ATTACHMENT 44
Groundwater Monitoring Plan
Special Waste Landfill Permit
Big Sandy Plant – Ash Pond Closure
Lawrence County, Kentucky

A Groundwater Monitoring Plan meeting the requirements of 401 KAR 45:110 and KAR 45:160, was created based on the findings in the ***Hydrogeological Site Investigation (HSI)*** in **Attachment 39**. A network of seven monitoring wells installed in 2012 and five previously existing wells were used as part of the HSI (**Attachment 30**).

REPORT
Groundwater Monitoring Plan

AEP BIG SANDY
HORSEFORD CREEK

Prepared for:

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1.0 INTRODUCTION

This groundwater monitoring plan (GMP) serves as the controlling document for the site closure groundwater monitoring program at the Horseford Creek site (referred to as the Site) near Louisa, Kentucky (Figure 1).

1.1 Plan Objectives

The purpose of the GMP is to establish the procedures for groundwater monitoring of the site during and after closure.

1.2 Plan Elements

This plan provides the Site background, schedule, sampling and laboratory methods, data evaluation procedures necessary to effectively monitor groundwater conditions, and the procedures to implement corrective action should an exceedance occur. The plan is divided into five sections and two appendices, as follows:

1. **INTRODUCTION** – Defines plan objectives.

2. **BACKGROUND** – Summarizes the facility descriptions and physical setting of the site based on previous investigations.
   References Appendix A – Existing Data: Existing Boring Logs and Well Construction.

3. **GROUNDWATER MONITORING PROGRAM** – Identifies the monitoring system and the proposed monitoring parameters.
   References Appendix B – Sampling and Analysis Plan and Quality Assurance Project Plan (SAP/QAPP).

4. **DATA EVALUATION, GROUNDWATER ASSESSMENT, AND CORRECTIVE ACTION** – Describes the methods to be used to evaluate data significance, to assess potential impact, and to prepare for corrective action.

5. **REFERENCES** – Lists references cited.

2.0 BACKGROUND

2.1 Facility Description

The Horseford Creek site is located approximately 3,000 feet west of the Big Sandy power plant entrance as illustrated in Figure 1. The site is a reservoir created by a dam across the Horseford Creek valley and is generally bounded by hillsides located on the north, west, and

south sides. Horseford Creek, prior to construction of the reservoir, occupied the center of the valley flowing generally southeast then east before turning north and draining to Blaine Creek (Figure 2).

Disposal of coal combustion products (CCPs) (including fly ash and bottom ash) sluiced from the Big Sandy power station began in 1970. The reservoir, as currently configured, occupies approximately 130 acres of the Site between approximately 670 and 685 feet above mean sea level (msl), and consists of approximately 30 acres of open water and 100 acres of exposed or vegetated ash deposits.

The property surrounding the Site is owned by Kentucky Power Company (KPC), a subsidiary of American Electric Power, Co., Inc. (AEP). The property is generally undeveloped with the exception of dirt or gravel access roads. Nearby facilities include an asphalt manufacturing facility located south of the site in the adjacent Burke Branch valley, and the Big Sandy power plant located roughly 3,000 feet to the southeast of the east edge of the reservoir.

2.2 Previous Investigations

The earliest identified investigation of the Site was a siting study consisting primarily of site reconnaissance and geotechnical borings performed for AEP in 2005 by Fuller Mossbarger Scott and May Engineers (FMSM). Additional investigation was completed between 2010 and 2011 by Geosyntec resulting in a Feasibility Evaluation Technical Memorandum provided to AEP on April 4, 2011.

The first permanent groundwater wells at the Site were MW-1007 through MW-1011, installed by AEP in 2010. Seven more groundwater wells (MW-1201 through MW-1207) were installed by URS Corporation (URS) on behalf of AEP in 2012. Groundwater samples from the monitoring wells were submitted for a suite of analyses including the parameters set forth in 401 Kentucky Administrative Regulation (KAR) 45:160 Section 7 (2). This regulation lists the parameters to be monitored to establish the baseline conditions “for special waste landfills used solely for coal combustion by-products.”

2.3 Physical Setting

The Site is mapped within the Cumberland Plateau section of the Appalachian Plateaus physiographic province (Davis, 1924). The Cumberland Plateau is described as an area of intricately dissected rocks of Pennsylvanian age in eastern Kentucky bounded to the west by the

Pottsville (or Cumberland) Escarpment formed by resistant beds of sandstone and conglomerate in the lower part of the Pennsylvanian strata. The mountain slopes are carved by ravines eroded through thick, flat-lying sequences of (Pennsylvanian age) coal-bearing units.

According to United States Geological Survey [USGS] (Lloyd and Lyke, 1995), the average mean air temperature for the site vicinity is approximately 55 degrees Fahrenheit (°F) with the warmest month generally occurring in July (average high mid to upper 80s) and the coolest month generally occurring in January (average highs in the low to mid 40s). The average annual precipitation is approximately 44 inches with monthly totals averaging between a low of approximately 3.0 inches in October and January to a high of approximately 5.5 inches in July.

2.4 Geological Setting

The Site is mapped within the Kentucky Geological Survey (KGS) geologic quadrangle map for Fallsburg, Kentucky-West Virginia (GQ-584). The regional geology consists of relatively flat-lying, Pennsylvanian-age bedrock underlying the upland areas, with relatively thin deposits of Quaternary-age alluvium typically consisting of unconsolidated deposits of silt, sand, and gravel filling in portions of the deeper stream valleys up to 50 feet thick (Lloyd and Lyke, 1995). A relatively thin layer of residual soils generally consisting of clay derived from the weathering of underlying bedrock is typically present at higher elevations. Within the confines of the site exists siltstones, sandstones, shales, and coal measures of the Monongahela, Conemaugh, and Breathitt formations, which comprise the bedrock stratigraphy.

The Monongahela is present at elevations generally greater than 910 feet, msl. This formation is underlain by the Conemaugh to an approximate elevation of 700 feet, msl with the Breathitt occupying elevations below this interval. A cross-section incorporating information from the KGS geologic quadrangle map with lithologic information derived from onsite borings is provided as Figure 3.

2.5 Hydrogeological Setting

The primary source of groundwater in the region is identified as the Appalachian Plateaus aquifer system (Lloyd and Lyke, 1995). The lithology of this aquifer is described as primarily shale associated with the Conemaugh Formation grading with increasing occurrences of sandstone, siltstone, and some coal measures associated with the Breathitt Formation. Groundwater within this Pennsylvanian aquifer is primarily stored within fractures recharged by precipitation. Coal seam underclays and other low permeability lithologic units may serve as

barriers to downward migration of groundwater. As a result, groundwater in the area will travel laterally on top of these units until commonly expressed as groundwater-fed streams, springs, and seeps at locations where these lower permeability lithologic units occur at or near the ground surface.

Uppermost groundwater at the Site is typically encountered relatively near the ground surface (generally within 40 feet) in the porosity of the residual soil, the weathered bedrock, and/or the somewhat deeper fractured bedrock, depending on the local dynamics of groundwater recharge and discharge. Figure 4 presents the measured groundwater elevations and inferred groundwater flow conditions for October 2012. Groundwater in this environment generally flows in a direction parallel to the topographic slope toward the valley bottoms, and may be observed at the ground surface as surface seeps or small springs where resistant beds direct groundwater flow laterally.

Discussed below are quantitative and qualitative constraints applicable to the fundamental aquifer characteristic parameters for groundwater flow at the Site.

- **Type of aquifer** – Unconfined: Conclusion based on the hydraulic testing conducted at five of the seven monitoring wells installed at the site in 2012. Exceptions occur at MW-1206 and MW-1207, both of which exhibited confined aquifer characteristics.

- **Hydraulic conductivity (K)** – Uppermost aquifer range between 10^{-3} and 10^{-7} centimeters per second [cm/sec] with 2.2×10^{-5} cm/sec from MW-1205 selected as the most representative value. Hydraulic conductivity was assessed through recovery tests conducted at seven wells installed in the Spring of 2012.

- **Effective porosity (n)** – 25 percent No direct measurement available for baseline flow through fractured rock at the Site. Porosity in fractured rock can range between 2-15 percent. The percentage assigned also accounts for potential flow of groundwater at the unconsolidated deposit/bedrock interface and through highly weathered fissile shales.

- **Hydraulic gradient (i)** – 0.145 Hydraulic gradient was estimated using the potentiometric elevation measured at MW-1202 relative to the elevation measured at MW-1203 and MW-1204 in May, July and October 2012.

- **Flow rate (V)** – 0.0361 feet/day The estimated flow rate (V) for uppermost groundwater at the Site was calculated by multiplying hydraulic conductivity by the hydraulic gradient and divided by effective porosity.

2.6 Water Quality

The general chemistry of the Site groundwater and surface water was evaluated through the hydrogeologic site investigation (HSI) conducted in 2012. The following discussion summarizes the findings of the HSI report.

The general chemistry of natural waters can be divided into four general chemistry categories: sodium + carbonate waters, calcium + carbonate waters, calcium + sulfate waters and sodium + chloride. The variations in groundwater quality characteristics are often a function of the groundwater residence time with and the chemical composition of the host rock.

Dissolved metals detected above the drinking water quality standard maximum contaminant levels (MCLs) in groundwater for the 2012 events were limited to arsenic and mercury. Arsenic was detected above its MCL in one or more wells in each of the reporting events but at concentrations that are likely to represent ambient conditions because of the relatively low level of the MCL (0.01 mg/L), the abundance of naturally occurring arsenic in the local soil and rock units, and the potential for soil particles to be entrained in the groundwater assessment samples. Anomalous mercury concentrations detected during the HSI in July 2012 were not confirmed with subsequent sampling conducted in October 2012, so the MCL exceedances for mercury were dismissed as potential laboratory or sampling interferences.

Surface water samples from the Site reported dissolved metals concentrations greater than MCLs for antimony and thallium in two of the three events conducted. Neither of these dissolved metals was detected above their respective MCL in any of the groundwater samples. Neither compound is typically associated with the waste material, so their origin is currently attributed to ambient conditions.

3.0 GROUNDWATER MONITORING PROGRAM

The components of the groundwater monitoring program are summarized below:

3.1 Sampling and Analysis and Quality Assurance Project Plan (SAP/QAPP)

Each sampling event will be conducted in accordance with the procedures specified in the SAP/QAPP (Appendix B). This plan includes:

- Procedures and techniques designed to accurately measure groundwater quality and groundwater elevation at monitoring wells;

- Methods for sample collection, preservation, and shipment;
- Laboratory analytical methods; and
- Quality assurance/quality control (QA/QC) and chain-of-custody protocols for the field activities and laboratory analysis.

All project activities will be conducted in accordance with the Site-specific Health and Safety Plan (HASP) to be prepared by the contractor(s).

3.2 Schedule

Implementation of the GMP will commence prior to implementation of the selected remedy with sampling events conducted during the first and third quarter each year. Reporting of the data to Kentucky Department for Environmental Protection (KDEP) from each event will occur in the second and fourth quarters respectively.

3.3 Groundwater Monitoring System

The groundwater monitoring system will consist of seven 2-inch inner diameter monitoring wells and one spring as listed below. Groundwater levels will be measured at each of the seven monitoring wells for each monitoring event prior to sampling.

Monitoring Well ID	**Monitoring Position**
MW-1202	Upgradient
MW-1204	Upgradient
SP-2	Upgradient
MW-1207	Downgradient
MW-1007	Downgradient
MW-1008	Downgradient
MW-1009	Downgradient
MW-1301 (Proposed)	Downgradient

If accessible and in proper condition, the groundwater level in each of the remaining monitoring wells at the site (MW-1010, MW-1011, MW-1201, MW-1203, MW-1205, MW-1206) will also be measured. These monitoring wells are not proposed to be repaired or replaced. As such, if damaged or otherwise deemed unsuitable for use they will be decommissioned.

Kentucky regulation 401 KAR 45:160 Section 3 (2) (b) requires monitoring well casings to have a diameter of 4 or more inches, unless otherwise approved by KDEP in writing. Therefore, written approval to use the existing monitoring wells, all of which were installed with 2-inch diameter casings, will need to be obtained from KDEP prior to implementation of this plan.

Two monitoring wells (MW-1202 and MW-1204) and one spring (SP-2) will be sampled to assess uppermost groundwater upgradient of the Site before coming into contact with the reservoir. Five monitoring wells (MW-1007, MW-1008, MW-1009, MW-1207 and proposed MW-1301) will be sampled to assess uppermost groundwater downgradient of the Site. The monitoring wells selected will provide adequate representative samples to evaluate water quality of the uppermost groundwater prior to entering and exiting the Site.

Specifications of the monitoring locations, including reference elevation, total depth, and screened interval (if applicable) are presented in Table 1.

3.4 Well Abandonment

Monitoring wells determined to be no longer suitable for their intended purpose are to be abandoned by a driller certified in the Commonwealth of Kentucky within 30 days of determination, but no sooner than 10 working days after KDEP has been notified, in accordance with 401 KAR 6:350 Section 11. A summary of the procedures in this regulation follows:

- Remove all components of the monitoring well including bollards, well pad, surface casing, monitoring well casing, well screen, filter pack, bentonite, and cement.
- Plug the borehole by introducing grout via tremmie pipe from the bottom to approximately 2 feet below ground surface (bgs).
- Plug the top 2 feet with material consistent with the surrounding ground surface.
- The driller is to submit a record of the abandonment to KDEP within 60 days of completion.

The regulation includes the option to request a variance to the abandonment procedure from KDEP for wells where removal of the well casing is not practical. The variance must be approved by KDEP prior to implementation.

3.5 Baseline Characterization

Baseline characterization monitoring will be conducted semiannually until the remedy (closure of the pond) is in place, and then for at least two semiannual events after its completion. The parameters to be analyzed include all those listed in 401 KAR 45:160 Section 7 (2) as provided in Table 2.

3.6 Detection Monitoring

Detection monitoring will be conducted semiannually following discontinuation of the baseline monitoring program. The parameters to be analyzed include those listed in 401 KAR 45:160 Section 8 (2) as provided in Table 3.

401 KAR 45:160 Section 8 (2) (c) states that monitoring for additional parameters may be required by KDEP based on a significant increase from the baseline characterization.

4.0 DATA EVALUATION, ASSESSMENT, AND CORRECTIVE ACTION

The data evaluation, assessment and corrective action procedures are summarized below:

4.1 Data Evaluation

The data evaluation procedures will be implemented in accordance with the Kentucky regulations for Special Waste Landfills 401 KAR 45:160 Section 4. Analytical results are to be evaluated within 48 hours of receipt from the laboratory. If the results do not indicate potential contamination, they are to be provided to KDEP on a form provided by KDEP. This form is to be provided within 60 days of sampling or 15 days after completion of the analyses, whichever comes first, unless otherwise approved by KDEP. If potential indications of contamination are identified, KDEP is to be notified within this same 48-hour period and arrangements are to be made to split a sample with KDEP no later than 10 days after receipt of the results.

4.2 Groundwater Assessment

401 KAR 45:160 Section 5 provides the following decision path if data evaluation per Section 4.1 above suggests the presence of one or more of the parameters listed in 40 CFR 302.4 Appendix A in one or more public or private water supplies or site monitoring well.

- The well(s) in question will be resampled (with split samples collected by KDEP, if requested) within 10 days.

- If resampling indicates, to the satisfaction of KDEP, that contamination is not present, then monitoring will resume on a semiannual basis, as required for detection-mode monitoring in 401 KAR 45:160 Section 8 (2).

- If resampling indicates contamination may be present, then a Groundwater Assessment Plan (GAP) will be prepared and submitted to KDEP within 30 days of the receipt of KDEP's judgment on the results (401 KAR 45;160 Section 5 (4)).

The GAP will propose specific methods for evaluating the existence, quality, quantity, areal extent, and depth of groundwater contamination, as well as the rate and direction of contaminant migration. The plan will be prepared by a qualified professional in the field of hydrogeology and will be implemented within 60 days of approval by KDEP. The plan will specify an implementation schedule and will include the following information:

- The number, location, size, casing type, and depth of wells, borings, springs, sedimentation basins, and other assessment structures or devices that may be utilized.

- Sampling and analytical methods to be used during the assessment.

- Data evaluation procedures that will be utilized to determine the concentration, rate, and extent of groundwater degradation from the Site.

- If a public or private water supply well(s) may have been adversely affected a detailed hydrogeologic study addressing the potential effect on the water supply is required to be included in the GAP.

A Groundwater Assessment Report (GAR) is to be submitted within 90 days of approval of the assessment by KDEP. The GAR will present the results of the GAP and provide recommendations on the necessity of corrective action (401 KAR 45:160 Section 5 (7)).

4.3 Corrective Action

If the GAR indicates the need for corrective action for the protection of human health and the environment at potential offsite receptor locations, a Remedial Action Plan (RAP) will be developed (401 KAR 45:160 Section 5 (9)). The RAP will be developed within 90 days of KDEP approval of the GAR, but no later than one (1) year after the event specified.

The RAP will specify corrective actions to be utilized to abate the existing groundwater contamination as well as measures to prevent further groundwater contamination. In addition, if local, public, or private water supplies are adversely affected by the contamination, the RAP will include a description of the means by which such water supplies will be restored or replaced. If

necessary, the plan will be modified to include additional measures deemed necessary by KDEP to protect human health and the environment.

5.0 SYSTEM CLOSURE

Groundwater monitoring of the Site will continue for a period of no less than 5 years after implementation of the remedy. Upon completion, a certification that the closure and post-closure period is complete is to be provided by AEP to KDEP. The components of the procedures are summarized below:

- AEP will provide certification to KDEP that all closure and post-closure period requirements have been achieved.
- KDEP will review certification including a site visit.
- If no deficiencies are identified, KDEP will acknowledge system closure to AEP within 180 days of receipt of the certification.
- Abandonment of all program monitoring wells will be completed after KDEP acknowledgement of system closure.

The certification shall meet the requirements in 401 KAR 45:110 Section 5 and 401 KAR 30:031 (Environmental Performance Standards). These performance standards are summarized as follows:

- Floodplains: Site does not restrict the flow of a 100-year floodplain, reduce temporary water storage capacity of the floodplain, or be placed in a manner to likely release waste that may pose a hazard to human health, wildlife, land or water resources.
- Endangered Species: No cause or contribute to any endangered, threatened or candidate species (Endangered Species Act, 1983)
- Surface waters: No discharge of pollutants into the waters of the Commonwealth (KRS Chapter 224 or 401 KAR Chapter 10, 401 KAR Chapter 8.
- Fill materials: No discharge of materials to waters of the Commonwealth (Section 404 of the Clean Water Act of 1977, as amended)
- Groundwater: No contamination of an underground drinking water beyond the point of compliance in excess of the MCL (401 KAR Chapter 8)

If all requirements have been met at the conclusion of the 5-year post-closure monitoring the owner or operator shall submit certification that the closure and post-closure is complete. KDEP will review the certification, permit records, and conduct a site visit to determine if the site

closure criteria have been achieved. If no deficiencies are identified KDEP is to acknowledge the certification of closure within 180 days of receipt of the certification.

6.0 REFERENCES

KGS, 1967; Geologic Map of the Fallsburg Quadrangle, Kentucky-West Virginia and the Pritchard Quadrangle in Kentucky (GQ-584); prepared by Sharps, Joseph A., in cooperation with the U.S. Geological Survey, Kentucky Geological Survey and University of Kentucky.

Lloyd, Jr., O.B., and Lyke, W.L., 1995. Ground Water Atlas of the United States, Segment 10: Illinois, Indiana, Kentucky, Ohio, Tennessee. Hydrologic Investigations Atlas 730-K. U. S. Geological Survey, Reston, VA.

URS, 2013; Hydrogeologic Site Investigation Report, dated June 14, 2013

TABLE 1

GROUNDWATER MONITORING PLAN
MONITORING LOCATION SPECIFICATIONS AND ELEVATIONS

AEP BIG SANDY, HORSEFORD CREEK SITE
LOUISA, KENTUCKY

Monitoring Well I.D.		Hydraulic Position (Upgradient/ Downgradient)	Top of Inner Casing Elevation (feet, msl)	Ground Surface Elevation (feet, msl)	Total Well Depth (feet)	Monitored Interval (feet, msl)	Groundwater Elevation** (feet, msl)
Site I.D.	AKGWA						
MW-1202*	8006-5305	Upgradient	852.24	849.59	44.90	814.7 - 804.7	818.48
MW-1204*	8006-5307	Upgradient	723.88	721.28	34.64	696.6 - 686.6	696.91
SP-2		Upgradient	NA	770.00	NA	NA NA	NA
MW-1207	8006-5301	Downgradient	697.61	695.02	530.02	175.5 - 165.5	611.41
MW-1007		Downgradient	711.31	708.93	77	661.9 - 631.9	668.44
MW-1008		Downgradient	721.60	719.09	100	659.1 - 619.1	637.90
MW-1009		Downgradient	713.01	710.50	85	645.5 - 625.5	653.59
Proposed							
MW-1301		Downgradient		550 (Est)	25 (Est)	535 (Est) - 525 (Est)	

AKGWA = Assembled Kentucky Groundwater Database
msl = Mean sea level
Survey Coordinates and elevations were measured on January 12, 2011, May 17, 2012 and May 21, 2012.
Northing and Easting values correspond to NAD 83 - Kentucky State Plane - North Zone.
*Monitoring well installed by Mr. Dave Schrencengost of Frontz Drilling (Kentucky Certified Driller Number 0302-0534-00)
**= Measured October 15, 2012

TABLE 2

GROUNDWATER MONITORING PLAN
BASELINE MONITORING - ANALYSIS SUMMARY

AEP BIG SANDY, HORSEFORD CREEK SITE
LOUISA, KENTUCKY

Parameter	KDEP		Method*	Reporting Limit µg/L	MCL µg/L	Container	Preservation	Holding Time
Indicator Parameters:								
Bicarbonate	x	1	SM20 4500-CO2D	5,000	NS	Plastic	-	14 days
Carbonate	x	1	SM20 2320B	5,000	NS	Plastic	-	14 days
Chemical Oxygen Demand	x	1	SM20 5220D	5,000	NS	Plastic	H2SO4, pH<2	28 days
Total Dissolved Solids	x	1	SM20 2540C	20,000	500,000**	Plastic	-	7 days
Total Organic Carbon	x	1	SM20 5310C	20	NS	Glass	H2SO4, pH<2	28 days
Chloride	x	2	EPA 300.1	100	250,000**	Plastic	-	28 days
Sulfate	x	2	EPA 300.1	400	NS	Plastic	-	28 days
Metals								
Calcium	x	3	EPA 200.7	20	NS	Plastic	-	6 months
Iron	x	3	EPA 200.8	10	300**	Plastic	HNO3, pH<2	6 months,
Magnesium	x	3	EPA 200.7	50	NS	Plastic	-	6 months
Potassium	x	3	EPA 200.7	50	NS	Plastic	-	6 months
Sodium	x	3	EPA 200.7	50	NS	Plastic	-	6 months
Zinc	x	3	EPA 200.8	0.5	5,000**	Plastic	HNO3, pH<2	6 months,
Specific Conductance	x		Field	NS	NS	Field	-	Field
pH	x		Field	NS	NS	Field	-	Field
Hazardous Constituents								
Metals								
Arsenic	x	3	EPA 200.8	0.1	10	Plastic	HNO3, pH<2	6 months,
Cadmium	x	3	EPA 200.8	0.05	5	Plastic	HNO3, pH<2	6 months,
Copper	x	3	EPA 200.8	0.05	1,300	Plastic	HNO3, pH<2	6 months,
Lead	x	3	EPA 200.7	0.01	15	Plastic	HNO3, pH<2	6 months,
Nickel	x	3	EPA 200.8	0.2	NS	Plastic	HNO3, pH<2	6 months,
Selenium	x	3	EPA 200.8	0.5	5	Plastic	HNO3, pH<2	6 months,
Mercury	x	3	EPA 245.2	2	2	Plastic	HNO3, pH<2	6 months,

* Method SW-846 refers to Test Methods for Evaluating Solid Waste, Physical/Chemical Methods

** Secondary Standard

KDEP = Kentucky Department for Environmental Protection parameters per 401 KAR 45:160 Section 7 (2)

1 Standard Methods for the Examination of Water & Wastewater, 20 th edition, 1998

2 EPA/815-R-00-014: Methods for the Determination of Organic and Inorganic Compounds in Drinking Water, Vol 1 , Aug 2000

3 EPA/600/R-94/111: Methods for the Determination of Metals in Environmental Samples, Supplement 1, May 1994

Note: All samples to be stored and shipped chilled at 4°C.

MCL = US EPA Maximum Contaminant Level

H2SO4 = Sulfuric acid

HNO3 = Nitric acid

NS = Not specified

TABLE 3

GROUNDWATER MONITORING PLAN
DETECTION MONITORING - ANALYSIS SUMMARY

AEP BIG SANDY, HORSEFORD CREEK SITE
LOUISA, KENTUCKY

Parameter	KDEP		Method*	Reporting Limit µg/L	MCL µg/L	Container	Preservation	Holding Time
Indicator Parameters:								
Chemical Oxygen Demand	x	1	SM20 5220D	5,000	NS	Plastic	H2SO4, pH<2	28 days
Total Dissolved Solids	x	1	SM20 2540C	20,000	500,000**	Plastic	-	7 days
Total Organic Carbon	x	1	SM20 5310C	20	NS	Glass	H2SO4, pH<2	28 days
Chloride	x	2	EPA 300.1	100	250,000**	Plastic	-	28 days
Sulfate	x	2	EPA 300.1	400	NS	Plastic	-	28 days
Specific Conductance	x		Field	NS	NS	Field	-	Field
pH	x		Field	NS	NS	Field	-	Field
Hazardous Constituents								
Metals								
Copper	x	3	EPA 200.8	0.05	1,300	Plastic	HNO3, pH<2	6 months,

* Method SW-846 refers to Test Methods for Evaluating Solid Waste, Physical/Chemical Methods
** Secondary Standard
KDEP = Kentucky Department for Environmental Protection parameters per 401 KAR 45:160 Section 7 (2)
1 Standard Methods for the Examination of Water & Wastewater, 20 th edition, 1998
2 EPA/815-R-00-014: Methods for the Determination of Organic and Inorganic Compounds in Drinking Water, Vol 1 , Aug 2000
3 EPA/600/R-94/111: Methods for the Determination of Metals in Environmental Samples, Supplement 1, May 1994

Note: All samples to be stored and shipped chilled at 4°C.
MCL = US EPA Maximum Contaminant Level
H2SO4 = Sulfuric acid
HNO3 = Nitric acid
NS = Not specified

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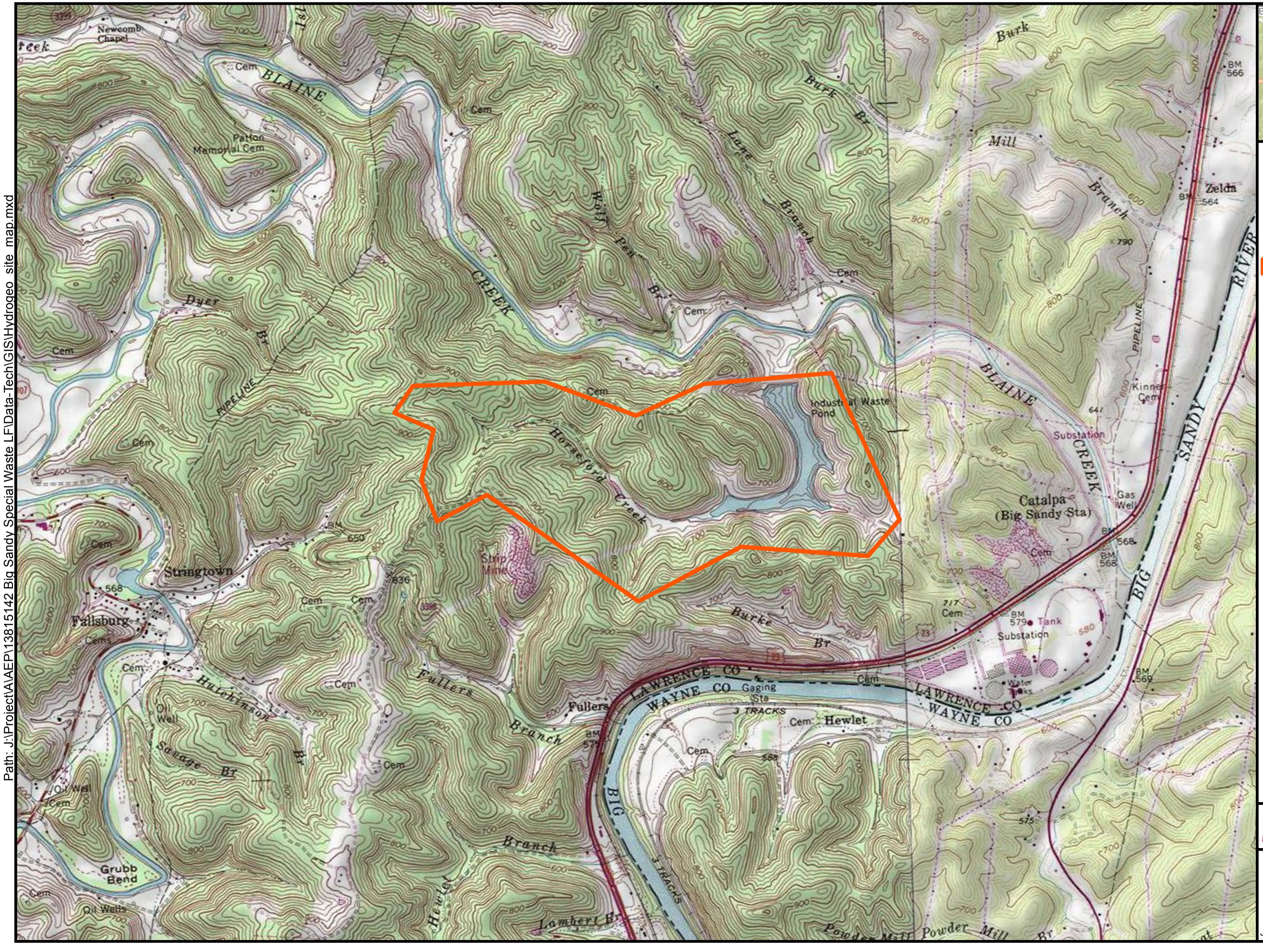
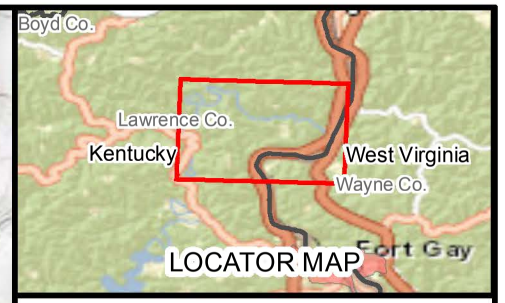




N

LEGEND:

Limit of Horseford Creek Site

0 1,600 3,200
Scale in Feet

0 520 1,040
Scale in Meters

BASE MAP SOURCE:
USGS Topographic Quadrangles:
Fallsburg, KY/WV (1978) and
Prichard, WV/KY (1977)

Big Sandy Horseford Creek Site
Groundwater Monitoring Plan

FIGURE 1
SITE MAP

JOB NO. 13815152

URS

J:\Projects\AEP\13815142 Big Sandy Special Waste LF\Deliverables\DRAFT GMP\DRAFT GW Mont Plan (Base is Ft Knox)\GMP Figures\fig2.fh10

B
SOUTHWEST

B'
NORTHEAST

MW-1301
MW-1008
MW-1007
SW-1
SB-3
EXISTING ROAD
PB-8
MW-1201
SP-2
PB-1
SW-2
SB-7
MW-1203
SP-1
PB-2
MW-1204
SB-4
MW-1202
PB-7
MW-1206
MW-1207
PB-3
MW-1009
PB-6
PB-4
SB-6
PB-5
MW-1205
SB-8
MW-1011
MW-1010

0 600 1,200
APPROXIMATE SCALE IN FEET

LEGEND:

	Limit of Horseford Creek Site	MW	Monitoring Well
	Boring Location		Seep Sampling Location
PB	Pond Boring		Surface Water Sampling Location
SB	Soil Boring		Proposed Monitoring Well Location
HB	Hydrogeologic Boring	B B'	Cross-Section Transect

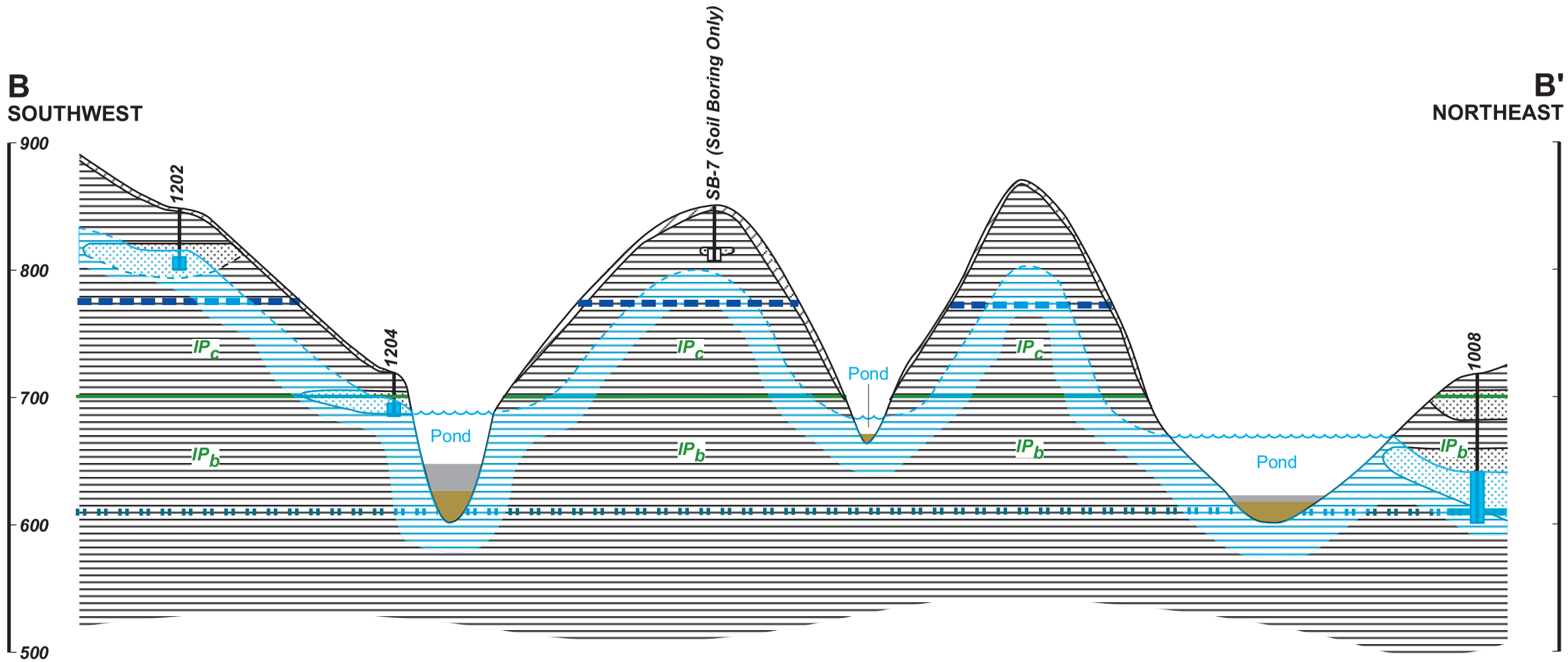
AEP

Big Sandy Horseford Creek Site
Groundwater Monitoring Plan

FIGURE 2
BORING AND WELL LOCATIONS

JOB NO. 13815152

URS



LEGEND:

- Brush Creek Limestone (Inferred from GQ-584)
- 1202 — Well ID
- Well
- Well Screen
- Water Level (Measured October 15, 2012) (Dashed Where Inferred)

GQ-584 — Geologic Quadrangle Map of Fallsburg Quadrangle, Kentucky-West Virginia, and the Pritchard, Quadrangle in Kentucky, (GQ-584) Joseph A. Sharpe, 1987.

- IP_c — Conemaugh Formation (Inferred from GQ-584)
- IP_b — Breathitt Formation (Inferred from GQ-584)
- Princess Coal #7 (Inferred from GQ-584)

- CL — Clay
- SC — Sandy Clay
- SS — Sandstone
- SH — Shale, Interbedded Shale, Siltstone, Sandstone, Mudstone
- Alluvium
- Ash
- Uppermost Groundwater Zone

100
0
0 600
SCALE IN FEET
VERTICAL EXAGGERATION = 6x

AEP

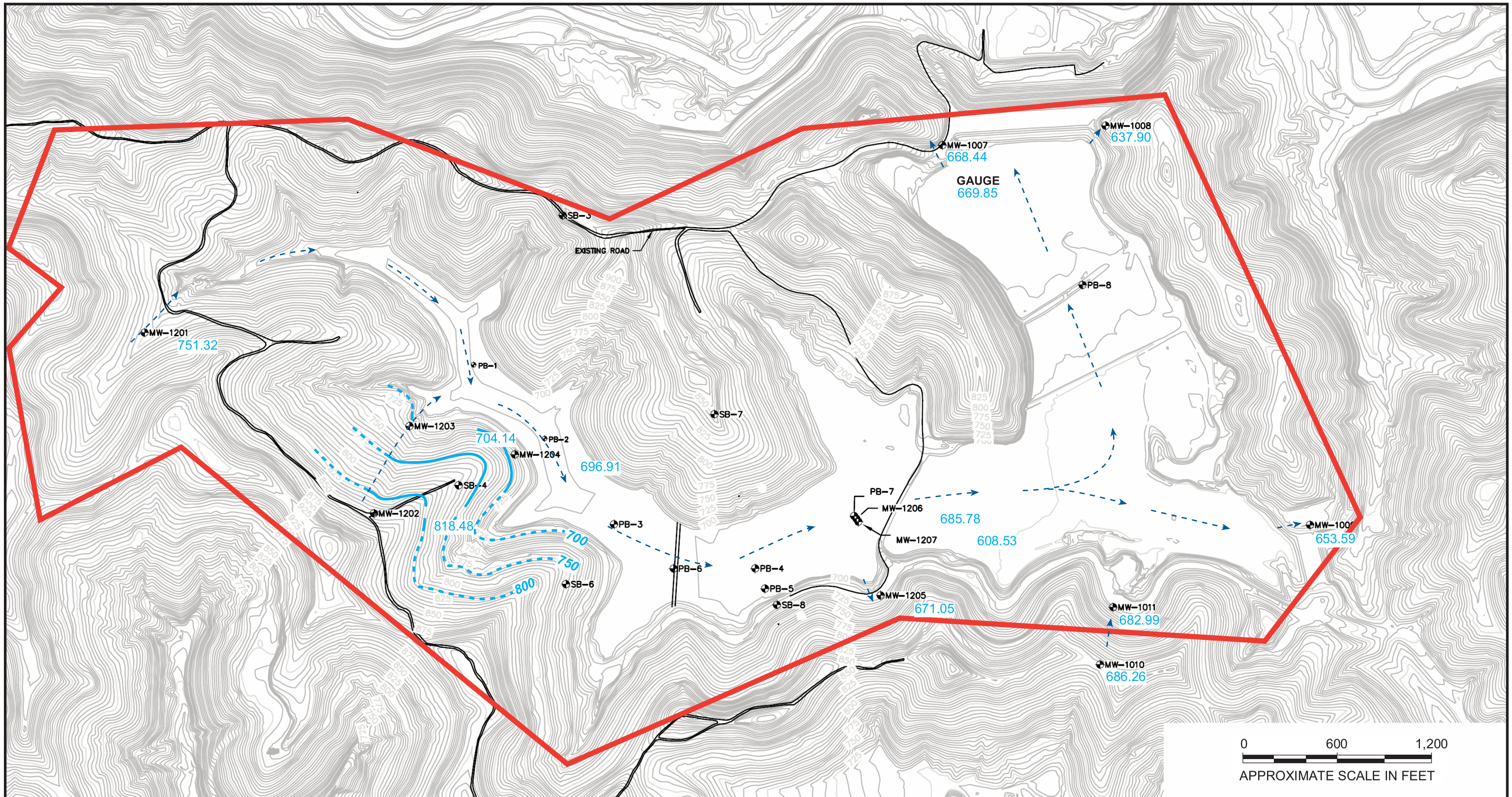
Big Sandy Horseford Creek Site
Groundwater Monitoring Plan

FIGURE 3
CROSS SECTION B-B'

JOB NO. 13815152

URS

J:\Project\A\AEP\13815142 Big Sandy Special Waste LF\Deliverables\DRAFT GMP\DRAFT GW Mont Plan (Base is Ft Knox)\GMP Figures\fig3.fh10



LEGEND:

	Limit of Horseford Creek Site	MW	Monitoring Well
✥	Boring Location	———	Potentiometric Line (Dashed Where Inferred)
PB	Pond Boring	- - - →	Inferred Flow Direction
SB	Soil Boring	NM	Not Measured
HB	Hydrogeologic Boring	818.48	Groundwater Elevation (Feet, msl)

AEP

Big Sandy Horseford Creek Site
Groundwater Monitoring Plan

FIGURE 4
GROUNDWATER ELEVATIONS
OCTOBER 15, 2012

JOB NO. 13815152

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APPENDIX A

BORING LOGS

2012 LOGS

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Key to Log of Boring/Rock Core

Elevation, feet	Depth, feet	SAMPLES: Type	SAMPLES: Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer, tsf	Graphic Log	MATERIAL DESCRIPTION		Well Graphic	REMARKS AND OTHER DETAILS
1	2	3	4	5	6	7	8	9		10	11	12

COLUMN DESCRIPTIONS

1 **Elevation:** Elevation in feet referenced to mean sea level (MSL) or site datum.

2 **Depth:** Depth in feet below the ground surface.

3 **Sample Type:** Type of soil sample collected at depth interval shown; sampler symbols are explained below.

4 **Sample Number:** Sample identification number.

5 **Sampling Resistance:** Number of blows required to advance driven sampler each 6-inch interval, or distance noted, using a 140-lb hammer with a 30-inch drop.

6 **Recovery:** Percentage of driven sample length actually recovered.

7 **Pocket Penetrometer:** Pocket penetrometer field consistency measurement in tons per square foot (tsf).

8 **Graphic Log:** Graphic depiction of subsurface material encountered; typical symbols are explained below.

9 **Material Description:** Description of material encountered; may include color, moisture, grain size, and density/consistency.

10 **Water Content** Water content of soil sample measured in laboratory, expressed as percent of dry weight of sample.

11 **Well Graphic:** Diagram of well installation

12 **Remarks and Other Details:** Comments and observations regarding drilling or sampling made by driller or field personnel. Also includes well details and laboratory testing results.

TYPICAL MATERIAL GRAPHIC SYMBOLS

- BOTTOM ASH
- FLY ASH
- FILL
- SEDIMENTS
- TOPSOIL
- WATER
- PEAT (PT)
- Fat Organic CLAY (OH)
- Lean Organic CLAY (OL)
- Lean CLAY (CL)
- Fat CLAY (CH)
- SILT (ML)
- Clayey SAND (SC)
- Silty SAND (SM)
- Poorly-graded SAND (SP)
- Poorly-graded SAND (SP-SM)
- Clayey GRAVEL (GC)
- Silty GRAVEL (GM)
- Clayey GRAVEL (GC)
- COAL
- LIMESTONE
- SANDSTONE
- SHALE

TYPICAL WELL GRAPHIC SYMBOLS

- Filter Sand
- Natural fill
- PVC Pipe in Bentonite Seal
- PVC Pipe in Bentonite Grout
- Bentonite Plug
- PVC Pipe in Filter Sand
- Slotted PVC Pipe in Filter Sand

OTHER GRAPHIC SYMBOLS

- First water encountered at time of drilling and sampling (ATD)
- Water level at time indicated on log
- Minor change in material properties within a lithologic stratum
- ---- Inferred or gradational lithologic contact

ATD At Time of Drilling
NR Not Recorded
NA Not Applicable

TYPICAL SAMPLER GRAPHIC SYMBOLS

- Split-spoon
- Core Barrel
- Shelby-tube
- Piston Tube
- Core

MINOR SOIL TYPE(s)

"trace" When the soil type's percentage is estimated, using visual/manual procedures, to be between 1 and 15 percent of the total sample.

"with" When the soil type's percentage is estimated, using visual/manual procedures, to be greater than 15 percent and less than 30 percent of the total sample.

"y" When the soil type's percentage is estimated, using visual/manual procedures, to be greater than 30 percent of the total sample.

Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive; field descriptions may have been modified to reflect lab test results. Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced; they are not warranted to be representative of subsurface conditions at other locations or times.

URS

KEY TO DESCRIPTIVE TERMS USED ON CORE LOGS

DISCONTINUITY DESCRIPTORS

a Dip of discontinuity, measured relative to a plane normal to the core axis.

b **Discontinuity Type:**

- F - Fault
- J - Joint
- Sh - Shear
- Fo - Foliation
- V - Vein
- B - Bedding

c **Aperture (inches):**

- W - Wide (0.5-2.0)
- MW - Moderately Wide (0.1-0.5)
- N - Narrow (0.05-0.1)
- VN - Very Narrow (<0.05)
- T - Tight (0)

d **Type of Infilling:**

- Cl - Clay
- Ca - Calcite
- Ch - Chlorite
- Fe - Iron Oxide
- Gy - Gypsum
- H - Healed
- Mn - Manganese Oxide
- No - None
- Py - Pyrite
- Qz - Quartz
- Sd - Sand

e **Amount of Infilling:**

- Su - Surface Stain
- Sp - Spotty
- Pa - Partially Filled
- Fi - Filled
- No - None

f **Surface Shape of Joint:**

- Pl - Planar
- Wa - Wavy
- St - Stepped
- Ir - Irregular

g **Roughness of Surface:**

- Slk - Slickensided [surface has smooth, glassy finish with visual evidence of striations]
- S - Smooth [surface appears smooth and feels so to the touch]
- SR - Slightly Rough [asperities on the discontinuity surfaces are distinguishable and can be felt]
- R - Rough [some ridges and side-angle steps are evident; asperities are clearly visible, and discontinuity surface feels very abrasive]
- VR - Very Rough [near-vertical steps and ridges occur on the discontinuity surface]

h **Discontinuity Spacing (feet):**

- EW - Extremely Wide (>6)
- W - Wide (2-6)
- M - Moderate (0.7-2)
- C - Close (0.2-0.7)
- VC - Very Close (<0.2)

ROCK WEATHERING / ALTERATION

Description	Recognition
Residual Soil	Original minerals of rock have been entirely decomposed to secondary minerals, and original rock fabric is not apparent; material can be easily broken by hand
Completely Weathered/Altered	Original minerals of rock have been almost entirely decomposed to secondary minerals, although original fabric may be intact; material can be granulated by hand
Highly Weathered/Altered	More than half of the rock is decomposed; rock is weakened so that a minimum 2-inch-diameter sample can be broken readily by hand across rock fabric
Moderately Weathered/Altered	Rock is discolored and noticeably weakened, but less than half is decomposed; a minimum 2-inch-diameter sample cannot be broken readily by hand across rock fabric
Slightly Weathered/Altered	Rock is slightly discolored, but not noticeably lower in strength than fresh rock
Fresh/Unweathered	Rock shows no discoloration, loss of strength, or other effect of weathering/alteration

ROCK STRENGTH

Description	Recognition	Approximate Uniaxial Compressive Strength (psi)
Extremely Weak Rock	Can be indented by thumbnail	35 - 150
Very Weak Rock	Can be peeled by pocket knife	150 - 700
Weak Rock	Can be peeled with difficulty by pocket knife	700 - 3,500
Medium Strong Rock	Can be indented 5 mm with sharp end of pick	3,500 - 7,200
Strong Rock	Requires one hammer blow to fracture	7,200 - 14,500
Very Strong Rock	Requires many hammer blows to fracture	14,500 - 35,000
Extremely Strong Rock	Can only be chipped with hammer blows	> 35,000

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
HB-1 (MW-1201)

Sheet 1 of 3

Date(s) Drilled	**4/10/12**	Logged By	**S. Becker**	Checked By	**J. Lach**
Drilling Method	**HSA, HQ Wireline Core**	Drill Bit Size/Type	**6 1/4" HSA/6" OD bit with HQ core**	Total Depth of Borehole	**49.5 ft**
Drill Rig Type	**CME 55**	Drilling Contractor	**Frontz Drilling**	Surface Elevation	**799.4 ft above msl**
Borehole Backfill	**Borehole finished as monitoring well MW-1201**	Sampling Method(s)	**Split-spoon, HQ Wireline**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 252,798.0 E 2,099,724.0**	Groundwater Level(s)	**Not encountered**		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Pene-trometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	0	SS	SS-1	WOH 2 2 3	50	1.0 2.0 2.0 3.25		Stiff, moist, brown to reddish brown lean CLAY (CL), trace silt and sand			Grout
	1							Stiff to very stiff, moist, brown to reddish brown, very fine sandy lean CLAY (CL) [RESIDUUM]			SCH 40 PVC 2" diameter riser
	2	SS	SS-2	5 5 5 7	50	3.5 4.5 3.5 4.5		becomes very stiff to hard			
	3								17.7		*PL=17 LL=35 PI=18 %F=67.9*
	4										
795		SS	SS-3	2 2 5 7	63	1.75 3.0 4.0 3.0		becomes mottled reddish brown and light gray			
	5										
	6	SS	SS-4	7 10 11 11	100	3.5 4.5 4.25		Medium dense, moist, dark reddish brown fine to medium clayey SAND (SC) with trace oxidized sandstone gravel, with tan and light gray mottling [RESIDUUM]			
	7										
	8	SS	SS-5	3 6 7 9	92	3.5 >4.5 3.5 >4.5		Very stiff to hard, moist, light gray to light tan, fat CLAY (CH), trace sand [RESIDUUM]			
	9							1/4" dark red-brown, highly weathered shale seam			
790											
	10	SS	SS-6	2 5 9 15	92	3.75 4.0 4.25 4.25					
	11										
	12	SS	SS-7	50/5"	8	>4.5		becomes gray to light gray			
	13	R	R1	24%	50			Quartz SANDSTONE, gray, slight to no weathering, very strong, slight to moderate HCL reaction (4.5"-6"), grading more flaggy and micaceous at 9"			*Auger/spoon refusal at 12.5 ft bgs*
	14							Fracture #1: 0, B, N, None ,None, Ir, SR, M			
785											
	15										
	16										
	17	R	R2	30%	50			SHALE, gray, slight to moderately weathered, very weak			
	18							Fracture #2: 0, B, 0, None, None, Pl, SR, VC			
	19										
780											
	20	R	R3	27%	77						

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Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
HB-1 (MW-1201)

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	20							becomes dark gray and slightly fossiliferous		*Brush creek limestone*
	21							Microcrystalline LIMESTONE, gray, slight to no weathering, very strong, fossiliferous		**SCH 40 PVC 2" diameter riser**
	22		R3	27%	77			SHALE, dark gray, slight to moderate weathering, very weak, slightly fossiliferous		
	23							Microcrystalline LIMESTONE, light gray to gray, slight to moderate weathering, strong		*Brush creek limestone*
								Fracture #3: 0, B, N to MW, None, None, Ir, R, EW		
	24							SHALE, dark gray, slight to moderate weathering, very weak		
775								becomes gray		
	25									
	26							becomes green, slight to no weathering, strong with trace brown clay in bedding planes		
	27		R4	13%	30			COAL, black, slight to no weathering, very weak		
	28							MUDSTONE, black to dark gray, slight to moderate weathering, medium strong		
	29							becomes gray		
770										
	30									
	31									
	32		R5	68%	87					
	33									
	34									
765										
	35							becomes with sand, trace mica (muscovite)		**Bentonite seal**
	36							becomes slightly fissile		
	37		R6	45%	100			2-inch gray sandstone seam		
								becomes wavy bedding		
	38							becomes without wavy bedding, without muscovite		**Filter sand**
	39									
760								becomes with sand, semi-fissile		
	40									**SCH 40 PVC 2" diameter 0.01" slotted screen**
	41									
			R7	52%	92					
	42							Quartz SANDSTONE with biotite and muscovite, slight weathering, medium strong, ~15° dip, cross bedded		
								Fracture #4: 15%, B, T, Ca, Pa, Pl, SR, VC		
	43									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
HB-1 (MW-1201)

Elevation, feet	Depth, feet	SAMPLES: Type	SAMPLES: Number	SAMPLES: Sampling Resist. Blows/6" OR CORE% RQD	SAMPLES: Recovery, %	SAMPLES: Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	44		R7	52%	92						Filter sand
755	45										
	46										
	47		R8	85%	100						
	48										
	49										
750	50							End of Boring at 49.5´ bgs			
	51										
	52										
	53										
	54										
745	55										
	56										
	57										
	58										
	59										
740	60										
	61										
	62										
	63										
	64										
735	65										
	66										

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Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
HB-2/SB-1 (MW-1202)

Date(s) Drilled	**4/13/12**	Logged By	**S. Becker**	Checked By	**J. Lach/V. Gautam**
Drilling Method	**HSA, HQ Wireline Core**	Drill Bit Size/Type	**6 1/4" HSA/6" OD bit with HQ core**	Total Depth of Borehole	**44.5 ft**
Drill Rig Type	**CME 55**	Drilling Contractor	**Frontz Drilling**	Surface Elevation	**849.6 ft above msl**
Borehole Backfill	**Finished as monitoring well MW-1202**	Sampling Method(s)	**Split-spoon, HQ Wireline**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 254,651.6 E 2,101,180.0**	Groundwater Level(s)	**Water level @ 28.85 ft bgs**		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	0										
		SS	SS-1	2 3 3 3	100	1.5 3.5 2.0 1.5		Loose, moist, brown, sandy CLAY (SC), trace gravel (topsoil)			Grout
	1							Loose, moist, brown sandy CLAY (SC), trace gravel [RESIDUUM]			SCH 40 PVC 2" diameter riser
								becomes mottled brown and gray			
	2							Stiff to very stiff, moist, tannish brown and gray mottled lean CLAY (CL), trace sand, trace gravel [RESIDUUM]			
		SS	SS-2	3 4 5 5	83	2.5 2.5 2.75 2.5					
	3							becomes reddish brown and gray mottled			
	4							becomes with weathered brown shale fragments			
845											
	5	SS	SS-3	2 4 5 6	21						
	6							becomes without shale fragments, hard			
		SS	SS-4	4 6 8 9	13	3.25					
	7										
	8							becomes gray and tan mottled, without sand, dry to moist, without gravel			
		SS	SS-5	3 6 9 12	58	3.0 4.5 4.5 3.5			17.7		*PL=21 LL=45 PI=24 %F=91*
840	9										
	10							becomes light gray			
		SS	SS-6	3 5 8 11	79	4.25 3.0 2.5					
	11										
	12							becomes brownish red			
		SS	SS-7	6 10 13 12	63	4.0 4.5 4.5					
	13							becomes gray to light gray, without silt			
	14										
		SS	SS-8	6 16 16 24	75	>4.5					
835	15							SHALE, greenish gray, highly weathered, very to extremely weak			
	16							becomes brownish gray, dry			
		SS	SS-9	24 49 50/4"	75						
	17							becomes greenish gray			
	18										
	19										*18 to 20 ft bgs - No Split Spoon Collected*
830	20										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
HB-2/SB-1 (MW-1202)

Elevation, feet	Depth, feet	SAMPLES: Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	20									
	21	SS-10		9 12 15 16	96					**SCH 40 PVC 2" diameter riser**
	22	SS-11		50/4"	63					
	23									
	24									*Augered 24-25 ft bgs to begin setup for wireline coring*
825	25							22.4 to 25 ft, bgs - No Recovery - HSA Only becomes with 1-2" weathered limestone 25 ft, bgs - Begin HQ Rock Coring		
	26							becomes with iron-stained lamina, slightly to moderately weathered, strong to very strong		
	27	R1		41%	48					*Dry run* *No water*
	28									**Bentonite seal**
	29									
820	30							Quartz SANDSTONE, gray, slightly to moderately weathered, strong, micaceous (muscovite), with iron-staining, thinly bedded		*Dry run* *No water*
	31							becomes with biotite Fracture #1: 0, B, T-N, Fe, Su, Ir, SR, M		**Filter sand**
	32	R2		27%	70			Fracture #2: 0, B, T, Fe, Su, Ir, SR, VC		**SCH 40 PVC 2" diameter 0.01" slotted screen**
	33									
	34							becomes wet		
815	35									*Water used*
	36							becomes without iron staining, no weathering, very strong to strong Fracture #3: 0, B, T-VN, --, No, Pl-Wa, SR, VC		
	37	R3		98%	103			Fracture #4: 0, B, MW-W, Fe, Su, Pl-Wa, R, M		
	38									
	39									
810	40									
	41									
	42	R4		68%	98			SHALE, greenish gray, no weathering, very weak		
	43							Fracture #5: 0, B, T, Cl-No, Su -No, Pl, S-SR, VC		

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
HB-2/SB-1 (MW-1202)

Elevation, feet	Depth, feet	SAMPLES: Type	SAMPLES: Number	SAMPLES: Sampling Resist. Blows/6" OR CORE% RQD	SAMPLES: Recovery, %	SAMPLES: Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	44		R4	68%	98						Filter sand
805	45							End of Boring at 44.5´ bgs			
	46										
	47										
	48										
	49										
800	50										
	51										
	52										
	53										
	54										
795	55										
	56										
	57										
	58										
	59										
790	60										
	61										
	62										
	63										
	64										
785	65										
	66										

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Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
HB-7/SB-2 (MW-1203)

Date(s) Drilled	**4/16/12**	Logged By	**S. Becker**	Checked By	**J. Lach**
Drilling Method	**HSA, HQ Wireline Coring**	Drill Bit Size/Type	**6 1/4" HSA/6" OD bit with HQ core**	Total Depth of Borehole	**54.5 ft**
Drill Rig Type	**CME 55**	Drilling Contractor	**Frontz Drilling**	Surface Elevation	**728.7 ft above msl**
Borehole Backfill	**Finished as monitoring well MW-1203**	Sampling Method(s)	**Split-spoon/Wireline**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 252,205.1 E 2,101,406.0**	Groundwater Level(s)	**Not encountered**		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Pene-trometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	0			3				Loose, moist, brown clayey SAND (SC), trace sandstone gravel [FILL]			**Grout**
	1	SS	SS-1	2 2 4	50	0.75 1.5			16.4		*PL=18 LL=31 PI=13 %G=8.3 %S=44.5 %F=47.2*
	2			4		3.5		Stiff to very stiff, moist, reddish brown, lean CLAY (CL) [FILL]			**SCH 40 PVC 2" diameter riser**
	3	SS	SS-2	4 5	71	3.0		1" red-brown medium sand seam 2" medium reddish brown sand seam with sandstone fragments			
725	4			6		3.0					
	5	SS	SS-3	3 4 7 7	83	3.5 4.5 4.5 3.5		becomes with sandstone fragments (gravel) with red-brown sand iron-staining	16.7		*PL=17 LL=31 PI=15*
	6			14		4.5		Dense, dry to moist, red to brown, clayey SAND (SC) with gravel [ALLUVIUM]			*Iron staining on sand and gravel*
	7	SS	SS-4	15 17 20	92	4.5 >4.5 >4.5					
	8			7		4.0		becomes mottled brown and orange			
720	9	SS	SS-5	12 13 16	100	4.0 4.5 4.0			10.4		*%G=19.3 %S=49.8 %F=30.9*
	10			5							
	11	SS	SS-6	13 14 12	100			becomes increasing sand and gravel content			
	12			11		3.5		Very stiff to hard, moist red-brown fat CLAY (CH) trace sand and gravel [ALLUVIUM]			
	13	SS	SS-7	17 27	92	3.25 3.5			17.6		
715	14			17		>4.5		4" reddish brown sand layer with trace clay			
	15	SS	SS-8	3 6 10 8	100	1.0 2.0 3.0		Medium stiff to stiff, moist, red-brown silty, clayey SAND (SC-SM) with weathered sandstone gravel [ALLUVIUM]			
	16			23		1.0					
	17	SS	SS-9	15 13 12	83	3.0 2.5 3.5		2" sandstone fragment in spoon	12.2		*PL=15 LL=20 PI=5 %G=16.6 %S=53.6 %F=29.8*
	18			4				Loose, moist to wet, red-brown clayey SAND (SC), trace sandstone gravel [ALLUVIUM]			
710	19	SS	SS-10	3 6 6	63						
	20										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
HB-7/SB-2 (MW-1203)

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	20			9				becomes brown		Grout
	21	SS	SS-11	4 5 24	58				13.9	SCH 40 PVC 2" diameter riser
	22			11				becomes medium dense		
	23	SS	SS-12	10 12	100					
705	24			9						
	25	SS	SS-13	4 8 10 17	83	3.5 4.5 >4.5 >4.5		Hard, moist, tan and brown mottled lean CLAY (CL), trace sand [RESIDUUM]		
	26	SS	SS-14	40 50/4"	40			SHALE, greenish tan, moderately weathered, extremely weak		
	27									
	28	SS	SS-15	50/4"	50			becomes greenish gray, slightly-moderately weathered		
700	29									
	30							Fracture#1: 0, B, T, Cl-No, Su-No, Ir, S-SR, VC		
	31							becomes brown		
	32	R	R1	44%	78			becomes mottled gray, light brown and red Fracture#2: 38, Sh, T, Cl, Su, Pl, S, VC		Bentonite seal
	33							Fracture#3: 30, Sh, N, Cl, Su, Pl, S, VC		
695	34							becomes greenish gray		
	35									Filter sand
	36									
	37	R	R2	58%	85			SANDSTONE, gray with very light black banding, slightly weathered, strong, micaceous (muscovite and biotite)		SCH 40 PVC 2" diameter 0.01" slotted screen
	38							Fracture#4: 0, B, MW, No, No, St, SR-S, C		
690	39									
	40							Fracture#5: 0, B, T, No-Sd, Sp, Pl, S-SR, VC		
	41	R	R3		100					
	42							Fracture#6: 25, Sh, T, Fe, Su, Pl-Wa, SR, VC		
	43							7" area Fe staining		

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
HB-7/SB-2 (MW-1203)

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
685	44	R3			100			Fracture#7: 25, Sh, T, Cl, Pa, Pl, SR, VC 5" Fe staining 12" Fe staining			SCH 40 PVC 2" diameter 0.01" slotted screen
	45										
	46							Fracture#8: 0-15, B, T, Fe, Su, Pl, SR, VC			
	47	R4		70%	100			Fe staining			Filter sand
	48										
680	49										
	50										
	51										
	52	R5		92%	92						
	53										
675	54										
	55							End of Boring at 54.5´ bgs			
	56										
	57										
	58										
670	59										
	60										
	61										
	62										
	63										
665	64										
	65										
	66										

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Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
HB-4/SB-5 (MW-1204)

Date(s) Drilled	**4/18/12**	Logged By	**J. Lach**	Checked By	**V. Gautam**
Drilling Method	**HSA, HQ Wireline Coring**	Drill Bit Size/Type	**6 1/4" HSA, 6" OD bit with HQ core**	Total Depth of Borehole	**35.0 ft**
Drill Rig Type	**CME 550 Truck**	Drilling Contractor	**Frontz Drilling**	Surface Elevation	**721.3 ft above msl**
Borehole Backfill	**Finished as monitoring well MW-1204**	Sampling Method(s)	**Split-spoon, HQ Wireline**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 252,025.3 E 2,102,075.0**	Groundwater Level(s)	**Not encountered**		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Pene-trometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	0			6				Light brown, heavily weathered sandstone (access road)		2.5 ft stickup
				22						Grout 20% mix ~30 gallons used
	1			42	86	>4.5		Hard, dry, light brown, lean CLAY (CL) [RESIDUUM OR FILL]		
720				50/3						
	2							Heavily weathered SANDSTONE, light brown, with some lean clay, dry (Auger Cuttings)		SCH 40 PVC 2" diameter riser
	3									*No recovery - HSA cuttings consist of mixture of lean clay and heavily weathered sandstone fragments - all dry*
	4									
	5							Fine to medium grained SANDSTONE, brown, moderately weathered, strong		*Auger refusal at 5.0 ft bgs*
	6							MUDSTONE, greenish brown, moderately weathered, weak Fracture #1: 0, B, No, W, VN, Pl, SR		
715	7		R1	18%	70			Fracture #2: 0, B, No, W, VN, Pl, SR		
	8									
	9							2" brown lean clay seam Fracture #3: 0, B, No, W, VN, Pl, SR		
	10							becomes lightly weathered, extremely weak, micaceous, with iron staining		
	11									
710	12		R2	22%	23					*Driller reported constant down pressure. Little to no H20 loss*
	13									
	14							Micaceous SANDSTONE, greenish gray, strong		
								becomes brown, moderately weathered (14.5 to 14.6 ft)		
	15							becomes greenish gray, very strong		
								becomes brown, slightly weathered		Bentonite Hydrated
	16									
705								becomes greenish gray, micaceous, cross-bedded, very weak		
	17							Fracture #4: 0, B, No, W, VN, Pl, SR		
	18		R3	85%	90					#5 filter sand
								becomes mottled with partial brown iron staining and greenish gray, strong in brown stained portions		
	19									
	20							becomes greenish gray, weak, with iron staining		

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
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Log of Boring/Rock Core
HB-4/SB-5 (MW-1204)

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	20							becomes greenish gray, micaceous, weak			SCH 40 PVC 2" diameter 0.1" slotted screen
	21										
700								Fracture #5: 0, B, No, W, VN, Pl, SR			
	22							becomes brown, coarse, very strong, micaceous			
								becomes greenish gray, strong, very micaceous, wet,			#5 filter sand
	23	R	R4	65%	82			coarse grained			
								becomes brown, coarse, very strong			
	24							becomes dark brown, moderately weathered, strong			
								becomes light gray, coarse, very strong with some			
	25							sections of slight weathering, brown			
	26										
695											
	27							becomes gray, coarse-grained, micaceous, weak with			
		R	R5	80%	100			stained sections (strong where stained)			
	28										
	29							Fracture #6: 90, J, Su, W, VN, Ir, VR			
	30							Fracture #7: 0, B, No, W, VN, Pl, SR			2" diameter sump
	31							SHALE, gray, fissile, strong			
690								MUDSTONE, gray, very weak, slightly fissile			
	32										
		R	R6	75%	88			becomes with decreasing fissility			
	33							SHALE, gray, fissile, weak			
								becomes with brown staining			
	34							MUDSTONE, gray, very weak, not fissile			
	35							End of Boring at 35´ bgs			
	36										
685											
	37										
	38										
	39										
	40										
	41										
680											
	42										
	43										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
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Log of Boring/Rock Core
HB-5 (MW-1205)

Sheet 1 of 3

Date(s) Drilled	**4/19/12**	Logged By	**S. Becker**	Checked By	**J. Lach**
Drilling Method	**HSA, HQ Wireline Coring**	Drill Bit Size/Type	**6 1/4" HSA/6" OD bit with HQ core**	Total Depth of Borehole	**54.5 ft**
Drill Rig Type	**CME 55**	Drilling Contractor	**Frontz Drilling**	Surface Elevation	**714.3 ft above msl**
Borehole Backfill	**Finished as monitoring well MW-1205**	Sampling Method(s)	**Split-spoon, HQ Core**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 251,131.0 E 2,104,397.0**	Groundwater Level(s)	**Not encountered**		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Pene-trometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	0										
		SS	SS-1	2 1 2 1	100			Very loose, moist, black bottom ash, trace gravel [BOTTOM ASH]			**Bentonite grout**
	1										**SCH 40 PVC 2" diameter riser**
	2										
		SS	SS-2	2 1 3 4	33	2.0		Medium stiff to very stiff, moist, brown to tan lean CLAY (CL) with sand and trace gravel [RESIDUUM]			
	4										
710		SS	SS-3	9 5 8 8	100	2.75 1.0 2.75 1.5		3" red sand seam	15.8		*PL=17 LL=33 PI=16 %F=47.6* *Shelby tube sample 5-7' bgs* *Down pressure (psi) = 200-600 psi*
	6							becomes stiff to very stiff, reddish-brown, trace sand			
		SS	SS-4	9 6 7 8	83	2.0 1.75 3.5 >4.5		becomes with trace tan-brown shale fragments	16.1		*PL=16 LL=32 PI=16 %F=49.5*
	8							SHALE, tan, moderate to highly weathered, weak to extremely weak, dry to moist			
705		SS	SS-5	8 15 12 12	75						
	10							becomes dry			
		SS	SS-6	4 17 23 19	100						
	12										
		SS	SS-7	21 28 29 35	83						
	14										
700		SS	SS-8	11 20 21 20	100			becomes white/gray			
	16	SS	SS-9	50/3"	100			becomes greenish gray			*Outside of spoon wet*
	17										
	18										
	19										
695											
	20	R	R1	17%	37			becomes gray, slight weathering, very weak to extremely weak			*Auger to 19.5 ft to begin coring.*

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Log of Boring/Rock Core
HB-5 (MW-1205)

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	20									
	21									SCH 40 PVC 2" diameter riser
	22		R1	17%	37					
	23									Bentonite grout
	24									
690								becomes red		
	25									
	26							becomes black and red		
	27		R2	47%	70					
	28							becomes gray		
	29									
685										
	30							Fracture #1: 0, B, T, Cl-No, Su-No, Pl, S, M-W		
	31									
	32		R3	35%	57					
	33									
	34									
680										
	35									
	36							becomes sandy		Bentonite chips
	37		R4	0%	100			SANDSTONE, gray, moderately to highly weathered, weak to medium strong, micaceous, thinly bedded, with numerous bedding plane fractures		
	38							Fracture #2: 0, B, T, Cl-No, Su-No, Pl, S, M		Filter sand
	39									
675										
	40									SCH 40 PVC 2" diameter 0.01 slotted screen
	41									
	42		R5	42%	100			becomes slightly-moderately weathered		
	43									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
HB-5 (MW-1205)

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
670	44		R5	42%	100					
	45									
	46									SCH 40 PVC 2" diameter 0.01 slotted screen
	47		R6	55%	93					
	48									
665	49									
	50									Filter sand
	51									
	52		R7		100			Sandy SHALE, gray, moderately weathered, moderately strong to weak		
	53							becomes less sandy		
	54							coal seam, 2" coal seam, 3"		
660								End of Boring at 54.5´ bgs		
	55									
	56									
	57									
	58									
	59									
655	60									
	61									
	62									
	63									
	64									
650	65									
	66									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
HB-3 (MW-1206)

Date(s) Drilled	**4/23/12**	Logged By	**S. Becker**	Checked By	**J. Lach**
Drilling Method	**Rotosonic (No vibration), Wireline**	Drill Bit Size/Type	**8.0" ID steel casing, 4.0" ID core barrel**	Total Depth of Borehole	**124.5 ft**
Drill Rig Type	**Versa-Sonic**	Drilling Contractor	**Frontz Drilling**	Surface Elevation	**695.4 ft above msl**
Borehole Backfill	**Finished as monitoring well MW-1206**	Sampling Method(s)	**Rotosonic Core Barrel**	Hammer Data	**Not Applicable**
Boring Location	**N 251,617.9 E 2,104,243.0**	Groundwater Level(s)	**Not encountered**		

Elevation, feet	Depth, feet	SAMPLES: Type Number	SAMPLES: Sampling Resist. Blows/6" OR CORE% RQD	SAMPLES: Recovery, %	SAMPLES: Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
695	0						See log for PB-7 from 0-111 ft bgs			Bentonite chips
	1									
	2									
	3									SCH 40 PVC 2" diameter riser
	4									
690	5									
	6									
	7									
	8									
	9									
685	10									
	11									
	12									
	13									
	14									
680	15									
	16									
	17									
	18									
	19									
	20									

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Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
HB-3 (MW-1206)

Elevation, feet	Depth, feet	SAMPLES: Type / Number	SAMPLES: Sampling Resist. Blows/6" OR CORE% RQD	SAMPLES: Recovery, %	SAMPLES: Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
675	20									
	21									Bentonite chips
	22									
	23									SCH 40 PVC 2" diameter riser
	24									
	25									
670	26									
	27									
	28									
	29									
	30									
665	31									
	32									
	33									
	34									
	35									
660	36									
	37									
	38									
	39									
	40									
655	41									
	42									
	43									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
HB-3 (MW-1206)

Elevation, feet	Depth, feet	SAMPLES: Type / Number	SAMPLES: Sampling Resist. Blows/6" OR CORE% RQD	SAMPLES: Recovery, %	SAMPLES: Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	44									
	45									Bentonite chips
650	46									
	47									SCH 40 PVC 2" diameter riser
	48									
	49									
	50									
645	51									
	52									
	53									
	54									
	55									
640	56									
	57									
	58									
	59									
	60									
635	61									
	62									
	63									
	64									
	65									
630	66									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
HB-3 (MW-1206)

Elevation, feet	Depth, feet	SAMPLES: Type / Number	SAMPLES: Sampling Resist. Blows/6" OR CORE% RQD	SAMPLES: Recovery, %	SAMPLES: Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	67									Bentonite chips
	68									
	69									SCH 40 PVC 2" diameter riser
	70									
625	71									
	72									
	73									
	74									
	75									
620	76									
	77									
	78									
	79									
	80									
615	81									
	82									
	83									
	84									
	85									
610	86									
	87									
	88									
	89									
	90									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
HB-3 (MW-1206)

Elevation, feet	Depth, feet	SAMPLES Type Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
605	91								Bentonite chips
	92								
	93								SCH 40 PVC 2" diameter riser
	94								
	95								
600	96								
	97								
	98								
	99								
	100								
595	101								
	102								
	103								
	104								
	105								
590	106								
	107								
	108								
	109								Bentonite seal
	110								
585	111				0.5		Soft, moist to wet, dark gray to dark greenish gray, sandy lean CLAY (CL) [ALLUVIUM]		# 5 filter sand
	112	CB-1		90	0.5				
	113						becomes greenish gray, trace oxidized red and gray		

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Project Location: Louisa, KY
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Log of Boring
HB-3 (MW-1206)

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	114					2.5		becomes very stiff with sand seams		SCH 40 PVC 2" diameter 0.01" slotted screen
						2.5				
	115							becomes with trace gray to dark gray sandstone fragments		
580						2.75				
	116									
						2.25				
	117	CB	CB-1		90					
						3.0				
	118									
						2.5				
	119									# 5 filter sand
						2.5				
	120							becomes greenish brown		
575						4.5				
	121									
						1.5		becomes brownish gray, intermittent sandy clay seams		
	122									
						2.0		becomes with trace sandy shale and sandstone cobbles and gravel		
	123	CB	CB-2		95					*Install MW-1206 at 123.5 ft on 4/24/2012*
						1.25		becomes stiff, grayish brown		*Clay expansion to 123.6 ft overnight*
	124									
								End of Boring at 124.5´ bgs		*Core barrel refusal at 124.5 ft bgs*
	125									
570										
	126									
	127									
	128									
	129									
	130									
565										
	131									
	132									
	133									
	134									
	135									
560										
	136									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
HB-6 (MW-1207)

Sheet 1 of 8

Date(s) Drilled	**4/24/12**	Logged By	**S. Becker**	Checked By	**J. Lach**
Drilling Method	**Rotosonic (No vibration), Wireline HQ**	Drill Bit Size/Type	**8" ID steel casing, 6" OD bit HQ Wireline**	Total Depth of Borehole	**166.0 ft**
Drill Rig Type	**Vibra-Sonic**	Drilling Contractor	**Frontz Drilling**	Surface Elevation	**695.0 ft above msl**
Borehole Backfill	**Finished as monitoring well MW-1207**	Sampling Method(s)	**HQ Wireline**	Hammer Data	**Not applicable**
Boring Location	**N 251,598.3 E 2,104,256.0**	Groundwater Level(s)	**Not encountered**		

Elevation, feet	Depth, feet	SAMPLES: Type / Number	SAMPLES: Sampling Resist. Blows/6" OR CORE% RQD	SAMPLES: Recovery, %	SAMPLES: Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
695	0						See log for boring PB-7		**Bentonite grout**
	1								**SCH 40 PVC 2" diameter riser**
	2								*Augered to 126 ft without sampling*
	3								
	4								
690	5								
	6								
	7								
	8								
	9								
685	10								
	11								
	12								
	13								
	14								
680	15								
	16								
	17								
	18								
	19								
675	20								

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
HB-6 (MW-1207)

Elevation, feet	Depth, feet	SAMPLES: Type / Number	SAMPLES: Sampling Resist. Blows/6" OR CORE% RQD	SAMPLES: Recovery, %	SAMPLES: Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
675	20									
	21									SCH 40 PVC 2" diameter riser
	22									Bentonite grout
	23									
	24									
670	25									
	26									
	27									
	28									
	29									
665	30									
	31									
	32									
	33									
	34									
660	35									
	36									
	37									
	38									
	39									
655	40									
	41									
	42									
	43									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
HB-6 (MW-1207)

Elevation, feet	Depth, feet	SAMPLES: Type / Number	SAMPLES: Sampling Resist. Blows/6" OR CORE% RQD	SAMPLES: Recovery, %	SAMPLES: Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	44									SCH 40 PVC 2" diameter riser
650	45									
	46									Bentonite grout
	47									
	48									
	49									
645	50									
	51									
	52									
	53									
	54									
640	55									
	56									
	57									
	58									
	59									
635	60									
	61									
	62									
	63									
	64									
630	65									
	66									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
HB-6 (MW-1207)

Elevation, feet	Depth, feet	SAMPLES: Type / Number	SAMPLES: Sampling Resist. Blows/6" OR CORE% RQD	SAMPLES: Recovery, %	SAMPLES: Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	67									SCH 40 PVC 2" diameter riser
	68									
	69									Bentonite grout
625	70									
	71									
	72									
	73									
	74									
620	75									
	76									
	77									
	78									
	79									
615	80									
	81									
	82									
	83									
	84									
610	85									
	86									
	87									
	88									
	89									
605	90									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
HB-6 (MW-1207)

Elevation, feet	Depth, feet	SAMPLES: Type / Number	SAMPLES: Sampling Resist. Blows/6" OR CORE% RQD	SAMPLES: Recovery, %	SAMPLES: Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	91									SCH 40 PVC 2" diameter riser
	92									
	93									Bentonite grout
	94									
600	95									
	96									
	97									
	98									
	99									
595	100									
	101									
	102									
	103									
	104									
590	105									
	106									
	107									
	108									
	109									
585	110									
	111									
	112									
	113									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
HB-6 (MW-1207)

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	114									SCH 40 PVC 2" diameter riser
580	115									Bentonite grout
	116									
	117									
	118									
	119									
575	120									
	121									
	122									
	123									
	124									
570	125									
	126							No recovery 126-131. Driller notes "softer material"		
	127									
	128		HQ1	0%	0					
	129									
565	130									
	131							No recovery 131-136. Shale cuttings		
	132									
	133		HQ2	0%	0					
	134									
560	135									
	136		HQ3	18%	80			SHALE, light gray to gray, moderately weathered, very to extremely weak		

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
HB-6 (MW-1207)

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	137							Fracture #1: 0, B, N-T, Cl, SP, Pl, S-SR, VC-M		SCH 40 PVC 2" diameter riser
	138									
	139	HQ3		18%	80					Bentonite grout
555	140							becomes with trace gray sandstone layers (occasional), up to 1/4"		
	141									
	142									
	143	HQ4		0%	50					
	144									
550	145							becomes dark gray to greenish gray, without sandstone seams		
	146									
	147							becomes dark gray to black		
	148							becomes light gray		
	149	HQ5		38%	38					
545	150									Bentonite seal
	151							3" layer of light gray, moist clay, with shale fragments		
	152									
	153							becomes interbedded with gray micaceous sandstone layers up to 1/4"		#5 filter sand
	154	HQ6		37%	83					
540	155									SCH 40 PVC 2" diameter 0.01" slotted screen
	156							6" sandstone, gray, slightly weathered, strong, thinly bedded to shaly		
	157							becomes extremely weak, highly fractured		
	158	HQ7		25%	73					
	159							interbedded sandstone up to 1/4"		
535	160							becomes dark gray, with thin light gray clay deposits on bedding		

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
HB-6 (MW-1207)

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
			HQ7	25%	73						
	161							SANDSTONE, gray, moderately weathered medium strong to very strong, flaggy, with thinly interbedded shale, micaceous			SCH 40 PVC 2" diameter 0.01" slotted screen
	162										
	163							Fracture #2: 0, B, T-VN, Cl, SP, Pl, S-SR, VC-M			#5 filter sand
			HQ8	42%	100						
	164										
530	165										
	166							End of Boring at 166´ bgs			
	167										
	168										
	169										
525	170										
	171										
	172										
	173										
	174										
520	175										
	176										
	177										
	178										
	179										
515	180										
	181										
	182										
	183										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
PB-1

Date(s) Drilled	**4/18/12**	Logged By	**J. Ristow**	Checked By	**V. Gautam**
Drilling Method	**Rotary/Water**	Drill Bit Size/Type	**4"**	Total Depth of Borehole	**57.0 ft**
Drill Rig Type	**Acker**	Drilling Contractor	**Pennsylvania Drilling**	Surface Elevation	**Top of water el. 695.1 ft above msl**
Borehole Backfill	**Cement Bentonite Grout**	Sampling Method(s)	**Piston tube/Split-spoon**	Hammer Data	**140#/30" Manual drop**
Boring Location	**38°10'57.4" N 83°38'41.3" W**	Groundwater Level(s)	**0' bgs**		

Elevation, feet	Depth, feet	SAMPLES: Type Number	SAMPLES: Sampling Resist. Blows/6" OR CORE% RQD	SAMPLES: Recovery, %	SAMPLES: Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
695	0						Water ▽			*Barge drilling- water @ 695.1.*
	1									
	2									
	3									
	4									
690	5									
	6									
	7									
	8									
	9									
685	10									
	11									
	12									
	13									
	14									
680	15									
	16									
	17									
	18									
	19									
	20									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-1

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
675	20										
	21										
	22										
	23							Soft sediments			*Top of sediment @ 22.5 ft. Casing sank to 27.5 ft.*
	24										
670	25										
	26										
	27							Loose, wet fly ash as silty sand (SM) [FLY ASH]			
	28	SS	SS-1	1 WH 0 0	38						
	29										
665	30										
	31	P	P-1		91						
	32										
	33										
	34										
660	35										
	36	P	P-2		77						
	37										
	38	SS	SS-2	3 6 8 5	100						
	39										
655	40										*Rods sank to 42'*
	41										
	42							12" loose, wet, fly ash as silt (ML), trace fine sand [FLY ASH]			
	43					<0.5					

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-1

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	44					2.0		Soft, moist, dark gray, lean CLAY (CL) [ALLUVIUM]			
								becomes stiff, yellow, some sand, trace gravel			
650	45							becomes very stiff, yellow brown with orange iron staining, with sand, trace gravel			
	46	SS	3	3 3 4 5	38	2.5					
	47										
	48										
	49										
645	50							becomes stiff to very stiff, sandy, trace gravel			
	51	SS	4	6 7 12 12	33	1.0 2.5					
	52										
	53										
	54							Shale, gray, dry, crushed			*Drilling change encountered @ 53.5 ft bgs*
640	55										
	56	SS	5	45 50/2"	33						
	57							End of Boring at 57´ bgs			
	58										
	59										
635	60										
	61										
	62										
	63										
	64										
630	65										
	66										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
PB-2

Sheet 1 of 4

Date(s) Drilled	**4/17/12-4/18/12**	Logged By	**J. Ristow**	Checked By	**V. Gautam**
Drilling Method	**Rotary/Water**	Drill Bit Size/Type	**4"**	Total Depth of Borehole	**77.0 ft**
Drill Rig Type	**Acker**	Drilling Contractor	**Pennsylvania Drilling**	Surface Elevation	**Top of water el. 695.1 ft above msl**
Borehole Backfill	**Bentonite chips**	Sampling Method(s)	**Piston/Split-spoon/Shelby-tube**	Hammer Data	**140#/30" Manual drop**
Boring Location	**38°10'52.5" N 83°33'35.2" W**	Groundwater Level(s)	**0 ft bgs**		

Elevation, feet	Depth, feet	SAMPLES: Type Number	SAMPLES: Sampling Resist. Blows/6" OR CORE% RQD	SAMPLES: Recovery, %	SAMPLES: Pocket Pene-trometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
695	0						Water			*Pond elevation - 695.1 ft*
	1									
	2									
	3									
	4									
690	5									
	6									
	7									
	8									
	9									
685	10									
	11									
	12									
	13									
	14									
680	15									
	16									
	17									
	18									
	19									
	20									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
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Log of Boring PB-2

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
675	20										
	21										
	22										
	23							Soft sediments			*Pond bottom @ 23' bgs*
	24										
670	25										*Casing sank to 25'*
	26		SS-1	2 1 2 3	17			Very loose, wet, gray bottom ash as medium to fine SAND (SP-SM) with some gravel and shale fragments, trace plant fragments [BOTTOM ASH]			
	27										
	28										
	29										
665	30							Loose, wet, fly ash as silty SAND (SM), light and dark laminations [FLY ASH]			
	31		P-1		0						
	32										*1 blow for 24 inches*
	33		SS-2	1 0 0 0	0						
	34										
660	35										
	36										
	37										
	38		P-2		91						
	39										
655	40		SS-3	2 1 1 2	27						
	41										
	42										
	43										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-2

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	44										
650	45										*Push to 45' bgs - casing sank to 46' bgs*
	46							becomes gray, with silty sand			
	47	SS-4		1 0 0 0							
	48										
	49										
645	50	P-3			99						
	51							becomes with silt and some fine black sand			
	52	SS-5		WH 0 0 0	100	>1.0		Very soft to stiff, moist, dark gray, lean CLAY (CL) [ALLUVIUM]			
	53										
	54										
640	55							becomes yellow			
	56	P-4									
	57							becomes soft, moist, grey/yellow, some silt, trace gravel, sand at base - root			
	58	SS-6		3 3 6 14	75	0.5 1.0		becomes stiff	20.6		*PL=16 LL=27 PI=12*
	59										
635	60										
	61	ST-1			50						
	62							becomes stiff, yellow brown with orange mottles, with gravel and trace sand			
	63	SS-7		7 8 9 5	25	1.5 2.0					
	64										
630	65										
	66	SS-8		3 WR WR	33	0.5		Loose, moist, orange brown with gray mottles, sandy CLAY (SC), trace gravel [ALLUVIUM]			

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
PB-2

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	67			6							*End at 67' 4/17/12* *Start on 4/18/12* *Begin by drilling to 70'*
	68										
	69							Very stiff, moist, yellow brown with gray mottles, silty CLAY (CL), some sand and gravel [RESIDUUM]			
625	70			5							
	71		SS-9	7 13 11	38	2.5 3.0			16.8		*PL=17 LL=24 PI=7*
	72										
	73										
	74							Shale, light gray, moderately weathered, dry			
620	75										
	76		SS-10	50/3"	13						
	77							End of Boring at 77´ bgs			
	78										
	79										
615	80										
	81										
	82										
	83										
	84										
610	85										
	86										
	87										
	88										
	89										
	90										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-3

Sheet 1 of 5

Date(s) Drilled	**4/9/12-4/10/12**	Logged By	**T. George**	Checked By	**V. Gautam**
Drilling Method	**HSA, Mud rotary with recirculated mud**	Drill Bit Size/Type	**4 1/4" ID/8" OD HSA, 4" tricore mud-rotary**	Total Depth of Borehole	**93.0 ft**
Drill Rig Type	**CME 55 Track Mounted and ATV-remote control**	Drilling Contractor	**Pennsylvania Drilling**	Surface Elevation	**698.3 ft above msl**
Borehole Backfill	**Finished as 2" PVC riser pipe set w/ grout**	Sampling Method(s)	**Split-spoon/Piston/Shelby-tube**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 251,582.4 E 2,102,704.0**	Groundwater Level(s)	**4' ATD**		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Pene-trometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	0							Bottom ash access road [BOTTOM ASH]		2.5' stickup; Grout
	1									SCH 40 PVC 2" diameter riser
	2									
	3									*Augered to 6' without sampling*
695	4									
	5									
	6	SS	SS-1	1 2 WOH 1	63			Very loose, wet, fly ash as interbedded light and dark sandy SILT (ML) and silty SAND (SM), trace root fibers [FLY ASH]		
	7									
690	8	SS	SS-2	1 2 1 1						
	9									
	10									
	11									
	12									
	13							becomes without root fibers		
685	14	SS	SS-3	WOH 0 0 0	79					
	15									
	16									
	17									
	18									
680	19	SS	SS-4	WOR 0 0 1	75					
	20									

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Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-3

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	20									
	21	P	1		71					
	22									
	23									
675	24	SS	5	WOH 0 0 0	0					
	25									
	26									
	27							Medium dense, moist, dark gray trace brown, bottom ash as medium to fine sand (SM), trace coal gravel [BOTTOM ASH]		*Increased drilling resistance @ 27' bgs*
	28	SS	6	7 13 13 14	67					
670	29									
	30							Wet, light to dark gray, fly ash as silty SAND (SM) to silt (ML) [FLY ASH]		
	31									
	32									
	33	P	2		0			Very loose, wet, black, bottom ash and coal fragments as coarse SAND (SP-SM) with gravel [BOTTOM ASH]		
665	34									
	35									
	36									
	37									
	38	P	3		0					
660	39									
	40							becomes black and gray, medium to coarse, with gravel		
	41	SS	7	1 1 1 2	100					
	42							becomes gravelly		*coal gravel up to 7/8"*
	43	SS	8	1	8					
655										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-3

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	44	SS	8	0 1 0	8					
	45									
	46									
	47									
650	48	SS	9	1 0 0 0	0					*Sample @ 47.5-49.5' bgs was driven to 50.5' bgs with 1 blow*
	49									
	50									
	51									
	52									
	53	SS	10	WOH 0 1 1	0			becomes coarse to fine		
645	54									
	55									
	56							Very loose, wet, light gray, fly ash as sandy SILT (ML) with interbedded fine sand [FLY ASH]		
	57									
	58	P	4		67					
640	59									
	60									
	61									
	62									
	63	SS	11	1 1 1 3	92			becomes with minor interbedded silty sand-laminations		
635	64									
	65									
	66									

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Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-3

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	67									
	68	P	P-5		83					
630	69									
	70									
	71									
	72									
	73									
625	74							Loose, moist, brown and black, clayey SAND (SC) with decayed plant matter (topsoil)		
	75	SS	SS-12	4 5 5 7	58	1.75 <0.5 1.25		becomes sandy silty clay (CL-ML), trace reddish brown root fibers Soft to stiff, moist, brown with gray mottling sandy lean CLAY (CL) [ALLUVIUM]		
	76									
	77									
	78	ST	ST-1	4 5 5 7	79			Medium dense, moist, variably brown with dark gray and gray mottling, gravelly clayey SAND (SC) [ALLUVIUM]		
620	79	SS	SS-13	18 6 6 9	33					*1 5/8" sandstone on bottom of tube*
	80									
	81									
	82									
	83	SS	SS-14	8 11 17 20	50			Medium dense, moist, variably brown with gray mottling, oxidation staining, clayey GRAVEL (GC), as completely to highly weathered sandstone, horizontal bedding [RESIDUUM]		
615	84									
	85									
	86							Medium dense, moist, variably brown with gray mottling, clayey SAND (SC), with gravel as completely weathered sandstone [RESIDUUM]		
	87									
	88	SS	SS-15	4 6 12 15	100					
610	89									
	90									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
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Log of Boring
PB-3

Elevation, feet	Depth, feet	SAMPLES Type Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	91						Sandy silty shale, gray with oxidation staining, moderately weathered, weak		
	92								
	93	SS-16	50/4.5"	100					
605	93						End of Boring at 93´ bgs		*Set PVC casing at 93' bgs. Cement-bentonite grout placed using tremie pipe*
	94								
	95								
	96								
	97								
600	98								
	99								
	100								
	101								
	102								
	103								
595	104								
	105								
	106								
	107								
	108								
590	109								
	110								
	111								
	112								
	113								
585									

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Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-4

Sheet 1 of 5

Date(s) Drilled	**4/11/12-4/13/12**	Logged By	**T. George**	Checked By	**V. Gautam**
Drilling Method	**HSA, Mud rotary**	Drill Bit Size/Type	**4 1/4" ID/8" OD HSA, 4" tricone bit**	Total Depth of Borehole	**112.2 ft**
Drill Rig Type	**CME 55 Rubber Track ATV, Remote control**	Drilling Contractor	**Pennsylvania Drilling**	Surface Elevation	**700.0 ft above msl**
Borehole Backfill	**2" PVC riser pipe set with grout**	Sampling Method(s)	**Piston/Split-spoon/Shelby-tube**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 251,302.5 E 2,103,601.0**	Groundwater Level(s)	**Encountered at 7.6' bgs ATD**		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Pene-trometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
700	0									2.5' stickup
										Grout
	1							Very loose, moist, dark gray bottom ash as coarse to fine SAND (SP-SM), trace gravel [BOTTOM ASH]		*Bottom ash access road*
	2									
	3									
	4									
695	5									
	6	SS	SS-1	2 2 2 2	83					
	7								▽	
	8	SS	SS-2	2 2 2 1	33			Very loose, wet, light gray to dark gray fly ash as silty SAND (SM) with minor interbedded sandy silt (ML) trace cat-tail roots [FLY ASH]		
690	9									
	10									
	11									
	12									
	13	SS	SS-3	2 1 1 1	75			becomes without cat-tails		
	14							becomes horizontally bedded		
685	15									
	16									
	17									
	18									*@ 18' bgs begin open hole mud rotary*
	19	SS	P-1		98					
680	20									

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Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-4

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
680	20									*sand becoming finer*
	21	SS	4	WOH 2 2 1	46					
	22									
	23									
	24	SS	5	2 1 1 1	50					
675	25									
	26									
	27									
	28	P	2		54					
	29									
670	30	SS	6	1 2 2 1	58					
	31									
	32									
	33	P	3		50					
	34									
665	35	SS	7	WOH 1 0 1	54					
	36									
	37							becomes mostly sand silt (ML) with minor silty sand (SM)		*Split-spoon intended at 37-39 fell to 43' bgs on WOH.*
	38	SS	8	WOH 0 0 0	58					
	39									
660	40									
	41									
	42									
	43									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-4

Elevation, feet	Depth, feet	SAMPLES Type Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	44								
655	45								
	46								
	47								
	48	P-4		50					
	49								
			WOH						
650	50	SS-9	0	67					
			0						
	51		1						
	52								
	53								
	54								
645	55						Loose, wet, variably gray, trace brown bottom ash as medium fine SAND (SP-SM), trace gravel, with interbedded minor fly ash as sandy silt (ML), mostly laminated [BOTTOM ASH]		
	56								
	57		3						
	58	SS-10	4	71					
			4						
	59		4						
640	60								
	61						Very loose, wet, gray, fly ash as fine silty SAND (SP-SM), with minor interbedded sandy silt [FLY ASH]		
	62								
	63	P-5		98					
	64								
			WOH						
635	65	SS-11	0	63					
			1						
	66		0						

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Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-4

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	67									
	68									
	69							becomes mostly sandy SILT (ML), with minor interbedded silty sand (SM) [FLY ASH]		
630	70									
	71									
	72			1						
	73		SS-12	0 0 0	75					*1 blow for 6 ft when attempting to sample @ 72-74' bgs. Driven to 78' bgs*
	74									
625	75									
	76									
	77									
	78									
	79									
620	80									
	81							Loose, wet, mostly dark gray with interbedded light gray, bottom ash as medium fine SAND (SP-SM), with interbedded fly ash as fine silty sand to sandy silt [BOTTOM ASH]		*Drilling resistance increases @ 80.5'*
	82			4						
	83		SS-13	4 5 3	58					
	84									
615	85									
	86							Stiff, moist, brown and red sandy lean CLAY (CL), trace gravel as sandstone gravel [ALLUVIUM]		
	87			2		2.0				*Topsoil in slough of sample @ 87-89' bgs.*
	88		SS-14	7 10 11	83	1.5 1.25 2.0		becomes orange-brown		
	89									
	90		ST-1		100					*400 to 600 psi down pressure*
610										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-4

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	91	ST-1			100	2.5		becomes very stiff		
	92							Medium dense, moist, variably orange-brown with trace black and gray mottling, clayey SAND (SC) to sandy lean clay (CL), trace weathered sandstone gravel, trace coal particles [ALLUVIUM]		
	93	SS-15		10 7 7 12	63	2.0 0.75 1.0				
	94									
605	95									
	96									
	97							becomes brownish-gray		
	98	SS-16		WOH 0 14 5	100	0.75 0.75 0.5		Medium stiff, moist, gray with black peat particles, organic CLAY (OH), trace sand seams [ALLUVIUM]		
	99							Medium stiff, moist, dark brownish-gray fibrous PEAT (PT) with interbedded clayey SAND (SC), trace undecayed stems [ALLUVIUM]		
600	100	ST-2			100	0.5				*150 to 300 psi down pressure*
	101									
	102							Medium stiff, moist, brown, organic lean CLAY (OL) with greenish-gray sand seams, trace peat particles [ALLUVIUM]		
	103	SS-17		WOH 0 3 7	83	0.75 0.75 0.75				
	104									
595	105									
	106							Medium dense, moist, greenish-gray with brown oxidation staining, clayey SAND (SC) with horizontally bedded sandstone gravel [RESIDUUM]		*Increased drilling resistance @ 106' bgs.*
	107									
	108	SS-18		11 11 9 11	38				12.0	*PL=15 LL=25 PI=10 %G=24.8 %S=35.3 %F=39.9*
	109									
590	110									
	111							Sandstone, medium to fine, gray, slightly weathered, medium strong		*Increased drilling resistance @ 111' bgs.*
	112	SS-19		50/1/2"	100			End of Boring at 112.15´ bgs		*Set PVC casing at 112' Cement-bentonite grout placed using tremie pipe.*
	113									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
PB-5

Sheet 1 of 3

Date(s) Drilled	**4/13/12,4/16/12**	Logged By	**T. George**	Checked By	**V. Gautam**
Drilling Method	**HSA, Mud rotary**	Drill Bit Size/Type	**4 1/4" ID/8" OD HSA, 4" tricone bit**	Total Depth of Borehole	**57.1 ft**
Drill Rig Type	**CME 55 Rubber Track ATV, Remote control**	Drilling Contractor	**Pennsylvania Drilling**	Surface Elevation	**700.9 ft above msl**
Borehole Backfill	**2" SCH 40 PVC riser grouted in place**	Sampling Method(s)	**Piston/Split-spoon**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 251,174.1 E 2,103,663.0**	Groundwater Level(s)	**Encountered 8' bgs ATD, W.L. @ 10.5' bgs on 4/16/12**		

Elevation, feet	Depth, feet	SAMPLES Type Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Pene-trometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	0						Very loose, moist, dark gray bottom ash as coarse to fine sand (SP-SM to SM), trace gravel [BOTTOM ASH]			**Grout**
700	1									**SCH 40 PVC 2" diameter riser**
	2									*Bottom ash access road material to 10.5 ft*
	3									*Auger to 7 ft without sampling.*
	4									
	5									
695	6									
	7	SS-1	2 1 1 1	92						
	8						becomes wet	▽		
	9									
	10									
690	11						Very loose, wet, light and dark gray fly ash as interbedded fine silty SAND (SM) and sandy SILT (ML) [FLY ASH]			
	12									
	13	SS-2	3 2 1 1	71						
	14									
	15									
685	16									
	17						becomes all fine silty sand, mostly light gray			
	18	SS-3	WOR 0 WOH 0	42						
	19									
	20									

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Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-5

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	20									
680	21									
	22			WOH				becomes interbedded with sandy silt (ML)		*Pushed piston tube in offset borehole 22.5-24.5 ft bgs. 17% recovery*
	23	SS	SS-4	0 0 1	17					
	24							becomes fine sand in bottom of tube		
	25									
675	26									
	27									
	28	P	P-1		0					
	29			WOH				becomes mostly fine silty sand, with minor interbedded sandy silt		
	30	SS	SS-5	1 1 2	79					
670	31									
	32									
	33									
	34									
	35									
665	36									
	37							Loose, moist, brown with gray mottling, silty, clayey SAND (SC-SM), trace sandstone gravel [ALLUVIUM]		*No fly ash in tube*
	38	P	P-2		17					
	39			5						
	40	SS	SS-6	3 3 3	50				20.2	*PL=16 LL=23 PI=7 %G=7.7 %S=55.6 %F=36.7*
660	41									
	42									
	43	SS	SS-7	3	54			Dense, moist, light brown with oxidation staining, medium		

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-5

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	44		SS-7	5 25 22	54			to fine SAND (SP-SM), with completely weathered sandstone gravel [ALLUVIUM]		
	45									
655	46									*Lose mud return between 42-47' bgs*
	47							Loose, moist, dark brown, clayey SAND (SC) to sandy lean CLAY (CL) with decayed plant matter [ALLUVIUM]		
	48		SS-8	3 4 5 10	75			Loose, moist, light brown, medium to fine SAND (SP-SM) with gravel as completely weathered sandstone [ALLUVIUM]		
	49									
	50									
650	51							Very dense, moist, brown with gray mottling, oxidation staining, silty SAND (SM) as completely to highly weathered sandstone [RESIDUUM]		
	52									
	53		SS-9	22 38 46 50/2"	85					*%G=4.0 %S=56.6 %F=39.4*
	54									
	55							Sandstone, fine to medium, gray, slightly weathered to fresh, medium strong		
645	56									
	57		SS-10	50/1/4"	100			End of Boring at 57.1´ bgs		*Set PVC casing at 57' bgs. Cement-bentonite grout placed using tremie pipe*
	58									
	59									
	60									
640	61									
	62									
	63									
	64									
	65									
635	66									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-6

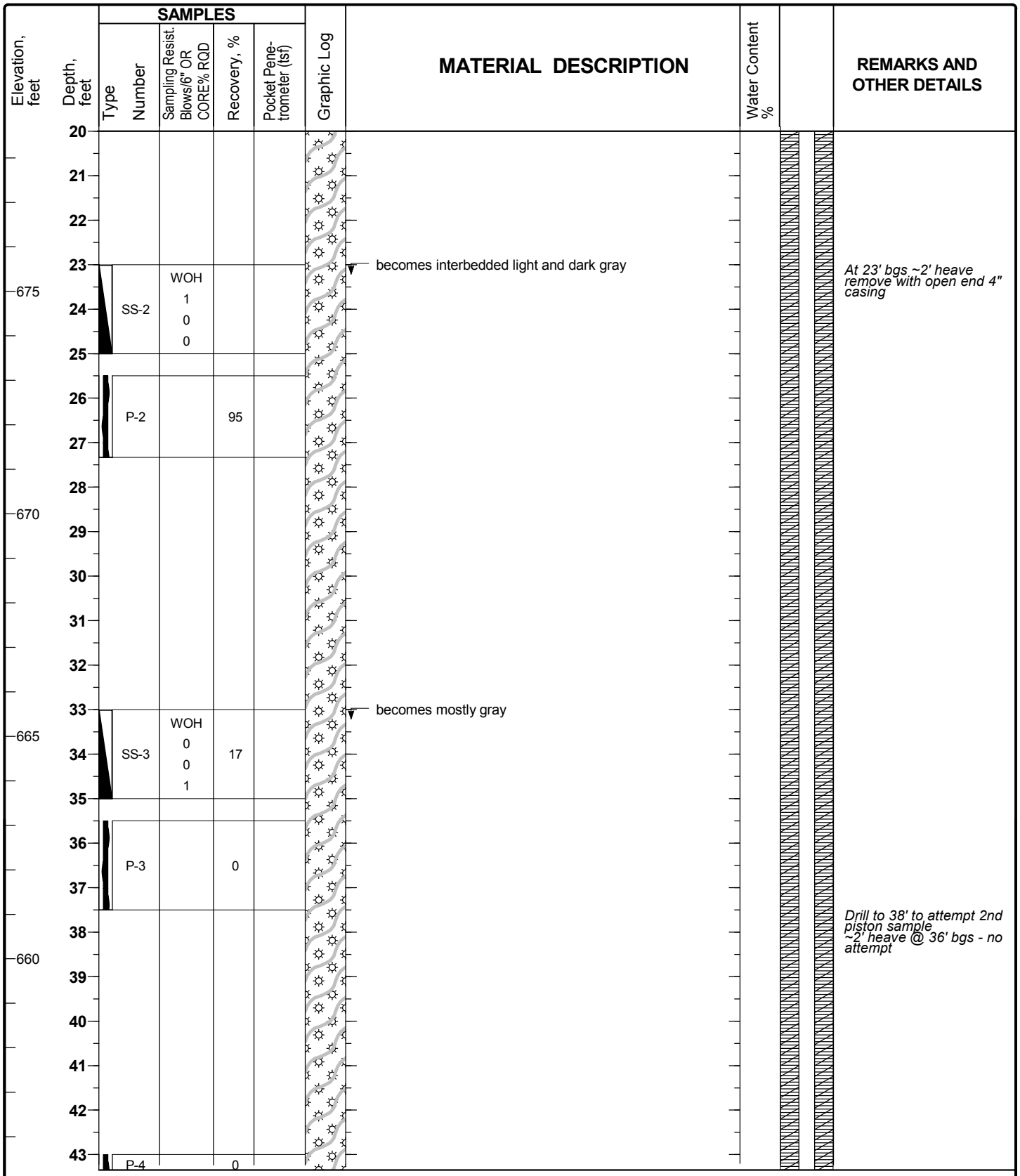
Sheet 1 of 5

Date(s) Drilled	**4/2/12**	Logged By	**T. George**	Checked By	**V. Gautam**
Drilling Method	**HSA, Mud rotary**	Drill Bit Size/Type	**4 1/4" ID/8" OD HSA, 4" tricone bit**	Total Depth of Borehole	**100.0 ft**
Drill Rig Type	**CME 55 Track Mounted Remote-control**	Drilling Contractor	**Pennsylvania Drilling**	Surface Elevation	**698.6 ft above msl**
Borehole Backfill	**2" SCH 40 PVC riser grouted in place**	Sampling Method(s)	**Piston/Split-spoon/Shelby-tube**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 251,301.0 E 2,103,083.0**	Groundwater Level(s)	**Not encountered**		

Elevation, feet	Depth, feet	SAMPLES Type Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Pene-trometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	0						Bottom ash access road [BOTTOM ASH]		2.6' stickup Grout
	1								*Drilled without sampling to 13' bgs.*
	2								
	3								2" SCH 40 PVC riser pipe
695	4								
	5								
	6								
	7								
	8								
690	9								
	10								
	11								
	12								
	13						Very loose, wet, gray with dark gray streaks fly ash as fine silty SAND (SM) [FLY ASH]		
685	14	SS-1	1 2 1 2	25					
	15								
	16								
	17	P-1		75					
	18								
680	19								
	20								

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-6



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Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-6

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
655	44	P-4			0			Very loose, wet, dark gray and black sandy coal as GRAVEL (GM)		
	45									
	46	P-5			88			Loose, wet, light and dark gray fly ash as fine silty SAND (SM) [FLY ASH]		
	47							becomes mostly sandy silt (ML) with interbedded silty clay (CL-ML) [FLY ASH]		
	48	SS-4		3 3 4 3	33					
650	49									
	50									
	51									
	52									
	53									
645	54	P-6			73					
	55									
	56	SS-5		WOH 0 0 0	0			becomes mostly silty SAND (SM), trace decayed root fibers [FLY ASH]		
	57							3/4" brown and gray mottled/layered lean clay (CL)		
	58	SS-6		WOH 1 2 3	92			becoming coarser ash particles		
640	59									
	60									
	61									
	62									
	63							becomes light gray		
635	64	P-7			96					
	65							12" loose, wet, gray fly ash as sandy silt		
	66	SS-7		2 3 5	100			becomes light and dark gray		

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-6

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	67			6						
	68									
630	69									
	70									
	71									*tube bent*
	72									
	73	P	P-8		100			Wet, brown, silty GRAVEL (GM), as sandstone fragments [ALLUVIUM]		*Fly ash mixed with gravel*
625	74									
	75									
	76									
	77							Stiff, moist, brown with oxidation staining, sandy lean CLAY (CL) to clayey sand (SC), trace gravel, trace root fibers [ALLUVIUM]		*Drilling resistance change @ 76.5' bgs*
	78			4		1.75				
620	79	SS	SS-8	7 7 17	54	1.5 1.5				
	80									
	81	ST	ST-1		50			Medium dense, moist, variably brown with oxidation staining, medium to fine SAND (SP-SM), trace gravel as sandstone fragments [ALLUVIUM]		*Shelby tube sample: 250 to 750 psi down pressure*
	82			7						
	83	SS	SS-9	6 9 9	4				14.4	
615	84									
	85									
	86							Stiff to very stiff, moist, grayish-green, trace oxidation staining, lean CLAY (CL), with sand, trace shale particles [ALLUVIUM]		
	87									
	88			3		1.25		1" clayey sand seam		
610	89	SS	SS-10	6 10 10	63	1.5 2.5				
	90									

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Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
PB-6

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	91									
	92							Loose, moist, greenish-grayish brown to brown with oxidation staining, fine to medium clayey SAND (SC), with interbedded lean clay seams, trace sandstone gravel [ALLUVIUM]		
	93			5						
605	94		SS-11	3 3 5	50	<0.5				
	95									
	96									
	97							Stiff, moist, grayish-brown, sandy lean CLAY (CL), trace peat [ALLUVIUM]		
	98			WOR		1.0				
600	99		SS-12	12 50/3"	100	1.0 1.25			21.8	*PL=17 LL=31 PI=14 %F=60.7*
	100							Sandstone, fine, gray with oxidation staining, moderately weathered, very weak to weak		
	101							End of Boring at 100´ bgs		*Set PVC casing @ 100' bgs. Cement-bentonite grout placed using tremie pipe.*
	102									
	103									
595	104									
	105									
	106									
	107									
	108									
590	109									
	110									
	111									
	112									
	113									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-7

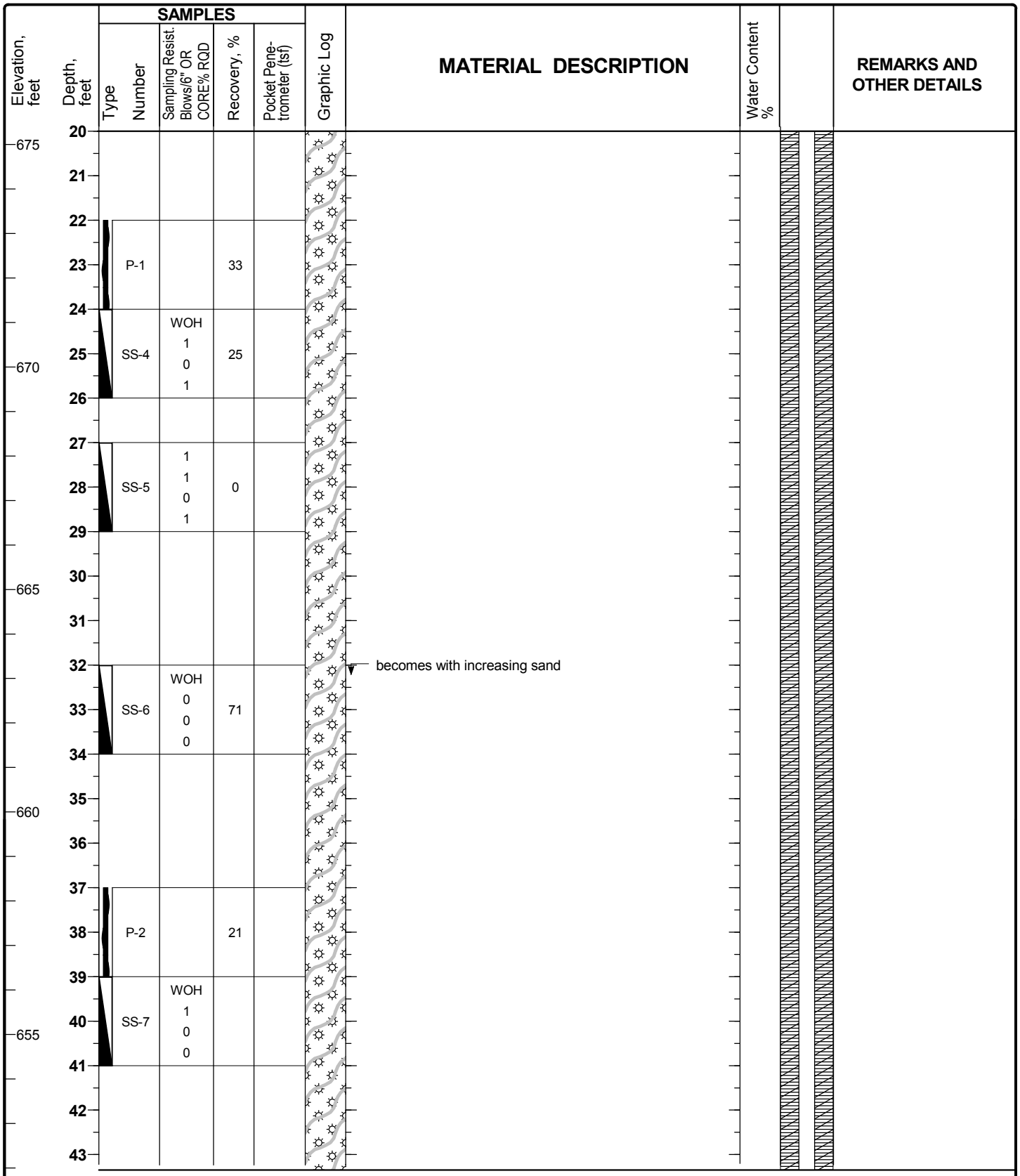
Sheet 1 of 6

Date(s) Drilled	**4/17/12-4/19/12**	Logged By	**T. George**	Checked By	**V. Gautam**
Drilling Method	**HSA, Mud rotary**	Drill Bit Size/Type	**4 1/4" ID/8" OD HSA, 4" tricore mud-rotary**	Total Depth of Borehole	**127.0 ft**
Drill Rig Type	**CME 55 Tracked ATV**	Drilling Contractor	**Pennsylvania Drilling**	Surface Elevation	**695.3 ft above msl**
Borehole Backfill	**2" SCH 40 PVC riser grouted in place**	Sampling Method(s)	**Piston/Split-spoon**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 251,635.0 E 2,104,228.0**	Groundwater Level(s)	**Encountered 8' ATD**		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Pene-trometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
695	0							Bottom ash access road [BOTTOM ASH]		2.5' stickup; Grout
	1									
	2									*Augered to 8' without sampling.*
	3									
	4									2" SCH 40 PVC riser pipe
	5									
690	6									
	7									
	8								▽	
	9	SS	SS-1	2 1 1 1	58			Very loose, wet, light gray with interbedded dark gray fly ash as mostly fine SAND (SP-SM to SM) with interbedded minor sandy SILT (ML) [FLY ASH]		
	10									
685	11									
	12									
	13							becomes mostly sandy silt (ML)		
	14	SS	SS-2	1 0 0 0	67					
	15									
680	16									
	17									
	18									
	19	SS	SS-3	1 0 1 1	58					
	20									

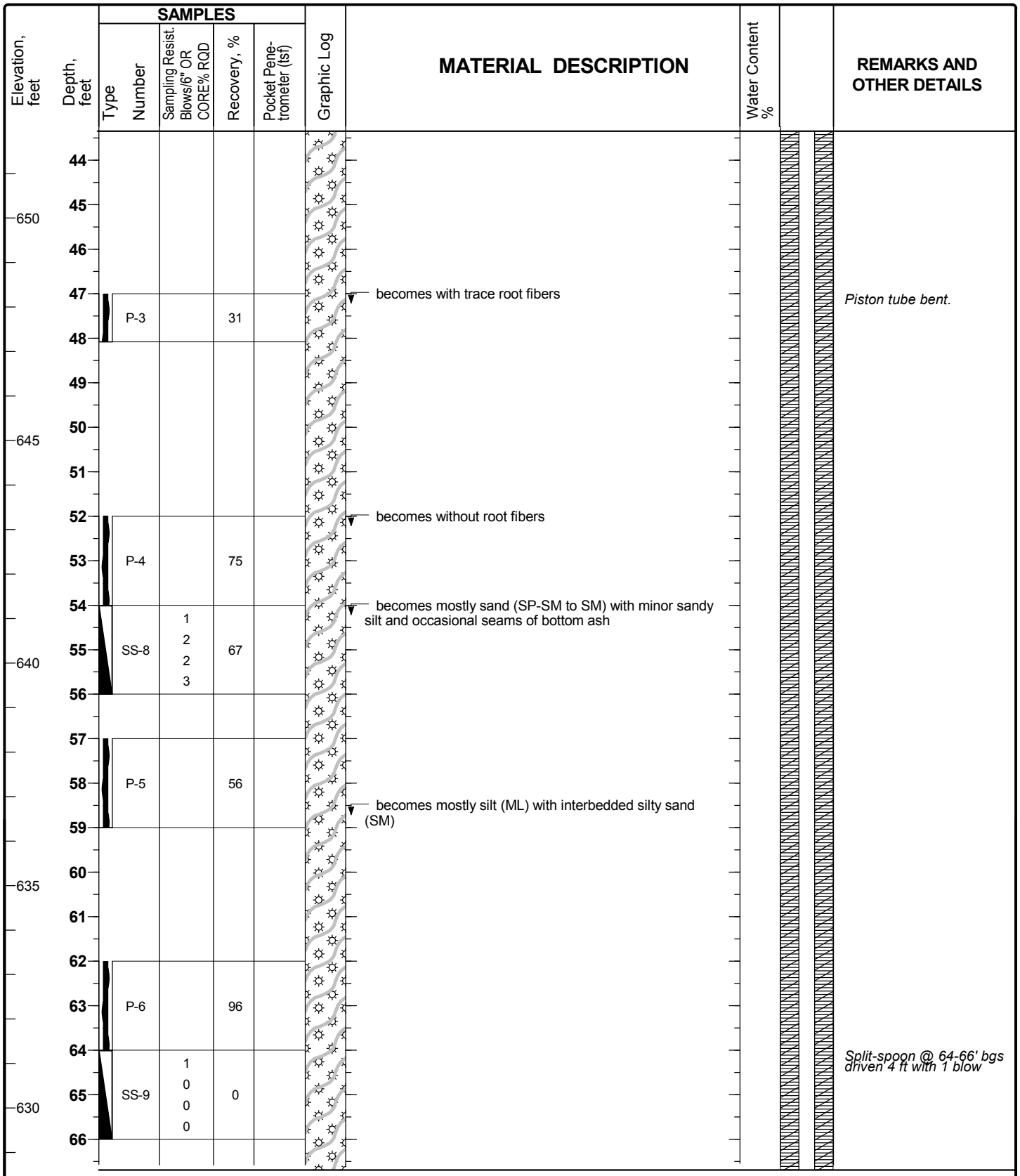
Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-7



Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-7



Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-7

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	67									
	68									
	69									
625	70									
	71									
	72									
	73		P-7		92					
	74									
	75		SS-10	2 1 3 6	92			becomes interbedded SM/SP/ML with light brown lean clay laminae		
620	76									
	77									
	78		P-8		75			becomes light brown and gray SILT (ML) with interbedded sand (SP-SM to SM), trace grass		
	79									
	80		SS-11	1 1 1 2	0					
615	81									
	82									
	83		P-9		92					
	84							becomes mostly sandy silt (ML)		
	85		SS-12	2 2 2 4	83			becomes mostly fine silty sand (SM)		
610	86									
	87									
	88		P-10		75					
	89							becomes mostly fine silty sand (SM) with minor interbedded sandy silt (ML)		*Sample at 89-91' bgs fell to 96' bgs under weight of rods*
	90		SS-13	WOR 0	100					

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-7

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
605	91	SS	13	0 0	100					
	92									
	93									
	94									
	95									
600	96									
	97	SS	14	WOR 0 0 0	0					*Split-spoon @ 97-99' bgs fell to 101.5' bgs*
	98									
	99									
	100									
595	101									
	102	SS	15	4 6 6 10	25			Medium dense, wet to moist, tan to brown with black staining and oxidation staining, clayey GRAVEL (GC), trace root fibers [ALLUVIUM]		*Gravel is sandstone fragments up to 1/2" diameter*
	103									
	104									
	105							Loose, wet, brown with oxidation staining, medium to fine SAND (SP-SM), trace interbedded lean clay [ALLUVIUM]		*Lean clay layers are <1" thick*
590	106									
	107	SS	16	3 4 3 2	71				23.7	*%G=0.0 %S=72.5 %F=27.5*
	108									
	109									
	110									
585	111							Medium dense, moist, brown with oxidation staining, gray and greenish gray, trace white, clayey SAND (SC) interbedded with silty sand (SM), trace sandstone gravel [ALLUVIUM]		
	112	SS	17	10 9 5	25					
	113									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-7

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	114		SS-17	4	25					
	115									
580	116									
	117							becomes all clayey sand (SC) with sandstone gravel		
	118		SS-18	12 11 11 11	54			Very stiff, moist, gray to dark brown and greenish gray lean CLAY (CL) with sand, trace sandstone gravel [ALLUVIUM]	15.1	*%G=11.8 %S=53.3 %F=34.9*
	119									
	120							Very dense, moist, variably brown with gray mottling, with oxidation staining, medium to fine SAND (SP-SM), with gravel as sandstone fragments [RESIDUUM]		
575	121									
	122									
	123		SS-19	10 30 33 50/1½"	71				14.1	*%G=11.1 %S=67.8 %F=21.1*
	124							Gray and dark gray shale, moderately weathered, weak		*Hard drilling 124-127' bgs*
	125									
570	126									
	127		SS-20	50/½"	100			becomes silty, dark gray, fresh, medium strong End of Boring at 127´ bgs		*Set PVC casing at 127' bgs. Cement-bentonite grout placed using tremie pipe.*
	128									
	129									
565	130									
	131									
	132									
	133									
	134									
	135									
560	136									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring
PB-8

Sheet 1 of 7

Date(s) Drilled	**4/20/12,4/23/12-4/25/12**	Logged By	**T. George**	Checked By	
Drilling Method	**HSA, Mud rotary**	Drill Bit Size/Type	**4 1/4" ID/8" OD HSA, 4" tricore mud-rotary**	Total Depth of Borehole	**153.0 ft**
Drill Rig Type	**CME 55 Rubber Track ATV, Remote control**	Drilling Contractor	**Pennsylvania Drilling**	Surface Elevation	**674.0 ft above msl**
Borehole Backfill	**2" SCH 40 PVC riser grouted in place**	Sampling Method(s)	**Piston/Split-spoon**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 253,100.3 E 2,105,679.0**	Groundwater Level(s)	**3.1 ft ATD**		

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Pene-trometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	0							Bottom ash splitter dike [BOTTOM ASH]		3.0' stickup; Grout
	1									SCH 40 PVC 2" diameter riser
	2									
	3								▽	*Drilled to 13' bgs without sampling*
670	4									
	5									
	6									
	7									
	8									
665	9									
	10									
	11									
	12									
	13							Very loose, wet, dark gray, bottom ash as coarse to fine SAND (SP-SM) trace gravel [BOTTOM ASH]		*Split-spoon @ 13' driven with 1 blow to 16'*
660	14	SS-1		1 0 0 0	100					*Bottom ash splitter dike*
	15									
	16									
	17									
	18									*~6" heave noted*
655	19	SS-2		1 0 1 0	100					
	20									

Report: GEO_CR_WELL; File K:\PROJECTS\AAEP\13815141_BSLF\DOCS\LOGS\AEPBORINGS-6-10-13.GPJ; 6/10/2013 11:23:45 AM

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Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-8

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	20									
	21									
	22							becomes loose		
	23	SS	SS-3	5 5 3 1	75					
650	24							Very loose, wet, gray fly ash as fine silty SAND (SM) [FLY ASH]		*Bottom of splitter dike @ 23.5' bgs*
	25									
	26									
	27	SS	SS-4	1 0 1 1						*Sample @ 27-29' fell 6" to 29.5' bgs*
645	29									
	30									
	31									
	32	P	P-1		88					
	33							becomes very loose, wet, gray, SILT (ML) with fine sand		
640	34	SS	SS-5	WOR 0 0 0	0					*Split-spoon @ 34'-36' WOR from 34'-41' bgs*
	35									
	36									
	37									
	38									
635	39									
	40									
	41									
	42	SS	SS-6	1 0 0	8			becomes light gray, interbedded with minor silty sand (SM)		*Split-spoon @ 42-44' 1 blow drives spoon 4 ft to 46' bgs*
	43									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-8

Elevation, feet	Depth, feet	SAMPLES Type Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
630	44	SS-6	0	8					
	45								
	46								
	47						becomes mostly silty sand (SM) with interbedded sandy silt (ML)		*At 47-49' bgs rods fell 13' from 47-60' bgs*
	48	SS-7	WOR 0 0 0	100					
625	49								
	50								
	51								
	52								
	53								
620	54								
	55								
	56								
	57								
	58								
615	59								
	60								
	61								
	62								
	63	P-2		92					
610	64								*Split-spoon @ 64-66' fell to 67' bgs*
	65	SS-8	WOR 0 0 0	100					
	66								

Report: GEO_CR_WELL; File K:\PROJECTS\A\AEP\13815141_BSLF\DOCS\LOGS\AEPBORINGS-6-10-13.GPJ; 6/10/2013 11:23:45 AM

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring PB-8

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	67									*Roller bit to 67'*
	68	SS	SS-9	WOH 0 0 0	33					
605	69									
	70							Very loose, wet, dark gray bottom ash as coarse to medium SAND (SP-SM), trace gravel [BOTTOM ASH]		
	71									
	72									
	73	SS	SS-10	1 1 1 1	33			Very loose, wet, gray fly ash as fine silty SAND (SM) [FLY ASH]		
600	74									
	75									*Drill rods clogged. Remove and flush.*
	76									
	77									*Bottom of piston tube is fly ash as sandy silt (ML)*
	78	P	P-3		88					
595	79									
	80	SS	SS-11	WOR 0 0 0	0					
	81									
	82									
	83									
590	84									
	85									
	86									
	87									
	88	P	P-4		88					
585	89									
	90	SS	SS-12	WOR 0	0					*Split-spoon @ 89-91' fell to 91.5' bgs*

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Log of Boring PB-8

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	91		SS-12	0 0	0					
	92									
	93									
580	94									
	95									
	96									
	97		P-5		96					*Bottom of piston tube is fly ash as silty sand (SM)*
	98									
575	99							becomes loose, interbedded light and dark gray, medium to fine SAND (SP-SM) to silty SAND (SM), with minor interbedded sandy silt [FLY ASH]		
	100		SS-13	2 2 3 2	63					
	101									
	102									
	103									
570	104							becomes very loose, mostly sandy SILT (ML) to silty SAND (SM) with minor interbedded (SP-SM)		
	105									
	106									
	107									
	108		SS-14	1 0 0 1	79					
565	109									
	110									
	111									
	112							becomes mostly silty sand (SM) with minor interbedded sandy silt (ML)		
	113		SS-15	2 1 0	58					

Project: AEP Big Sandy Landfill Investigation
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Log of Boring PB-8

Elevation, feet	Depth, feet	SAMPLES Type Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	114	SS-15	1	58					
560	115								
	116								
	117								
	118	P-6		96					
555	119						becomes mostly sandy silt (ML)		
	120	SS-16	WOR 0 0 0	13					
	121								
	122								
	123								
550	124								
	125								
	126						becomes light gray with interbedded grayish brown mostly sandy SILT (ML) with minor interbedded silty sand, trace decayed plant stems		
	127								*Split-spoon at 127-129' fell to 131' bgs*
	128	SS-17	WOR 0 0 0	88					
545	129								
	130								
	131								*Roller bit dropped to 132' when reinserted at 127'*
	132								
	133						Dense, wet, dark gray, medium to fine silty SAND (SM) with brown sandstone gravel [ALLUVIUM]		*Material is possibly a fill*
540	134								
	135								
	136								

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
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Log of Boring
PB-8

Elevation, feet	Depth, feet	SAMPLES: Type / Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	137								
	138	SS-18	20 17 18 21	79					
535	139								
	140						becomes moist, variably brown with gray mottling, trace greenish-gray, trace brownish-red		
	141								
	142								
	143	SS-19	19 17 26 31	79					
530	144								
	145								
	146								
	147								*Split-spoon at 147': 6" recovery appears the same as sample @ 142'. Blow counts may not be representative of material.*
	148	SS-20	21 2 1 11	25			No material in sampler representative of blow counts @ 147.5-149	14.3	*%G=31.4 %S=49.3 %F=19.3*
525	149								
	150								*Drill change at 150'*
	151						becomes with trace decayed vegetation		
	152	SS-21	15 50/1"	100					
	153						Micaceous, silty sandstone, light gray, slightly weathered, weak to medium strong End of Boring at 153´ bgs		*Set PVC casing @ 152.5 ft bgs. Cement-bentonite grout placed using tremie pipe.*
520	154								
	155								
	156								
	157								
	158								
515	159								
	160								

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
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Log of Boring/Rock Core
SB-3

Date(s) Drilled	**4/11/12**	Logged By	**J. Ristow**	Checked By	**V. Gautam**
Drilling Method	**HSA/NX Core**	Drill Bit Size/Type	**3 1/4" HSA/2" Core**	Total Depth of Borehole	**54.0 ft**
Drill Rig Type	**D-120**	Drilling Contractor	**AEP**	Surface Elevation	**845.7 ft above msl**
Borehole Backfill	**Bentonite grout**	Sampling Method(s)	**Split-spoon/NX Core**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 253,542.1 E 2,102,379.0**	Groundwater Level(s)	**Not encountered**		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
845	0	SS	SS-1	50/4"	100			Dense, moist, medium to fine grained SAND (SP) [FILL]			*Road material as weathered sandstone*
	1										
	2										
	3	SS	SS-2	50/5"	100						
	4										
	5	SS	SS-3	50/4"	100						
840	6										
	7										
	8										
	9										
	10										*Shale in cuttings*
835	11										
	12	SS	SS-4	18 31 50/4"	75			Shale, gray brown, highly to completely weathered			
	13										
	14	SS	SS-5	20 50/5"	100						
	15										
830	16										
	17	SS	SS-6	21 36 50/4"	88						
	18										
	19	SS	SS-7	36 50/4"	80			becomes light brown			*Vertical filled fracture noted*
	20										

Project: AEP Big Sandy Landfill Investigation
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Log of Boring/Rock Core
SB-3

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	20										
825	21										
	22	SS	SS-8	35 50/4"	100						
	23										
	24	SS	SS-9	35 50/5"	91						
	25										
820	26	SS	SS-10	50/3"	100						
	27										
	28	SS	SS-11	50/5"	100						
	29							becomes gray			
	30							Dark grey, fine sandstone			*Auger refusal @ 30' bgs*
815	31										
	32							Sandstone, light green, moderately weathered, weak rock - iron staining on fractures Fracture #1: 0, B, Vn, Fe, None, PL, R			
	33							Shale, light gray, moderately weathered, extremely weak			
	34	R	R1	92.4%	87			Sandstone, light gray with iron staining (red), moderately weathered, strong rock			
	35							Shale, light brown, moderately weathered, extremely weak rock becomes dark gray, weak			
810	36							3" sandstone, pebbly, strong			
	37							becomes light brown			
	38							Fracture #2: 90, J, VN, Fe, Sp, IR, R			
	39							Fracture #2			
	40							becomes sandy, gray Fracture #2 Fracture #3: 60, J, VN, Fe, Sp, IR, R Fracture #3			
805	41	R	R2	88.3%	100						
	42										
	43										

Project: AEP Big Sandy Landfill Investigation
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Log of Boring/Rock Core
SB-3

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	44										
	45							Sandstone, gray, moderately weathered, weak, medium grained			
800	46	R2		88.3%	100						
	47							Fracture #4: 45, J, None, None, None, IR, R			
	48										
	49							Light gray shale, extremely weak becomes with sandy laminae			
795	50										
	51	R3		83.3%	80						
	52										
	53										
	54							End of Boring at 54´ bgs			
	55										
790	56										
	57										
	58										
	59										
	60										
785	61										
	62										
	63										
	64										
	65										
780	66										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
SB-4

Date(s) Drilled	**4/10/12**	Logged By	**J. Ristow**	Checked By	**V. Gautam**
Drilling Method	**HSA**	Drill Bit Size/Type	**3 1/4" HSA/NX Core**	Total Depth of Borehole	**30.0 ft**
Drill Rig Type	**D-120**	Drilling Contractor	**AEP**	Surface Elevation	**794.0 ft above msl**
Borehole Backfill	**Bentonite grout**	Sampling Method(s)	**Split-spoon/NX Core**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 251,829.7 E 2,101,718.0**	Groundwater Level(s)	**Not encountered**		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Pene-trometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	0							Stiff, moist, light brown with gray mottling lean CLAY (CL) [RESIDUUM]			
	1	SS-1		3 4 5 9	21				23.8		
	2							becomes very stiff with no mottling			
	3	SS-2		4 6 10 22	67				20.2		*PL=23 LL=45 PI=22 %F=96.5*
790	4										
	5							becomes with gray mottling			
	6	SS-3		5 15 26 50/1"	89			becomes buff to tan, sandy	12.6		
	7							Sandstone, light brown to tan, moderately weathered, strong, mica on split surfaces			
	8	R1		84.7%	100			Fracture #1: 0, B, VN, CL, Sn, Wa, S, C			
785	9							Shale, brown, extremely weak			
	10							Fracture #2: 90, J, VN, Fe, Fi becomes orange-stained			
	11							1" sandstone, strong becomes with iron staining, orange to gray, extremely weak			
	12	R2		50%	60			Sandstone, dark brown, strong, quartz crystal lined, iron stained			
	13							Fracture #1 Fracture #3: 90, B, VN, Fe, Pa, Ir			
780	14										
	15							becomes fine-grained, iron staining Fracture #1			
	16							Fracture #3			
	17	R3		56.7%	61			Fracture #3			
	18							Shale, gray to black, extremely weak			
775	19										
	20										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
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Log of Boring/Rock Core
SB-4

Elevation, feet	Depth, feet	SAMPLES: Type	SAMPLES: Number	SAMPLES: Sampling Resist. Blows/6" OR CORE% RQD	SAMPLES: Recovery, %	SAMPLES: Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	20										
	21										
	22		R3	56.7%	61						
	23										
770	24										
	25							becomes moderately weathered, extremely weak to very weak			
	26										
	27		R4	85%	100			Fracture #4: 90, J, T, None, None, Wa, S			
	28							becomes sandy, weak to very weak, slightly weathered, no fractures			
765	29										
	30							End of Boring at 30´ bgs			
	31										
	32										
	33										
760	34										
	35										
	36										
	37										
	38										
755	39										
	40										
	41										
	42										
	43										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
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Log of Boring/Rock Core
SB-6

Date(s) Drilled	**4/12/12**	Logged By	**J. Ristow**	Checked By	**V. Gautam**
Drilling Method	**HSA/NX Core**	Drill Bit Size/Type	**3 1/4" HSA/2" Core**	Total Depth of Borehole	**39.3 ft**
Drill Rig Type	**D-120**	Drilling Contractor	**AEP**	Surface Elevation	**768.8 ft above msl**
Borehole Backfill	**Bentonite grout**	Sampling Method(s)	**Split-spoon/NX Core**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 251,202.5 E 2,102,399.0**	Groundwater Level(s)	**Not encountered**		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Pene-trometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %	REMARKS AND OTHER DETAILS
	0							1" dark brown topsoil		
	1	SS	SS-1	4 3 7 6	38	2.25		Stiff, moist, light brown with trace dark brown mottling, fat CLAY (CH) [RESIDUUM]		
	2							2" sandstone gravel		
	3	SS	SS-2	2 3 5 11	58	2.25 to 3.25		becomes stiff to very stiff, with brown mottles	26.3	*PL=23 LL=62 PI=37 %F=89.6*
765	4							2" cemented shale with red/orange iron stains		
	5							becomes hard		
	6	SS	SS-3	3 5 9 22	83	>4.5		becomes black	29.5	*PL=30 LL=59 PI=29*
	7									
	8	SS	SS-4	19 25 21 38	96	>4.5		9" coal seam		
760	9							becomes with coal		
	10									
	11	SS	SS-5	12 21 27 50/3"	100	2.5		5 1/2" coal seam becomes stiff, black and gray 2 1/2" coal seam becomes with black coal		
	12									
	13	SS	SS-6	30 50/5"	100			3" coal seam		
755	14							3" shale, light gray, very weathered 3" coal seam Shale, gray with some black partings		
	15	SS	SS-7	49 50/3"	100					
	16									
	17									*Back of spoon wet* *Auger refusal @ 17.2' bgs*
	18							becomes light gray, moderately weathered, weak		
750	19	R	R1	70.7%	97			Fracture #1: 60, V, N, Cl, Fi, Wa, R		
	20									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
SB-6

Elevation, feet	Depth, feet	SAMPLES: Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	20							Fracture #2: 90, V, N, Cl, Fi, Wa, R			
	21										
	22	R	1	70.7%	97			becomes sandy shale			*Interbedded sandy shale and shale interbeds with sand are 3" to 1/8"; shale beds are 1/8 to 1 1/2" thick*
	23										
745	24										
	25										
	26							Fracture #3: 30 to 90, J, N, None, None, Ir, Vr Fracture #3			
	27										
	28										
740	29	R	2	61.6%	98			Sandstone, light gray, some lamination, some iron staining, slightly weathered, strong rock			
	30										
	31										
	32										
	33										
735	34										
	35							Shale, gray, moderately weathered, weak rock			
	36										
	37	R	3	100%				Sandy shale, light gray, slightly weathered, strong rock, interbeds of sandy shale and shale			
	38										
730	39										
	40							End of Boring at 39.3´ bgs			
	41										
	42										
	43										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
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Log of Boring/Rock Core
SB-7

Date(s) Drilled	**4/10/12**	Logged By	**J. Ristow**	Checked By	**V. Gautam**
Drilling Method	**HSA/Core**	Drill Bit Size/Type	**3 1/4" HSA/3" Core**	Total Depth of Borehole	**29.7 ft**
Drill Rig Type	**D-120**	Drilling Contractor	**AEP**	Surface Elevation	**850.4 ft above msl**
Borehole Backfill	**Bentonite grout**	Sampling Method(s)	**Split-spoon/NX Core**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 252,280.4 E 2,103,342.0**	Groundwater Level(s)	**Not encountered**		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Pene-trometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
850	0							Medium stiff, moist, brown, lean CLAY (CL) (topsoil)			
	1	SS	SS-1	4 3 3 8	38	1 2.0		becomes stiff, trace brown mottles [RESIDUUM]			
	2										
	3	SS	SS-2	3 5 8 15	42	3.5 to 4.5		becomes very stiff to hard, light brown with red mottles			
	4										
	5										
845	6	SS	SS-3	10 22 40 50/3"	86	3.5 >4.0		becomes dark red becomes with red mottles	10.4		*PL=19 LL=39 PI=20 %F=71.7*
	7							Shale, sandy, light brown, moderately weathered, weak			
	8										
	9							becomes very weak			
840	10										
	11	R	R1	15%	29						
	12										
	13										
	14										
	15							becomes shale fragments, moderately weathered, very weak with iron-staining			
835	16										
	17	R	R2	0%	18						
	18							8" sandstone fragments, brown with iron staining, strong, but fractured vertically and horizontal			
	19										
	20										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
SB-7

Elevation, feet	Depth, feet	SAMPLES: Type / Number	SAMPLES: Sampling Resist. Blows/6" OR CORE% RQD	SAMPLES: Recovery, %	SAMPLES: Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
830	20									
	21									*Shale is mechanically broken-- no fractures observable*
	22	R2	0%	18						
	23									
	24									
	25						becomes brown shale, moderately weathered, weak			*25-27' bgs: shale is soft--mechanically broken No fractures observable*
825	26									
	27	R3	20%	20						
	28									
	29									
	30						End of Boring at 29.7´ bgs			
820	31									
	32									
	33									
	34									
	35									
815	36									
	37									
	38									
	39									
	40									
810	41									
	42									
	43									

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
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Log of Boring/Rock Core
SB-8

Date(s) Drilled	**4/12/12**	Logged By	**J. Ristow**	Checked By	**V. Gautam**
Drilling Method	**HSA**	Drill Bit Size/Type	**3 1/4" HSA/NX Core**	Total Depth of Borehole	**49.3 ft**
Drill Rig Type	**D-120**	Drilling Contractor	**AEP**	Surface Elevation	**711.3 ft above msl**
Borehole Backfill	**Bentonite grout**	Sampling Method(s)	**Split-spoon/NX Core**	Hammer Data	**140#/30" Drop Auto**
Boring Location	**N 251,071.0 E 2,103,738.0**	Groundwater Level(s)	**Not encountered**		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Pene-trometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	0							3" Bottom ash (road fill)			
		SS	SS-1	4 3 5 15	58	3.25 to 3.5		Very stiff, moist, light yellow/brown, lean CLAY (CL) [RESIDUUM]			
710	1							Shale, light yellow brown, with orange red iron oxidation staining, completely to moderately weathered			
	2										
	3	SS	SS-2	9 6 8 13	13						
	4										
	5										
	6	SS	SS-3	9 19 31 34	96						
705	7										
	8	SS	SS-4	11 21 32 50	58			becomes light gray, without iron oxidation			
	9										
	10							becomes with red mottle staining			
	11	SS	SS-5	10 18 47 50/3"	76			becomes red with gray mottles			
700	12										
	13	SS	SS-6	21 49 50/3"	80			2" crushed chert nodules becomes gray with red mottles to light gray			
	14										
	15							becomes gray with some red mottles			
	16	SS	SS-7	15 18 50/3"	80						
695	17										
	18	SS	SS-8	12 50/5"	100			becomes with some orange mottles			
	19										
	20										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
SB-8

Elevation, feet	Depth, feet	SAMPLES: Type	Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	20			18				becomes with orange staining			
	21	SS	SS-9	31	100						
690				50/5"							
	22										
		SS	SS-10	50/3"	100			becomes without orange staining, crushed			
	23										
	24										
	25	SS	SS-11	50/5"	100			1" sandstone, gray, crushed			
	26										
685											
	27										
	28										
	29							Sandstone, gray with zones of iron staining, moderately weathered, medium strong, fine-grained Fracture #1: 10, J, VN, Fe, Su, PL, SR			*Auger refusal @ 28.4' bgs*
	30							Fracture #1			
	31	R	R1	85.7%	95			Fracture #1			
680											
	32										
	33										
	34										
	35							becomes with shale fragments			
	36							becomes sandstone massive with orange Fe staining			
675											
	37							Fracture #1			
	38							shale, orange concretion			
	39	R	R2	93.3%	100			becomes gray, slightly weathered, strong, no fractures			
	40										
	41										
670											
	42							becomes slightly weathered to fresh, strong, medium-grained			
	43										

Project: AEP Big Sandy Landfill Investigation
Project Location: Louisa, KY
Project Number: 13815141.10000

Log of Boring/Rock Core
SB-8

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	Sampling Resist. Blows/6" OR CORE% RQD	Recovery, %	Pocket Penetrometer (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content %		REMARKS AND OTHER DETAILS
	44	R2		93.3%	100			becomes with orange staining			*No natural fractures*
	45										
	46										
665	47	R3		100%	100						
	48										
	49										
								End of Boring at 49.3´ bgs			
	50										
	51										
660	52										
	53										
	54										
	55										
	56										
655	57										
	58										
	59										
	60										
	61										
650	62										
	63										
	64										
	65										
	66										
645											

Report: GEO_CR_WELL; File K:\PROJECTS\AAEP\13815141_BSLF\DOCS\LOGS\AEPBORINGS-6-10-13.GPJ; 6/10/2013 11:23:54 AM

2010 LOGS

Frontz Drilling, Inc.
2031 Millersburg Road
Wooster, Ohio 44691
330-263-5301

Soil Boring Log

Boring No: B-1007

Date: 11/19/2010 **Proj. No.:** E10028
Client: AEP
Drilling Company: Frontz Drilling, Inc.
Logged By: Larry Reitz
Surface Elevation: 692'
Total Depth: 90' **Diameter:**
Comments:

Project: Big Sandy
Location:
Driller:
Drilling Method: Air Rotary
Top of Casing Elevation:
Sampling Method:

Depth (feet)	REC / RQD	Sample #	Lithology	Description/Soil Classification (Color, Texture, Moisture, Structures)
10.0				Yellow brown Sandstone
20.0		S1		
30.0		S2		
		S3		
40.0		S4		
		S5		Yellow brown fine to coarse sandstone, minor limonite (added water when groundwater encountered at approximatley 49' bgs)
50.0		S6		color to light gray
		S7		color to yellow brown
60.0		S8		
		S9		color to light gray
70.0		S10		
		S11		
80.0		S12		Gray Shale and Coal (black sheen in return water)
90.0				
100.0				
110.0				
120.0				
130.0				
140.0				
150.0				

Frontz Drilling, Inc.
2031 Millersburg Road
Wooster, Ohio 44691
330-263-5301

Soil Boring Log

Boring No: B-1007

Date: 11/23/2010 **Proj. No.:** E10028
Client: AEP
Drilling Company: Frontz Drilling, Inc.
Logged By: Larry Retz
Surface Elevation:
Total Depth: 200' **Diameter:** 6"-15"
Comments:

Project: Big Sandy
Location: Louiza, Ky
Driller:
Drilling Method: Sonic/HQ core
Top of Casing Elevation:
Sampling Method:

Depth (feet)	Sample #	Lithology	Description/Soil Classification (Color, Texture, Moisture, Structures)
160.0			Medium gray medium to very coarse Sandstone
170.0			
180.0			
190.0			
200.0			
210.0			
220.0			
230.0			

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER BS-CL-2133

COMPANY Frontz Drilling, Inc.

PROJECT Big Sandy Plant

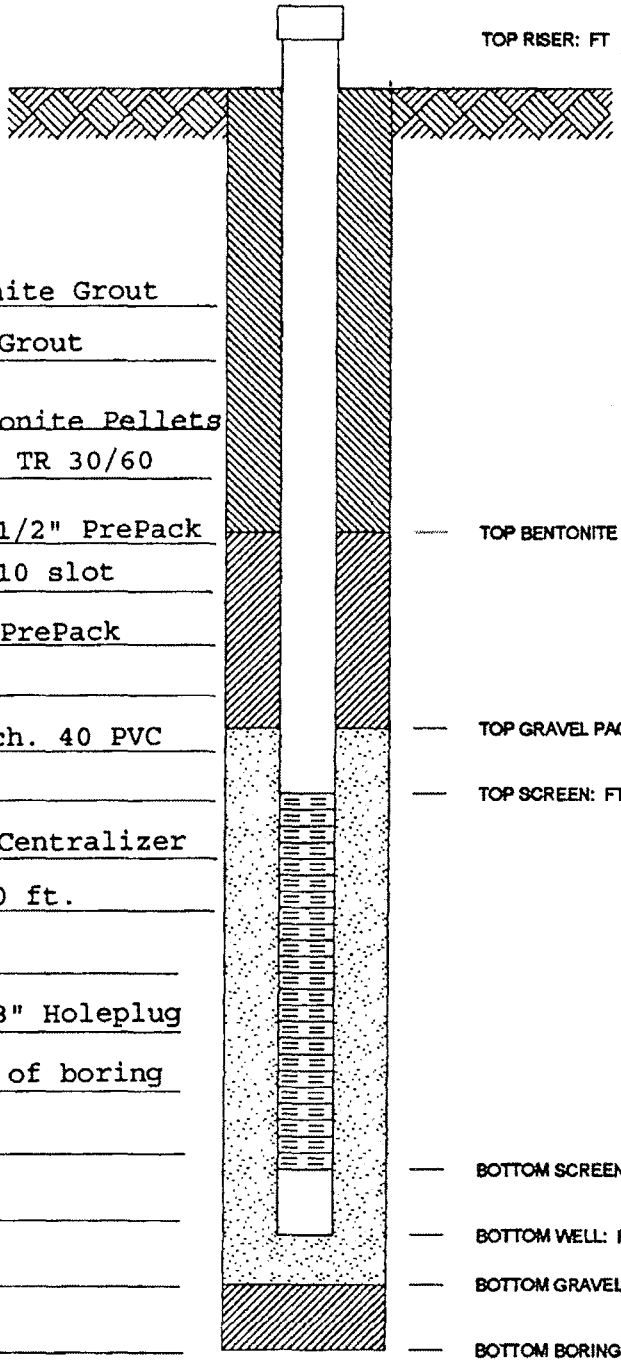
COORDINATES 38.18628 N -82.63430 W

SYSTEM GPS

WELL No KY6555 BORING No. MW-1007 INSTALLED 12-7-10

GROUND ELEVATION FT 692

AEP supplied



TOP RISER: FT 2

GROUT SEAL: Bentonite Grout

Bariod Quick-Grout

BENTONITE SEAL: Bentonite Pellets

3/8" Pel Plug TR 30/60

SCREEN: dia., 2"x3-1/2" PrePack

PVC .007 & .010 slot

GRAVEL PACK: #7 in PrePack

#4 Borehole

RISER PIPE:, dia., 2" Sch. 40 PVC

SPACERS, DEPTH: PVC Centralizer

77 ft. and 40 ft.

TOP BENTONITE SEAL: FT 40

TOP GRAVEL PACK: FT 45

TOP SCREEN: FT 47

BOTTOM SCREEN: FT 77

BOTTOM WELL: FT 77

BOTTOM GRAVEL PACK: FT 78

BOTTOM BORING: FT 86

Notes:

Bentonite 3/8" Holeplug

Bottom 8 ft. of boring

BLANK_MONT_WELL_LOG CIVIL LAB.GPJ AEP.GDT 11/24/09

Frontz Drilling, Inc.
2031 Millersburg Road
Wooster, Ohio 44691
330-263-5301

Soil Boring Log

Boring No: B-1008

Date: 11/17/2010 **Proj. No.:** E10028
Client: AEP
Drilling Company: Frontz Drilling, Inc.
Logged By: Larry Reitz
Surface Elevation:
Total Depth: 120' **Diameter:**
Comments:

Project: Big Sandy
Location:
Driller:
Drilling Method: Air Rotary
Top of Casing Elevation:
Sampling Method:

Depth (feet)	REC / RQD	Sample #	Lithology	Description/Soil Classification (Color, Texture, Moisture, Structures)
		S1		Yellow brown silty Clay
		S2		color to yellow gray
10.0		S3		
		S4		color to yellow brown Sandstone
20.0		S5 ▼		Groundwater encountered at approximately 25' bgs
		S6		
30.0		S7		
		S8		Medium gray Shale
40.0		S9		
		S10		
50.0		S11		Same as above with fine sand
		S12		
60.0		S13		Medium gray Sandstone
		S14		
70.0		S15		
		S16		
80.0		S17		
		S18		
90.0		S19		
		S20		color to light gray Sandstone
100.0		S21		Medium gray Shale
		S22		Possible coal (black sheen in return water)
110.0		S23		
120.0				
130.0				
140.0				
150.0				

Frontz Drilling, Inc.
2031 Millersburg Road
Wooster, Ohio 44691
330-263-5301

Soil Boring Log

Boring No: B-1008

Date: 11/23/2010 **Proj. No.:** E10028
Client: AEP
Drilling Company: Frontz Drilling, Inc.
Logged By: Larry Retz
Surface Elevation:
Total Depth: 200' **Diameter:** 6"-15"
Comments:

Project: Big Sandy
Location: Louiza, Ky
Driller:
Drilling Method: Sonic/HQ core
Top of Casing Elevation:
Sampling Method:

Depth (feet)		Sample #	Lithology	Description/Soil Classification (Color, Texture, Moisture, Structures)
160.0				Medium gray medium to very coarse Sandstone
170.0				
180.0				
190.0				
200.0				
210.0				
220.0				
230.0				

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER BS-CL-2133

COMPANY Frontz Drilling, Inc.

PROJECT Big Sandy Plant

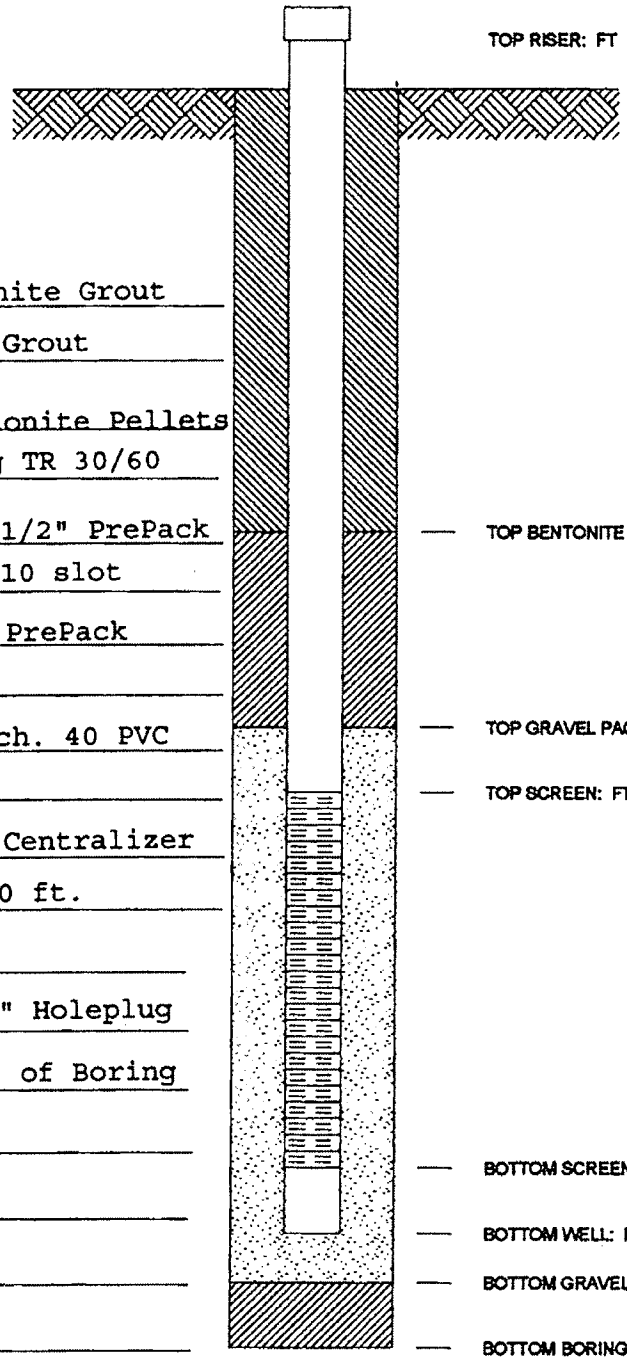
COORDINATES 38.18657 N -82.63066 W

SYSTEM GPS

WELL No KY6556 BORING No. MW-1008 INSTALLED 12-7-10

GROUND ELEVATION FT 725

AEP supplied



TOP RISER: FT 2

GROUT SEAL: Bentonite Grout

Bariod Quick-Grout

BENTONITE SEAL: Bentonite Pellets

3/8" Pel Plug TR 30/60

SCREEN: dia.,, 2"x3-1/2" PrePack

PVC .007 & .010 slot

GRAVEL PACK: #7 in PrePack

#4 Borehole

RISER PIPE: , dia., 2" Sch. 40 PVC

SPACERS, DEPTH: PVC Centralizer

100 ft. and 50 ft.

TOP BENTONITE SEAL: FT. 53

TOP GRAVEL PACK: FT. 58

TOP SCREEN: FT. 60

BOTTOM SCREEN: FT 100

BOTTOM WELL: FT. 100

BOTTOM GRAVEL PACK: FT. 102

BOTTOM BORING: FT 113

Notes:

Bentonite 3/8" Holeplug

Bottom 11 ft. of Boring

BLANK_MONT_WELL_LOG CIVIL LAB.GPJ AEP.GDT 1/2/409

FRONTZ DRILLING
WOOSTER, OHIO

Frontz Drilling, Inc.
2031 Millersburg Road
Wooster, Ohio 44691
330-263-5301

Soil Boring Log

Boring No: B-1009

Date: 11/18/2010 **Proj. No.:** E10028
Client: AEP
Drilling Company: Frontz Drilling, Inc.
Logged By: Larry Reitz
Surface Elevation:
Total Depth: 124' **Diameter:**
Comments:

Project: Big Sandy
Location:
Driller:
Drilling Method: Air Rotary
Top of Casing Elevation:
Sampling Method:

Depth (feet)	REC / RQD	Sample #	Lithology	Description/Soil Classification (Color, Texture, Moisture, Structures)
10.0		S1		Yellow brown Sandstone
20.0		S2		
		S3		
30.0		S4		
		S5		
40.0		S6		Gray Shale
		S7		Yellow brown Sandstone
50.0		S8		Gray Shale
		S9		
60.0		S10		
		S11		Water encountered at approximately 68' bgs; (added water, black sheen in return)
70.0		S12		Possible coal
		S13		
80.0		S14		Light gray Sandstone
		S15		
90.0		S16		Color grades to medium gray
		S17		Possible coal
100.0		S18		Medium gray Shale
		S19		
110.0		S20		
		S21		
120.0		S22		
130.0				
140.0				
150.0				

Frontz Drilling, Inc.
2031 Millersburg Road
Wooster, Ohio 44691
330-263-5301

Soil Boring Log

Boring No: B-1009

Date: 11/23/2010 **Proj. No.:** E10028
Client: AEP
Drilling Company: Frontz Drilling, Inc.
Logged By: Larry Retz
Surface Elevation:
Total Depth: 200' **Diameter:** 6"-15"
Comments:

Project: Big Sandy
Location: Louiza, Ky
Driller:
Drilling Method: Sonic/HQ core
Top of Casing Elevation:
Sampling Method:

Depth (feet)		Sample #	Lithology	Description/Soil Classification (Color, Texture, Moisture, Structures)
80.0				Medium gray medium to very coarse Sandstone

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER BS-CL-2133

COMPANY Frontz Drilling, Inc.

PROJECT Big Sandy Plant

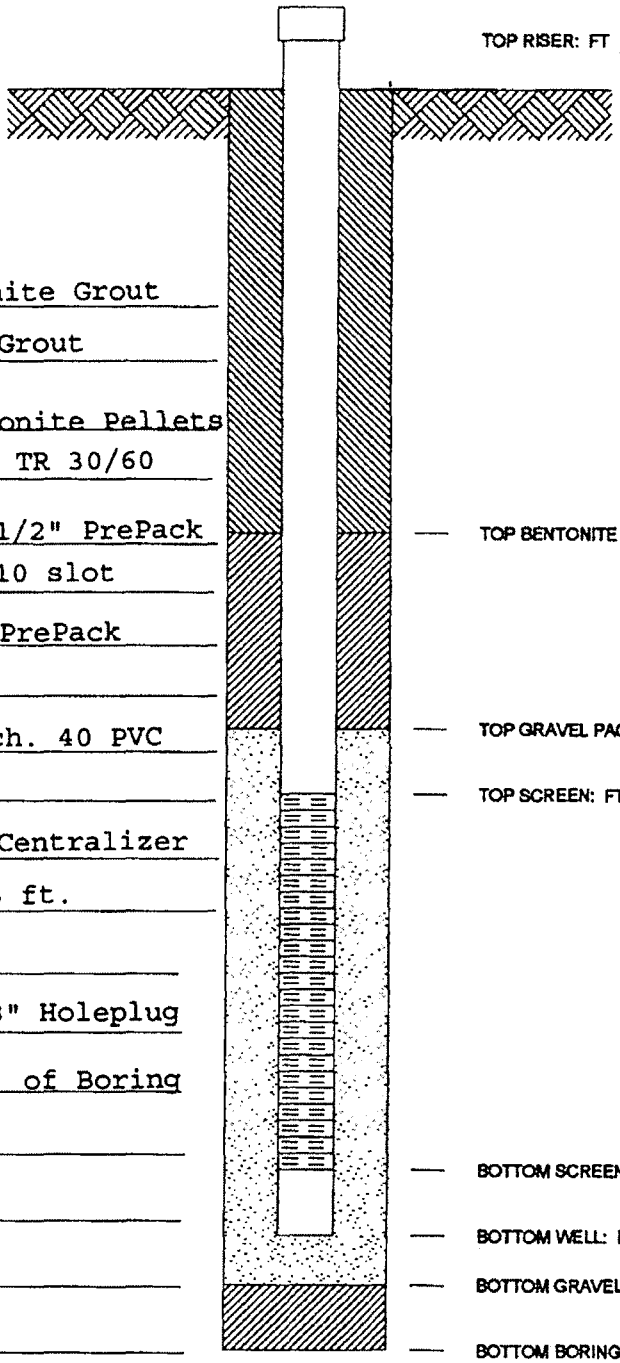
COORDINATES 38.17955 N -82.62633 W

SYSTEM GPS

WELL No KY6557 BORING No. MW-1009 INSTALLED 12-7-10

GROUND ELEVATION FT 733

AEP supplied



TOP RISER: FT 2

GROUT SEAL: Bentonite Grout

Bariod Quick-Grout

BENTONITE SEAL: Bentonite Pellets

3/8" Pel Plug TR 30/60

SCREEN: dia., 2"x3-1/2" PrePack

PVC .007 & .010 slot

GRAVEL PACK: #7 in PrePack

#4 Borehole

RISER PIPE: , dia , 2" Sch. 40 PVC

SPACERS, DEPTH: PVC Centralizer

85 ft. and 55 ft.

TOP BENTONITE SEAL: FT 58

TOP GRAVEL PACK: FT 63

TOP SCREEN: FT 65

BOTTOM SCREEN: FT 85

BOTTOM WELL: FT 85

BOTTOM GRAVEL PACK: FT 87

BOTTOM BORING: FT 124

Notes:

Bentonite 3/8" Holeplug

Bottom 37 ft. of Boring

BLANK_MONT_WELL_LOG CIVIL LAB.GPJ AEP.GDT 1/2/09

FRONTZ DRILLING
WOOSTER, OHIO

Frontz Drilling, Inc.
2031 Millersburg Road
Wooster, Ohio 44691
330-263-5301

Soil Boring Log

Boring No: B-1010

Date: _____ **Proj. No.:** E10028
Client: AEP
Drilling Company: Frontz Drilling, Inc.
Logged By: Larry Reitz
Surface Elevation: _____
Total Depth: 200' **Diameter:** _____
Comments:

Project: Big Sandy
Location: _____
Driller: _____
Drilling Method: Air Rotary
Top of Casing Elevation: _____
Sampling Method: _____

Depth (feet)	REC / RQD	Sample #	Lithology	Description/Soil Classification (Color, Texture, Moisture, Structures)
10.0		S1		Red gray Sandstone
		S2		
20.0		S3		
		S4		
30.0		S5		Medium gray Shale
		S6		Coal
40.0		S7		Medium gray Shale
		S8		
50.0		S9		
		S10		
60.0		S11		
		S12		
70.0		S13		
		S14		
80.0		S15		Coal with carbonaceous Shale
		S16		Medium gray Shale
90.0		S17		
		S18		
100.0		S19		Same as above with some sand
		S20		
110.0		S21		
		S22		
120.0		S23		
		S24		
130.0		S25		
		S26		
140.0		S27		Medium gray Shale
		S28		
150.0				

Frontz Drilling, Inc.
2031 Millersburg Road
Wooster, Ohio 44691
330-263-5301

Soil Boring Log

Boring No: B-1010

Date: _____ **Proj. No.:** E10028
Client: AEP
Drilling Company: Frontz Drilling, Inc.
Logged By: Larry Retz
Surface Elevation: _____
Total Depth: 200' **Diameter:** _____
Comments:

Project: Big Sandy
Location: Louiza, Ky
Driller: _____
Drilling Method: Air Rotary
Top of Casing Elevation: _____
Sampling Method: _____

Depth (feet)	Sample #	Lithology	Description/Soil Classification (Color, Texture, Moisture, Structures)
	S29		
	S30		
160.0			
	S31		
	S32		Gray Sandstone
170.0			
			Gray Shale
	S33		
	S34		
180.0			
	S35		
	S36		
190.0			
	S37		Same as above with some sand
	S38		
200.0			
210.0			

AMERICAN ELECTRIC POWER SERVICE CORPORATION
AEP CIVIL ENGINEERING LABORATORY
MONITORING WELL CONSTRUCTION

JOB NUMBER BS-CL-2133
COMPANY Frontz Drilling, Inc.
WELL No KY6558 BORING No. MW-1010 INSTALLED 12-6-10
PROJECT Big Sandy Plant
COORDINATES 38.17721 N -82.63093 W
SYSTEM GPS

GROUND ELEVATION FT. 849
AEP supplied

TOP RISER: FT 2

GROUT SEAL: Bentonite Grout
Bariod Quick-Grout

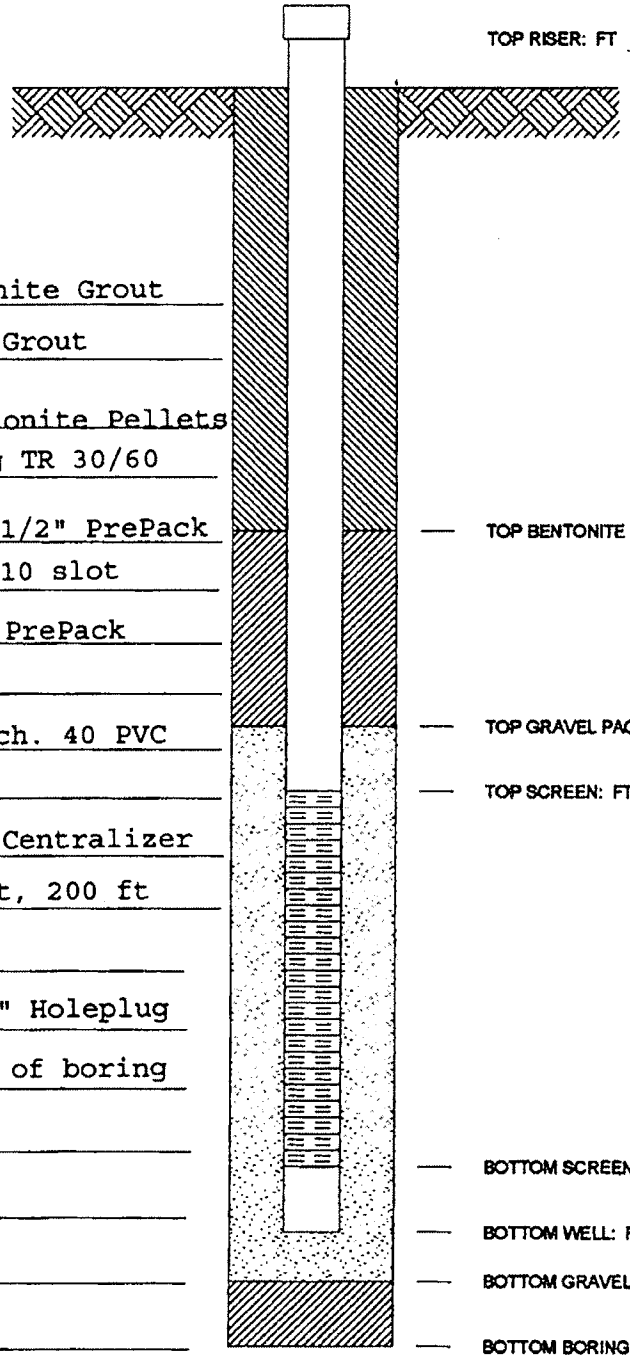
BENTONITE SEAL: Bentonite Pellets
3/8" Pel Plug TR 30/60

SCREEN: dia., 2"x3-1/2" PrePack
PVC .007 & .010 slot

GRAVEL PACK: #7 in PrePack
#4 Borehole

RISER PIPE: , dia., 2" Sch. 40 PVC

SPACERS, DEPTH: PVC Centralizer
100 ft, 160 ft, 200 ft



TOP BENTONITE SEAL: FT. 163
TOP GRAVEL PACK: FT 168
TOP SCREEN: FT. 170
BOTTOM SCREEN: FT. 200
BOTTOM WELL: FT. 200
BOTTOM GRAVEL PACK: FT 201
BOTTOM BORING: FT. 245

Notes:

Bentonite 3/8" Holeplug
Bottom 44 ft. of boring

BLANK_MONT_WELL_LOG CIVIL LAB.GPJ AEP.GDT 11/24/09

FRONTZ DRILLING
WOOSTER, OHIO

Frontz Drilling, Inc.
2031 Millersburg Road
Wooster, Ohio 44691
330-263-5301

Soil Boring Log

Boring No: 1011

Date: 11/16 to 11/18 2010 **Proj. No.:** E10028
Client: AEP
Drilling Company: Frontz Drilling, Inc.
Logged By: Larry Reitz
Surface Elevation: 685'
Total Depth: 80' **Diameter:**
Comments:

Project: Big Sandy
Location: Ash pond (south)
Driller:
Drilling Method: Sonic/HQ core
Top of Casing Elevation:
Sampling Method:

Depth (feet)	REC / RQD	Well Construction	Lithology	Description/Soil Classification (Color, Texture, Moisture, Structures)	Sample Number
				Fill	
				Mottled very light gray and red Clay	
5.0				mottled medium red brown and light gray weathered Shale	
				Light gray Clay with limonite stains and yellow brown very fine sand, silty	
10.0				Gray brown very fine Sand, some yellow brown clay	
				Light yellow brown silty Clay; medium gray shale with limonite beds	
15.0	1' / 0%			Dark gray green Shale pieces	
20.0				Dark gray green wethered Shale	
25.0	8' / 50%				
30.0				Grades to medium gray medium to coarse Sandstone	
35.0	8.8' / 51%				
40.0				Same as above with limonite staining	
45.0	8.4' / 78%				
50.0					
55.0	10' / 71%			Medium gray fine to coarse Sandstone; fine interbedded medium gray shale and medium to coarse sandstone	
60.0				Meduim gray coarse to very coarse Sandstone Carbonaceous lens at 62.6 to 63.1	
65.0	9.9' / 53%			Medium gray medium to coarse Sandstone, grades to very coarse Sandstone	
70.0					
75.0	9.7' / 47%			Dark gray Shale lens	

Frontz Drilling, Inc.
2031 Millersburg Road
Wooster, Ohio 44691
330-263-5301

Soil Boring Log

Boring No: 1011

Date: 11/23/2010 **Proj. No.:** E10028
Client: AEP
Drilling Company: Frontz Drilling, Inc.
Logged By: Larry Retz
Surface Elevation:
Total Depth: 200' **Diameter:** 6"-15"
Comments:

Project: Big Sandy
Location: Louiza, Ky
Driller:
Drilling Method: Sonic/HQ core
Top of Casing Elevation:
Sampling Method:

Depth (feet)		Well Construction	Lithology	Description/Soil Classification (Color, Texture, Moisture, Structures)	Sample Number
80.0	9.7' / 47%			Medium gray medium to very coarse Sandstone	

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER BS-CL-2133

COMPANY Frontz Drilling, Inc.

PROJECT Big Sandy Plant

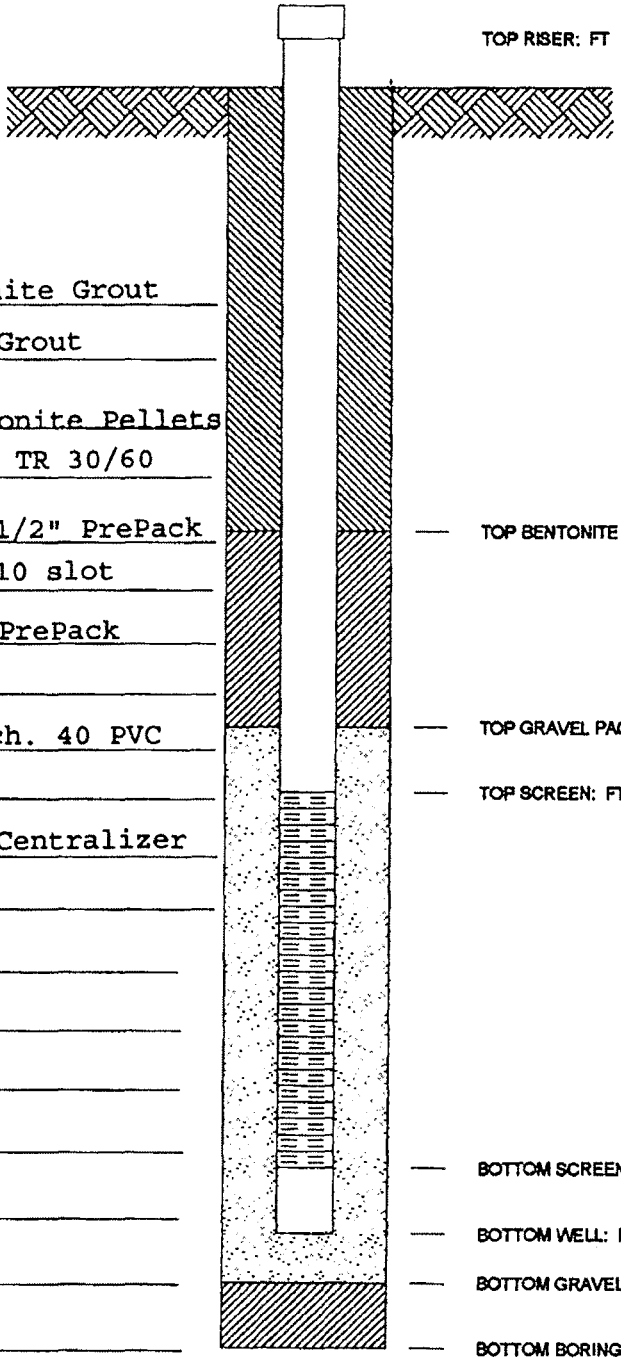
COORDINATES 38.17819 N -82.63071 W

SYSTEM GPS

WELL No KY6559 BORING No. MW1011 INSTALLED 12-8-10

GROUND ELEVATION FT. 685

AEP supplied



TOP RISER: FT 2

GROUT SEAL: Bentonite Grout

Bariod Quick-Grout

BENTONITE SEAL: Bentonite Pellets

3/8" Pel Plug TR 30/60

SCREEN: dia., 2"x3-1/2" PrePack

PVC .007 & .010 slot

GRAVEL PACK: #7 in PrePack

#4 Borehole

RISER PIPE: , dia., 2" Sch. 40 PVC

SPACERS, DEPTH: PVC Centralizer

75 ft

TOP BENTONITE SEAL: FT. 28

TOP GRAVEL PACK: FT. 33

TOP SCREEN: FT. 35

BOTTOM SCREEN: FT. 75

BOTTOM WELL: FT. 75

BOTTOM GRAVEL PACK: FT. 81

BOTTOM BORING: FT. 81

Notes:

BLANK_MONT_WELL_LOG CIVIL LAB.GPJ AEP.GDT 11/24/09

APPENDIX B

SAMPLING AND ANALYSIS PLAN AND QUALITY ASSURANCE PROJECT PLAN (SAP/QAPP)

SAMPLING AND ANALYSIS PLAN

AEP BIG SANDY
HORSEFORD CREEK

JOB NO.: 13815152
June 12, 2013

URS Corporation
525 Vine Street, Suite 1800
Cincinnati, Ohio 45202
Tel: 513.651.3440
Fax: 877.660.7727

CONTENTS

SECTION **PAGE**

APPENDICES

1.0 INTRODUCTION

The following presents the combined Sampling and Analysis Plan and Quality Assurance Project Plan (SAP/QAPP) for the American Electric Power (AEP) / Kentucky Power Company (KPC) Big Sandy Plant's Horseford Creek site in Lawrence County, Kentucky. The combined plan describes the sampling and analysis and quality assurance/quality control (QA/QC) procedures involved in the implementation of the groundwater monitoring plan (GMP) to which this document is appended.

2.0 PROJECT DESCRIPTION AND ORGANIZATION

2.1 Project Description

AEP operates a coal combustion power plant (Big Sandy) adjacent to the Big Sandy River approximately 4.5 miles (7.2 kilometers) north-northwest of Louisa, Kentucky. The coal combustion products (CCPs) generated at Big Sandy are sluiced to a reservoir constructed at the nearby Horseford Creek site, hereafter referred to as the "Site", as shown on Figure 1 of the GMP.

On behalf of AEP, URS Corporation (URS) conducted a hydrogeologic site investigation (HSI) and developed a groundwater monitoring plan (GMP) in preparation for closure of the Site (pond closure). The purpose of the SAP/QAPP is to formalize the sampling analysis and quality assurance (QA) procedures involved in the implementation of the GMP.

2.2 Project Organization

AEP will retain overall responsibility for implementation and management of the GMP. The AEP Dolan Laboratory in Groveport, Ohio or a qualified laboratory selected by AEP, will serve as the primary analytical laboratory for analysis of the collected samples. AEP will report findings to the Kentucky Department for Environmental Protection (KDEP) which will be the regulating authority.

Overall management of the groundwater monitoring project will be the responsibility of AEP Environmental Services in Columbus, Ohio. Laboratory analyses will be conducted by the AEP Dolan Laboratory. The management staffing is listed below by position.

QA Officer—AEP holds the prime contract, so the QA officer will be an employee of AEP's Environmental Services Division in Columbus, Ohio. The AEP Project Manager for this project is Guy Cerimele.

Contractor QA Manager— QA management of the program will be performed by a contractor selected by AEP's Environmental Services Division in Columbus, Ohio. The contractor QA manager will have overall responsibility for ensuring that the data collected meet the defined data quality objectives (DQOs) including review of field documentation provided by EHS Support, Inc. (EHS), and validation of analytical data provided by Dolan Laboratories (See Section 6.1). The contractor QA manager will report to the QA officer.

Laboratory QA Organization and Responsibility— The AEP Dolan Laboratory's QA organization and responsibility are summarized in Section 4.0 of the attached laboratory QAPP (Appendix B-1).

2.3 Data Quality Objectives

The groundwater data obtained from the site will need to meet the DQOs under United States Environmental Protection Agency (U.S. EPA) standards, as referenced in *Data Quality Objectives for Remedial Response Activities, EPA/540/R-93/071*. The standards require that groundwater samples will be analyzed using the appropriate U.S. EPA analytical methods found in *Test Methods for Evaluating Solid Wastes, SW-846, Third Edition, November 1986* (SW-846). The methods may be the same as, or similar to, those specified by the Contract Laboratory Program (CLP), achieving similar detection limits, but without providing the high level of QA/QC document assembly and presentation required by CLP.

3.0 FIELD SAMPLING PLAN

The field sampling plan (FSP) details the number and location of groundwater samples to be collected, the type and quantity of QA/QC samples, equipment needs, sampling methods, and sample handling/chain-of-custody (COC) procedures. Examples of the various forms to be completed during implementation of the field components of this plan are provided as Appendix B-2.

3.1 Field Documentation

Field activities will be documented (using indelible ink) on a daily field memorandum or dedicated field log book. This log will document the event name, date, general weather conditions, site conditions, safety observations, names of sampling crew and visitors. The log will also record any other useful observations such as deterioration of access roads and well maintenance needs. Groundwater level measurements, as well as comments regarding the well condition or factors that may affect the validity of the measurements collected will be

documented on a Measurement of Groundwater Levels form. Monitoring well specific information collected during sampling such as well condition, water levels, water quality parameters, and visual/olfactory observations will be recorded on a well-by well basis on individual Groundwater Sampling Data Sheets.

3.2 Sampling Scope

Water levels for potentiometric evaluation will be collected from up to 12 existing monitoring wells at the Site. The groundwater sampling scope shall consist of the collection of representative samples from up to seven monitoring wells and one spring as identified on Table 1 of the GMP. Groundwater samples will be collected for either baseline monitoring or detection monitoring depending on the closure status of the site. Tables B-1 and B-2 provide a summary of the parameters to be analyzed for baseline monitoring or detection monitoring respectively. A summary listing of the number of samples, duplicates, and QA samples per event is provided as Table B-3. Depending upon the outcome of the proposed Federal Coal Combustion Residuals (CCR) rule, parameters may be added or removed from these lists.

3.3 QA/QC Samples

QA/QC samples will include 10 percent field duplicates and 5 percent matrix spike/matrix spike duplicates (MS/MSDs) on select analyses. Although only five monitoring wells will be sampled, at least one of each QA/QC sample type (i.e., duplicate, MS/MSD) will be tested. One monitoring well will be selected for collection of a field duplicate sample for each event. The laboratory shall randomly select one sample for MS/MSD analysis from the samples submitted for each event.

3.4 Sampling Equipment

Monitoring wells are equipped with dedicated 2-inch diameter bladder pumps that are positioned within the screened interval of the monitoring well to withdraw groundwater from the water-producing zone. The discharge and air supply tubing were cut to fit the well depth and are permanently attached to a well seal, which is secured to the top of the inner casing. The well seals are designed with ports at the top to eliminate the need for removing the cap.

The sampling team will arrive at each well location with the following equipment:

- Site-specific Health and Safety Plan prepared by the contractor
- Personal protective equipment [PPE] (see *Site-specific Health and Safety Plan*)

- Field forms (Field Memorandum or Log, Measurement of Groundwater Levels, Groundwater Sampling Data Sheet, Calibration Log)
- Laboratory-supplied sample coolers, bottles, preservatives, chain-of-custody forms, labels, custody seals, shipping placards, permanent markers and pens.
- Portable air compressor, or compressed air supply and bladder pump controller.
- Dedicated or new single-use pump discharge hoses (maintained by contractor)
- Electronic water-level indicator
- Water quality meter with flow-through cell (temperature, pH, conductivity, dissolved oxygen (DO), turbidity and oxidation-reduction potential (ORP))**.**
- Calibration standards for pH, conductivity and turbidity.
- 5-gallon containers
- Graduated cylinder or similar calibrated water volume measuring device
- Disposable in-line filters (0.45 micron)
- Ice for sample preservation.
- Shipping materials: resealable plastic bags, packing tape, bubble wrap or similar inert materials used to secure sample container positions in cooler.
- Decontamination supplies including non-phosphate detergent, dilute nitric acid (~5%), distilled or deionized water, brushes, and buckets.

3.5 Instrument Calibration

Field calibrations and checks using calibration solutions will be conducted at the beginning of each work shift and as needed throughout each shift based on instrument response to correct any drift or other error in instrument response that may occur during the shift. All field checks and calibrations will be documented on a Calibration Log (Appendix B-2). The actual steps to be performed for calibrating these meters will vary between manufacturers. General procedures for field calibration of each instrument are presented below.

3.5.1 pH Calibration

The pH meter will be calibrated with standard buffer solutions prior to each groundwater sampling event. For this FSP calibration of pH will include three buffer solutions at least three

pH units apart to encompass the expected pH of the groundwater at the Site. The pH calibration standards typically used in calibration are pH-4, pH-7, and pH-10.

The procedures for pH calibration on most hand-held water quality multimeters are menu driven and vary from instrument to instrument. Therefore, the calibration procedure is to be performed according to instrument-specific manufacturer's instructions.

3.5.2 Thermometer Calibration

Typically, water quality multimeters cannot be calibrated for temperature in the field so calibration will not be required for this FSP. Temperature readings can be checked by testing a liquid of known temperature, such as ice water that has reached equilibrium. However, this method will only provide an approximate temperature that may vary a few degrees due to minor influences on the temperature of the liquid such as the level of impurities in the water and air pressure. Record of any temperature checks shall be included in the calibration log (Appendix B-2).

3.5.3 Conductivity Meter Calibration

Most water quality multimeters have an on screen menu that allows the calibration of conductivity to be performed in the field using an established calibration solution, and documented on the calibration log (Appendix B-2). The conductivity cell of the meter will be cleaned and checked against a known conductivity standard. If the check indicates the need for calibration, the meter will be calibrated according to instrument manufacturer's instructions.

3.5.4 Dissolved Oxygen (DO) Meter Calibration

The DO probe is recommended to only be used with meters equipped with flow-through cells. Calibration of this parameter is typically not performed in the field. As such, a record of the calibration documentation provided by the supplier should be maintained. DO response can be evaluated in the field to verify reasonable response from the instrument. Record of any DO checks shall be included in the calibration log (Appendix B-2). The process involves filling the instrument calibration cup with distilled or deionized water, and threading the cup loosely onto the meter making sure the probe is not submerged. Let the instrument sit for 15 to 20 minutes in a room at room temperature (approximately 20 degrees Celsius [^{o}C]) to allow the air within the calibration cup to become fully saturated with moisture. The DO probe is expected to measure approximately 9.1 milligrams per liter (mg/L) and the DO saturation percentage is expected to be near 100 percent. If the recorded measurements are not within approximately

10% of the expected value, the probe membrane will be replaced in accordance with manufacturer instructions or the meter replaced by the instrument supplier.

3.5.5 Oxidation-Reduction Potential (ORP) Calibration

The ORP probe calibration is performed by the instrument supplier prior to issuance and is rarely attempted in the field. According to manufacturer's specifications, the instrument is expected to hold its ORP calibration for a period of time significantly greater than the duration of any groundwater monitoring event. As such, calibration for this parameter is not required for this FSP. An ORP standard of 200-275 mV, sometimes referred to as "Zobell's Solution", can be used to evaluate ORP response in the field to provide a rough validation of the factory calibration.

3.5.6 Turbidity Calibration

The turbidity meter will be calibrated daily using a three point calibration following manufacturer instructions. The calibration procedure will involve setting the low, middle, and high range of the instrument using calibration standards of known turbidity. The lowest standard typically consists of distilled or deionized water with an expected response of 0 Nephrometric Turbidity Unit (NTU). The remaining two standards are typically 10 to 20 NTU for mid-range and 40 NTU or greater.

4.0 SAMPLING

Groundwater sampling methods will involve groundwater level measurement, well purging, sample collection, and documentation.

4.1 Well Level Measurement

The depth-to-water (DTW) in monitored wells will be measured to the nearest hundredth of a foot using an electronic water level indicator at the beginning of each event as well as prior to and during purging (when using the low-flow purging method) following the Standard Operating Procedure (SOP) for Well Inspection and Depth to Water measurement presented in Appendix B-3. The bottom of the monitoring wells will not be readily accessible due to the presence of the bladder pumps. As such the total depth (TD) of the well will be a reported depth provided on the well construction log. All depth-to-water measurements collected for an event will be recorded on a Measurement of Groundwater Levels form provided in Appendix B-2.

4.2 Well Purging and Sampling

The SOP for well purging and sampling is provided in Appendix B-3. Purging will be completed using the dedicated bladder pumps installed in each of the five monitoring wells. All field parameter measurements and depth-to-water measurements for each well collected during purging and sampling will be recorded on a groundwater sampling data sheet (Appendix B-2)

4.2.1 Low-Flow Purging Method

Groundwater purging and sampling using the low-flow sample method as defined in Puls and Barcelona, 1996 will be the primary sampling method employed at the Site. This method is designed to passively draw groundwater from the formation with minimal mixing of stagnant water associated with casing storage by drawing groundwater from the well at a purge rate of between approximately 50 to 200 milliliters per minute (mL/min) such that drawdown of water level of no more than 4 inches from static depth to water as measured by a water level indicator probe.

Field parameters will be measured using a multimeter equipped with a flow-through cell equipped to test DO, pH, specific conductance, temperature, turbidity, and ORP. Low-flow purging will continue until the field parameters for temperature, pH, and specific conductance (at a minimum) have attained the appropriate stabilization range as follows:

Field Parameter	**Stabilization Range**
Temperature	±1.0 ^{o}F
pH	±0.1 Standard Units
Specific conductance	±3%
Turbidity	±□□10%
ORP	±10mV
DO	±□□10%

If the water level cannot be maintained within 4 inches of static due to lack of recharge the well will be purged using the purge and sample option discussed below.

4.2.2 Purge and Sample Option

The purge and sample method involves the removal of at least three well volumes of water from the well to obtain a representative sample. This volume is well-specific as determined by the height of the static water column as determined by subtracting the measured DTW from reported TD. The height of the static water column is then multiplied by 0.5 (for 2-inch inner diameter wells) to calculate the three well volumes to be purged.

Purging will be conducted using the same equipment as the low-flow method. The purge and sample method requires the removal of a minimum three well volumes of water and stabilization of groundwater quality parameters for temperature, specific conductance, and pH have been reached.

If field parameter stabilization does not occur after three well volumes, the purging will be continued for up to a fourth well volume. If parameter stabilization has not occurred after four well volumes the sample will be collected and the discrepancy noted in the field log and on the well sampling form (Appendix B-2).

4.2.3 Low Yielding Wells

If the yield in a monitoring well is insufficient to conduct purging by low-flow or purge and sample methods, it will be purged dry a minimum of two times prior to sample collection. The measured field parameters, calculated purge volume and actual purge volume will be recorded on the well sampling data sheet (Appendix B-2).

4.2.4 Disposal of Purge Water

Water purged from the monitoring wells at this site is considered to be non-hazardous and should be disposed to ground surface downgradient of the well. However, if analytical data of the corresponding groundwater samples reports a compound at or above the U.S. EPA Maximum Contaminant Levels [MCLs], the procedure for the disposal of purge water should be reviewed for possible amendment for subsequent sampling events.

4.2.5 Decontamination of Equipment

All reusable equipment that will or may come into contact with groundwater must be decontaminated prior to use following the SOP (Appendix B-3).

4.3 Sample Collection

Groundwater samples will be collected upon completion of purging for either baseline monitoring or detection monitoring depending on the closure status of the Site, as described in Section 3 of the GMP. A water sample from each monitored well will be submitted for laboratory analysis of the parameters in either Table 1 (Baseline) or Table 2 (Detection). The purging procedures prior to sampling will be similar for both types of monitoring events. However, the number of sample bottles to be filled and the preservatives to be added at each sampling

location may be different depending on laboratory requirements to fulfill the different analysis requirements.

The SOPs for sample collection are provided in Appendix B-3. Groundwater samples will be collected using either single-use, dedicated, or decontaminated equipment only. All water quality meters must be removed from the discharge train prior to dispensing the sample to the laboratory-supplied containers. The samples will be collected immediately after purging is completed, or in the case of low-yielding wells, when sufficient recovery allows sampling to commence.

QA/QC samples:

- One duplicate will be collected as a split sample in the field during each monitoring event.
- Bottles specifically for MS/MSD analysis will NOT be collected in the field. This QA/QC sample will be selected at random by the laboratory from the samples submitted.

All filled sample bottles will be affixed with a label containing the project name, well number, date and time, preservation, analysis, and sampling crew initials. This information will be entered on a laboratory-supplied COC form after sample collection is complete and before mobilizing to the next location. (See Section 4.4 for further details on Chain-of-Custody procedures).

4.4 Sample Documentation and COC

Custody of the samples will be recorded on a COC form after securing the samples in the cooler, and before mobilizing to the next sampling location. This form will remain with the cooler and provide an accurate record of all samples the cooler contains. The COC will be unique to each cooler and contain information describing all of the samples contained within. The information to be recorded on the COC includes the following:

- Client, project name, project number.
- Name of the sampler and project manager.
- The sample identification, date, time for every sample in the cooler.
- The number, type and preservation of containers.
- The requested analyses for every sample.

5.0 SAMPLE PACKING AND SHIPMENT

The SOP for sample packing and shipment is provided as Appendix B-3. The sampler (or custodian) who relinquishes the samples will do so by signing the COC(s). This individual will be responsible for the verifying the samples are properly secured, chilled and labeled to minimize the potential loss of sample(s) due to damage, inadequate preservation or preventable shipping delay. A copy of each relinquished COC and shipping tracking number will be placed in the field project file, and the laboratory will be contacted the following morning to confirm the cooler(s) arrived in good condition.

Upon receipt of the sample cooler, the laboratory will accept custody by signing the COC form as “Received by” and will log in the samples. The log-in procedure will include measuring the cooler temperature using a temperature blank sample that accompanied the cooler. The laboratory will immediately contact the project manager regarding any problems with sample breakage, chain-of-custody, or other discrepancy, so that corrections or replacements can be made as necessary.

6.0 ANALYTICAL METHODS AND LABORATORY QA/QC

Groundwater sample analyses for the monitoring events will follow Federal Register approved methods referenced on Table B-1 and Table B-2. The methods will be stated on the COC. nformation regarding the data analysis procedures and reporting requirements for each analytical method is presented in the Dolan Chemical Laboratory Quality Assurance Manual (QAM) Revision 18, Effective Date, December 1, 2012 included here as Appendix B-1. The laboratory QAM details the following:

- Personnel Descriptions and Responsibilities (Section 16)
- Technical Requirements for Equipment (Section 19)
- Procedure for Test Methods and Validation (Section 18)
- Technical Requirements for Sample Handling (Section 22)
- Technical Requirements for Calibration and Reference Standards and Reagents (Section 20)
- Technical Requirements for Reporting, Validation and Documentation (Section 24)
- Technical Requirements for QA (Section 23)
- Procedure for Records Control (Section 13)
- Procedure for Laboratory Audits (Section 14)

6.1 Data Validation

All analytical data will undergo a data review to assess validity. Validation procedures for this groundwater monitoring program are outlined in the following U.S. EPA guidance document:

> *U.S. EPA Contract Laboratory Program, National Functional Guidelines for Inorganic Data Review* (U.S. EPA, January 2010).

The laboratory deliverable will include, at a minimum, the sample COC forms, analytical results, and QC summaries. The contractor QA manager will evaluate the overall completeness of the data package. Completeness checks will be administered on all data to determine whether deliverables specified in this SAP and QA/QC Plan are present. The reviewer will determine whether all required items are present and request copies of missing deliverables.

APPENDIX B-1

DOLAN LABORATORY
QUALITY ASSURANCE MANUAL (QAM)

APPENDIX B-2

FIELD DOCUMENTATION

MEASUREMENT OF GROUNDWATER LEVELS

Job Number: _____ **Date:** _____

Owner: AEP - Big Sandy **By:** _____

Location: Horseford Creek Site **Instrument:** _____

Serial #: _____

Well ID Number	Time	Reference Point	Elevation of Reference	Depth to Water (DTW)	Total Depth (TD)	Water Elevation

Comments:

Groundwater Sampling Data Sheet

AEP - Kentucky Power Company / Big Sandy Power Plant
Horseford Creek Site

Date: _____

Field Technician/Sampler(s) _____

Well Identification: _____ Monitoring Well Tag Number: _____

Well Diameter: 2-inch Well Depth (ft): _____ Water Level: _____

Height Water Column (ft.) _____ Well Volume: _____ Three Well Volumes: _____

Start Purge Time: _____ Method of Purging Well: _____

End Purge Time: _____ Total Purge Amount (gals.) _____

Well Purging Comments: _____

Instrument calibration used prior to purging:

pH buffers used pH 4 _____ Conductivity Standard: _____
pH 7 _____ Other standards: _____
pH 10 _____

Groundwater Chemistry Purge Data

Date & Time	Turbidity (NTU)	pH (s.u.)	Conductivity (mhos/cm)	Temperature (^{o}C)	ORP (mV)	DO (mg/L)	Gallons Purged

Groundwater Sampling Data

Water Level Depth (ft.): _____ Method of Sample Collection: _____
Sampling Date (Start): _____ Sampling Time (Start): _____
(End): _____ (End): _____

Instrument calibration used prior to sampling:

pH buffers used pH 4 _____ Conductivity Standard: _____
pH 7 _____ Other standards: _____
pH 10 _____

Date	Time	pH (s.u.)	Conductivity (mhos/cm)	Temperature (^{o}C)	Dissolved O_2 (mg/L)	ORP (mV)	Others/Comments

Metal Filtration: start time: _____ end time: _____

Comments: _____

Signed: _____ Date: _____

FIELD MEMORANDUM

DATE:	PAGE	OF
NAME:		
TO (FILE/PM):		

CLIENT: **AEP Big Sandy**	SITE: **Horseford Creek Site**	PROJECT #:

SUBJECT:

Chain-of-Custody Record and Analysis Request Form

Form COC-2
Rev. 4, 09/16/11

Page ___ of ___

Location: (District, Region, Plant, etc.) Big Sandy Plant

Program/Project: (If applicable) Groundwater Monitoring

Submitted/Requested By:

Phone/Fax/E-mail: 285-1416

Sample(s) Origin - * Sample Source and Description:
(NPDES Permit, Outfall No., etc.)

Additional Information:
(Site Description, Sample Type, etc.)

Analyses Requested:
(Attach information if necessary)

Results Turnaround: (Select One ☑) (Please Date Non-Routine) **Routine** ☐ **Priority** ☐ **Rush** ☐ **Date By:**

Weather Conditions Affecting Sampling:

Bottle or Analysis ID's	Preservatives and Filtering (Codes/Colors)	Quantity of the *Sample	Sampler(s) Initials	Flow	Select One Per Line: COMPOSITE Date/Time	COMPOSITE mL Added	GRAB Date/Time

Units of Flow ☑
☐ mgd ☐ gpm ☐ Other _____

Preservatives and Filtering

(Codes)	{Colors}
(A) None	{White}
(B) Cool, ≤ 6°C	{Blue}
(C) NaOH; pH > 12	{Yellow}
(D) HNO_3; pH < 2	{Red}
(E) 1:1 H_2SO_4; pH < 2	{Green}
(F) Filtered	{Pink}
(G) 1:1 HCl; pH < 2	{Gray}
(H) Zinc Acetate	{Black}
(I) Other _____	

Samplers Initials Code

Initials	Print Name of Person

*** Sample Collector Info**

Name
Mailing Address
Phone

Relinquished By: (Sampling supervisor or personnel): _____ **Date/Time:** _____

Transportation: ☑ ☐ Employee ☐ AEP Courier ☐ UPS ☐ Fed-Ex ☐ Other (Name): ***Date of Shipment to Lab:** _____

Received By Transporter: _____ **Date/Time:** _____

Relinquished By Transporter: _____ **Date/Time:** _____

Received By Laboratory: (Testing laboratory receiving personnel) _____ **Date/Time:** _____

Receipt Notes: _____

*** Dolan Chemical Laboratory**
4001 Bixby Road
Groveport, Ohio 43125
Phone: 614-836-4211
Fax: 614-836-4168

A PROPERLY FILLED OUT COPY OF THIS FORM MUST ACCOMPANY EACH SET OF SAMPLES SENT TO THE WATER TESTING LABORATORY.
ALSO, A TAG ON THE SAMPLE OR CONTAINER IS NECESSARY FOR THE SAMPLE(S) TO BE PROPERLY PROCESSED.
FEDERAL REGULATIONS REQUIRE THAT THIS INFORMATION BE RETAINED FOR AT LEAST THREE YEARS.
LABORATORY DATA FOR THESE SAMPLES SHOULD BE FILED WITH THIS CHAIN-OF-CUSTODY RECORD.

**** NOTE: For PCB analysis must complete: sample collector name, mailing address & phone; quantity of the sample; sample source & description; date of shipment to lab.***

AEP DOLAN CHEMICAL LAB
CHAIN OF CUSTODY RECORD - INSTRUCTIONS
FORM COC-02

GENERAL

1 All applicable information must be completed - optional entries are noted in these instructions.
2 COC forms must be completed legibly and in permanent ink.
3 Any errors must be corrected by a single line through the mistake, and the date and initials of the individual making the correction.
4 Shaded areas of the chain of custody (COC) are for laboratory use only.

RECORD COMPLETION

1 Page Numbering: Enter the page number of each individual page and the total number of pages.
2 Location: Enter the location or applicable AEP operating company - district, region, plant, etc.
3 Program/Project Name: Enter the name of the program, project or site where the samples originated.
4 Contact Person: Print the name of the person to receive the final analytical results.
5 Contact Information: Enter the phone number, fax number, and email of the person to receive the final analytical results.
6 Sample(s) Origin - Source & Description: Describe the sample for identification purposes. This could be a company or serial number for equipment, an outfall number, NPDES permit, or other source.
* *This is required for shipment of samples for PCB analysis.*
7 Additional Information: Include site description, sample type, and any information that may be useful.
8 Analyses Requested: Clearly state which analyses are requested and any specific reference method or test methodology that is required. (Attach information, if necessary)
9 Results Turnaround: Select one of the following turnaround times - routine, priority or rush. If Non-Routine turnaround is selected, indicate the requested date of results.
10 Weather Conditions Affecting Sampling: Describe weather conditions encountered during sampling event(s).
11 SAMPLE INFORMATION - It is the intent of this record that each sample container is entered on a different line
a. **Bottle or Analysis ID(s):** Enter an ID number that matches the ID on the sample container label.
b. **Preservatives and Filtering (Codes/Colors):** Indicate the preservative(s) added to the sample and/or filtering performed on the sample using the Codes (A through I) and Colors defined in the center box.
c. **Quantity of the Sample:** Enter the volume of the sample. You may use the sample container volume measurement as the quantity of the sample.
* *This is required for shipment of samples for PCB analysis.*
d. **Units of Flow:** Select the units of flow from those listed, or select "other" and state the units of flow used.
e. **Sampler(s) Initials:** The sampler(s) initials as defined in the bottom, center box.
f. **Flow:** The flow rate of sample collection, if known.
g. **Composite/Grab:** The sampling technique (composite or grab sample). Indicate the date and time the sample was collected under the appropriate header- Composite or Grab. Additionally, indicate the volume of sample added during composite sampling.
h. **Samplers Initial Code:** List the initials and the printed name of the sample collector(s).
i. **Sample Collector Information:** Print the name, mailing address, and phone number of the sample collector.
* *This is required for shipment of samples for PCB analysis.*
12 IDENTIFICATION AND SIGNATURES FOR CUSTODY PURPOSES –
– Two sections are provided to show transfer and receipt of samples - from the sample collector(s)/site personnel, to the transporter, to the final destination in the laboratory.
a. **Relinquished By (Sign, Date, Time):** Signature of the person turning the sample(s) over to another person (such as the sample collector, supervisor, or other coworker).
b. **Transportation: Select** which carrier was used for shipment - employee, AEP courier, UPS, Fed-Ex, other. If "other" is selected, indicate the name.
c. **Date of Shipment to Lab:** Enter the date the sample(s) is shipped to the lab.
******This is required for shipment of samples for PCB analysis.*
d. **Received By Transporter (Sign, Date, Time):** Signature of the Transporter personnel receiving the sample(s) as they are relinquished.
e. **Relinquished By Transporter (Sign, Date, Time):** Signature of the Transporter personnel turning the sample(s) over to another person (at the laboratory).
f. **Received By Laboratory (Sign, Date, Time):** Signature of the laboratory personnel receiving the samples as they are relinquished.
g. **Receipt Notes:** Include pertinent observations and comments in relation to receiving the sample(s).

CALIBRATION LOG

Project Name: AEP Big Sandy – Horseford Creek Site Project #:_____

Instrument Type:_____ Serial #_____

DATE	INSTRUMENT	PARAMETER	CALIBRATION STANDARD(S) Unit(s) or Concentration(s)			CALIBRATED BY	REMARKS

_____

_____

_____

_____

APPENDIX B-3

STANDARD OPERATING PROCEDURES (SOPs)

STANDARD OPERATING PROCEDURE (SOP)
WELL INSPECTION AND DEPTH TO WATER MEASUREMENT

Scope: This procedure describes acceptable methodologies for well inspection, collecting Depth-to-Water (DTW) measurements.

Purpose: The purpose of describing this procedure is to create a uniform method of well inspection and DTW procedures between field personnel and between measurement events.

Equipment: Electronic water level probe, field forms including a Field Memo, groundwater level measurements, personal protective equipment [PPE] (Level D, hard hat, cut resistant and nitrile or equivalent gloves). Decontamination equipment will include distilled water and non-phosphate detergent.

Procedure:

1. Identify and locate each monitoring well to be measured for DTW and total depth.

2. Approach each monitoring well to be measured and complete a visual inspection of the condition of the procasing, bollards, and pad. Note any damage or degradation in condition such as rust, cracks, worn hinges, chipped or faded paint etc.

3. Remove the lock using the appropriate key and procasing lid. Inspect the interior for properly functioning well cap and signs of wildlife (insects, nests etc.). Remove signs of wildlife from the interior if observed and can be done safely.

4. Remove the locking well cap and lower the probe down the well until the probe responds indicating top of water.

5. Measure the DTW from the reference mark on the Top of Inner Casing (TOIC). Raise and the probe a few inches at above and below the top of water to confirm. Record measurement on the appropriate field forms (Well Data Sheet form). **Note: Total Depth (TD) measurement will not be performed due to bladder pump obstruction. A report TD from the well construction for each monitoring well will be used to calculate purge volume.**

6. Decontaminate probe and cable with non-phosphate detergent and distilled or Deionized (DI) water solution followed by distilled or DI water rinse before proceeding to the next well.

STANDARD OPERATING PROCEDURE (SOP)
MONITORING WELL SAMPLING

Scope: This procedure describes acceptable methodologies for purging and sampling monitoring wells so that representative samples can be obtained.

Purpose: The purpose of describing this procedure is to create a uniform method of sampling between field personnel in order to provide representative samples of the saturated unit while maintaining proper quality control (QC) practices.

Equipment Needed: Bladder pump controller, discharge elbow, air and discharge tubing, air compressor, water quality multimeter with flow-through-cell, calibration standards (3-point pH, 3-point turbidity and conductivity), electronic water level indicator, plastic sheeting, two or more 5-gallon buckets, personal protective equipment [PPE] (see contractor specific Health and Safety Plan), chemically resistant gloves, laboratory supplied, coolers bottles, preservatives, labels and chain of custodies.

Procedure: Initial Setup

1) Locate and identify monitoring well to be sampled and inspect for evidence of possible damage or tampering.

2) Place plastic sheeting around the well, and unlock protective casing and remove the cap.

3) Measure the depth-to-water (DTW)
(See SOP Well Inspection–Water Level/Total Depth (TD) Measurement)

4) Calculate of the purge volume requirements by subtracting measured DTW from the reported TD and multiplying by 0.5 (for 2-inch well).

5) Attach discharge elbow and connect air supply tubing from controller to the pump and connect air tubing from compressor to the controller.

6) Connect flow-through-cell of a calibrated water quality meter to well discharge tubing. **(Note: Calibration for pH, Specific Conductivity and Turbidity required daily at a minimum)**

7) Put on new single use chemical resistant gloves and continue with either **Low-Flow** or **Purge and Sample** method.

Low-Flow Procedure

8) Start the compressor and adjust the controller per instruction manual such that purge rate is approximately 50 millimeters per minute (ml/min).

9) Measure the DTW and increase purge rate up to a maximum of approximately 200 ml/min keeping drawdown to less than 4 inches from static as measured in Step 4. **(NOTE: If drawdown cannot be maintained at 4 inches or continue purging via the purge and sample method below)**

10) Continue purging and record DTW and field parameter readings on the Groundwater Sample Data Sheet at roughly 5 minute intervals adjusting purge rate as needed such that drawdown does not exceed four inches.

11) Once field parameters for ph, Specific Conductance and Temperature (minimum) have stabilized the well is ready to sample.

Field Parameter	Stabilization Range
ORP	±10mV
Dissolved oxygen	±10%
pH	±0.1 Standard Units
Specific conductance	±3%
Temperature	±1.0 ^{o}F
Turbidity	±10%

12) Label a set of sample containers (provided by the lab) the Project name, Well ID, sample date, sample time, analysis requested, preservative, and sampler initials.

13) Remove the discharge line from the flow-through-cell and fill all appropriate laboratory supplied sample containers.

14) **Duplicate QA Sample:** When a duplicate sample is to be collected the containers for the primary and duplicate samples will be filled alternately such that the two containers are filled simultaneously. Special care should be taken to minimize differences between the two samples, especially in sediment content.

15) Add preservatives per laboratory instructions to appropriate filled containers and secure the samples in a cooler chilled with wet ice to between 2 to 4 degrees Celsius (^{o}C).

16) Shutdown the air compressor.

17) Record the sample identification, date, time, analysis, and preservation information on a Chain of Custody.

18) Complete the Groundwater Sampling Data sheet recording any additional observations. (i.e. color, odor, air bubbles in discharge etc.).

19) Disconnect all sampling equipment, secure locking well cap and procasing lid and lock back on the well. Place all disposable equipment such as gloves, plastic sheeting and non-dedicated tubing used for sample collection into a trash bag for proper disposal.

20) Decontaminate water level probe and flow-through-cell in accordance with the SOP-C.

Purge and Sample Procedure

8) Start the compressor and adjust the controller per instruction manual such that the purge rate is roughly equivalent to the maximum sustainable yield of the well.

9) Continue purging and record DTW and parameter readings on the Groundwater Sample Data Sheet at roughly 5 minute intervals.

10) Once field parameters for pH, Specific Conductance and Temperature (minimum) have stabilized the well is ready to sample.

Field Parameter	Stabilization Range
ORP	□10 mV
Dissolved oxygen	□˜ı
pH	□0.1 Standard Units
Specific conductance	□3%
Temperature	□ı°F
Turbidity	□˜ı

11) Label a set of sample containers (provided by the lab) the Project name, Well ID, sample date, sample time, analysis requested, preservative, and sampler initials.

12) Remove the discharge line from the flow-through-cell and fill all appropriate laboratory supplied sample containers.

13) **Duplicate QA Sample:** When a duplicate sample is to be collected the containers for the primary and duplicate samples will be filled alternately such that the two containers are filled simultaneously. Special care should be taken to minimize differences between the two samples, especially in sediment content.

14) Add preservatives per laboratory instructions to appropriate filled containers, and secure the samples in a cooler chilled with wet ice to between 2 to 4 ^{o}C.

15) Shutdown the air compressor.

16) Record sample identification, date, time, analysis, and preservation information on a Chain of Custody.

17) Complete the Groundwater Sampling Data sheet recording any additional observations. (i.e. color, odor, air bubbles in discharge etc.).

18) Disconnect all sampling equipment, secure locking well cap and procasing lid and lock back on the well. Place all disposable equipment such as gloves, plastic sheeting and non-dedicated tubing used for sample collection into a trash bag for proper disposal.

19) Decontaminate the water level probe and flow-through-cell in accordance with the procedures described in the decontamination SOP.

STANDARD OPERATING PROCEDURE (SOP)
DECONTAMINATON

Scope: This procedure describes acceptable methodologies for decontamination of non-dedicated sampling equipment.

Purpose: The purpose of describing this procedure is to create a uniform method for decontamination of reusable equipment that will come into contact with the a well or sample such as water level probes and flow-cells as well as equipment that may be used such as submersible pumps.

Equipment Needed: Two 5-gallon buckets, one scrub brush, potable water, non-phosphate detergent, spray bottle filled with dilute nitric acid (~5%) labeled “Dilute Nitric Acid”, spray bottle filled with distilled or deionized water and a roll of paper towels. Note: Label the spray bottle containing dilute nitric acid

Procedure:

1. Mix 2 to 3 gallons of potable water. (Distilled or deionized water can be used) with approximately one table spoon of non-phosphate detergent in one of the 5-gallon buckets.

2. Decontaminate for solids: Place the portion of the equipment to be decontaminated in the 5-gallon bucket to soak and scrub the exposed surfaces with the brush to remove deposits.

3. Remove the equipment from the bucket and place over the empty 5-gallon bucket.

4. Decontaminate for metals: Using the dilute nitric acid bottle, spray all portions of the equipment being decontaminated making sure to capture the liquid in the 5-gallon bucket.

5. Rinse all portions of the equipment that have been decontaminated using the spray bottle containing only distilled or deionized water.

6. Dry the equipment using a new single use sheet or sheets of paper towels.

7. Store the now decontaminated equipment until ready for use at the next sampling location.

STANDARD OPERATING PROCEDURE (SOP)
SAMPLE PACKING AND SHIPMENT

Scope: This procedure describes acceptable methodology for packaging and shipping environmental samples to an analytical laboratory for chemical analyses.

Purpose: The purpose of this procedure is to provide a uniform and documented means of securely transporting environmental samples to the laboratory and to preserve the integrity and quality of the sample(s).

Required Supplies: Packaging tape, paper towels, mailing labels, chain-of-custody forms, chain-of-custody seals, shipping forms, packaging material, and ice.

Procedures:

1. Assemble all sample containers from the completed sampling event.

2. Locate, identify and record all types of containers from each well identification on a chain-of-custody form.

3. Subtotal the number of containers of similar types and then add them all together for a total bottle count. Check bottle counts of similar bottle types and total bottle counts with the filled samples present in the sample coolers.

4. Check that sample containers were properly labeled.

5. Secure glass bottles in protective packaging material (i.e., bubble wrap).

6. Place plastic bag large enough to enclose all samples, packing materials and ice in each cooler. This will serve as a form of secondary containment should a leak occur during shipping.

7. Place protective packaging material in the bottom of each cooler to prevent direct contact of the glass bottles with the bottom of the cooler.

8. Arrange sample bottles in cooler to minimize movement. Plastic bottles may be placed between glass bottles when possible as an added protective measure.

9. Place ice (contained in resealable bags) into each cooler adequate to keep samples chilled at approximately 4 degrees Celsius (°C) until arriving at the laboratory.

STANDARD OPERATING PROCEDURE (SOP)
FOR SAMPLE PACKING AND SHIPMENT (CONTINUED)

10. Close and tie off the large plastic bag such that all samples, packing material and ice are inside. Then place the top copy (original) of the chain-of-custody in a resealable plastic bag on top of this bag.

11. Close lid of cooler and seal with packing tape at a minimum of two locations. Encircle the cooler at least three times per location. Place custody seals over the lid opening on the front right and back left of the cooler and cover with clear tape. This custody seal should be initialed and dated by the custodian prior to placing on the cooler.

12. Properly complete an address/shipping form and affix to the cooler lid with "This Side Up⇧", "Fragile" and “Glass” labels on two sides of each cooler. Samples will be delivered via overnight courier to arrive at the laboratory the next morning.

13. Deliver to an appropriate manned overnight shipper drop-off station.

14. File a copy of the chain-of-custody form and the shipping form in the project file.

15. Contact laboratory the next morning to confirm arrival and condition of samples.