLETION	DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED	SURFACE COMPLETION GROUT
[X] ABOVE GROUND	LENGTH 5.0 FT.	DIAMETER 12.0 IN.	[X] CONCRETE
[ ] FLUSH MOUNT	DIAMETER 4.0 IN.	LENGTH 2.5 FT.	[ ] OTHER

LOCATION OF WELL

LAT. 38 ° 7' 18.18"
LONG. 90 ° 15' 12.99"

SMALLEST 1/4 1/4 LARGEST NW 1/4

SEC. 9 TWN. 39 NORTH
RANGE 7 Direction E

MONITORING FOR:
[ ] RADIONUCLIDES [ ] PETROLEUM PRODUCTS ONLY
[ ] EXPLOSIVES [ ] METALS [ ] VOC
[ ] SVOCS [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
[ ] GAS MIGRATION WELL [X] OBSERVATION
[ ] EXTRACTION WELL [ ] OPEN HOLE
[ ] PIEZOMETERS
[ ] DIRECT PUSH

[ ] LOCKING CAP
[ ] WEEP HOLE

ELEVATION _____FT.

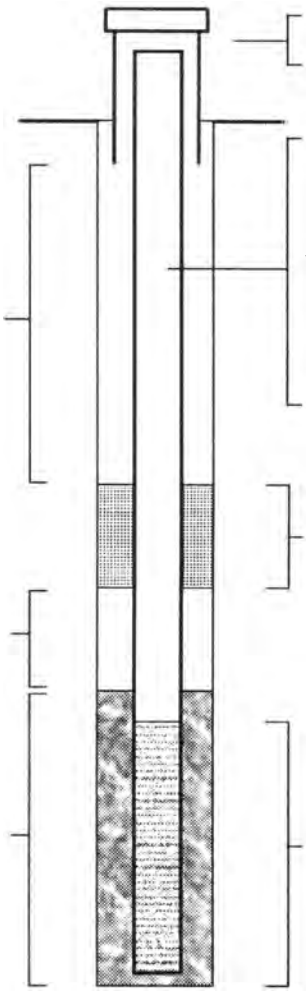
ANNULAR SEAL
LENGTH 59.0FT.
[ ] SLURRY [ ] CHIPS
[ ] PELLETS [ ] GRANULAR
[ ] CEMENT/SLURRY

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 0.0FT.

DEPTH TO TOP OF PRIMARY
FILTER PACK: 66.0FT.

LENGTH OF PRIMARY FILTER PACK: 14.0FT.



SURFACE COMPLETTION
[ ] STEEL [X] ALUMINUM [ ] PLASTIC

RISER
RISER PIPE DIAMETER 2.0IN.
RISER PIPE LENGTH 72.0FT.
HOLE DIAMETER 6.0IN.
WEIGHT OR SDR# SCH40

MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

BENTONITE SEAL
LENGTH: 4.0
[X] CHIPS [ ] PELLETS [ ] GRANULAR
[ ] SLURRY
[ ] SATURATED ZONE [ ] HYDRATED

SCREEN
SCREEN DIAMETER: 2.0IN.
SCREEN LENGTH: 10.0FT.
DIAMETER OF DRILL HOLE: 6.0IN.
DEPTH TO TOP 70.0FT.

SCREEN MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	6.5	SLTY CLY
6.5	11.7	SLT
11.7	12.4	SLTY CLY
12.4	15.0	SLT
15.0	18.3	CLY SLT
18.3	19.6	SLTY CLY
19.6	20.0	SLT
20.0	21.3	SLTY CLY
21.3	27.3	CLY SLT
27.3	29.5	CLY
29.5	80.0	SND
TOTAL DEPTH:		80.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR)	PERMIT NUMBER	DATE WELL DRILLING WAS COMPLETED
x JEFFREY INGRAM	006124	10/31/2015

I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS

[ ] PUMP INSTALLED

SIGNATURE (WELL DRILLER)	PERMIT NUMBER	SIGNATURE (APPRENTICE)	APPRENTICE PERMIT NUMBER
x JASON DRABEK	004484	x	

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO	DATE RECEIVED
00512531	12/23/2015
CR NO	CHECK NO.
	170065
STATE WELL NO	REVENUE NO.
A206106 01/04/2016	122315
ENTERED NRSMITK4 / PH1 PH2 PH3 / 12/28/2015 12/28/2015 12/28/2015	APPROVED BY / ROUTE

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME AMEREN MISSOURI	CONTACT NAME BILL KUTOSKY		VARIANCE GRANTED BY DNR NUMBER
OWNER ADDRESS 3700 S LINDBERGH BLVD	CITY ST LOUIS	STATE MO / ZIP 63127	
SITE NAME AMEREN MISSOURI		WELL NUMBER MW-4	COUNTY JEFFERSON
SITE ADDRESS RUSH INLAND ENERGY CENTER 100 BIG HOLLOW ROAD		CITY FESTUS	STATIC WATER LEVEL 26.1 FT

SURFACE COMPLETION

TYPE	LENGTH AND DIAMETER OF SURFACE COMPLETION	DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED	SURFACE COMPLETION GROUT
[X] ABOVE GROUND	LENGTH 5.0 FT.	DIAMETER 12.0 IN.	[X] CONCRETE
[ ] FLUSH MOUNT	DIAMETER 4.0 IN.	LENGTH 2.5 FT.	[ ] OTHER

LOCATION OF WELL

LAT. 38 ° 7' 2.73"
LONG. 90 ° 15' 15.69"

SMALLEST ____ 1/4 ____ 1/4 ____ SE 1/4 LARGEST

SEC. 4 TWN. 39 NORTH
RANGE 7 Direction E

MONITORING FOR:
[ ] RADIONUCLIDES [ ] PETROLEUM PRODUCTS ONLY
[ ] EXPLOSIVES [ ] METALS [ ] VOC
[ ] SVOCS [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
[ ] GAS MIGRATION WELL [X] OBSERVATION
[ ] EXTRACTION WELL [ ] OPEN HOLE
[ ] PIEZOMETERS
[ ] DIRECT PUSH

[ ] LOCKING CAP
[ ] WEEP HOLE

ELEVATION ____ FT.

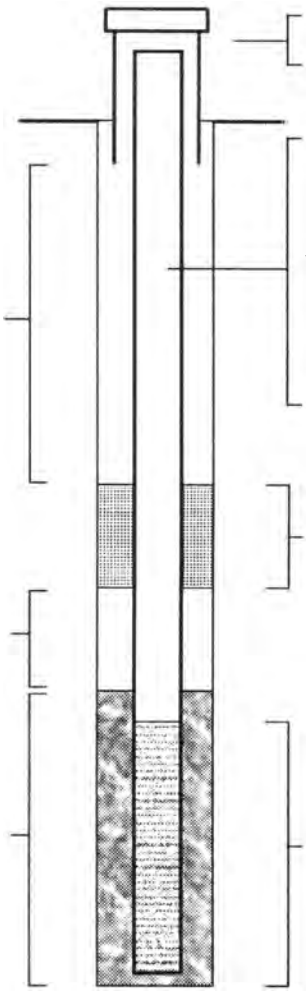
ANNULAR SEAL
LENGTH 69.0 FT.
[ ] SLURRY [ ] CHIPS
[ ] PELLETS [ ] GRANULAR
[ ] CEMENT/SLURRY

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 0.0 FT.

DEPTH TO TOP OF PRIMARY FILTER PACK: 77.0 FT.

LENGTH OF PRIMARY FILTER PACK: 13.0 FT.



SURFACE COMPLETTION
[ ] STEEL [X] ALUMINUM [ ] PLASTIC

RISER
RISER PIPE DIAMETER 2.0 IN.
RISER PIPE LENGTH 84.0 FT.
HOLE DIAMETER 6.0 IN.
WEIGHT OR SDR# SCH40

MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER ____

BENTONITE SEAL
LENGTH: 5.0
[X] CHIPS [ ] PELLETS [ ] GRANULAR
[ ] SLURRY
[ ] SATURATED ZONE [ ] HYDRATED

SCREEN
SCREEN DIAMETER: 2.0 IN.
SCREEN LENGTH: 10.0 FT.
DIAMETER OF DRILL HOLE: 6.0 IN.
DEPTH TO TOP 80.0 FT.

SCREEN MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	5.0	SLTY CLY
5.0	14.0	SLTY SND
14.0	29.6	SLTY CLY
29.6	43.0	SND
43.0	73.8	SLTY CLY SND
73.8	78.1	CLY SND
78.1	82.0	SND
82.0	90.0	SND
TOTAL DEPTH:	90.0 FEET	

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR)	PERMIT NUMBER	DATE WELL DRILLING WAS COMPLETED
x JEFFREY INGRAM	006124	10/30/2015

I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS

[ ] PUMP INSTALLED

SIGNATURE (WELL DRILLER)	PERMIT NUMBER	SIGNATURE (APPRENTICE)	APPRENTICE PERMIT NUMBER
x JASON DRABEK	004484	x	

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO	DATE RECEIVED
00512532	12/23/2015
CR NO	CHECK NO.
	170065
STATE WELL NO	REVENUE NO.
A206107 01/04/2016	122315
ENTERED NRSMITK4 PH1 PH2 PH3 12/28/2015 12/28/2015 12/28/2015	APPROVED BY
ROUTE	

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME AMEREN MISSOURI	CONTACT NAME BILL KUTOSKY		VARIANCE GRANTED BY DNR NUMBER _____
OWNER ADDRESS 3700 S LINDBERGH BLVD	CITY ST LOUIS	STATE MO	ZIP 63127
SITE NAME AMEREN MISSOURI		WELL NUMBER MW-5	COUNTY JEFFERSON
SITE ADDRESS RUSH INLAND ENERGY CENTER 100 BIG HOLLOW ROAD		CITY FESTUS	STATIC WATER LEVEL 23.0 FT

SURFACE COMPLETION

TYPE	LENGTH AND DIAMETER OF SURFACE COMPLETION	DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED	SURFACE COMPLETION GROUT
[X] ABOVE GROUND	LENGTH 5.0 FT.	DIAMETER 12.0 IN.	[X] CONCRETE
[ ] FLUSH MOUNT	DIAMETER 4.0 IN.	LENGTH 2.5 FT.	[ ] OTHER

LOCATION OF WELL

LAT. 38 ° 7' 6.2"
LONG. 90 ° 15' 27.01"

SMALLEST LARGEST
_____ 1/4 _____ 1/4 _____SE 1/4

SEC. 4 TWN. 39 NORTH
RANGE 7 Direction E

MONITORING FOR:
[ ] RADIONUCLIDES [ ] PETROLEUM PRODUCTS ONLY
[ ] EXPLOSIVES [ ] METALS [ ] VOC
[ ] SVOCS [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
[ ] GAS MIGRATION WELL [X] OBSERVATION
[ ] EXTRACTION WELL [ ] OPEN HOLE
[ ] PIEZOMETERS
[ ] DIRECT PUSH

[ ] LOCKING CAP
[ ] WEEP HOLE

ELEVATION _____FT.

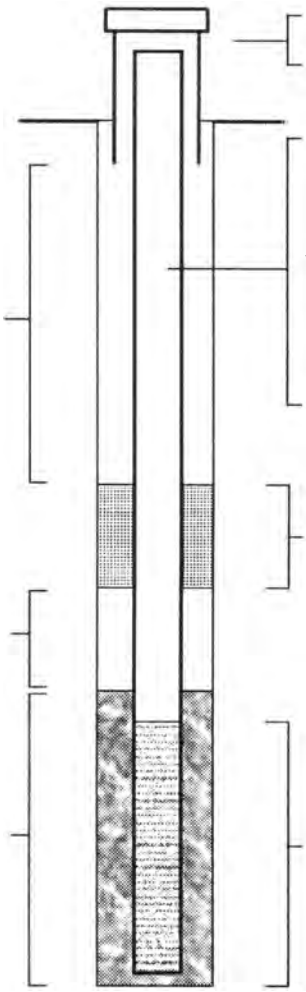
ANNULAR SEAL
LENGTH 43.0FT.
[ ] SLURRY [ ] CHIPS
[ ] PELLETS [ ] GRANULAR
[ ] CEMENT/SLURRY

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 0.0FT.

DEPTH TO TOP OF PRIMARY
FILTER PACK: 56.5FT.

LENGTH OF PRIMARY FILTER PACK: 7.5FT.



SURFACE COMPLETTION
[ ] STEEL [X] ALUMINUM [ ] PLASTIC

RISER
RISER PIPE DIAMETER 2.0IN.
RISER PIPE LENGTH 37.0FT.
HOLE DIAMETER 6.0IN.
WEIGHT OR SDR# SCH40

MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

BENTONITE SEAL
LENGTH: 5.5
[X] CHIPS [ ] PELLETS [ ] GRANULAR
[ ] SLURRY
[ ] SATURATED ZONE [ ] HYDRATED

SCREEN
SCREEN DIAMETER: 2.0IN.
SCREEN LENGTH: 5.0FT.
DIAMETER OF DRILL HOLE: 6.0IN.
DEPTH TO TOP 59.0FT.

SCREEN MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	7.5	SLT
7.5	14.5	SLTY CLY
14.5	16.4	SLTY SND
16.4	18.8	SLT
18.8	20.0	SLTY CLY
20.0	22.0	SLTY SND
22.0	26.5	CLY SLT
26.5	40.0	SND
40.0	41.8	SLTY SND
41.8	43.4	SLTY CLY
43.4	50.0	SND
50.0	64.0	SND
TOTAL DEPTH:		64.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR)	PERMIT NUMBER	DATE WELL DRILLING WAS COMPLETED
x JEFFREY INGRAM	006124	10/29/2015

I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS

[ ] PUMP INSTALLED

SIGNATURE (WELL DRILLER)	PERMIT NUMBER	SIGNATURE (APPRENTICE)	APPRENTICE PERMIT NUMBER
x JASON DRABEK	004484	x _____	_____

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO 00512533	DATE RECEIVED 12/23/2015
CR NO	CHECK NO. 170065
STATE WELL NO A206108 01/04/2016	REVENUE NO. 122315
ENTERED NRSMITK4 PH1 PH2 PH3 12/28/2015 12/28/2015 12/28/2015	APPROVED BY / ROUTE

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME: AMEREN MISSOURI	CONTACT NAME: BILL KUTOSKY		VARIANCE GRANTED BY DNR NUMBER:
OWNER ADDRESS: 3700 S LINDBERGH BLVD	CITY: ST LOUIS	STATE: MO / ZIP: 63127	
SITE NAME: AMEREN MISSOURI		WELL NUMBER: MW-6	COUNTY: JEFFERSON
SITE ADDRESS: RUSH INLAND ENERGY CENTER 100 BIG HOLLOW ROAD		CITY: FESTUS	STATIC WATER LEVEL: 35.0 FT

SURFACE COMPLETION

TYPE: [X] ABOVE GROUND [ ] FLUSH MOUNT

LENGTH AND DIAMETER OF SURFACE COMPLETION: LENGTH 5.0 FT. DIAMETER 4.0 IN.

DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED: DIAMETER 12.0 IN. LENGTH 2.5 FT.

SURFACE COMPLETION GROUT: [X] CONCRETE [ ] OTHER

LOCATION OF WELL

LAT. 38 ° 7' 17.1"
LONG. 90 ° 15' 39.41"

SMALLEST 1/4 1/4 SE 1/4 LARGEST

SEC. 4 TWN. 39 NORTH
RANGE 7 Direction E

MONITORING FOR:
[ ] RADIONUCLIDES [ ] PETROLEUM PRODUCTS ONLY
[ ] EXPLOSIVES [ ] METALS [ ] VOC
[ ] SVOCS [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
[ ] GAS MIGRATION WELL [X] OBSERVATION
[ ] EXTRACTION WELL [ ] OPEN HOLE
[ ] PIEZOMETERS
[ ] DIRECT PUSH

[ ] LOCKING CAP
[ ] WEEP HOLE

ELEVATION _____FT.

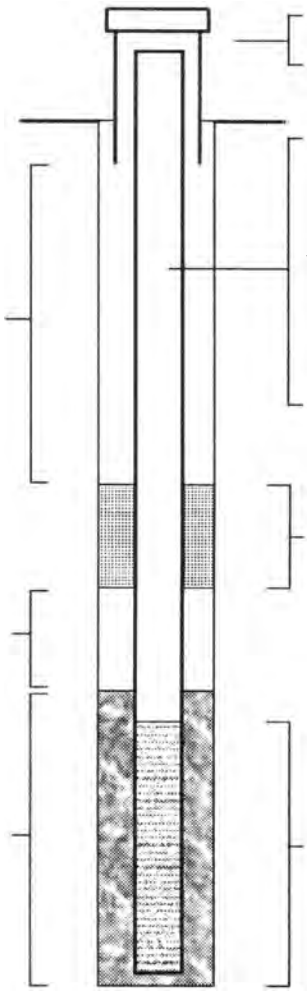
ANNULAR SEAL
LENGTH 43.5FT.
[ ] SLURRY [ ] CHIPS
[ ] PELLETS [ ] GRANULAR
[ ] CEMENT/SLURRY

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 0.0FT.

DEPTH TO TOP OF PRIMARY
FILTER PACK: 52.0FT.

LENGTH OF PRIMARY FILTER PACK: 8.5FT.



SURFACE COMPLETTION
[ ] STEEL [X] ALUMINUM [ ] PLASTIC

RISER
RISER PIPE DIAMETER 2.0IN.
RISER PIPE LENGTH 56.0FT.
HOLE DIAMETER 6.0IN.
WEIGHT OR SDR# SCH40

MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

BENTONITE SEAL
LENGTH: 5.5
[X] CHIPS [ ] PELLETS [ ] GRANULAR
[ ] SLURRY
[ ] SATURATED ZONE [ ] HYDRATED

SCREEN
SCREEN DIAMETER: 2.0IN.
SCREEN LENGTH: 5.0FT.
DIAMETER OF DRILL HOLE: 6.0IN.
DEPTH TO TOP 55.5FT.

SCREEN MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	2.0	SND
2.0	7.0	SLTY SND
7.0	10.0	SLTY CLY
10.0	11.5	SND
11.5	20.0	SLTY SND
20.0	21.0	SLTY CLY
21.0	22.1	CLY SND
22.1	41.7	SND SLTY CLY
41.7	50.0	SLT CLY
50.0	55.0	SLTY SND
55.0	60.5	GRVL
TOTAL DEPTH:		60.5 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR) x JEFFREY INGRAM	PERMIT NUMBER 006124	DATE WELL DRILLING WAS COMPLETED 10/30/2015
I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS		[ ] PUMP INSTALLED
SIGNATURE (WELL DRILLER) x JASON DRABEK	PERMIT NUMBER 004484	SIGNATURE (APPRENTICE) x _____ / APPRENTICE PERMIT NUMBER _____

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO 00512534	DATE RECEIVED 12/23/2015
CR NO	CHECK NO. 170065
STATE WELL NO A206109 01/04/2016	REVENUE NO. 122315
ENTERED NRSMITK4 PH1 PH2 PH3 12/28/2015 12/28/2015 12/28/2015	APPROVED BY / ROUTE

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME: AMEREN MISSOURI	CONTACT NAME: BILL KUTOSKY		VARIANCE GRANTED BY DNR NUMBER:
OWNER ADDRESS: 3700 S LINDBERGH BLVD	CITY: ST LOUIS	STATE: MO / ZIP: 63127	
SITE NAME: AMEREN MISSOURI		WELL NUMBER: MW-7	COUNTY: JEFFERSON
SITE ADDRESS: RUSH INLAND ENERGY CENTER 100 BIG HOLLOW ROAD		CITY: FESTUS	STATIC WATER LEVEL: 41.05 FT

SURFACE COMPLETION

TYPE	LENGTH AND DIAMETER OF SURFACE COMPLETION	DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED	SURFACE COMPLETION GROUT
[X] ABOVE GROUND	LENGTH 5.0 FT.	DIAMETER 12.0 IN.	[X] CONCRETE
[ ] FLUSH MOUNT	DIAMETER 4.0 IN.	LENGTH 2.5 FT.	[ ] OTHER

LOCATION OF WELL

LAT. 38 ° 7' 31.14"
LONG. 90 ° 15' 45.17"

SMALLEST 1/4 1/4 LARGEST NW 1/4

SEC. 4 TWN. 39 NORTH
RANGE 7 Direction E

MONITORING FOR:
[ ] RADIONUCLIDES [ ] PETROLEUM PRODUCTS ONLY
[ ] EXPLOSIVES [ ] METALS [ ] VOC
[ ] SVOCS [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
[ ] GAS MIGRATION WELL [X] OBSERVATION
[ ] EXTRACTION WELL [ ] OPEN HOLE
[ ] PIEZOMETERS
[ ] DIRECT PUSH

[ ] LOCKING CAP
[ ] WEEP HOLE

ELEVATION _____FT.

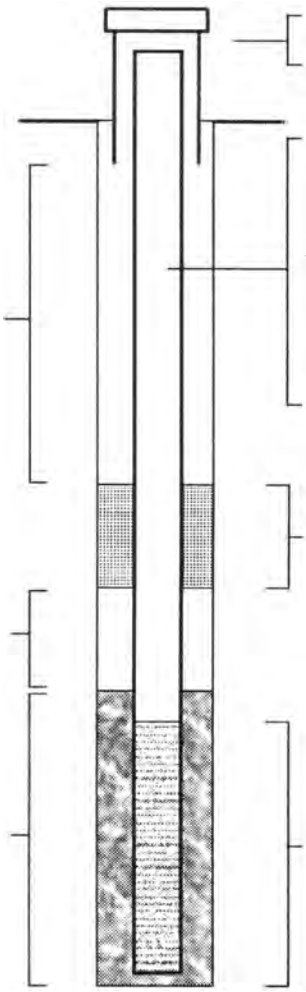
ANNULAR SEAL
LENGTH 72.5FT.
[ ] SLURRY [ ] CHIPS
[ ] PELLETS [ ] GRANULAR
[ ] CEMENT/SLURRY

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 0.0FT.

DEPTH TO TOP OF PRIMARY
FILTER PACK: 84.0FT.

LENGTH OF PRIMARY FILTER PACK: 13.0FT.



SURFACE COMPLETTION
[ ] STEEL [X] ALUMINUM [ ] PLASTIC

RISER
RISER PIPE DIAMETER 2.0IN.
RISER PIPE LENGTH 84.0FT.
HOLE DIAMETER 6.0IN.
WEIGHT OR SDR# SCH40

MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

BENTONITE SEAL
LENGTH: 7.0
[X] CHIPS [ ] PELLETS [ ] GRANULAR
[ ] SLURRY
[ ] SATURATED ZONE [ ] HYDRATED

SCREEN
SCREEN DIAMETER: 2.0IN.
SCREEN LENGTH: 10.0FT.
DIAMETER OF DRILL HOLE: 6.0IN.
DEPTH TO TOP 87.0FT.

SCREEN MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	5.0	SLTY SND
5.0	10.0	CLY SND
10.0	32.0	SLT CLY
32.0	34.6	SNDY SLTY CLY
34.6	40.0	SND
40.0	52.0	SND
52.0	52.5	GRVL
52.5	57.0	SND
57.0	59.5	CLY SND
59.5	82.3	SND
82.3	97.0	SND
TOTAL DEPTH:		97.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR) x JEFFREY INGRAM	PERMIT NUMBER 006124	DATE WELL DRILLING WAS COMPLETED 10/28/2015
I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS		[ ] PUMP INSTALLED
SIGNATURE (WELL DRILLER) x JASON DRABEK	PERMIT NUMBER 004484	SIGNATURE (APPRENTICE) x _____ / APPRENTICE PERMIT NUMBER _____

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO	DATE RECEIVED
00512527	12/23/2015
CR NO	CHECK NO.
	170065
STATE WELL NO	REVENUE NO.
A206102 01/04/2016	122315
ENTERED NRSMITK4	APPROVED BY
PH1 PH2 PH3	ROUTE
12/28/2015 12/28/2015 12/28/2015	

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME	CONTACT NAME			VARIANCE GRANTED BY DNR
AMEREN MISSOURI	BILL KUTOSKY			
OWNER ADDRESS	CITY	STATE	ZIP	NUMBER
3700 S LINDBERGH BLVD	ST LOUIS	MO	63127	
SITE NAME		WELL NUMBER		COUNTY
AMEREN MISSOURI		MW-B1		JEFFERSON
SITE ADDRESS		CITY		STATIC WATER LEVEL
RUSH INLAND ENERGY CENTER 100 BIG HOLLOW ROAD		FESTUS		45.6 FT

SURFACE COMPLETION

TYPE	LENGTH AND DIAMETER OF SURFACE COMPLETION	DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED	SURFACE COMPLETION GROUT
[X] ABOVE GROUND	LENGTH 5.0 FT.	DIAMETER 12.0 IN.	[X] CONCRETE
[ ] FLUSH MOUNT	DIAMETER 4.0 IN.	LENGTH 2.5 FT.	[ ] OTHER

LOCATION OF WELL

LAT. 38 ° 8' 1.43"
LONG. 90 ° 15' 52.75"

SMALLEST 1/4 1/4 LARGEST NE 1/4

SEC. 5 TWN. 39 NORTH
RANGE 7 Direction E

MONITORING FOR:
[ ] RADIONUCLIDES [ ] PETROLEUM PRODUCTS ONLY
[ ] EXPLOSIVES [ ] METALS [ ] VOC
[ ] SVOCS [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
[ ] GAS MIGRATION WELL [X] OBSERVATION
[ ] EXTRACTION WELL [ ] OPEN HOLE
[ ] PIEZOMETERS
[ ] DIRECT PUSH

[ ] LOCKING CAP
[ ] WEEP HOLE

ELEVATION _____FT.

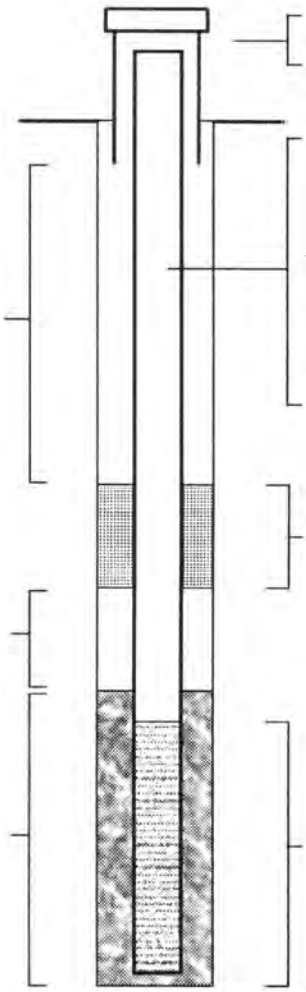
ANNULAR SEAL
LENGTH 77.0FT.
[ ] SLURRY [ ] CHIPS
[ ] PELLETS [ ] GRANULAR
[ ] CEMENT/SLURRY

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 0.0FT.

DEPTH TO TOP OF PRIMARY
FILTER PACK: 86.0FT.

LENGTH OF PRIMARY FILTER PACK: 13.0FT.



SURFACE COMPLETTION
[ ] STEEL [X] ALUMINUM [ ] PLASTIC

RISER
RISER PIPE DIAMETER 2.0IN.
RISER PIPE LENGTH 90.0FT.
HOLE DIAMETER 6.0IN.
WEIGHT OR SDR# SCH40

MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

BENTONITE SEAL
LENGTH: 5.0
[X] CHIPS [ ] PELLETS [ ] GRANULAR
[ ] SLURRY
[ ] SATURATED ZONE [ ] HYDRATED

SCREEN
SCREEN DIAMETER: 2.0IN.
SCREEN LENGTH: 10.0FT.
DIAMETER OF DRILL HOLE: 6.0IN.
DEPTH TO TOP 89.0FT.

SCREEN MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	19.0	SND
19.0	21.4	CLY SND
21.4	22.5	SLTY CLY
22.5	25.0	SLTY CLY
25.0	32.0	SND CLY
32.0	35.0	SLTY SND
35.0	40.0	SLTY CLY
40.0	55.0	SND
55.0	99.0	SND
TOTAL DEPTH:		99.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR)	PERMIT NUMBER	DATE WELL DRILLING WAS COMPLETED
x JEFFREY INGRAM	006124	10/28/2015

I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS

[ ] PUMP INSTALLED

SIGNATURE (WELL DRILLER)	PERMIT NUMBER	SIGNATURE (APPRENTICE)	APPRENTICE PERMIT NUMBER
x JASON DRABEK	004484	x	

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO 00512526	DATE RECEIVED 12/23/2015
CR NO	CHECK NO. 170065
STATE WELL NO A206101 01/04/2016	REVENUE NO. 122315
ENTERED NRSMITK4 PH1 PH2 PH3 12/28/2015 12/28/2015 12/28/2015	APPROVED BY / ROUTE

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME AMEREN MISSOURI	CONTACT NAME BILL KUTOSKY		VARIANCE GRANTED BY DNR NUMBER
OWNER ADDRESS 3700 S LINDBERGH BLVD	CITY ST LOUIS	STATE MO / ZIP 63127	
SITE NAME AMEREN MISSOURI		WELL NUMBER MW-B2	COUNTY JEFFERSON
SITE ADDRESS RUSH INLAND ENERGY CENTER 100 BIG HOLLOW ROAD		CITY FESTUS	STATIC WATER LEVEL 32.5 FT

SURFACE COMPLETION

TYPE	LENGTH AND DIAMETER OF SURFACE COMPLETION	DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED	SURFACE COMPLETION GROUT
[X] ABOVE GROUND	LENGTH 5.0 FT.	DIAMETER 12.0 IN.	[X] CONCRETE
[ ] FLUSH MOUNT	DIAMETER 4.0 IN.	LENGTH 2.5 FT.	[ ] OTHER

LOCATION OF WELL

LAT. 38 ° 8' 2.99"
LONG. 90 ° 16' 24.73"

SMALLEST 1/4 ____ 1/4 ____ NE 1/4 LARGEST

SEC. 5 TWN. 39 NORTH
RANGE 7 Direction E

[ ] LOCKING CAP
[ ] WEEP HOLE

ELEVATION ____FT.

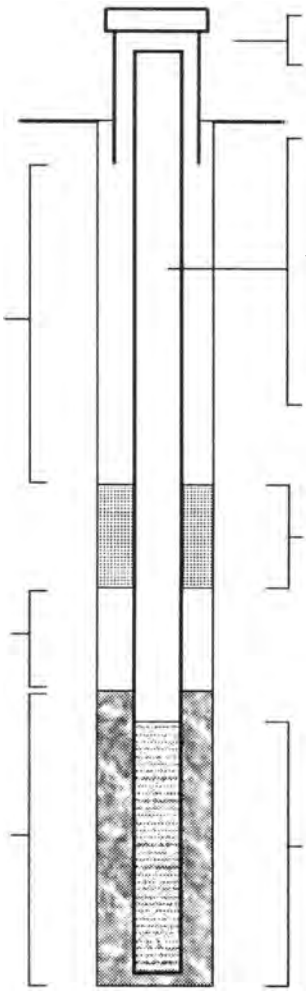
ANNULAR SEAL
LENGTH 63.0FT.
[ ] SLURRY [ ] CHIPS
[ ] PELLETS [ ] GRANULAR
[ ] CEMENT/SLURRY

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 0.0FT.

DEPTH TO TOP OF PRIMARY
FILTER PACK: 73.0FT.

LENGTH OF PRIMARY FILTER PACK: 14.0FT.



SURFACE COMPLETTION
[ ] STEEL [X] ALUMINUM [ ] PLASTIC

RISER
RISER PIPE DIAMETER 2.0IN.
RISER PIPE LENGTH 79.0FT.
HOLE DIAMETER 6.0IN.
WEIGHT OR SDR# SCH40

MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

BENTONITE SEAL
LENGTH: 7.0
[X] CHIPS [ ] PELLETS [ ] GRANULAR
[ ] SLURRY
[ ] SATURATED ZONE [ ] HYDRATED

SCREEN
SCREEN DIAMETER: 2.0IN.
SCREEN LENGTH: 10.0FT.
DIAMETER OF DRILL HOLE: 6.0IN.
DEPTH TO TOP 77.0FT.

SCREEN MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

MONITORING FOR:
[ ] RADIONUCLIDES [ ] PETROLEUM PRODUCTS ONLY
[ ] EXPLOSIVES [ ] METALS [ ] VOC
[ ] SVOCS [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
[ ] GAS MIGRATION WELL [X] OBSERVATION
[ ] EXTRACTION WELL [ ] OPEN HOLE
[ ] PIEZOMETERS
[ ] DIRECT PUSH

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	8.8	SND
8.8	20.0	SLTY CLY
20.0	24.0	SLTY CLY
24.0	30.0	SND
30.0	43.0	SLTY CLY
43.0	54.5	SND
54.5	60.0	SLTY CLY
60.0	65.0	SND
65.0	87.0	SND
TOTAL DEPTH:		87.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR) x JEFFREY INGRAM	PERMIT NUMBER 006124	DATE WELL DRILLING WAS COMPLETED 10/27/2015
I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS		[ ] PUMP INSTALLED
SIGNATURE (WELL DRILLER) x JASON DRABEK	PERMIT NUMBER 004484	SIGNATURE (APPRENTICE) x _____ / APPRENTICE PERMIT NUMBER

APPENDIX H
Statistical Analysis Plan

Statistical Analysis Plan

STATISTICAL ANALYSIS PLAN

Prepared in accordance with the United States Environmental Protection Agencies Coal Combustion Rule, part 40 CFR 257.93 for Ameren Missouri's RCPA Surface Impoundment at the Rush Island Energy Center, Jefferson County, Missouri

Submitted To: Ameren Missouri
1901 Chouteau Avenue
St. Louis, Missouri 63103

Submitted By: Golder Associates Inc.
820 S. Main Street, Suite 100
St. Charles, MO 63301 USA

Date: October 12, 2017

Project No.153-1406

EXECUTIVE SUMMARY

This Statistical Analysis Plan (SAP) was developed to meet the requirements of United States Environmental Protection Agency (USEPA) 40 CFR Part 257 “Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule” (the Rule or CCR Rule). The Rule requires owners or operators of an existing Coal Combustion Residuals (CCR) Surface Impoundment to install a groundwater monitoring system and develop a sampling and analysis program (§§ 257.90 - 257.94). Ameren Missouri has determined that the RCPA Surface Impoundment at the Rush Island Energy Center in Franklin County, Missouri is subject to the requirements of the CCR Rule.

As a part of the groundwater sampling and analysis requirements of the Rule, statistical methods as described in Section §257.93(f) of the Rule need to be implemented to statistically evaluate groundwater quality. The selected statistical method must then be certified by a qualified professional engineer stating that the statistical method is appropriate for evaluating the groundwater monitoring data for the CCR Unit. Detailed descriptions of the acceptable statistical data methods are provided in the USEPA’s *Statistical Analysis of Groundwater Data at RCRA Facilities, Unified Guidance* (USEPA, 2009) (Unified Guidance). The Unified Guidance is also recommended in the CCR Rule to be used for guidance in the selection of the appropriate statistical evaluation method.

This SAP details the statistical procedures to be used to establish background conditions, to implement detection monitoring, and to implement assessment monitoring (if needed) for Ameren Missouri at the above mentioned CCR Unit. Detailed information on collection, sampling techniques, preservation, etc. are provided in the Groundwater Monitoring Plan (GMP) for the CCR Unit specified above. This SAP is a companion documents to the GMP and assumes that data analyzed by the procedures described in this SAP are from samples that were collected in accordance with the GMP.

This SAP was prepared by Golder Associates, Inc. (Golder) on behalf of Ameren in order to document appropriate method of groundwater data evaluation in compliance with CCR Rules. The methods and groundwater data evaluation techniques used in this SAP are appropriate for evaluation of the groundwater monitoring data for the above mentioned CCR Unit and are in compliance with performance standards outlined in Section §257.93(g) of the CCR Rule.

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1.0 BASELINE STATISTICS

This section discusses the procedures, methods, and processes that will be implemented as part of the Detection Monitoring statistical evaluation. Detection Monitoring will begin after eight rounds of sampling are completed at each monitoring well for each of the Appendix III and Appendix IV parameters. This background monitoring period provides baseline data for each monitoring well which can be used as the basis of the statistical evaluation. Detection monitoring will be completed on a semiannual basis unless adequate groundwater flow is not available for semiannual sampling and proper documentation as outlined in §257.94(d) is completed. Detection monitoring will analyze for Appendix III analytes as outlined in the Groundwater Monitoring Plan for this CCR Unit.

1.1 STATISTICAL DATA PREPARATION AND INITIAL REVIEW

Many of the statistical comparison tests used in detection, and assessment monitoring require various analyses to be completed prior to the data being used for the calculation of statistical limits. This section discusses the methods and procedures for completing this initial review of the data. The analyses required include testing for statistical independence, physical independence, and procedures to evaluate potential outliers.

1.1.1 Physical and Statistical Independence of Groundwater Samples

Detection, and Assessment Monitoring statistical evaluations assume that background and downgradient sampling results are statistically independent. The Unified Guidance states that *"Physical independence of samples does not guarantee statistical independence, but it increases the likelihood of statistical independence."* (Section 14.1, Unified Guidance). Physical independence is most likely achieved when consecutive groundwater samples are collected from independent volumes of water within a given aquifer zone. Using the Darcy Equation, minimum time intervals between sampling events can be calculated in order to confirm the minimum time interval for groundwater to travel through the borehole is less than the time between sampling events (**Table 1, Physical Independence**). This minimum time can be calculated as displayed in Section *14.3.2* of the Unified Guidance.

Table 1: Physical Independence

Well ID	Hydraulic Conductivity	Average Hydraulic Gradient	Effective Porosity	Well Bore Volume	Minimum Time
Symbol	K	I	n	D	T_{min}
Units	Feet/Day	Feet/Foot	%	Feet	Days
MW-1	88	0.0007	0.35	0.5	2.8
MW-2	64	0.0007	0.35	0.5	3.9
MW-3	44	0.0007	0.35	0.5	5.7
MW-4	56	0.0007	0.35	0.5	4.5
MW-5	92	0.0007	0.35	0.5	2.7
MW-6	37	0.0007	0.35	0.5	6.8
MW-7	37	0.0007	0.35	0.5	6.8
MW-B1	54	0.0007	0.35	0.5	4.6
MW-B2	45	0.0007	0.35	0.5	5.6

Notes:
1. Average hydraulic gradient and effective porosity taken from table 2 in the Groundwater Monitoring Plan (GMP)
2. Hydraulic Conductivity taken from table 3 of the Groundwater Monitoring Plan (GMP)
3. Calculation completed using the Darcy Equation as outlined in section 14.3.2 of the Unified Guidance.

1.1.2 Data Review – Testing For Outliers

Careful review of the data is critical for verifying that there is an accurate representation of the groundwater conditions. Early identification of anomalous data (outliers) helps play a key role in a successful SAP. Possible causes for outliers include:

- Sampling error or field contamination;
- Analytical errors or laboratory contamination;
- Recording or transcription errors;
- Faulty sample preparation, preservation, or shelf-life exceedance; or
- Extreme, but accurately detected environmental conditions (e.g., spills, migration from the facility).

The following sections outline a few graphical and statistical tests that should be completed prior to the data being used to calculate statistical limits.

1.1.2.1 Time Series Plots

Time Series plots are a quick and simple method to check for possible outliers. Time series plots should be generated with the concentration of the analyte on the Y-axis and the sample date (time) on the X-axis. If any data points look to be potential outliers, the data should be flagged and further evaluated as described in Section 1.1.2.2 below.

1.1.2.2 Dixon's and Rosner's Tests

If graphical methods demonstrate that potential outliers exist, further investigation of these data points can be completed using Dixon's test for datasets with fewer than 25 samples and Rosner's test with datasets greater than 20 samples. Formal testing should only be performed if an observation seems particularly high compared to the rest of the dataset. If statistical testing is to be completed to whether an outlier exists, it should be cautioned that these outlier tests assume that the rest of the data (other than the outlier) are normally distributed. Additionally, because log-normally distributed data often contain one or more values that appear high relative to the rest, it is recommended that the outlier test be run on the transformed values instead of their original observations. This way, one can avoid classifying a high log-normal measurement as an outlier just because the test assumptions were violated. Most groundwater statistical packages can complete Dixon's and Rosner's tests and more information about Dixon's and Rosner's tests is provided in Sections 12.3 and 12.4 of the Unified Guidance. If the test designates an observation as a statistical outlier, the source of the abnormal measurement should be investigated. In general, if a data point is found to be a statistical outlier, it should not be used for statistical evaluation. However, outlier removal should be performed carefully, and typically only when a specific cause for the outlier can be identified.

In some cases where a specific cause for an outlier cannot be identified, professional judgment can be used to determine whether the outlier significantly affects the statistical results to the extent that removal is deemed necessary. If an outlier value with much higher concentration than other background observations is not removed from background prior to statistical testing, it will tend to increase both the background sample mean and standard deviation. In turn, this may substantially raise the magnitude of the prediction limit or control limit calculated from that data set. Thus, experience shows that it is a good practice to remove obvious outliers from the database even when independent evidence of the source of the outlier does not exist. The removal of outliers tends to normalize the data and therefore produce a more robust statistical limit. Outlier removal also tends to produces a more conservative statistical limit, since the data variability is decreased, thereby decreasing the standard deviation.

1.2 Upgradient Monitoring Wells

Following the identification and removal of outliers, the upgradient data are further reviewed to determine appropriate methods for statistical evaluation to maintain adequate statistical power while minimizing the chance of false positives. The following sections describe the procedures and methods that should be used, based on the background dataset, to compare the background datasets, to calculate the data distribution, to handle non-detect (ND) data, and to select appropriate statistical evaluation methods (interwell vs intrawell).

1.2.1 Calculate for Mean and Standard Deviation

Following outlier removal, initial summary statistics including mean and standard deviation should be calculated for the background monitoring well datasets. While these summary statistics are easily

completed in many groundwater statistical software packages, it is important to account for values that have low or zero values as described below.

1.2.1.1 Reporting of Low and Zero Values

1.2.1.1.1 Estimated Values (J Flag)

Estimated values are values that have a concentration between the method detection limit (MDL[1]) and the practical quantitation limit (PQL[2]) for any given compound. These values are typically displayed with a J flag in laboratory report packages and are often referred to as "J-values". In most cases, The Unified Guidance recommends using the estimated value provided for statistical evaluation. Estimated values are typically used because the accuracy and power of most statistical evaluations lose power as the percentage of non-detects increases. While they are below the PQL, estimated values are considered detectable concentrations for statistical calculations, which has the effect of lowering the percentage of non-detects.

This "rule" should be applied with care, as there is an exception. Estimated values are not considered detectable concentrations if all values for a single constituent are less than the PQL. This is discussed in more detail in Section 1.3.5 of this document.

1.2.1.1.2 Non-Detects Values (ND)

Non-Detect Values (ND) are concentrations that were not detected at a concentration above the MDL. ND values are typically displayed with a "U" or "ND" flag in laboratory data report packages. The following approaches for managing ND values are based on recommendations in the Unified Guidance and are applicable for use with the statistical evaluation procedures that will be further discussed and used in this SAP (prediction intervals, confidence intervals, and tolerance intervals):

- If <15% ND, substitute ½ the PQL;
- If between 15% to 50% ND, use the Kaplan-Meier or robust regression on ordered statistics to estimate the mean and standard deviation;
- If >50% but less than 100% ND, use a non-parametric test; or
- If 100% of values are less than the PQL, use the Double Quantification Rule.

1.2.2 Data Distribution

Statistical evaluations of groundwater data require an understanding of the data distribution for each analyte in each monitoring well. Data typically fall into one of the following distributions:

[1] MDL = lowest level of an analyte (substance) that the laboratory can reliably detect with calibrated instrumentation; generally based on results of an annual "MDL study" performed in accordance with 40 CFR Part 136, Appendix B; MDLs are generally set using laboratory grade deionized water spiked with a known concentration and thus do not account for effects of matrix interference inherent in typical groundwaters.

[2] PQL = minimum concentration of an analyte (substance) that can be measured with a high degree of confidence that the analyte is present at or above that concentration (typically 5-10x higher than the MDL).

- Normal distribution – Sometimes referred to as Gaussian distribution, a normal distribution is a common continuous distribution where data form a symmetrical bell-shaped curve around a mean. Normally distributed data are tested using parametric methods.
- Transformed-normal distribution – Similar to a normal distribution, however, data are asymmetrical until transformation is applied to all data which then causes it to form a bell-curve. Transformed-normal data distributions are also tested use parametric methods.
- Non-Normal Distribution – When the data are not or cannot be transformed into a symmetrical distribution. Non-normal data distributions are tested using Non-parametric methods.

Testing for data distributions can be completed in several different ways including the skewness coefficient, probability plots with Filliben's test, or the Shapiro-Wilk/Shapiro-Francia Test. All of these methods may be employed, however, the Shapiro-Wilk and Shapiro-Francia tests are generally considered the best method according to the Unified Guidance. The Shapiro-Wilk test is best for sample sizes under 50 while the Shapiro-Francia test is best with larger datasets of 50 or more observations. Most groundwater statistical software packages can complete both Shapiro-Wilk and Shapiro-Francia tests and a detailed discussion of the testing procedures is provided in Section *10.5.1* of the Unified Guidance.

Based on the outcome of the data distribution testing, data will use either Parametric or Non-parametric tests. It is important to note that non-parametric testing usually requires larger datasets in order to minimize the Site Wide False Positive Rate (SWFPR) therefore when the raw data are not normally distributed, a transformed-normal distribution is preferred when possible.

1.2.3 Temporal Trend

Most statistical tests assume that the sample data are statistically independent and identically distributed. Therefore, samples collected over a period of time should not exhibit a time dependence. A time dependence could include the presence of trends or cyclical patterns when observations are graphed on a time series plot. Trend analysis methodologies test to see whether the dataset displays an increasing, decreasing, or seasonal trend. A statistically significant increasing or decreasing trend could indicate a release from the CCR unit (or alternative source) and further investigation of the cause of the trend may be necessary.

If a trend is suspected, a Theil-Sen trend line should be used to estimate slope and the Mann-Kendall Trend Test should be used to evaluate the slope significance (Chapter 14, Unified Guidance). If a statistically significant trend is reported, based on a Sen's slope/Mann-Kendall trend test, the source of the trend should be investigated. If the trend can be shown to be a result of an upgradient or off-site source, the data can be de-trended and used to calculated statistical limits. De-trending can be accomplished by computing a linear regression on the data (see Section 17.3.1 of the Unified Guidance) and then using the regression residuals instead of the original measurements in subsequent statistical analysis.

1.2.4 Comparing Background Datasets (Spatial Variation)

After physical independence, outlier, trend, and summary statistical testing is completed, the datasets from the background monitoring wells should be compared to one another for each individual constituent. The comparison of these background datasets is useful for determining whether spatial variability exists in the background dataset, and can also be used to decide whether an interwell or intrawell approach is more appropriate for statistical evaluation.

Box and whisker plots can be used to perform side by side comparison for each well and can be completed for each individual analyte to determine if the variance is equal across the background datasets. If the box plots appear to be staggered and do not appear to be from the same population (same variance) then a Lavene's test using an α of 0.01 should be used as a check to determine if the background datasets have spatial variation. Testing methods and procedures are provided in Section 11.2 of the Unified Guidance.

The preferred method for comparing background datasets is a Mann-Whitney (or Wilcoxon Rank Sum) Test, which evaluates the ranked medians of both the historical and new dataset populations. An α of 0.05 should be used for this evaluation. After calculation, if the Mann-Whitney statistic does not exceed the critical point, the test assumes that the two data populations have equal medians, and therefore are likely from the same statistical distribution. The testing methods and procedures for this analysis are provided in Section 16.2 of the Unified Guidance.

If spatial variability is identified within the background dataset, an additional investigation may be needed in order to confirm that the variability is not caused by impacts from the CCR unit. If there is spatial variability and it is not caused by impacts from the CCR Unit, then an intrawell approach to statistical evaluation may be appropriate.

1.3 Compliance Monitoring Wells and Statistically Significant Increases

After completing the previously described analyses of the background data, a statistical evaluation of the compliance monitoring data should be completed to determine if there are any Statistically Significant Increases[3] (SSIs) that could trigger assessment monitoring. Section §257.93(F) of the CCR Rule specifies the list of methods that can be used for statistical evaluation. These specific methods to be used for statistical evaluation of data from the RMSGS are detailed below. Further, the Unified Guidance is recommended in the CCR Rule to be used for guidance in the selection of the appropriate statistical evaluation method. This section provides a guide to choosing the correct statistical evaluation to analyze the compliance wells for SSIs, the basic principles of each method, and response activities for identified SSIs.

[3] SSI = a verified statistical exceedance; under compliance monitoring programs, the first time an exceedance is reported it is an initial statistical exceedance and is only considered an SSI if a confirmatory result verifies the initial exceedance.

1.3.1 Interwell vs Intrawell Statistical Analysis

1.3.1.1 Interwell Statistical Analysis

An interwell statistical evaluation compares the groundwater results from the compliance (downgradient) monitoring wells to a pool of background (typically upgradient) monitoring well results. If results from the downgradient wells are statistically higher (or significant) than the background dataset then an exceedance is triggered. This upgradient verses downgradient method typically assumes that:

- Naturally, un-impacted groundwater characteristics in the compliance monitoring wells is comparable and equal on average to the background monitoring wells.
- Upgradient and downgradient monitoring well samples are drawn from the same aquifer and are screened in essentially the same hydrostratigraphic position.
- The aquifer unit is homogeneous and isotropic.
- Groundwater flow is in a definable pathway from upgradient to downgradient wells beneath the CCR Unit.

An interwell approach is preferable for statistical evaluation because it compares data to a background dataset that is not influenced by the CCR Unit. Interwell methods should be used with two exceptions: (1) there are significant differences in the datasets of the background wells (as indicated by methods described in Section 1.2.4) or (2) it can be demonstrated that groundwater geochemistry at all wells (background and compliance) is not impacted by the CCR Unit.

1.3.1.2 Intrawell Statistical Analysis

An intrawell statistical evaluation compares the groundwater results from a compliance monitoring well to historical data collected from that same compliance monitoring well. This method can be used for CCR monitoring when groundwater data from the background monitoring wells is statistically different than that of the compliance monitoring wells or when it can be shown that there is no impact from the CCR Unit in either upgradient or downgradient/compliance wells.

1.3.2 Statistical Power

As discussed above, one of the primary goals of the selection of a proper statistical evaluation method is to limit the potential for results to falsely trigger a SSI while also maintaining sufficient statistical power to detect a true SSI. Falsely triggering a SSI when no release from the CCR unit has occurred is referred to as a false positive. The False Positive Rate (FPR), typically denoted by the Greek letter α, is also known as the “significance level”. The FPR is the probability that a future compliance observation will be declared to be from a different statistical distribution than the background data. If the FPR is set too high, it can lead to the conclusion that there is evidence of impact when none exists. Conversely, if the FPR is set too low, it can lead to a false conclusion that no contamination exists, when it actually does exist (also known as a “false negative”). Ultimately, the ability to accurately identify SSIs depends on the selection of an appropriate FPR, which is referred to as the statistical power. FPRs are set for each parameter (or for each

parameter in each well for intrawell analysis). However, statistical analysis programs and the resulting decision making do not depend on each individual measurement/comparison error rates, but are dependent on the collective error rate from all of the individual comparisons. When the individual FPRs are integrated over the entire statistical monitoring program, it is referred to as the site-wide false positive rate (SWFPR), which is a better measure of the ability of the entire statistical program to detect false positive observations.

1.3.2.1 Site-Wide False Positive Rate

For CCR monitoring, detection monitoring events are based on multiple comparisons, which include the seven (7) Appendix III parameters, at each compliance monitoring well. The SWFPR can be calculated based on several input parameters, including the assumed FPR, the number of downgradient monitoring wells (n), the number of parameters, and the number of statistical comparisons events in a given year for the CCR Unit. The Unified Guidance recommends that a statistical evaluation program be designed with an annual, cumulative SWFPR of approximately 10%.

The Unified Guidance recommends measuring statistical power using power curves which display the probability that an individual comparison will detect a concentration increase relative to background results. After determining the statistical method based on the background data, a power curve can be generated in order to determine the statistical power of the compliance monitoring program. The methods and procedures for calculating the SWFPR are described in Section 6.2.2 of the Unified Guidance.

1.3.2.2 Verification Sampling

Verification Sampling is an important aspect of the SAP as it improves statistical power while maintaining the SWFPR. Most statistical evaluations incorporate verification sampling mathematically into their determination of the SWFPR. Verification sampling is typically completed at a 1 of 2 pass strategy. As described above if an initial statistical exceedance is reported, then verification sampling will be performed to confirm the initial exceedance. Verification samples should be collected on a schedule that allows for physical independence of the samples. In a 1 of 2 pass strategy, if the concentration of the verification sample is less than the calculated compliance limit, then no SSI is triggered. If the initial and subsequent verification observation are above the calculated compliance limit, a SSI is triggered.

Due to the time constraints for reporting put forth in the CCR rule, it is suggested that verification sampling not be completed at the next regularly scheduled sampling event, but instead be collected prior to the next sampling event. Verification sampling within 90 days (assuming a 1 of 2 pass verification sampling strategy) will typically allow sufficient time to complete laboratory and statistical analysis in accordance with the timeframes set forth in the CCR Rules.

1.3.3 Statistical Evaluation Methods

As outlined above, the CCR rule list 5 possible methods for statistical evaluation. The different methods that can be employed for CCR monitoring as outlined in §257.93(F) are:

- ***§257.93(F)(1)*** *"A parametric analysis of variance followed by multiple comparison procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's mean and the background mean levels for each constituent."*
- ***§257.93(F)(2)*** *"An analysis of variance based on ranks followed by multiple comparison procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's median and the background median levels for each constituent."*
- ***§257.93(F)(3)*** *"A tolerance or prediction interval procedure, in which an interval for each constituent is established from the distribution of the background data and the level of each constituent in each compliance well is compared to the upper tolerance or prediction limit."*
- ***§257.93(F)(4)*** *"A control chart approach that gives control limits for each constituent."*
- ***§257.93(F)(5)*** *"Another statistical test method that meets the performance standards of paragraph (g) of this section."*

1.3.4 Prediction Intervals

Section §257.93(F)(3) outlines using prediction intervals or tolerance intervals for statistical evaluation. Based on recommendation from the Unified Guidance, prediction limits are the preferred method for calculating detection monitoring compliance limits and will be used to calculate compliance limits for the seven Appendix III constituents. In addition, the Unified Guidance suggests using prediction limits with verification sampling (Chapter 19 of the Unified Guidance), because prediction limits help to maintain low SWFPR while still providing high statistical power. Tolerance intervals, which are a backward looking procedure, should not be used for detection monitoring, but will likely be used in assessment monitoring, as further described in Section 2.0 below. If, at any point in the future, a different statistical method becomes more applicable to the site conditions, this document may be modified to include that method as recommended by the Unified Guidance.

Prediction interval methods can be used for parametric and non-parametric datasets as well as for intrawell or interwell statistical analysis. Prediction limits use background data from either background monitoring wells for interwell analysis or from historical data for intrawell analysis calculate a concentration that represents an upper limit of expected future concentrations for a particular population. In contrast to tolerance limits, prediction intervals are a forward looking, predictive analysis, which incorporate uncertainty in future measurements, and are thus the most appropriate method for detection monitoring programs. Typically, a one-sided upper prediction limit is used to evaluate detection monitoring observations. Observations must be lower than the prediction limit (or within the upper and lower prediction limits for pH) to be considered "in control". Parametric methods are generally preferred over non-parametric methods, because they result in lower SWFPRs and higher statistical power.

For detection monitoring, if parametric testing is required, the procedures outlined in Section 19.3.1 of the Unified Guidance should be used to calculate prediction limits for the statistical analysis. If non-parametric testing is required, the procedures outlined in Section 19.4.1 of the Unified Guidance should be used to calculate prediction limits. Most groundwater statistical software includes algorithms for calculating either parametric or non-parametric prediction limits.

1.3.5 Double Quantification Rule

In situations where the entire background dataset is reported as ND or Estimated (J-flag), the Double Quantification Rule (DQR) will be used to supplement the prediction limit analyses. Generally, the Appendix III constituents occur at detectable concentrations in natural groundwater; however, if ND results are encountered for a given constituent, the DQR can be implemented. A demonstration that this statistical evaluation is as least as effective as any other test and results as described in §257.93(f)(5) can be made. The DQR is recommended by the Unified Guidance as a supplement to prediction limits because it reduces the number of non-detects used for statistical analysis and provides a lower SWFPR while maintaining statistical power.

Under the DQR, a SSI is triggered if a compliance well observation is higher than the reporting limit (RL)/PQL in either (1) both a detection monitoring sample and its verification resample, or (2) two consecutive sampling events in a program were resampling is not utilized.

1.4 Responding to SSIs

If the statistical evaluation for an Appendix III analyte triggers a SSI, the data must be evaluated to determine if the cause of the SSI is due to a release from the CCR Unit or from an alternative source. Possible alternative sources may include laboratory causes, sampling causes, statistical evaluation causes, or natural variation. If the SSI can be attributed to one of these sources and the SSI was not caused by the CCR Unit, an alternate source demonstration (ASD) can be completed. An ASD must be certified by a qualified professional engineer and completed in writing within 90 days of completing the statistical evaluation for a particular sampling event. If the SSI cannot be attributed to an alternative source and is from the CCR Unit, then Assessment Monitoring is triggered.

1.5 Updating Background Values

The Unified Guidance suggests that updating statistical limits should only be completed after a minimum of 4 to 8 new measurements are available (i.e., every 2 to 4 years of semiannual monitoring, assuming no verification sampling). The periodic update of background, during which additional data are incorporated into the background, improves statistical power and accuracy by providing a more conservative estimate of the true background population. Prior to incorporating new data into the background dataset, a test should be performed to demonstrate that the “new data” are from the same statistical population as the existing

background results. Below are three methods that can be used in determining if the "new" data should be included in the background:

- Time Series Graphs – As described in Section 1.1.2.1, time series graphs can be used as a qualitative test to assist with the determination whether a new group of data match the historical data or if there is a concentration trend that could be indicative of a release or evolving groundwater conditions.
- Box-Whisker plots can also be used to determine whether or not the datasets are similar.
- Mann-Whitney (or Wilcoxon Rank) Test – Used to evaluate the ranked medians of both the historical and new dataset populations. An α of 0.05 should be used for this evaluation. After calculation, if the Mann-Whitney statistic does not exceed the critical point, the test assumes that the two data populations have equal medians, and therefore are likely similar.

Ultimately, the Mann-Whitney (Wilcoxon Rank Sum) Test is the statistical test that is used to determine whether new observations should be included in the background dataset. It is important to note that a difference in background datasets does not automatically prevent the new data from being used; however, if differences are noted, a review of the new data will be conducted to determine if the noted difference is a result of a change in the natural conditions of the groundwater or if it is the result of a potential release from the CCR Unit. If the new data are included in the background dataset, the prediction limits will be recalculated, as described in Section 1.3.4 above.

2.0 ASSESSMENT MONITORING STATISTICAL EVALUATION

This section discusses the procedures, methods, and processes that will be implemented as part of the assessment monitoring statistical evaluation, if required. Assessment monitoring will be initiated if a SSI is triggered during detection monitoring. As per the CCR Rule in Section §257.95(b), assessment monitoring must be initiated within 90 days of identifying an SSI (not the sample event which provided the data that resulted in the SSI). This 90-day period includes sampling the groundwater monitoring network for the Appendix IV constituents. Following the initial sampling event for all Appendix IV constituents, the monitoring network is then sampled again within 90 days of receiving the results from the initial Appendix IV sampling event. Following these initial assessment monitoring events, assessment monitoring is performed on a semiannual basis. During one of the two semiannual events, the full list of Appendix IV constituents must be tested. During the second assessment monitoring event of each year, only the Appendix IV constituents that are detected during the previous semiannual event are required to be monitored. Assessment monitoring is terminated if concentrations for all Appendix III and Appendix IV constituents in all compliance wells are statistically lower than background for two consecutive sampling events (§257.95(e)). The following sections discuss the procedures, methods, and processes that will be implemented as part of the assessment monitoring statistical evaluation. As discussed in Section 1.1 of this document, many of the statistical comparisons used in assessment monitoring require various analyses to be completed prior to the data being accepted into the statistical evaluation. Before using the results from assessment monitoring, the steps outlined in Sections 1.1 and 1.2 will be completed. Please refer to those sections for descriptions on the methods and techniques required to complete these analyses.

2.1 Establishing a Ground Water Protection Standard (GWPS)

Following the removal of outliers and the performance of general statistics described in Sections 1.1 and 1.2, GWPS will be developed for use in the assessment monitoring program. The GWPS is a key element to the assessment monitoring process. GWPS must be generated for each of the detected Appendix IV analytes. If interwell methods are utilized (preferred method), a site-wide GWPS will be generated for each analyte based on Appendix IV results reported for background/hydraulically upgradient wells. If intrawell methods are utilized, a well specific GWPS will be generated for each analyte.

For Appendix IV parameters that have a maximum contaminant level (MCL), as established by the United States Environmental Protection Agency, the GWPS is set equal to the MCL. For those constituents whose background concentration are greater than the MCL, the GWPS will be calculated from the background data. Finally, for those constituents that do not have an established MCL, the GWPS will be calculated. Several analytes (cobalt, lead, lithium, and molybdenum) do not have MCLs established and therefore the GWPS must be calculated based on their background concentrations.

2.1.1 Maximum Contaminant Level (MCL) Based GWPS

Many of the Appendix IV analytes have USEPA MCL levels. As specified in the CCR Rule in Section §257.95(b), the GWPS must either be the MCL, or a limit based on background data, whichever is greater. This section describes the methods to be used for statistical analysis when the MCL is to be used as the GWPS.

For Assessment Monitoring, the Unified Guidance recommends the confidence interval method to evaluate for potential exceedances, which are referred to as "statistically significant levels" (SSLs) (Chapter 21, Unified Guidance). Using confidence intervals, SSLs are identified by comparing the calculated confidence interval against the GWPS. A confidence interval statistically defines the upper and lower bounds of a specified population within a stipulated level of significance. Confidence intervals are required to be calculated based on a minimum of 4 independent observations, but a more representative confidence interval can be developed when all of the available data are utilized.

The specific type of confidence interval should be based the attributes of the data being analyzed, including: (1) the data distribution, (2) the detection frequency, and (3) potential trends in the data. Table 1 below is based on Table 4-4 from the Electric Power Research Institute's *Groundwater Monitoring Guidance for the Coal Combustion Residual Rule* (2015), which displays the criteria for selecting an appropriate confidence interval. The method and procedure for calculating the Upper Confidence Limit (UCL) and Lower Confidence Limit (LCL) is provided in the section reference from the Unified Guidance, which is listed in the last column of Table 1, below.

Table 2- Confidence Interval Method Selection

Data Distribution	Non-detect Frequency	Data Trend	Confidence Interval Method
Normal	Low	Stable	Confidence Interval Around Normal Mean (Section 21.1.1)
Transformed Normal (Log-Normal)	Low	Stable	Confidence Interval Around Lognormal Arithmetic Mean (Section 21.1.3)
Non-normal	N/A	Stable	Nonparametric Confidence Interval Around Median (Section 21.2)
Cannot Be Determined	High	Stable	Nonparametric Confidence Interval Around Median (Section 21.2)
Residuals After Subtracting Trend are Normal (with equal variance)	Low	Trend	Confidence Band Around Linear Regression (Section 21.3.1)
Residuals after Subtracting Trend are Non-Normal	Low	Trend	Confidence Band Around Theil-Sen Line (Section 21.3.2)

In an assessment monitoring program the LCL is of prime interest. If the LCL exceeds the GWPS, there is statistical evidence that a SSL has been triggered. An initial SSL should be confirmed by verification sampling. If only the UCL exceeds the GWPS while the LCL is below the GWPS, the test is considered inconclusive and the Unified Guidance recommends that this situation be interpreted as ”in compliance”. If both the UCL and the LCL are below the GPWS, the data are also “in compliance” with the GWPS.

It is important to note that a slightly different set of criteria are used to determine whether assessment monitoring can be terminated. Additional discussion of the criteria used for exiting assessment monitoring and returning to detection monitoring is provided below in Section 2.2.

During Assessment Monitoring, a per test FPR (α) of 0.05 will be used as an initial error level for calculating the two-tailed confidence intervals for the compliance wells (which actually means 2.5% FPR per tail). In some cases based on recommendations from the Unified Guidance, it is appropriate to adjust the FPR of the confidence interval based on the number of data points available as well as the distribution of the data being evaluated. If deemed necessary based on recommendations from the Unified Guidance, an approach is provided in Section 22 of the Unified Guidance for determining an appropriate per test FPR based on the data characteristics.

When performing assessment monitoring statistical evaluations, it is important to evaluate the compliance data for shifts. If no shifts have occurred, then all of the available Appendix IV data for a particular constituent can be used in the statistical evaluation. If shifts are noted (typically based on qualitative evaluation of a time series plot), only the data collected after the shift should be used in the statistical evaluation.

2.1.2 Non-MCL Based GWPS

Background or historical concentration limits should be assessed using the following techniques for all Appendix IV analytes. These concentration limits should then be compared with the MCL, if available, and the higher of these two values will be used as the GWPS.

The Unified Guidance provides two acceptable approaches for establishing a non-MCL based GWPS (unless all values are ND, in which case the Double Quantification Rule as described above in Section 1.3.5 should be used). The two methods include the tolerance interval approach or the prediction interval approach.

2.1.2.1 Tolerance Interval Approach

If the background dataset is normally or transformed normally distributed, the Unified Guidance recommends Tolerance Intervals over the Prediction Intervals for establishing a GWPS. The GWPS should be based on a 95 percent coverage/95 percent confidence tolerance interval. If the background data are non-normal (even after transformation), then a large number of background observations are required to calculate a non-parametric tolerance interval (typically a minimum of 60 background observations are required to meet these requirements). If there is an insufficient number of background observations to calculate a non-parametric tolerance interval, then a non-parametric Prediction Interval approach should be used, as described in Section 2.1.2.2 below.

The Upper Tolerance Limit (UTL) is calculated for each detected Appendix VI constituent. Tolerance Limits, as outlined in the Unified Guidance (Section 17.2), are a concentration limit that is designed to contain a pre-specified percentage of the dataset population. Two coefficients associated tolerance intervals are (1) the specified population proportion and (2) the statistical confidence. The coverage coefficient (γ), which is used to contain the population portion, and the tolerance coefficient (or confidence level ($1-\alpha$)), which is used to set the confidence of the test. Typically, the UTL is calculated to have a coverage and confidence of 95%. When an MCL does not exist or the background concentrations are greater than the MCL, the calculated UTL for each constituent is used as the GWPS. The confidence interval for each compliance well is then compared with the GWPS.

In order to calculate a valid confidence interval, a minimum of four data points are necessary for each of the detected Appendix IV constituents in each compliance monitoring well (or four “new” assessment

monitoring observations in each well when intrawell statistical methods are employed). Using the Tolerance Interval Approach, a statistically significant level (SSL) is triggered when calculated lower confidence limit (LCL) for each compliance well is greater than the GWPS.

Tolerance limits can be completed using both parametric (Section 17.2.1 of Unified Guidance) or non-parametric methods (Section 17.2.2 of Unified Guidance). However, as described above, the non-parametric method requires at least 60 background (or historical) measurements in order to achieve 95% confidence with 95% coverage. Tolerance Intervals can be calculated using most groundwater statistical software packages.

2.1.2.2 Prediction Interval Approach

If Tolerance Intervals cannot be used to calculate the GWPS (based on recommendation from the Unified Guidance, such as non-parametric datasets, ect.), then a Prediction Interval method should be used. This method is very similar to Section 1.3.4 of this document, however, for assessment monitoring, the Unified Guidance suggests using a prediction interval about a future mean for normally/transfomred-normally distributed datasets or a prediction interval about a future median for datasets with a high percent of ND or non-normally distributed data.

When using prediction intervals to calculate for a GWPS, a one-sided prediction interval is calculated using background (or historical) datasets based on a specified number of future comparisons - four future comparisons is typical. The Upper Prediction Limit that is calculated as a product of this method then becomes the GWPS, and is compared against the confidence interval for the compliance data, as described in Section 2.1.2.1, above. As also described above, if the LCL is greater than the calculated prediction limit then an SSL is triggered.

2.2 Returning to Background Detection Monitoring

As specified in 257.95(e) of the CCR Rule, in order to return to detection monitoring, the concentration of all constituents listed in Appendix III and Appendix IV must be shown to be at or below calculated "background (or historical) values" for two consecutive semiannual sampling events. This determination of background values is based on the statistical evaluation procedure established for detection monitoring. Therefore, if prediction limits (with the double quantification rule for analytes with all non-detects) are used for detection monitoring, prediction limits should be calculated and used for all Appendix III and IV analytes to determine when the monitoring program can return to Detection Monitoring. It is important to remember that Appendix IV constituents are only required to be sampled annually with only those Appendix IV constituents that are detected during the previous semiannual event being required to be analyzed during the second semiannual event of a given year. If statistical results demonstrate that concentrations for all constituents are below background levels for a particular event, all Appendix IV constituents should be sampled during the next event in order to achieve this goal of returning to Detection Monitoring. If this

statistical evaluation demonstrates that any of the Appendix III or Appendix IV are at a concentration above background levels, but no SSLs have been triggered, then the CCR unit will remain in assessment monitoring (257.95(f)).

2.3 Response to a SSL

If the assessment monitoring statistical evaluation demonstrates that a SSL has been triggered, then the owner/operator of the CCR unit must complete the following four actions as described in 257.95(g):

1. Prepare a notification identifying the constituents in Appendix IV that have exceeded a CCR Unit specific GWPS. This notification must be placed in the facilities operating record within 30 days of identifying the SSL
2. Define the nature and extent of the release and any relevant site conditions that may affect the corrective action remedy that is ultimately selected. The characterization must be sufficient to support a complete and accurate assessment of the corrective measures necessary to effectively clean up releases from the CCR Unit and must include at least the following;
    A. Installation of additional monitoring wells that are necessary to define the contaminant plume,
    B. Collect data on the nature and estimated quantity of the material released,
    C. Install and sample at least one additional monitoring well at the facility boundary in the direction of the contaminant plume migration,
3. Notify off-site property owners if the contamination plume has migrated offsite on to their property, and
4. If possible, provide an alternative source demonstration that determines that the SSL is not caused by a release at the facility within 90 days of completing the statistical evaluation. If no alternative source demonstration can be made and the plume is determined to have come from the CCR Unit then initiate corrective action.

Actions 1-3 must be completed regardless of whether or not an alternate source demonstration can be made.

2.4 Updating Background Values

The background for Assessment Monitoring Parameters should be updated using the same methods and techniques described in Section 1.5 for updating detection monitoring background data.

3.0 REFERENCES

EPRI. 2015. Groundwater Monitoring Guidance for the Coal Combustion Residual Rule. Electric Power Research Institute. November.

USEPA. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. Office of Resource Conservation and Recovery – Program Implementation and Information Division. March

USEPA. 2015. Federal Register. Volume 80. No. 74. Friday April 17, 2015. Part II. Environmental Protection Agency. 40 CFR Parts 257 and 261. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule/ [EPA-HQ-RCRA-2009-0640; FRL-9919-44-OSWER]. RIN-2050-AE81. April.

APPENDIX I
Example Field Forms

Golder Associates

WELL DEVELOPMENT/PURGING FORM

Project Ref: ____________________ **Project No.:** ____________________

Location

Monitored By: Date Time

Well Piezometer Data

(*circle one*)

Depth of Well (from top of PVC or ground) feet

Depth of Water (from top of PVC or ground) feet

Radius of Casing inches / feet

Casing Volume cubic feet / gallons

Development / Purging Discharge Data

Purging Method

Start Purging Date Time

Stop Purging Date Time

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft TOC)	Appearance of Water and Comments

GROUNDWATER SAMPLE COLLECTION FORM

Project Ref: __ _____ **Project No. :**_____

WEATHER CONDITIONS

Temperature _____ Weather _____

SAMPLE INFORMATION

Sample Location _____ Sample No. _____

Sample Date _____ Time _____ Sample By_____

Sample Method _____ Sample Type_____

Water Level Before Purging: _____

Well Volume: _____

Volume Water Removed Before Sampling: _____

Water Level Before Sampling: _____

Water Level After Sampling: _____

Appearance of Sample: _____

FIELD MEASUREMENTS

Parameter	Units	Measurement	Measurement	Measurement	Measurement	Sample
Time	hhmm					
Volume Discharge	gals					
pH	Standard					
Spec. Cond.	___S/CM					
Turbidity	NTU					
Temperature	°___					
Dissolved Oxygen	mg/l					
Redox Potential	+/- mV					

LABORATORY CONTAINERS

Sub-Sample	Analysis Requested	Type and Size of Sample Container	Filtered (Yes or No)	Type of Preservative
1				
2				
3				
4				
5				
6				
7				
8				

REMARKS: _____

NA = Not applicable

SAMPLING METHODS:

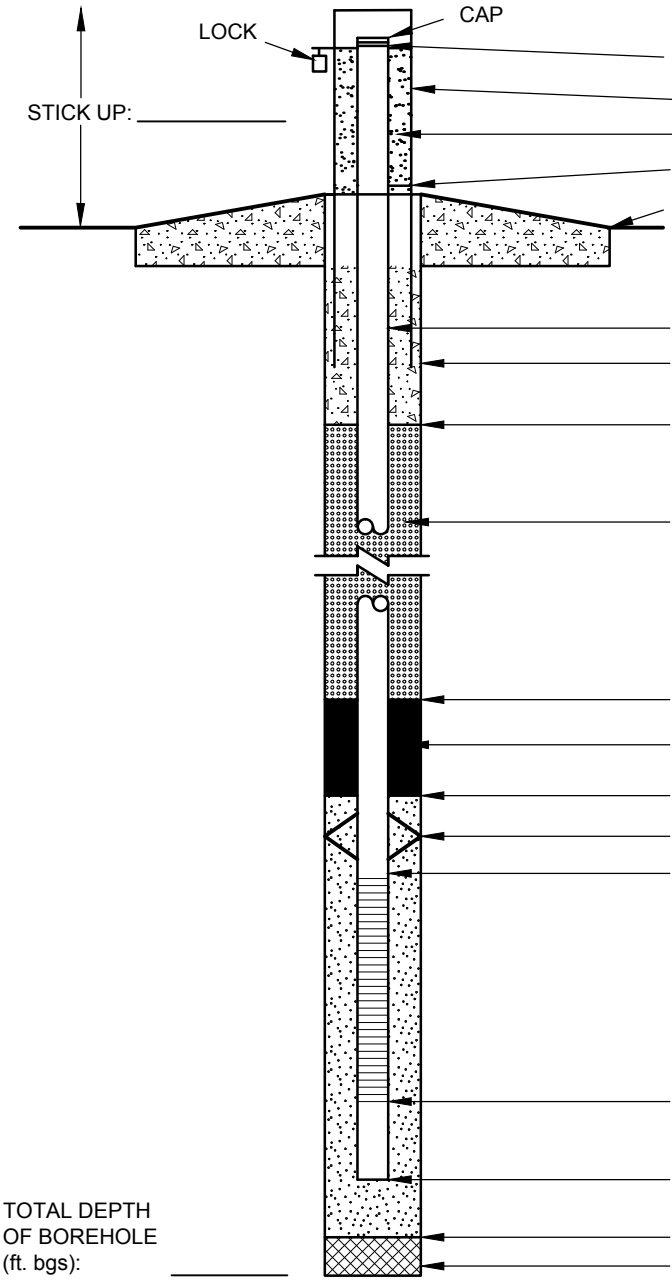
Bailer: PVC/PE Peristaltic Pump Air-Lift Pump

Stainless Steel Submersible Pump Other_____

Teflon Hand Pump

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG _____

PROJECT NAME:	PROJECT NUMBER:	
SITE NAME:	LOCATION:	
CLIENT:	SURFACE ELEVATION:	
GEOLOGIST:	NORTHING:	EASTING:
DRILLER:	STATIC WATER LEVEL:	COMPLETION DATE:
DRILLING COMPANY:	DRILLING METHODS:	



TOP OF CASING ELEVATION: _____

PROTECTIVE CASING (yes □no): _____

PEA GRAVEL OR SAND

WEEP HOLE

GROUND SURFACE ELEVATION: _____

DIAMETER OF RISER PIPE (in.): _____

DIAMETER OF BOREHOLE (in.): _____

CONCRETE SEAL DEPTH (ft. bgs): _____

TYPE AND AMOUNT OF ANNULAR SEAL: _____

TOP OF BENTONITE SEAL DEPTH (ft. bgs): _____

TYPE AND AMOUNT OF BENTONITE SEAL: _____

TOP OF SAND PACK DEPTH (ft. bgs): _____

CENTRALIZER (yes □no) - TYPE: _____

TOP OF SCREEN DEPTH (ft. bgs): _____

TYPE OF SCREEN: _____

SCREEN SLOT SIZE (in.): _____

SIZE OF SAND PACK: _____

AMOUNT OF SAND: _____

BOTTOM OF SCREEN DEPTH (ft. bgs): _____

BOTTOM OF WELL DEPTH (ft. bgs): _____

BOTTOM OF FILTER PACK (ft. bgs): _____

TYPE AND AMOUNT OF BACKFILL: _____

ADDITIONAL NOTES: _____

CHECKED BY: _____

DATE CHECKED: _____

PREPARED BY: _____

RECORD OF WATER LEVEL READINGS

Project Name: _____ **Location:** _____ **Project No.:** _____

Borehole No.	Date	Time	Measuring Device / Serial No.	Measurement Point (M.P)	Water Level Below M.P.	Correction To Survey Mark	Survey Mark Elevation	Water Level Elevation	By	Comments

Sheet ___ of ___

INSTRUMENT CALIBRATION FORM

Project Name: _____ **Project No:** _____

Calibration By: _____

Instrument Details

Instrument Name	
Serial No.	
Model No.	

Calibration Details

Required Calibration Frequency/Last Calibration	
Calibration Standard	
Calibration Standard(s) Expiration Date	

Calibration:

Date	Time	**Calibration Standard** Units: _____	**Instrument Reading** Units: _____

Comments:

>>> Select a Laboratory <<<

#N/A
#N/A
#N/A
#N/A

Chain of Custody Record

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

Client Contact	**Project Manager:**	**Site Contact:**	**Date:**	COC No:
Your Company Name here	**Tel/Fax:**	**Lab Contact:**	**Carrier:**	_____ of _____ COCs
Address	**Analysis Turnaround Time**			Sampler:
City/State/Zip	☐ CALENDAR DAYS ☐ WORKING DAYS			**For Lab Use Only:**
(xxx) xxx-xxxx Phone	TAT if different from Below _____			Walk-in Client:
(xxx) xxx-xxxx FAX	☐ 2 weeks			Lab Sampling:
Project Name:	☐ 1 week			
Site:	☐ 2 days			Job / SDG No.:
P O #	☐ 1 day			

Sample Identification	**Sample Date**	**Sample Time**	**Sample Type (C=Comp, G=Grab)**	**Matrix**	**# of Cont.**	**Filtered Sample (Y / N)**	**Perform MS / MSD (Y / N)**															Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H_2SO_4; 4=HNO_3; 5=NaOH; 6= Other _____

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return to Client ☐ Disposal by Lab ☐ Archive for_____ Months

Special Instructions/QC Requirements & Comments:

Custody Seals Intact: ☐ Yes ☐ No | Custody Seal No.: | Cooler Temp. (°C): Obs'd:_____ Corr'd:_____ Therm ID No.:_____

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

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Field Boring Log

DEPTH HOLE _____ **PROJ. NO.** _____ **PROJECT** _____ **BORING NO.** _____

DEPTH SOIL DRILL _____ **GA INSP.** _____ **DRILLING METHOD** _____ **SHEET** _____ **OF** _____

DEPTH ROCK CORE _____ **WEATHER** _____ **DRILLING COMPANY** _____ **SURFACE ELEV.** _____

ABANDONMENT _____ **DRILL RIG** _____ **DRILLER** _____ **DATUM** _____

DEPTHS _____/_____/_____/_____ **SAMPLER HAMMER TYPE** _____ **WT.** _____ **DROP** _____ **STARTED** _____/_____
WATER LEVEL CAVE-IN DATE-TIME NOTE TIME DATE

DEPTHS _____/_____/_____/_____ **HOLE LOCATION** _____ **COMPLETED** _____/_____
(DELAYED) WATER LEVEL CAVE-IN DATE-TIME NOTE TIME DATE

SAMPLE TYPES

	A.S.	AUGER SAMPLE
	C.S.	CHUNK SAMPLE
*	D.O.	DRIVE OPEN (SPT)
	D.S.	DENISON SAMPLE
	F.S.	FOIL SAMPLE
	P.S.	PITCHER SAMPLE
	S.C.	SOIL CORE
*	T.O.	THIN-WALLED, OPEN
*	T.P.	THIN-WALLED, PISTON
	W.S.	WASH SAMPLE
*	____	_____
*	____	_____
*	____	_____

* NOTE SIZE

ABBREVIATIONS

ANG	ANGULAR	GR	GRAY	R	RED
BL	BLACK	HE	HETEROGENEOUS	RES	RESIDUAL
BR	BROWN	HO	HOMOGENEOUS	RX	ROCK
C	COARSE	LYD	LAYERED	RND	ROUNDED
CIN	CAVE-IN	M	MEDIUM	SAT	SATURATED
CO	COHESIVE	MIC	MICACEOUS	SD	SAND
CL	CLAY	MOT	MOTTLED	SI	SILT
CLY	CLAYEY	MST	MOIST	SIY	SILTY
D	DRY	NC	NON-COHESIVE	SM	SOME
EL	ELONGATED	NP	NON-PLASTIC	TR	TRACE
F	FINE	OG	ORANGE	WL	WATER LEVEL
FL	FLAT	ORG	ORGANIC	WH	WEIGHT OF HAMMER
FRAG	FRAGMENTS	PP	POCKET PEN.	WR	WEIGHT OF RODS
GL	GRAVEL	PL	PLASTIC LIMIT	Y	YELLOW

ORDER OF DESCRIPTION

CONSTITUENTS
1) GROUP SYMBOL
2) SOIL GROUP NAME
3) PRIMARY COMPONENTS
4) SECONDARY COMPONENTS
5) MINOR COMPONENTS;

PLUS DESCRIPTION:
CL/SI: PLASTICITY
SD: SIZE, GRADING
GL: SIZE, GRADING, SHAPE, ROCK TYPE

GENERAL
6) COLOR
7) WEATHERING
8) STRUCTURE
9) SENSITIVITY
10) CONTAMINATION
11) MINEROLOGY
12) ORIGIN;

BEHAVIOR
13) BEHAVIOR (CO/NC)
14) MOISTURE/WATER CONTENT
15) DENSITY/CONSISTENCY

PROPORTIONS

"TRACE"	0 – 5%
"SOME"	5 – 12%
PREFIX "-Y"	12 – 35%
"AND"	35 – 50%

NON-COHESIVE SOILS

RELATIVE DENSITY		BLOWS
VERY LOOSE	VLS	0 – 4
LOOSE	LS	4 – 10
COMPACT	CP	10 – 30
DENSE	DN	30 – 50
VERY DENSE	VDN	>50

MOISTURE CONDITION

DRY	SOIL FLOWS
MOIST	FEELS COOL
WET	WITH FREE WATER

COHESIVE SOILS

CONSISTENCY		PP(TSF)	FINGER PRESSURE
VERY SOFT	VS	<0.25	EXTRUDES
SOFT	S	0.25 - 0.5	MOLDS EASILY
FIRM	FM	0.5 – 1	MOLDS
STIFF	ST	1 – 2	THUMB INDENTS
VERY STIFF	VST	2 – 4	THUMBNAIL INDENTS
HARD	H	>4	RESISTS THUMBNAIL

WATER CONTENT - W

W < PL	CANNOT ROLL 4 mm THREAD
W ~ PL	CAN ROLL THREAD 2 – 4 mm
W > PL	CAN ROLL THREAD <2 mm

ELEV. / DEPTH	LITHOLOGY	SAMPLES NO.	TYPE	DEPTH	SPT N / PP(TSF)	BLOWS PER 6 IN	REC / ATT	CONSTITUENTS GL	SD	CL/SI (PROPORTION; SIZE, SHAPE, GRADING; PLASTICITY)	BEHAVIOR CO or NC	MOIST. or W	DENS./ CONS.	USCS	SAMPLE DESCRIPTION AND DRILLING NOTES

Dec 2012

Golder Associates

Established in 1960, Golder Associates is a global, employee-owned organization that helps clients find sustainable solutions to the challenges of finite resources, energy and water supply and management, waste management, urbanization, and climate change. We provide a wide range of independent consulting, design, and construction services in our specialist areas of earth, environment, and energy. By building strong relationships and meeting the needs of clients, our people have created one of the most trusted professional services organizations in the world.

Africa	+ 27 11 254 4800
Asia	+ 852 2562 3658
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
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