Plan of Operation Modification
We Energies Pleasant Prairie Power Plant Ash Landfill
Pleasant Prairie, Wisconsin
September 29, 2023

Appendix O

Environmental Sampling and Analysis Plan

Intended for
We Energies

Date
December 14, 2023

Project No.
1940104079

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM

REVISION 1

PLEASANT PRAIRIE POWER PLANT

ASH LANDFILL

RAMBOLL Bright ideas. Sustainable change.

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM REVISION 1 PLEASANT PRAIRIE POWER PLANT ASH LANDFILL

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Approved by	**Nathaniel R. Keller, PG**
Description	**Environmental Sampling and Analysis Plan Addendum for Plan of Operation Modification required by Ch. NR 515.045 Wis Adm Code**

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I, Nathaniel R. Keller, hereby certify that I am a licensed professional geologist in the State of Wisconsin in accordance with the requirements of Ch. GHSS 2, Wis. Adm. Code; that the preparation of this document has not involved any unprofessional conduct as detailed in Ch. GHSS 5, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in Chs. NR 500 to 538, Wis. Adm. Code.

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I, Eric J. Tlachac, hereby certify that I am a licensed professional engineer in the State of Wisconsin in accordance with the requirements of Ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in Ch. A-E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in Chs. NR 500 to 538, Wis. Adm. Code.

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DOCUMENT REVISION RECORD

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TABLES (IN TEXT)

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FIGURES (ATTACHED)

APPENDICES

ACRONYMS AND ABBREVIATIONS

§	Section
40 CFR 257	Title 40 of the Code of Federal Regulations, Subtitle D Part 257
ACL	Alternative Concentration Limit
bgs	below ground surface
CCR	coal combustion residuals
Ch.	Chapter
ES	Enforcement Standard
GMP	Groundwater Monitoring Plan
HDPE	high-density polyethylene
mg/L	milligrams per liter
NAVD88	North American Vertical Datum of 1988
NRT/OBG	Natural Resource Technology, an OBG Company
P4	Pleasant Prairie Power Plant
PAL	Preventive Action Limit
Ramboll	Ramboll Americas Engineering Solutions, Inc.
STS	STS Consultants, Ltd.
TDS	total dissolved solids
Wis Adm Code	Wisconsin Administrative Code
WDNR	Wisconsin Department of Natural Resources

EXECUTIVE SUMMARY

This Environmental Sampling and Analysis Plan Addendum was completed by Ramboll Americas Engineering Solutions, Inc. (Ramboll) for the We Energies' Pleasant Prairie Power Plant (P4) Ash Landfill to present a coal combustion residuals (CCR) groundwater monitoring program that fulfills the requirements of Chapter (Ch.) NR 507.15(3), Wisconsin Administrative Code (Wis Adm Code), established in August 2022. This Addendum also includes revisions to the monitoring parameters for the existing (non-CCR) monitoring well network.

The P4 Ash Landfill is located in the Village of Pleasant Prairie, Kenosha County, Wisconsin (**Figure 1-1**). P4 is bordered by primarily industrial and residential properties (**Figure 1-2**). The P4 Ash Landfill was constructed in 1980 and began accepting waste in 1981, before Ch. NR 500 of the Wis Adm Code was promulgated in 1988. All waste was removed from the landfill for beneficial use in the early 2010s. A new liner and leachate collection system (new Cell 1) were constructed in 2013-2014 in the northern end of the permitted footprint of the landfill to bring it into substantial compliance with Ch. NR 500 requirements. The new Cell 1 was placed in service in 2014. Final cover construction commenced in 2018 and was completed in 2022.

Three hydrostratigraphic units have been identified at the P4 Ash Landfill based on stratigraphic relationships and common hydrogeologic characteristics, including:

- Fill: Typically composed of silty clay fill less than five feet thick.
- Unlithified Glacial Deposits: Primarily low hydraulic conductivity clays and silts of the Oak Creek Formation, 50 to 100 feet thick across the site. Potentially discontinuous glaciofluvial deposits of sands and gravels within the Oak Creek formation are thickest at the southern extent of the site, thinning to the north. Sand and gravels immediately overlying the uppermost aquifer are thin and discontinuous across the site.
- Uppermost Aquifer: This unit is composed of massively bedded dolomite from the Niagara Formation, with up to four feet of weathered bedrock cap. The top of the dolomite aquifer is generally at least 100 feet below ground surface (bgs) across the site.

Groundwater quality at the P4 Ash Landfill is currently monitored under federal and state programs. The existing state (Ch. NR 500, Wis Adm Code) groundwater monitoring network monitors the shallow glacial deposits. Groundwater is analyzed for concentrations of dissolved parameters specified in Table 2 of NR 507 and compared to Ch. NR 140, Wis Adm Code Preventative Action Limits (PALs) and Enforcement Standards (ESs). Beginning in 2015, the Uppermost Aquifer (bedrock unit) has been monitored in accordance with detection monitoring requirements in Title 40 of the Code of Federal Regulations, Part 257 Subpart D (40 CFR § 257), including the collection of eight independent groundwater samples prior to October 17, 2017 and analysis of parameters listed in Appendices III and IV of 40 CFR § 257. Subsequent to these eight independent samples, semiannual sampling has been conducted, with samples analyzed for parameters listed in Appendix III of 40 CFR § 257, and parameter concentrations compared to statistically derived background concentrations. Monitoring wells screened in the glaciofluvial sands and gravels (which are also part of the state program) are also monitored as a potential contaminant migration pathway and observed concentrations reported with uppermost aquifer data.

The proposed CCR monitoring network includes six monitoring wells, 2 background (W20D and W77) and 4 downgradient monitoring wells (W73, W74, W75, and W76). Wells W17B, W20B, and W31B are already monitored as part of the existing state monitoring network. Parameters specified in Table 1A of Appendix I, Ch. NR 507, will be monitored in the CCR wells on a semi-annual basis. Baseline groundwater quality required by Ch. NR 507.15(3)(L)(1) is being submitted with this document for parameters analyzed for 40 CFR § 257. Parameters specified in Tables 1A and 3 of Appendix I, Ch. NR 507, and not already analyzed for 40 CFR § 257 are currently being collected to complete eight rounds of sampling so the results can be evaluated against Ch. NR 140 PALs and ESs or Alternative Concentration Limits (ACLs; WDNR, 2007), if appropriate.

Background monitoring wells W20D and W77 meet the background well criteria for ACLs for the following parameters:

- Boron,
- Fluoride, and
- Sulfate.

Exemptions to the Ch. NR 140 PALs are proposed for all Uppermost Aquifer monitoring wells (W20D, W73, W74, W75, W76, and W77), which also meet the ACL exemption criteria for the parameters referenced above.

Sampling results and groundwater elevations will be submitted to the Geographic Environmental Monitoring Systems (GEMS database) with state monitoring program data within 60 days of the end of the sampling period, as well as any deviations from the sampling plan with an explanation of the deviations. Annual reporting will be completed by January 31 of each year in accordance with Ch. NR 507.15(m).

1. INTRODUCTION

1.1 Overview

This Environmental Sampling and Analysis Plan Addendum was completed by Ramboll Americas Engineering Solutions, Inc. (Ramboll) as part of the Plan of Operation Modification for the We Energies' Pleasant Prairie Power Plant (P4) Ash Landfill to present a coal combustion residuals (CCR) groundwater monitoring program that fulfills Wisconsin Administrative Code Section NR 507.15(3) requirements, established in August 2022. This Addendum also includes revisions to the monitoring parameters for the existing (non-CCR) monitoring well network.

1.2 Site Location

The P4 Ash Landfill is located in Kenosha County, southeastern Wisconsin, in Section 9, Township 1 North, and Range 22 East in the Village of Pleasant Prairie approximately four and one-half miles west Lake Michigan (**Figure 1-1**). It is bordered by industrial property to the north and east, a secondary environmental corridor to the south, and residential property to the west.

1.3 Background

The P4 Ash Landfill was constructed in 1980 and began accepting waste in 1981, before Ch. NR 500 of the Wis Adm Code was promulgated in 1988. Initial construction of Cell 1 was completed on native clay. Cells 2-4 were constructed over 5 feet of compacted clay. In the early 2010s, all waste was removed from Cells 1-4 for beneficial use. In 2013-2014, a new landfill cell (new Cell 1) was constructed in the north end of the permitted landfill footprint to bring it into substantial compliance with Ch. NR 500 requirements. The new Cell 1 was constructed with a composite liner, consisting of a 60-mil high-density polyethylene (HDPE) geomembrane and geosynthetic clay liner, and a leachate collection system.

Final cover construction commenced in 2018 and was completed in 2022. The final cover consists of the following, beginning at the ground surface:

- 6 inches of topsoil,
- 24 inches of rooting zone soil,
- A geocomposite drainage layer,
- 40-mil textured linear low-density polyethylene geomembrane liner, and
- A 2-foot-thick compacted barrier layer.

With placement of the final cover, precipitation is directed away from the landfill cell and flows into nearby surface water bodies. The leachate collection system continues to operate; leachate is managed in accordance with the landfill operating permit and disposed through the Kenosha Water Utility (KWU). Leachate levels are monitored with leachate head wells in the landfill and collection sump level monitoring; the system includes high level alarms to notify the landfill operators if leachate levels exceed predetermined levels. The leachate lines and system are annually jetted as part of routine operation and maintenance.

Groundwater quality at the P4 Ash Landfill is currently monitored under federal and state programs. Samples collected from the existing state (Ch. NR 500, Wis Adm Code) groundwater monitoring well network are analyzed for concentrations of dissolved parameters specified in

Table 2 of NR 507 and compared to Ch. NR 140, Wis Adm Code Preventative Action Limits (PALs) and Enforcement Standards (ESs). Monitoring has been performed at the site since approval was received from the Wisconsin Department of Natural Resources (WDNR) in a July 13, 2013 letter.

In 2015, five additional monitoring wells were installed into bedrock, which represents the Uppermost Aquifer, as defined in 40 CFR § 257.53, to supplement the existing monitoring network, and comply with the requirements of 40 CFR § 257. Documentation of the installation and discussion of the hydrogeologic site conditions is provided in Section 2.

The Uppermost Aquifer is monitored in accordance with detection monitoring requirements. Parameters listed in Appendix III of 40 CFR § 257 are compared to statistically derived background concentrations. Monitoring wells screened in shallow glaciofluvial sands and gravels are also monitored as a potential contaminant migration pathway and observed concentrations reported with Uppermost Aquifer data.

2. GEOLOGY AND HYDROGEOLOGY

Significant investigation and analyses have been completed in both the overlying glacial sediments and the Uppermost Aquifer at the P4 Ash Landfill. Previous investigations include soil borings and monitoring well installations to characterize the site geology and hydrogeology prior to permitting the ash landfill and to comply with Ch. NR 500, Wis Adm Code. The current monitoring well networks and locations are shown on **Figure 2-1**. Historic investigations (which occurred periodically from 1975-1997) and subsequent monitoring for the WDNR characterized the geology and water quality mostly in the glacial materials below the ash landfill.

With the promulgation of the 40 CFR § 257 in 2015, the current Uppermost Aquifer monitoring well network was installed to fulfill the requirements of that rule. Six monitoring wells including two background (W20D and W77) and four downgradient monitoring wells (W73, W74, W75, and W76) comprise the Uppermost Aquifer monitoring well network (**Table 2-1**). Wells were screened between approximately 545 and 565 feet NAVD88 within the underlying Silurian bedrock. The boring logs, well construction forms, and other related monitoring well forms (including a Well Information Form [WIF]) are included in **Appendix A**.

2.1 Site Hydrogeology

Shallow groundwater flow immediately adjacent to the P4 Ash Landfill is generally to the east. Groundwater flow within the bedrock is generally northeast-east, towards Lake Michigan.

2.1.1 Hydrostratigraphic Units

Three hydrostratigraphic units have been identified at P4 based on stratigraphic relationships and common hydrogeologic characteristics. Cross-sections of the identified units are presented in **Figures 2-2 through 2-5** and are summarized as follows:

- Fill: Consists of primarily silty clay less than five feet thick and CCR within the landfill footprint.
- Unlithified Glacial Deposits: Consists of clays and silts of the Oak Creek Formation, with isolated sand lenses; this unit is 100 to 125 feet thick across the site.
- Uppermost Aquifer: This unit is composed of dolomite from the Niagara Formation. The top of this unit is contoured on **Figure 2-6**. The base of this unit was not encountered during any investigations at the site.

2.1.1.1 Fill

This unit is typically composed of silty clay. Where present, the fill unit ranges from less than one foot thick up to 5 ft thick. The CCR waste was removed from the landfill prior to reconstruction in 2013.

2.1.1.2 Unlithified Deposits

Extensive characterization of the unlithified deposits started in the 1970s and continued into the 1990s. The unlithified deposits consist of the Oak Creek Formation, which underlies the entire site, is over 100 feet thick, and generally has low hydraulic conductivity. The formation is primarily glacial tills with glacial-lacustrine and glaciofluvial deposits. The till and lacustrine deposits are predominantly fine-grained silt and clay deposits with thinner layers of silty sand lacustrine deposits.

Cross-sections (**Figures 2-2 through 2-5**) indicate most silt, sand, and gravel lenses are not laterally continuous beneath the current landfill area. However, silt, sand, and gravel lenses occurring between elevations 625 and 675 feet North American Vertical Datum of 1988 (NAVD88) may be interconnected beneath the current landfill area but do not appear to be present in the northeast portion of the site. The glaciofluvial deposits are encountered approximately 30-40 feet below ground surface (bgs) and consist of sands and gravels with varying amounts of fines. The glaciofluvial deposits are between seven and 17 feet thick on the south end of the site and thin moving north to less than five feet thick. These coarser-grained units are monitored as part of the existing Ch. NR 507 Wis Adm Code monitoring program. Based on available data, groundwater flow in the coarser-grained glacial deposits is east.

In addition, a thin, sandy unit overlies bedrock beneath most of the landfill area. Where present, the sand unit in contact with the bedrock is monitored with the 40 CFR § 257 groundwater monitoring network with the wells screened in the shallow bedrock.

2.1.1.3 Uppermost Aquifer (Bedrock)

The Silurian-aged Niagara Dolomite comprises the Uppermost Aquifer beneath the site. It is generally identified as a thickly-bedded dolomite with up to four feet of weathered material on top of competent bedrock. The Uppermost Aquifer was encountered in one boring advanced in 2013 (W73) and five borings advanced in 2015 (W20D, W74, W75, W76, and W77). Bedrock was drilled using rotosonic methods which recovered sections of core for logging and observations. The rock observed in these borings is described as a massive, fossiliferous dolomite with pitting. Slight to moderate decomposition and disintegration was noted in all borings with traces of pyrite recrystallization. W73 was noted as containing open vugs between 1 millimeter to 3 centimeters wide. Site-specific data for the Uppermost Aquifer has not been collected, but estimates of hydraulic conductivity in the Niagara Aquifer range between 10^{-4} and 10^{-2} cm/s, based on yield tests for domestic and high-capacity wells (USGS, 1976).

2.1.2 Groundwater Potentiometric Surface Elevations and Flow Direction

Wells W20D and W73-W77 monitor groundwater flow in the Uppermost Aquifer. Groundwater elevations measured on April 13, 2022 were between 668.24 and 671.03 feet NAVD88 and indicate a groundwater flow direction to the north-northeast (**Figure 2-7**). These observations are consistent with previous monitoring events. Seasonal variation in the groundwater elevations has been observed in the Uppermost Aquifer, with groundwater elevations measured in the spring up to ten feet higher than those measured in the fall. Although elevations seasonally vary, the groundwater flow direction in the Uppermost Aquifer is generally consistent and likely controlled by the proximity and hydraulic connection to Lake Michigan.

3. MONITORING PARAMETER REVISIONS FOR EXISTING CH NR 507 MONITORING WELL NETWORK

3.1 Existing Ch. NR 507 Monitoring Program

Semi-annual (annual where noted) groundwater monitoring is completed in accordance with Ch. NR 507, Wis Adm Code. In accordance with the Plan of Operation Environmental Monitoring Summary (issued August 24, 2016), the monitoring well network (**Figure 2-1**) consists of 16 monitoring wells screened in the unlithified glacial sediments and these other sampling locations:

- P10RR, W16R, W17AR, W17BR, W17CR, W19, W20A, W20B, W20C, W28, W31A [annual], W31B [annual], W31C, W35A [annual], W35B [annual], and W35C)
- one monitoring well screened in the uppermost aquifer (W73)
- the leachate tank (LTANK)
- two leachate head wells (HW1A and HW1B)

Semi-annual and annual samples for the monitoring wells are analyzed for the field and laboratory parameters listed in **Table A** below; the leachate tank sample parameters are listed in **Table B**. Leachate head wells are measured for liquid elevations quarterly and reported semi-annually. This program will continue to be performed in accordance with the previously approved sampling and analysis plan, incorporating parameter modifications in Section 3.2, if approved.

Table A – Ch. NR 507 Groundwater Monitoring Program Monitoring Well Parameters

Field Parameters[1]		
Groundwater Elevation	Specific Conductance	Water Color
Odor	Temperature	
pH	Turbidity	
Metals (Dissolved)		
Boron	Molybdenum	Selenium
Inorganics (Dissolved)		
Alkalinity	Hardness	Sulfate
Other		
Dissolved Organic Carbon		

[1] Dissolved oxygen, oxidation/reduction potential, and turbidity will be recorded during sample collection.

Table B – Ch. NR 507 Groundwater Monitoring Program Leachate Parameters

Field Parameters[1]		
pH	Specific Conductance	Water Color
Odor	Turbidity	
Metals (Dissolved)		
Boron	Lead	Molybdenum
Cadmium	Manganese	Selenium
Iron	Mercury	

Table B – Ch. NR 507 Groundwater Monitoring Program Leachate Parameters (continued)

Inorganics (Dissolved, except Total Suspended Solids)		
Alkalinity	Hardness	Total Suspended Solids
Chloride	Sulfate	
Other		
Biological Oxygen Demand	Leachate Volume[2]	
Chemical Oxygen Demand	Semi-volatile organic compound scan NR 507, App. IV NR 507.17(4)[3]	

[1] Dissolved oxygen, oxidation/reduction potential, and temperature are recorded during sample collection.

[2] Leachate volumes are compiled monthly.

[3] Semi-volatile organic compound testing is completely annually.

3.2 Proposed Monitoring Parameter Revisions

We Energies proposes to remove from the groundwater monitoring program the following parameters not included in Ch. NR507 Appendix I Table 2 (requirements for fly ash or bottom ash): molybdenum, and selenium. Molybdenum was added to the Ch. NR 507 monitoring program in 2014 as a result of investigations into molybdenum in southeast WI. Although molybdenum has been detected at concentrations above the PAL and ES (**Table 3-1)**, regional information indicates the molybdenum exceedances are naturally occurring as a result of groundwater interactions in the Silurian dolomite (Harkness et al, 2017).

Selenium has been included since 1993. A substantial data set has been generated and indicates that selenium has not exceeded the PAL in groundwater in the last 10 years (**Table 3-1,** no exceedances).

The lack of elevated concentrations of CCR indicators (boron and sulfate) in conjunction with low selenium concentrations and molybdenum concentrations that are consistent with regional levels provide evidence that concentrations of both selenium and molybdenum are unrelated to the P4 Ash Landfill. Based on this information, We Energies requests to eliminate molybdenum and selenium from the monitoring parameter list. Monitoring will be performed for the Table 2 parameters listed in Ch. NR 507 Appendix I, Table 2.

4. EXISTING 40 CFR § 257 MONITORING PROGRAM AND PROPOSED CH NR 507.15(3) MONITORING PLAN

Monitoring of the Uppermost Aquifer was initiated in 2015, following promulgation of 40 CFR § 257 Subpart D. These monitoring wells are proposed to be added to the Ch. NR 507 monitoring program to comply with related requirements added to Ch. NR 507 in 2022.

4.1 40 CFR § 257 Monitoring Program

The 40 CFR § 257 well network for the P4 Ash Landfill (**Figure 2-1**) consists of six monitoring wells installed within the uppermost aquifer, two background monitoring wells (W20D and W77) and four downgradient monitoring wells (W73, W74, W75, and W76). Monitoring wells screened in shallow glaciofluvial sands and gravels are also monitored as a potential contaminant migration pathway and observed concentrations reported with the Uppermost Aquifer data.

Groundwater is being monitored at the P4 Ash Landfill in accordance with the Detection Monitoring Program requirements specified in 40 CFR § 257.94. Details on the procedures and techniques used to fulfill the groundwater sampling and analysis program requirements are found in the Sampling and Analysis Plan for the P4 Ash Landfill (Natural Resource Technology, an OBG Company [NRT/OBG], 2017).

Groundwater samples are collected semiannually and analyzed for the laboratory and field parameters from Appendix III of 40 CFR § 257, summarized in **Table C** below.

Table C – 40 CFR § 257 Groundwater Monitoring Program Parameters

Field Parameters[1]		
Groundwater Elevation	pH	
Appendix III Parameters (Totals)		
Boron	Chloride	Sulfate
Calcium	Fluoride	Total Dissolved Solids (TDS)

Notes:

[1] Dissolved oxygen, temperature, specific conductance, oxidation/reduction potential, and turbidity are recorded during sample collection.

Results and evaluation of groundwater data are reported annually by January 31 of the following year and made available on the publicly accessible website required by 40 C.F.R. § 257.

4.2 Proposed Ch. NR 507.15(3) Groundwater Monitoring Network

The proposed Ch. NR 507.15(3) monitoring network (CCR wells) will consist of two background monitoring wells (W20D and W77) and four downgradient monitoring wells (W73, W74, W75, and W76; **Table 2-1**). Wells are located at the point of standards application in accordance with Ch. NR 507.15(3)(L)(4) (waste boundary). The network is designed to monitor potential impacts to the Uppermost Aquifer from the P4 Ash Landfill. CCR wells will be inspected in accordance with NR507.13 and maintained as necessary to ensure representative groundwater samples are collected for the purposes of this monitoring program. Samples will be collected and analyzed in accordance with the SAP (Appendix B).

Wells W20B, W31B, and W17B are not included in this network because they are already being monitored as part of the existing Ch. NR 507 monitoring program.

4.3 Ch. NR 507.18(5) Baseline Monitoring

Chs. NR 507.15(3)(L)(1) and NR507.18(5) require baseline groundwater quality be established and submitted to WDNR through the collection of eight independent samples and analysis for the parameters listed for CCR landfills in Tables 1A and 3 of Appendix I, Ch. NR 507. Eight rounds of baseline groundwater quality data for the parameters referenced in Appendices III and IV of 40 CFR § 257 were collected beginning on December 2, 2015 and extending through August 31, 2017 (**Appendix C-1**). All laboratory analyses were performed by the We Energies laboratory or Pace Analytical, Wisconsin certified laboratories, using appropriate methods that yielded adequate sensitivity and detection limits lower than the Ch. NR 140 PAL and ES.

Copper, manganese, silver, zinc, alkalinity, hardness, and nitrate + nitrite (as N) are not required to be monitored under 40 CFR § 257. Data collection for baseline groundwater quality for these parameters is currently being conducted and will be submitted to the WDNR with the semiannual reporting (GEMS submittals) to meet this requirement. Baseline monitoring parameters are summarized in **Table D,** below.

Table D. NR507 Appendix I, Tables 1A and 3. Baseline and Assessment Monitoring Parameters

Field Parameters[1]			
Groundwater Elevation	pH	Specific Conductance	Temperature
Metals (Total)			
Antimony	Cadmium	Lead	Selenium
Arsenic	Calcium	Lithium	Silver
Barium	Chromium	Manganese	Thallium
Beryllium	Cobalt	Mercury	Zinc
Boron	Copper	Molybdenum	
Inorganics (Total, except TDS)			
Alkalinity	Fluoride	Nitrate + Nitrite (as N)	TDS
Chloride	Hardness	Sulfate	
Other (Total)			
Radium 226 and 228 combined			

4.4 Ch. NR 507.15(3)(L) Detection Monitoring

Beginning in the second quarter of 2023, and continuing semi-annually thereafter (April and October), groundwater will be collected from the CCR wells and sent to a Wisconsin certified laboratory for analysis of parameters summarized in **Table E** on the following page and detailed in **Table 4-1**. The sampling and analysis summary provided on **Table 4-1** includes a summary of groundwater analytical methods for the full detection and baseline/ assessment monitoring list with method detection limits (MDLs) and reporting limits (RLs) as well as the NR140 standards. Results and notifications will be reported as discussed in **Section 4.6.**

Table E. NR507 Appendix I, Tables 1A, Detection Monitoring Parameters

Field Parameters[1]			
Groundwater Elevation	pH	Specific Conductance	Temperature
Metals (Total)			
Boron	Calcium		
Inorganics (Totals)			
Alkalinity	Fluoride	Sulfate	
Chloride	Hardness	TDS	

[1] Dissolved oxygen, oxidation/reduction potential, and turbidity will be recorded during sample collection.

4.5 Expanded Ch. NR 507 Leachate Monitoring

Leachate will also be sampled semi-annually (April and October) for parameters listed in **Table F**. Parameters in italicized text are additions to the existing Ch. NR 507 monitoring program. Results and notifications will be reported as discussed in **Section 4.6.**

Table F. NR507 Appendix I, Table 4, Detection Leachate Monitoring Parameters

Field Parameters[1]		
pH	Specific Conductance	Water Color
Odor	Turbidity	Temperature
Metals		
Antimony	*Fluoride*	*Lithium*
Beryllium	Iron	Molybdenum
Boron	Lead	Selenium
Cadmium	Manganese	*Thallium*
Cobalt	Mercury	
Inorganics		
Alkalinity	Hardness	Total Suspended Solids
Chloride	Sulfate	
Other		
Biological Oxygen Demand	*Radium-226 and 228, combined*	
Chemical Oxygen Demand	Semi-volatile organic compound scan NR 507, App. IV NR 507.17(4)[3]	
Leachate Volume[2]		

[1] Dissolved oxygen, oxidation/reduction potential, and temperature are recorded during sample collection.
[2] Leachate volumes are compiled monthly.
[3] Semi-volatile organic compound testing is completely annually.

4.6 Groundwater Standards

Groundwater analytical results will be compared to PALs and ESs listed in Ch. NR 140 Tables 1, 1A, and 2 where applicable. PALs for calcium and TDS were calculated in accordance with Ch. NR 140.20. However, an exemption may be requested, and Alternative Concentration Limits (ACLs) proposed, when the background concentration of a public health or welfare parameter exceeds the NR 140 PAL or ES (WDNR, 2007). Background wells W20D and W77 are unaffected by a release and their associated monitoring results for boron, fluoride, and/or sulfate meet the following criteria, presented in **Table 4-2**:

- Two or more values exceed a PAL and
- The average of the values is greater than the PAL.

Based on the above criteria, all CCR compliance monitoring wells require exemptions and ACLs for boron, fluoride, and sulfate. Downgradient monitoring wells W73 through W76 met one or more of the following criteria for boron, fluoride, and/or sulfate:

- Any of the values exceeds an ES,
- Two or more of the values exceed a PAL, or
- The average of the values is greater than the PAL.

The mean concentration and standard deviation of data for each well/parameter set was calculated using data collected per 40 CFR § 257 beginning in 2015. When a parameter was below detection limits in a well, one-half the detection limit was used in the calculation. Detailed calculation summary tables are provided in **Appendix C-2** and the applicable ACLs for boron, fluoride, and sulfate are included in **Table 4-3**, and PALs for calcium and TDS are included in **Table 4-4**.

The data used in PAL and ACL calculations were examined for potential outliers using a combination of box-whisker plots and trend graphs. Potential outliers were identified at multiple wells for multiple parameters and are discussed in below. In an effort to provide conservative PAL and ACL values, data were excluded from calculations where the outlier increased the calculated PAL or ACL. If the outlier had minimal impact on the PAL or ACL value (less than a 10-percent difference), and there was no information to suggest an errant value, data were included in the calculations.

ACL parameter trends were further evaluated using Mann-Kendall trend analyses in R (R Core Team, 2022). If the indicated long-term trend (December 2015 to present) was downward, a short-term trend (excluding baseline data) was evaluated. This is due to the potential for monitoring well installation to temporarily elevate parameter concentrations in groundwater. Trend analysis summaries are provided in **Appendix C-3**.

4.7 Reporting

4.7.1 GEMS Reporting

Consistent with the sampling and reporting requirements for the existing NR507 monitoring program, results from the CCR well sampling will be reported to the WDNR Groundwater and Environmental Monitoring System (GEMS) within 60 days of the end of sampling period. Results from both programs (NR507 and NR514) will be reported under License No. 2786.

4.7.2 Deviations from Sampling Plan

Any deviations from the sampling plan, wells not able to be sampled, elevated detection limits, etc., will be submitted to the WDNR within 60 days of the end of the sampling period. Proposed actions to address issues will be included with documentation.

4.7.3 Annual Groundwater Monitoring & Corrective Action Report

Annual Groundwater Monitoring and Corrective Action Reports documenting the status of the groundwater monitoring and any corrective action implemented at the CCR landfill will be submitted to the WNDR by January 31 of the following year, and placed in the operating record and on the publicly accessible website as required by Ch. 506.17(2) and (3). Annual reports will:

- Summarize key activities completed [including at least those required in Ch. NR 507.15(3)(m)]
- Describe any problems encountered,
- Discuss actions to resolve the problems, and
- Project key activities for the upcoming year.

4.8 Response Actions

4.8.1 Notifications

A notification will be provided to the department when results indicate concentrations have attained or exceeded groundwater standards in accordance with Ch. NR 507.30. The notification shall specify the parameters that have attained or exceeded standards, the wells at which the standards (PAL, ES, or ACL) were attained or exceeded, and provide a preliminary analysis of the cause and significance of each concentration in accordance with Ch. NR 140.24 (1)(a) or 140.26 (1)(a). The notification shall also include the intent to either begin assessment monitoring or determine whether a false exceedance occurred. Two copies of the notification shall be submitted to WDNR within 60 days from the end of the sampling period.

All data, statistical analysis, and reports will be submitted to WDNR as required by NR506.17(4), placed in the operating record per Ch. NR 506.17(2), and uploaded onto a publicly available website as required by Ch. NR 506.17(3).

4.8.2 False Exceedance Demonstrations

As described in Chs. NR 508.06(1)(c) and NR 507.28(3), if a groundwater standard exceedance is detected in a CCR well, a demonstration may be completed to indicating a source other than the P4 Ash Landfill is the cause or the exceedance is due to an error. The intent to complete this demonstration must be included in the notification referenced in Section 4.6.2.1. The demonstration will be submitted to the WDNR for review and comment within 60 days of the notification and placed in the operating record. Any verification sampling completed as part of this demonstration will be completed within 90 days of the original sampling date.

If WDNR concurs with the false exceedance demonstration within 30 days of receipt, detection monitoring will continue as specified in Section 4.4. If WDNR does not concur within 30 days, an assessment monitoring program in accordance with Ch. NR 508.06(2) will be initiated following discussion with the department.

4.8.3 Ch. NR 508.06(2) Assessment Monitoring Program

An initial assessment monitoring sampling event will be collected within 90 days of triggering an assessment monitoring program and annually thereafter. Groundwater from the CCR wells will be sampled and analyzed for all constituents listed under Ch. NR 507, Appendix I, Table 3 (**Table D,** above).

Within 90 days of obtaining the initial assessment monitoring results, and semiannually thereafter, CCR wells will be sampled and analyzed for all detection monitoring parameters under Ch. NR 507, Appendix I, Table 1A and for those constituents under Ch. NR 507, Appendix I, Table 3 that are detected in the initial assessment monitoring event. Results will be reported to the WDNR in accordance with Ch NR 507.30(1).

If an assessment monitoring parameter is detected at concentrations above the PAL, ACL, or ES, one of the following will be completed within 60 days:

- A site investigation workplan will be prepared in accordance with Ch. NR 716 and submitted to WDNR.
- A report demonstrating a source other than the CCR landfill caused the exceedance or that it resulted from error in sampling, analysis, or natural variation in background groundwater quality will be submitted to WDNR. If WDNR concurs with the demonstration within 30 days of receipt, the site will remain in assessment monitoring. If WDNR does not concur within 30 days a site investigation workplan will be prepared in accordance with Ch. NR 716.

4.8.4 Remedial Action

4.8.4.1 Site Investigation Workplan

The site investigation workplan will be prepared in accordance with Chs. NR 716.05 through 716.11 and submitted to the WDNR within 60 days of confirming an exceedance of a PAL, ACL, or ES and contain the information required under Ch. NR 716.09(2). The site investigation will be initiated within 90 days of the workplan submittal. A site investigation report, in accordance with Chs. NR 716.15 through 716.17 will be submitted following the investigation and within 60 days of receipt of laboratory data in accordance with Ch. NR 716.15(1).

4.8.4.2 Remedial Action Options Evaluation

If a PAL, ACL, or ES has been attained or exceeded at any CCR well and the alternate source demonstration (ASD) was not successful, remedial action options will be identified and evaluated in accordance with Ch. NR 722to assess potential corrective measures to prevent further releases, remediate any releases, and restore the affected area to original conditions if possible. The findings of the evaluation will be submitted to the WDNR in a remedial action options report (RAOR) within 90 days of the confirmation of a release from the CCR landfill in accordance with Ch. NR 722.13. If appropriate, a request to extend the deadline by up to 60 days may be submitted for WDNR approval.

The remedial action options report may be updated based on the findings of the site investigation in an addendum submitted department within 60 days of the submittal date of the site investigation report.

The RAOR, any addendum, and WDNR response will be placed in the written operating record required by Ch. NR 506.17 (2) and posted on a publicly accessible internet site required by Ch. NR 506.17 (3).

4.8.4.3 Remedial Action Selection

Based on the results of the remedial action options evaluation, a remedy will be selected that meets the following standards:

- Be protective of human health and the environment.
- Be shown to have the ability to attain the groundwater protection standards under Ch. NR 140.
- Control the source or sources of releases to reduce or eliminate, to the maximum extent feasible, further releases of constituents under Ch. NR 507, Appendix I for CCR landfills into the environment.
- Remove from the environment as much of the contaminated material that may have been released from the CCR landfill as is feasible, accounting for factors such as avoiding inappropriate disturbance of sensitive ecosystems.
- Comply with standards for management of wastes as specified under Ch. NR 506 for CCR material.

The selected remedy will also meet the requirements under Ch. NR 722 for the selection of remedial actions. The selected remedy will be included in the RAOR and specify how the selected remedy meets the standards listed above. In accordance with Ch. NR 508.06(4)(c), factors to be considered in remedy selection are summarized as follows:

- The long- and short-term effectiveness and protectiveness of the potential remedy or remedies, along with the degree of certainty that the remedy will prove successful.
- The effectiveness of the remedy in controlling the source to reduce further releases.
- The ease or difficulty of implementing a potential remedy.

The RAOR will all provide a proposed schedule for implementing and completing the selected remedial activities. It is expected that the remedy will be completed within a reasonable period of time, at the discretion of the WDNR. The schedule for implementing and completing the selected remedial activities will consider the factors listed in Ch. NR 508.06(4)(d) 1-6.

4.8.4.4 Remedial Action Implementation NR508.06(5)

The selected remedial action will be initiated within 90 days of WDNR approval. Implementation and completion of remedial activities will follow the schedule established in the RAOR and include the following:

- Establish and implement a corrective action groundwater monitoring program that, at a minimum, meets the requirements of an assessment monitoring program, documents the effectiveness of the corrective action remedy, and demonstrates compliance with the groundwater protection standards under Ch. NR 140.
- Implement the selected corrective action remedy approved by the WDNR.
- Take any interim measures necessary to reduce the contaminants leaching from the CCR landfill and potential exposures to human or ecological receptors. Interim measures will, to the greatest extent feasible, be consistent with the objectives of and contribute to the performance of the remedy approved by the department in the RAOR. Determination of whether an interim measure is needed will be based on factors listed in Ch. NR 508.06(5)(a)3.

If the selected remedy fails to remediate the groundwater to Ch. NR140 standards, an alternative remedy may be proposed for WDNR review and approval. The proposed alternative remedy will be evaluated as a remedial action option as described above.

Following implementation and monitoring, the remedy will be considered complete when the WDNR determines all of the following:

- The groundwater protection standards under Ch. NR 140 have been achieved at all points within the plume of contamination that lie beyond the groundwater monitoring well system established at the CCR landfill.
- Groundwater concentrations of constituents detected under Ch. NR 507, Appendix I, Tables 1A, 3, and 4 have not exceeded the groundwater protection standards under Ch. NR 140 for a period of 3 consecutive years.
- All actions required to complete the remedy have been satisfied.

Upon completion of the remedy, a notification will be submitted to the WDNR in accordance with Ch. NR 507.30(1). The notification will also be placed in the written operating record required by Ch. NR 506.17(2) and posted on a publicly accessible internet site required by Ch. NR 506.17(3). In addition, an application for case closure under Ch. NR 726 will be submitted to WDNR.

5. REFERENCES

Harkness, Jennifer S. Thomas H. Darrah, Myles T. Moore, Colin J. Whyte, Paul D. Mathewson, Tyson Cook, and Avner Vengosh. 2017. Naturally Occurring versus Anthropogenic Sources of Elevated Molybdenum in Groundwater: Evidence for Geogenic Contamination from Southeast Wisconsin, United States. *Environmental Science & Technology* **2017** *51* (21), 12190-12199

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TABLES

TABLE 2-1. CCR GROUNDWATER MONITORING WELL INFORMATION
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL
WE ENERGIES
PLEASANT PRAIRIE, WISCONSIN

Well Designation	Wisconsin Unique Well Number	DNR GEMS ID	Date Well Installed	Drilling Subcontractor	Drilling Method	Gradient Position	State Plane Northing	State Plane Easting	Latitude	Longitude	Ground Surface Elevation (ft NAVD88)	Top of Protective Cover Pipe Elevation (ft NAVD88)	Top of Well Riser Elevation (ft NAVD88)	Borehole Drilled Depth (ft bgs)	Borehole Bottom Elevation (ft NAVD88)	Depth to Top of Well Screen (ft bgs)	Depth to Well Bottom (ft bgs)	Top of Screen Elevation (ft NAVD88)	Well Bottom Elevation (ft NAVD88)	Depth to Top of Bedrock (ft bgs)	Top of Bedrock Elevation (ft NAVD88)
W20D	VQ580		3/4/2015	Cascade Drilling	Sonic	upgradient	212,757.97	2,533,085.40	42°33'51.3592"	-87°54'15.0776"	686.45	689.03	688.41	140.0	546.4	135.0	140.0	551.4	546.4	125.0	561.4
W73	VN433	292	10/2/2013	Boart Longyear Company	Sonic	downgradient	213,367.88	2,534,399.36	42°33'57.0560"	-87°53'57.3214"	688.66	691.07	690.58	130.0	558.7	125.0	130.0	563.7	558.7	114.0	574.7
W74	VQ578		3/3/2015	Cascade Drilling	Sonic	downgradient	213,321.15	2,533,126.93	42°33'56.9099"	-87°54'14.3343"	685.02	687.49	686.83	140.0	545.0	135.0	140.0	550.0	545.0	124.5	560.5
W75	VQ577		3/23/2015	Cascade Drilling	Sonic	downgradient	213,321.56	2,533,540.32	42°33'56.8116"	-87°54'08.8120"	687.42	690.31	689.91	141.0	546.4	136.0	141.0	551.4	546.4	125.0	562.4
W76	VQ576		3/24/2015	Cascade Drilling	Sonic	downgradient	213,300.53	2,534,065.51	42°33'56.4738"	-87°54'01.8036"	689.00	692.11	691.63	141.0	548.0	136.0	141.0	553.0	548.0	125.0	564.0
W77	VQ575		3/19/2015	Cascade Drilling	Sonic	upgradient	212,178.92	2,534,660.05	42°33'45.2513"	-87°53'54.2383	684.89	687.63	687.23	126.0	558.9	121.0	126.0	563.9	558.9	110.0	574.9

Notes:
"--" indicates data is not available or does not apply.
bgs = below ground surface
HSA = Hollow Stem Auger
Sonic = vibratory (i.e. roto-Sonic®)
1. The data source for ground surface and top of well riser elevations is STS Consultants Ltd. Final Hydrogeologic Investigation Report: Wisconsin Electric Power Company , Pleasant Prairie Power Plant Ash Landfill, Pleasant Prairie, Wisconsin. April 4, 1997.
2. Ground surface, top of protective cover pipe and top of well riser elevations for wells were surveyed by A.W. Oakes & Son, Inc. on March 16, 2015 and March 27, 2015. Vertical datum assumed to be NAVD88 .
3. Horizontal datum is Wisconsin State Plane Coordinates South Zone, NAD 83.
4. All wells constructed with 2-inch nominal size schedule 80 PVC with 5-foot long 10-slot screens. All wells are screened in dolomite bedrock.

Table 3-1. Molybdenum and Selenium Exceedances 2014 -Present
Pleasant Prairie Ash LF
Limit Exceptions (List)

Date Range: 01/01/2013 to 10/31/2022

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
PAL	Molybdenum, dissolved	01060	ug/L	P10RR	04/14/2014	9.50	0.00	8.00
					10/22/2014	12.40	0.00	8.00
					04/08/2015	8.70	0.00	8.00
					10/12/2015	10.00	0.00	8.00
					10/11/2016	10.10	0.00	8.00
					10/24/2017	9.70	0.00	8.00
					10/23/2018	8.40	0.00	8.00
					10/30/2019	10.00	0.00	8.00
					04/15/2020	8.60	0.00	8.00
					10/13/2020	10.60	0.00	8.00
					04/12/2021	8.80 J	0.00	8.00
					10/11/2021	10.30	0.00	8.00
					10/03/2022	11.00	0.00	8.00
				W16R	04/14/2014	28.00	0.00	8.00
					10/21/2014	24.60	0.00	8.00
					04/08/2015	17.00	0.00	8.00
					10/12/2015	23.00	0.00	8.00
					04/13/2016	15.00	0.00	8.00
					10/11/2016	12.40	0.00	8.00
					04/11/2017	20.00	0.00	8.00
					10/23/2017	18.00	0.00	8.00
					04/17/2018	22.00	0.00	8.00
					10/23/2018	25.00	0.00	8.00
					04/16/2019	12.00	0.00	8.00
					10/30/2019	19.00	0.00	8.00
					04/13/2020	12.00	0.00	8.00
					10/12/2020	16.00	0.00	8.00
					04/12/2021	13.70	0.00	8.00
					10/11/2021	10.30	0.00	8.00
					04/12/2022	14.90	0.00	8.00
					10/03/2022	22.40	0.00	8.00
				W17AR	04/14/2014	240.00	0.00	8.00
					10/21/2014	251.00	0.00	8.00

Table 3-1. Molybdenum and Selenium Exceedances 2014 -Present
Pleasant Prairie Ash LF
Limit Exceptions (List)

Date Range: 01/01/2013 to 10/31/2022

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
PAL	Molybdenum, dissolved	01060	ug/L	W17AR	04/08/2015	240.00	0.00	8.00
					10/12/2015	260.00	0.00	8.00
					04/14/2016	230.00	0.00	8.00
					10/11/2016	228.00	0.00	8.00
					04/11/2017	160.00	0.00	8.00
					10/23/2017	130.00	0.00	8.00
					04/17/2018	180.00	0.00	8.00
					10/23/2018	210.00	0.00	8.00
					04/16/2019	180.00	0.00	8.00
					10/30/2019	210.00	0.00	8.00
					04/13/2020	200.00	0.00	8.00
					10/12/2020	241.00	0.00	8.00
					04/12/2021	262.00	0.00	8.00
					10/11/2021	279.00	0.00	8.00
					04/12/2022	253.00	0.00	8.00
					10/03/2022	289.00	0.00	8.00
				W17BR	04/14/2014	120.00	0.00	8.00
					10/21/2014	142.00	0.00	8.00
					04/08/2015	140.00	0.00	8.00
					10/14/2015	150.00	0.00	8.00
					04/14/2016	150.00	0.00	8.00
					10/12/2016	143.00	0.00	8.00
					04/11/2017	150.00	0.00	8.00
					10/23/2017	140.00	0.00	8.00
					04/16/2018	140.00	0.00	8.00
					10/23/2018	150.00	0.00	8.00
					04/15/2019	140.00	0.00	8.00
					10/30/2019	150.00	0.00	8.00
					04/14/2020	150.00	0.00	8.00
					10/13/2020	147.00	0.00	8.00
					04/13/2021	160.00	0.00	8.00
					10/12/2021	162.00	0.00	8.00
					04/13/2022	158.00	0.00	8.00

Table 3-1. Molybdenum and Selenium Exceedances 2014 -Present
Pleasant Prairie Ash LF
Limit Exceptions (List)

Date Range: 01/01/2013 to 10/31/2022

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
PAL	Molybdenum, dissolved	01060	ug/L	W17BR	10/05/2022	170.00	0.00	8.00
				W17CR	10/21/2014	10.50	0.00	8.00
					04/08/2015	10.00	0.00	8.00
					10/12/2015	12.00	0.00	8.00
					04/14/2016	13.00	0.00	8.00
					10/11/2016	14.40	0.00	8.00
					04/11/2017	12.00	0.00	8.00
					10/23/2017	13.00	0.00	8.00
					04/17/2018	13.00	0.00	8.00
					10/23/2018	14.00	0.00	8.00
					04/16/2019	13.00	0.00	8.00
					10/30/2019	13.00	0.00	8.00
					04/13/2020	13.00	0.00	8.00
					10/12/2020	15.80	0.00	8.00
					04/12/2021	15.20	0.00	8.00
					10/11/2021	15.00	0.00	8.00
					04/12/2022	13.90	0.00	8.00
					10/03/2022	16.50	0.00	8.00
				W20A	04/14/2014	19.00	0.00	8.00
					10/21/2014	18.20	0.00	8.00
					04/08/2015	17.00	0.00	8.00
					10/12/2015	20.00	0.00	8.00
					04/13/2016	19.00	0.00	8.00
					10/11/2016	16.70	0.00	8.00
					04/10/2017	18.00	0.00	8.00
					10/23/2017	18.00	0.00	8.00
					04/17/2018	18.00	0.00	8.00
					10/22/2018	19.00	0.00	8.00
					04/16/2019	18.00	0.00	8.00
					10/29/2019	18.00	0.00	8.00
					04/13/2020	18.00	0.00	8.00
					10/12/2020	18.00	0.00	8.00
					04/12/2021	18.60	0.00	8.00

Table 3-1. Molybdenum and Selenium Exceedances 2014 -Present
Pleasant Prairie Ash LF
Limit Exceptions (List)

Date Range: 01/01/2013 to 10/31/2022

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
PAL	Molybdenum, dissolved	01060	ug/L	W20A	10/11/2021	18.20	0.00	8.00
					04/12/2022	17.70	0.00	8.00
					10/31/2022	19.60	0.00	8.00
				W20B	04/14/2014	22.00	0.00	8.00
					10/21/2014	24.70	0.00	8.00
					04/08/2015	26.00	0.00	8.00
					10/14/2015	27.00	0.00	8.00
					04/13/2016	27.00	0.00	8.00
					10/12/2016	23.40	0.00	8.00
					04/10/2017	26.00	0.00	8.00
					10/23/2017	22.00	0.00	8.00
					04/16/2018	19.00	0.00	8.00
					10/22/2018	27.00	0.00	8.00
					04/15/2019	26.00	0.00	8.00
					10/29/2019	27.00	0.00	8.00
					04/14/2020	26.00	0.00	8.00
					10/13/2020	24.00	0.00	8.00
					04/13/2021	30.10	0.00	8.00
					10/12/2021	17.10	0.00	8.00
					04/13/2022	29.20	0.00	8.00
					10/05/2022	27.40	0.00	8.00
				W20C	10/11/2021	10.10	0.00	8.00
				W28	04/08/2015	8.20	0.00	8.00
					10/11/2016	8.50	0.00	8.00
					10/11/2021	8.10 J	0.00	8.00
					10/03/2022	8.80 J	0.00	8.00
				W31C	04/15/2014	12.00	0.00	8.00
					10/22/2014	13.00	0.00	8.00
					04/07/2015	13.00	0.00	8.00
					10/12/2015	13.00	0.00	8.00
					04/14/2016	14.00	0.00	8.00
					10/11/2016	11.60	0.00	8.00
					04/10/2017	12.00	0.00	8.00

Table 3-1. Molybdenum and Selenium Exceedances 2014 -Present
Pleasant Prairie Ash LF
Limit Exceptions (List)

Date Range: 01/01/2013 to 10/31/2022

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
PAL	Molybdenum, dissolved	01060	ug/L	W31C	10/24/2017	12.00	0.00	8.00
					04/17/2018	11.00	0.00	8.00
					10/22/2018	13.00	0.00	8.00
					04/16/2019	12.00	0.00	8.00
					10/29/2019	13.00	0.00	8.00
					04/13/2020	12.00	0.00	8.00
					10/12/2020	12.70	0.00	8.00
					04/12/2021	12.60	0.00	8.00
					10/11/2021	13.30	0.00	8.00
					04/12/2022	12.10	0.00	8.00
					10/03/2022	13.80	0.00	8.00
				W35A	04/14/2014	44.00	0.00	8.00
					04/08/2015	45.00	0.00	8.00
					04/15/2016	41.00	0.00	8.00
					04/10/2017	47.00	0.00	8.00
					04/17/2018	45.00	0.00	8.00
					04/16/2019	48.00	0.00	8.00
					04/13/2020	50.00	0.00	8.00
					04/12/2021	52.20	0.00	8.00
					04/12/2022	49.50	0.00	8.00
				W73	04/15/2014	97.00	0.00	8.00
					10/21/2014	98.50	0.00	8.00
					04/07/2015	95.00	0.00	8.00
					10/14/2015	100.00	0.00	8.00
					04/14/2016	99.00	0.00	8.00
					10/12/2016	98.10	0.00	8.00
					04/11/2017	100.00	0.00	8.00
					10/24/2017	97.00	0.00	8.00
					04/16/2018	94.00	0.00	8.00
					10/23/2018	100.00	0.00	8.00
					04/15/2019	93.00	0.00	8.00
					10/30/2019	96.00	0.00	8.00
					04/15/2020	96.00	0.00	8.00

Table 3-1. Molybdenum and Selenium Exceedances 2014 -Present
Pleasant Prairie Ash LF
Limit Exceptions (List)

Date Range: 01/01/2013 to 10/31/2022

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
PAL	Molybdenum, dissolved	01060	ug/L	W73	10/13/2020	106.00	0.00	8.00
					04/13/2021	104.00	0.00	8.00
					10/12/2021	109.00	0.00	8.00
					04/13/2022	100.00	0.00	8.00
					10/05/2022	112.00	0.00	8.00
ES				W35A	04/14/2014	44.00	0.00	40.00
					04/08/2015	45.00	0.00	40.00
					04/15/2016	41.00	0.00	40.00
					04/10/2017	47.00	0.00	40.00
					04/17/2018	45.00	0.00	40.00
					04/16/2019	48.00	0.00	40.00
					04/13/2020	50.00	0.00	40.00
					04/12/2021	52.20	0.00	40.00
					04/12/2022	49.50	0.00	40.00

Table 4-1. Summary of Groundwater Sampling Parameters, Methods, and Analytical Limits Environmental Sampling and Analysis Plan Addendum Revision 1

We Energies NR 507 Groundwater Monitoring
Pleasant Prairie Power Plant Ash Landfill, Pleasant Prairie, Wisconsin

Constituent	CAS	Unit	Analytical Method$^{(1,4)}$	PAL	ES	RL	MDL	USEPA MCL $^{(2)}$
Metals								
Antimony	7440-36-0	µg/L	EPA 200.8	1.2	6	0.07	0.021	6
Arsenic	7440-38-2	µg/L	EPA 200.8	1	10	1.4	0.41	10
Barium	7440-39-3	µg/L	EPA 200.7	400	1000	0.93	0.28	2000
Beryllium	7440-41-7	µg/L	EPA 200.7	0.4	4	0.1	0.029	4
Boron	7440-42-8	µg/L	EPA 200.7	200	1000	11	3.2	NS
Cadmium	7440-43-9	µg/L	EPA 200.7	0.5	5	1.4	0.42	5
Calcium	7440-70-2	µg/L	EPA 200.7	NS	NS	87	26	NS
Chromium	7440-47-3	µg/L	EPA 200.7	10	100	1.7	0.51	100
Cobalt	7440-48-4	µg/L	EPA 200.7	8	40	3.7	1.1	NS
Copper	7440-50-8	µg/L	EPA 200.7	130	1300	10	3.4	1.3
Lead	7439-92-1	µg/L	EPA 200.8	1.5	15	0.037	0.011	15
Lithium	7439-93-2	µg/L	EPA 200.7	TBD	TBD	0.27	0.082	NS
Manganese	7439-96-5	µg/L	EPA 200.7	25	50	5	1.5	NS
Mercury	7439-97-6	µg/L	EPA 245.7	0.2	2	0.0024	0.00071	2
Molybdenum	7439-98-7	µg/L	EPA 200.7	8	40	3.7	1.1	NS
Selenium	7782-49-2	µg/L	EPA 200.8	10	50	2.2	0.67	50
Silver	7440-22-4	µg/L	EPA 200.7	10	50	10	3.2	NS
Thallium	7440-28-0	µg/L	EPA 200.8	0.4	2	0.032	0.01	2
Zinc	7440-66-6	µg/L	EPA 200.7	2500	5000	40	11.6	NS
Inorganics								
Alkalinity	--	mg/L	2320B	NS	NS	20	20	NS
Chloride	16887-00-6	mg/L	EPA 300.0 / EPA 9056	125	250	2	4	250 $^{(3)}$
Fluoride	16984-48-8	mg/L	EPA 300.0 / EPA 9056	0.8	4	0.2	0.4	4
Hardness	--	mg/L	EPA 200.7 by 2340B	NS	NS	54	10	NS
Nitrate + Nitrite, N	--	mg/L	EPA 300.0 / EPA 9056	2	10	0.15	0.04	NS
Sulfate	14808-79-8	mg/L	EPA 300.0 / EPA 9056	125	250	2	4	250
Total Dissolved Solids	None	mg/L	SM 2540C	NS	NS	8.68	20	500
Other								
Radium 226	7440-14-4	pCi/L	903.1	NS	NS	1	NS	5
Radium 228	7440-14-4	pCi/L	904	NS	NS	1	NS	5
Field								
pH	NA	SU	SM 4500-H+ B	NS	NS	NA	NA	NS
Oxidation/Reduction Potential	NA	mV	SM 258/0B	NS	NS	NA	NA	NS
Dissolved Oxygen	NA	mg/L	SM 4500-O/405.1	NS	NS	NA	NA	NS
Temperature	NA	°C	SM 2550	NS	NS	NA	NA	NS
Turbidity	NA	NTU	EPA Method 180.1	NS	NS	NA	NA	NS
Specific Conductivity	NA	µS/cm	SM 2510 B	NS	NS	NA	NA	NS

Notes:

°C = degrees Centigrade
µg/L = micrograms per liter
µS/cm = microSiemens per centimeter
CAS = Chemical Abstract Number
ES = Enforcement Standard
MDL = method detection limit as established by the laboratory
mg/L = milligrams per liter
mV = milliVolt
NA = not applicable
NS = No standard
NTU = Nephelometric Turbidity Unit
PAL = Preventive Action Limit
pCi/L = picoCuries per liter
RL = Reporting limit as established by the laboratory
SM = Standard Methods for the Examination of Water and Wastewater
SU = standard units
TBD = to be determined

1. Analytical method numbers are from SW-846 unless otherwise indicated.
2. USEPA MCL = United States Environmental Protection Agency Maximum Contaminant Level.
3. Secondary standard.
4. Analytical methods, quality control, reporting limits and method detection limits will vary depending on the laboratory performing the work; methods utilized will meet the necessary reporting limits for the requested analytes.

Table 4-2. ACL CALCULATION TABLES
ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM REVISION 1
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL
PLEASANT PRAIRIE, WISCONSIN

Location	Parameter	Units	Count	Mean	Median	Maximum	Minimum	Standard Deviation
W20D	Boron, total	mg/L	19	0.43	0.43	0.46	0.39	0.019
	Fluoride, total	mg/L	19	1.0	1.0	1.2	0.88	0.075
	Sulfate, total	mg/L	18	170	180	200	72	28
W77	Boron, total	mg/L	19	0.41	0.42	0.45	0.37	0.022
	Fluoride, total	mg/L	19	0.97	1.0	1.1	0.095	0.23
	Sulfate, total	mg/L	18	130	140	160	68	20
W73	Boron, total	mg/L	19	0.44	0.44	0.47	0.40	0.019
	Fluoride, total	mg/L	18	1.0	1.0	1.1	0.89	0.060
	Sulfate, total	mg/L	18	120	120	140	120	7.0
W74	Boron, total	mg/L	18	0.39	0.39	0.42	0.36	0.017
	Fluoride, total	mg/L	19	1.0	1.0	1.2	0.87	0.091
	Sulfate, total	mg/L	18	150	150	170	140	8.9
W75	Boron, total	mg/L	18	0.42	0.42	0.45	0.38	0.017
	Fluoride, total	mg/L	18	1.0	1.0	1.2	0.91	0.074
	Sulfate, total	mg/L	18	150	140	210	120	25
W76	Boron, total	mg/L	19	0.44	0.44	0.51	0.40	0.024
	Fluoride, total	mg/L	18	1.0	1.0	1.1	0.94	0.048
	Sulfate, total	mg/L	18	130	140	140	100	9.9

Notes:
> = greater than
ES = Enforcement Standard
mg/L = milligrams per liter
PAL = Preventive Action Limit

Table 4-2. ACL CALCULATION TABLES

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM REVISION 1
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL
PLEASANT PRAIRIE, WISCONSIN

Location	**Parameter**	**Units**	**ES (mg/L)**	**Max > ES?**	**Mean > ES?**	**PAL (mg/L)**	**Mean > PAL?**	**Number Values > PAL**	**2 Values > PAL?**
W20D	Boron, total	mg/L	1	No	No	0.2	**Yes**	19	**Yes**
	Fluoride, total	mg/L	4	No	No	0.8	**Yes**	19	**Yes**
	Sulfate, total	mg/L	250	No	No	125	**Yes**	17	**Yes**
W77	Boron, total	mg/L	1	No	No	0.2	**Yes**	19	**Yes**
	Fluoride, total	mg/L	4	No	No	0.8	**Yes**	18	**Yes**
	Sulfate, total	mg/L	250	No	No	125	**Yes**	15	**Yes**
W73	Boron, total	mg/L	1	No	No	0.2	**Yes**	19	**Yes**
	Fluoride, total	mg/L	4	No	No	0.8	**Yes**	18	**Yes**
	Sulfate, total	mg/L	250	No	No	125	No	8	**Yes**
W74	Boron, total	mg/L	1	No	No	0.2	**Yes**	18	**Yes**
	Fluoride, total	mg/L	4	No	No	0.8	**Yes**	19	**Yes**
	Sulfate, total	mg/L	250	No	No	125	**Yes**	18	**Yes**
W75	Boron, total	mg/L	1	No	No	0.2	**Yes**	18	**Yes**
	Fluoride, total	mg/L	4	No	No	0.8	**Yes**	18	**Yes**
	Sulfate, total	mg/L	250	No	No	125	**Yes**	16	**Yes**
W76	Boron, total	mg/L	1	No	No	0.2	**Yes**	19	**Yes**
	Fluoride, total	mg/L	4	No	No	0.8	**Yes**	18	**Yes**
	Sulfate, total	mg/L	250	No	No	125	**Yes**	15	**Yes**

Notes:

> = greater than
ES = Enforcement Standard
mg/L = milligrams per liter
PAL = Preventive Action Limit

TABLE 4-3. PROPOSED ALTERNATIVE CONCENTRATION LIMITS
ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM REVISION 1
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL
PLEASANT PRAIRIE, WISCONSIN

Location ID	Boron (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)
Background Monitoring Wells			
W20D	0.47	1.2	201
W77	0.45	1.2	160
Downgradient Monitoring Wells			
W73	0.48	1.1	134
W74	0.42	1.2	168
W75	0.45	1.1	200
W76	0.49	1.1	146

Notes:
mg/L = milligrams per liter

TABLE 4-4. CALCULATED PREVENTATIVE ACTION LIMITS
ENVIRONMENTAL SAMPLING AND ANLAYSIS PLAN ADDENDUM REVISION 1
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL
PLEASANT PRAIRIE, WISCONSIN

Calcium (mg/L)					
Location ID	**Mean**	**Standard Deviation**	**PAL Using 3 Standard Deviations**	**PAL Using NR 140 Table 3 Increment**	**Selected PAL**
Background Monitoring Wells					
W20D	30	5.4	46	55	55
W77	28	3.2	38	53	53
Downgradient Monitoring Wells					
W73	24	7.1	46	49	49
W74	23	5.0	38	48	48
W75	22	3.5	33	48	48
W76	19	0.9	22	44	44

Total Dissolved Solids (mg/L)					
Location ID	**Mean**	**Standard Deviation**	**PAL Using 3 Standard Deviations**	**PAL Using NR 140 Table 3 Increment**	**Selected PAL**
Background Monitoring Wells					
W20D	405	58	580	610	610
W77	374	29	470	580	580
Downgradient Monitoring Wells					
W73	315	22	380	520	520
W74	357	21	430	560	560
W75	349	51	510	550	550
W76	320	41	450	520	520

Notes:
All concentrations shown in mg/L.
mg/L = milligrams per liter
PAL = Preventive Action Limit

FIGURES

Y:\GIS\Projects\16\1660\P4\MXD\Plan_of_Operations\Figure 1-1_Site Location.mxd

PROJECT: 169000XXXX | DATED: 11/21/2022 | DESIGNER: galarnmc

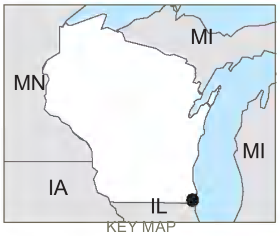
Service Layer Credits: Copyright:© 2013 National Geographic Society, i-cubed

Map Scale: 1:24,000 | Map Center: 89°39'38"W 44°38'22"N

▭ UNIT BOUNDARY

SITE LOCATION MAP

FIGURE 1-1



KEY MAP

0 1,000 2,000 Feet

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN
ADDENDUM REVISION 1
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL
PLEASANT PRAIRIE, WISCONSIN

Y:\GIS\Projects\16\1660\P4\MXD\Plan_of_Operations\Figure 2-1_Active Well Networks Map.mxd

PROJECT: 169000XXXX | DATED: 1/17/2023 | DESIGNER: galarnmc

🟨 UNIT BOUNDARY

🟦 ACTIVE WELL IN NR 500 MONITORING PROGRAM

🟩 ACTIVE WELL IN 40CFR PART 257 MONITORING PROGRAM

◉ ACTIVE WELL IN BOTH NR500 AND 40CFR PART 257 MONITORING PROGRAMS

○ PROPOSED NR514.045 GROUNDWATER MONITORING NETWORK

0 200 400 Feet

ACTIVE WELL NETWORKS MAP

FIGURE 2-1

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN
ADDENDUM REVISION 1
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL
PLEASANT PRAIRIE, WISCONSIN

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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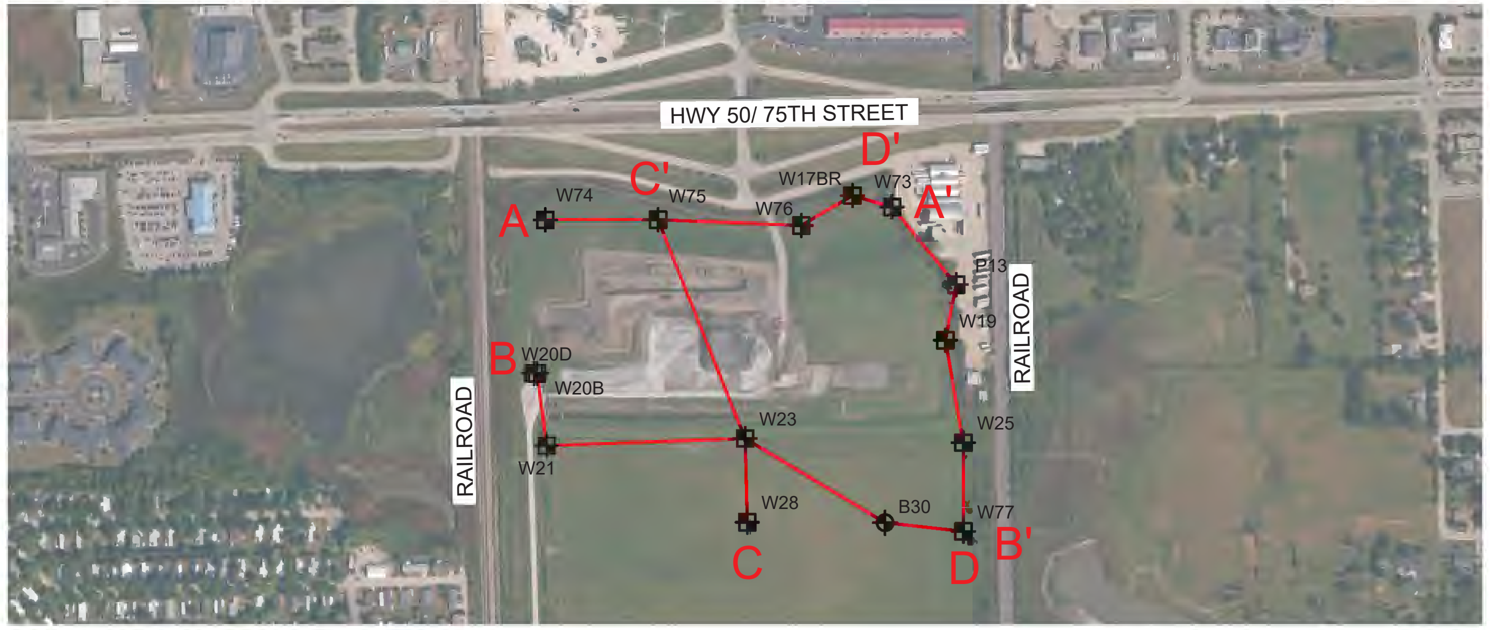
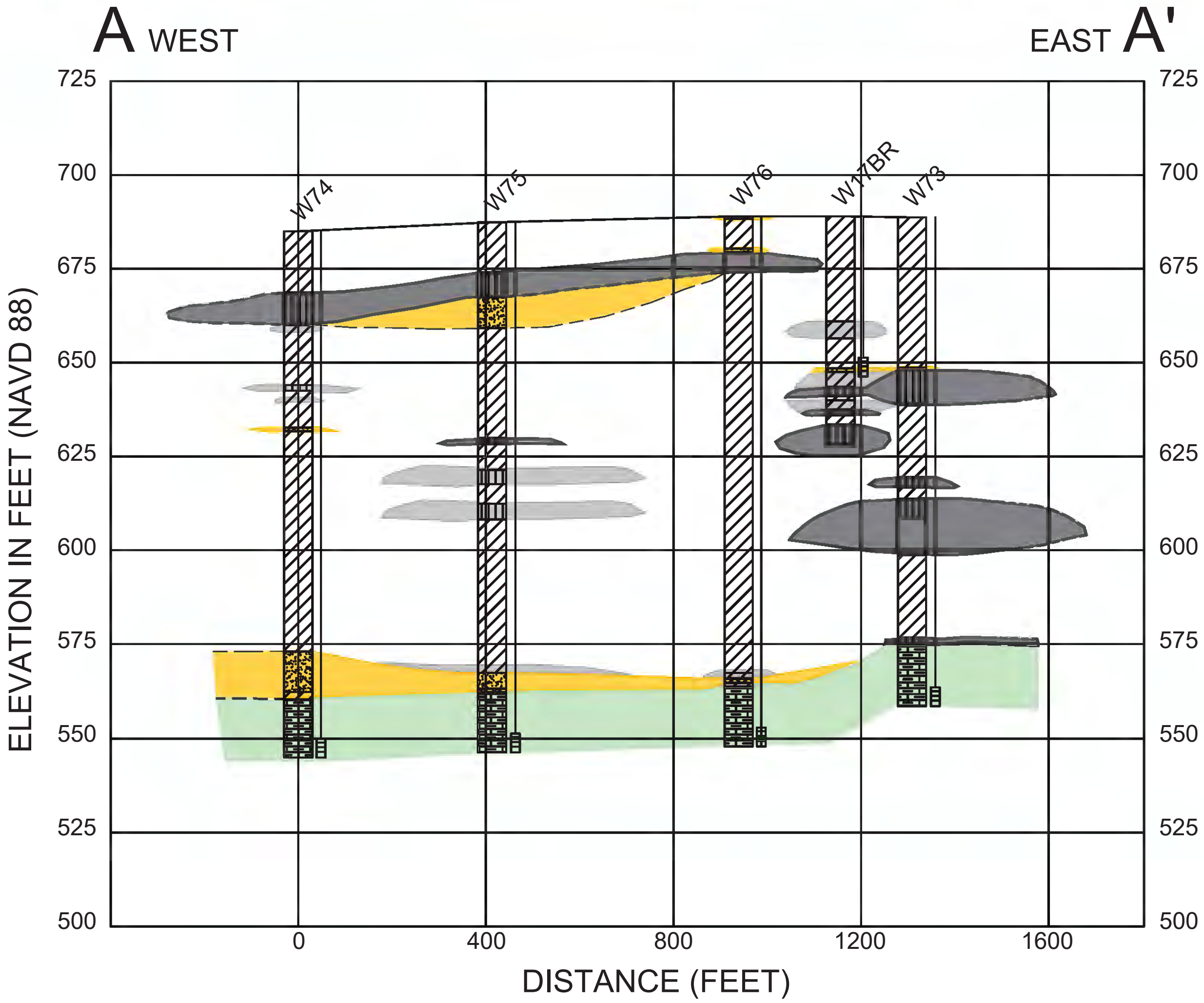


N

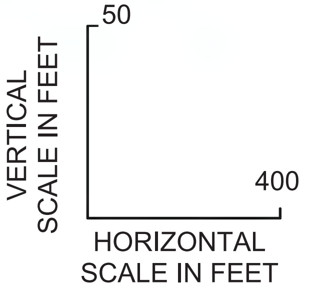
0 200 400 800
SCALE IN FEET

SOURCE NOTES:

1. DIGITAL ORTHOPHOTO FROM BING MAPS © 2012.
2. COORDINATE SYSTEM IS NAD27 WISCONSIN STATE PLANE, SOUTH ZONE, U.S. FOOT.



B30 ⌖	SOIL BORING LOCATION
W16D ⌖	MONITORING WELL LOCATION
B — B'	CROSS-SECTION TRANSECT
▨	SAND
▨	GRAVEL
▥	SILT
▨	CLAY
▦	DOLOMITE (BEDROCK)
☐	LOW/ NO RECOVERY
▤	WELL SCREEN
🟨	SAND/ GRAVEL
⬛	SILT
⬜	SANDY CLAY/ SANDY SILT
🟩	DOLOMITE (BEDROCK)
- - - - -	INFERRED CONTACT



VERTICAL EXAGGERATION = 8

PROJECT: ####

DATED: 12/2/2022

DESIGNER: CAWRSEAG

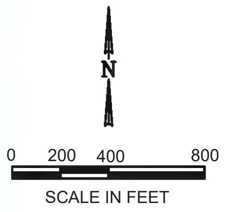
GEOLOGIC CROSS-SECTION A-A'

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN
ADDENDUM REVISION 1
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL
PLEASANT PRAIRIE, WISCONSIN

FIGURE 2-2

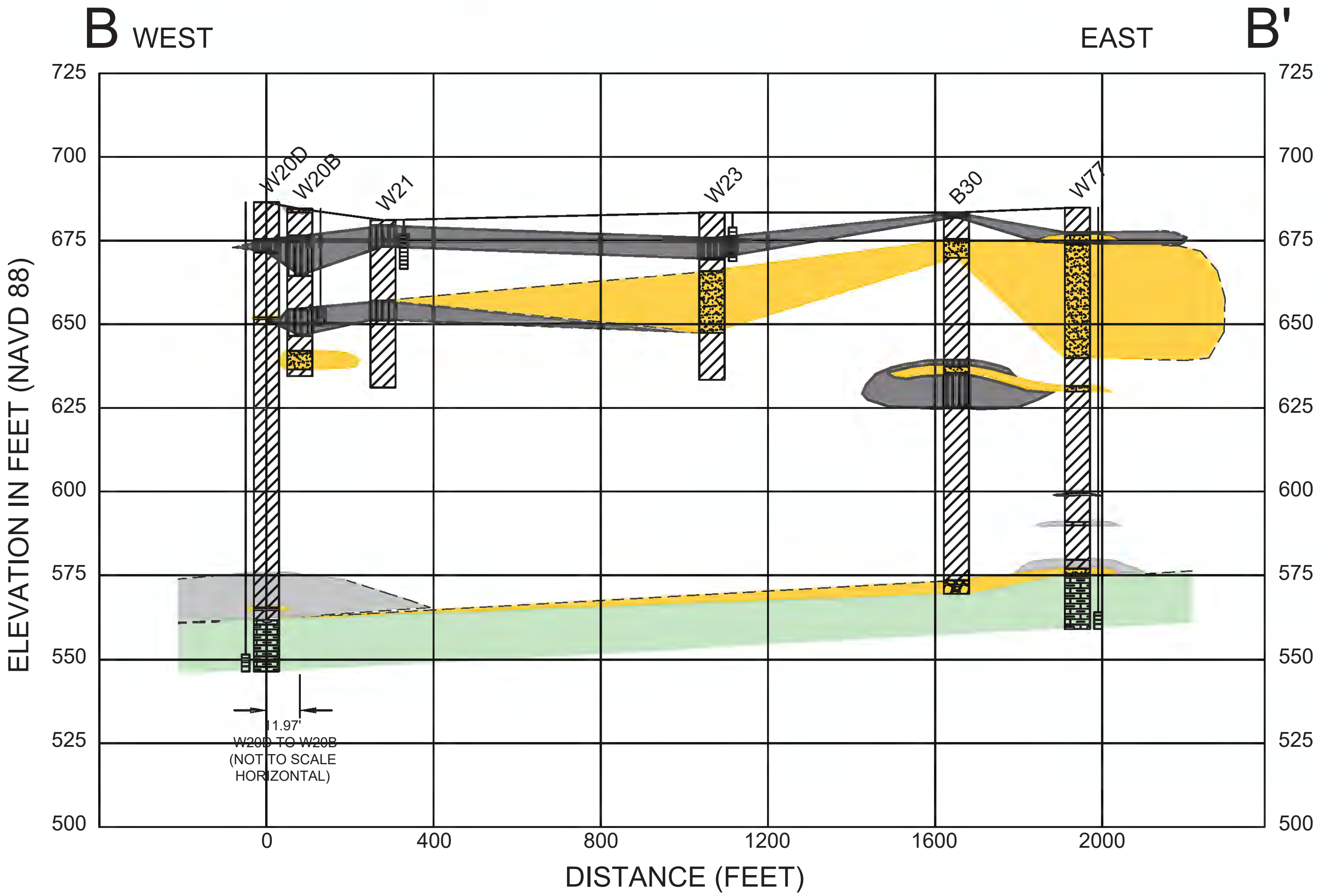
RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL



SOURCE NOTES:

1. DIGITAL ORTHOPHOTO FROM BING MAPS © 2012.
2. COORDINATE SYSTEM IS NAD27 WISCONSIN STATE PLANE, SOUTH ZONE, U.S. FOOT.



B30 ⌖ SOIL BORING LOCATION

W16D ⌖ MONITORING WELL LOCATION

B—B' CROSS-SECTION TRANSECT

▩ ASH

▨ SAND

▩ GRAVEL

▥ SILT

▨ CLAY

▦ DOLOMITE (BEDROCK)

☐ LOW/ NO RECOVERY

▤ WELL SCREEN

🟫 ASH

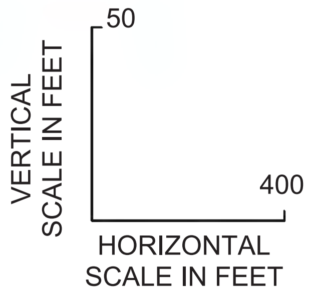
🟨 SAND

⬛ SILT

⬜ SANDY CLAY/ SANDY SILT

🟩 DOLOMITE (BEDROCK)

– – – – INFERRED CONTACT



VERTICAL EXAGGERATION = 8

Y:\ACADData\Projects\16\1660\1-7-1\1660-171-B03.dwg

DESIGNER: CAWRSEAG

DATED: 12/2/2022

PROJECT: ####

GEOLOGIC CROSS-SECTION B-B'

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN
ADDENDUM REVISION 1
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL
PLEASANT PRAIRIE, WISCONSIN

FIGURE 2-3

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

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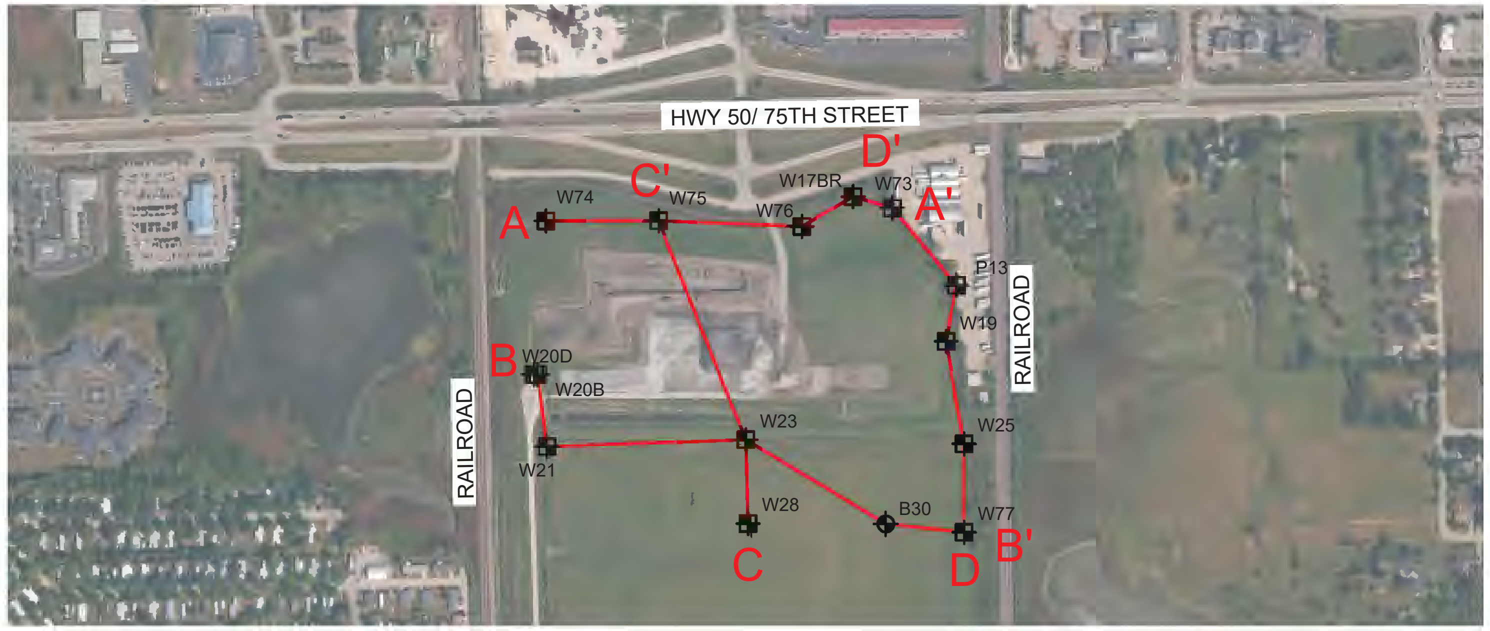


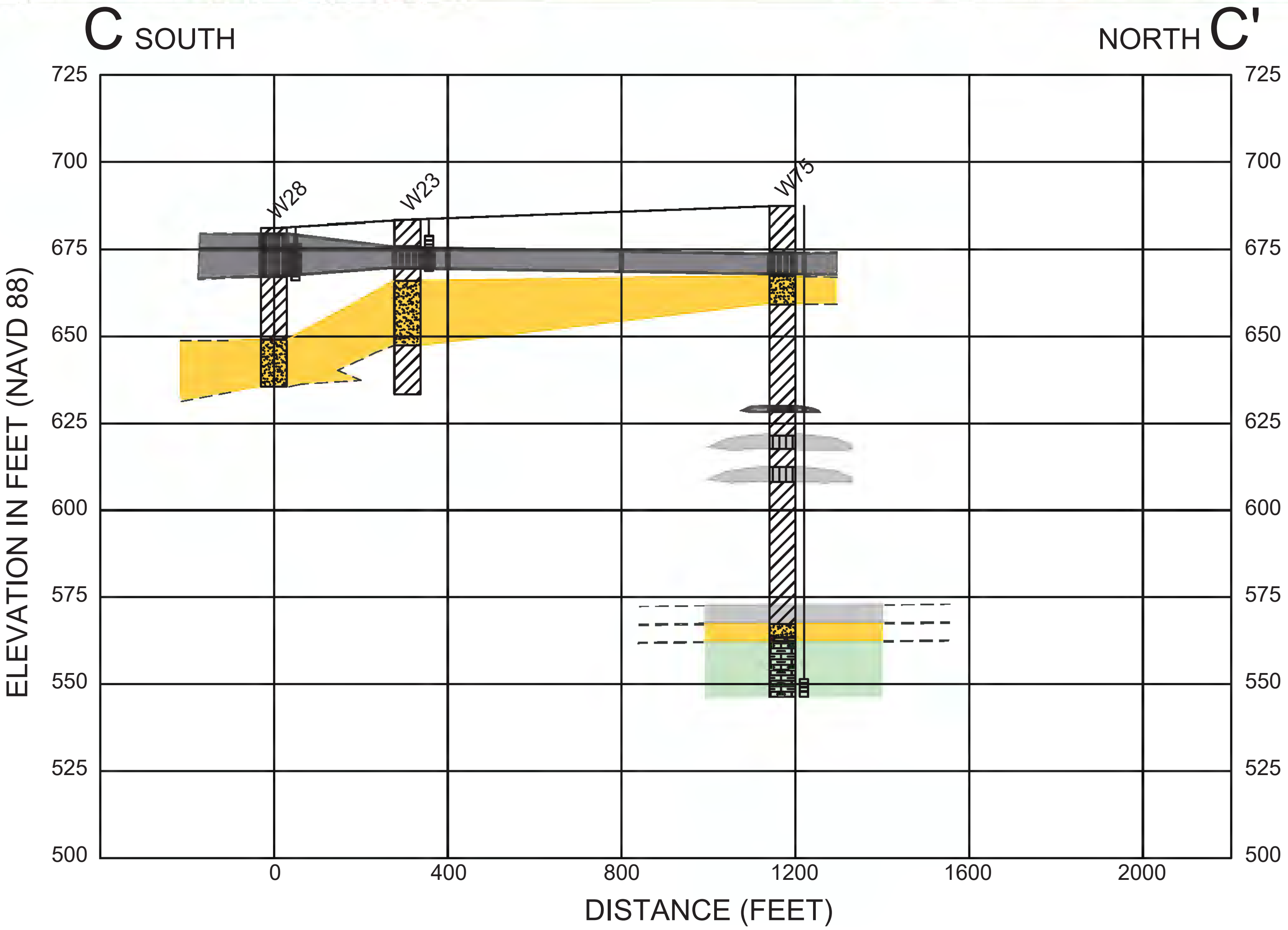
N

0 200 400 800

SCALE IN FEET

SOURCE NOTES:

1. DIGITAL ORTHOPHOTO FROM BING MAPS © 2012.
2. COORDINATE SYSTEM IS NAD27 WISCONSIN STATE PLANE, SOUTH ZONE, U.S. FOOT.



- ⯐ B30 SOIL BORING LOCATION
- ⊞ W16D MONITORING WELL LOCATION
- C—C' CROSS-SECTION TRANSECT
- ▨ SAND
- ▥ SILT
- ▨ CLAY
- ▨ GRAVEL
- ▦ DOLOMITE (BEDROCK)
- ☐ LOW/ NO RECOVERY
- ▤ WELL SCREEN
- 🟨 SAND/ GRAVEL
- ■ SILT
- ■ SANDY CLAY/ SANDY SILT
- 🟩 DOLOMITE (BEDROCK)
- – – – – INFERRED CONTACT

50

VERTICAL SCALE IN FEET

400

HORIZONTAL SCALE IN FEET

VERTICAL EXAGGERATION = 8

DESIGNER: CAWRSEAG

DATED: 12/2/2022

PROJECT: ####

GEOLOGIC CROSS-SECTION C-C'

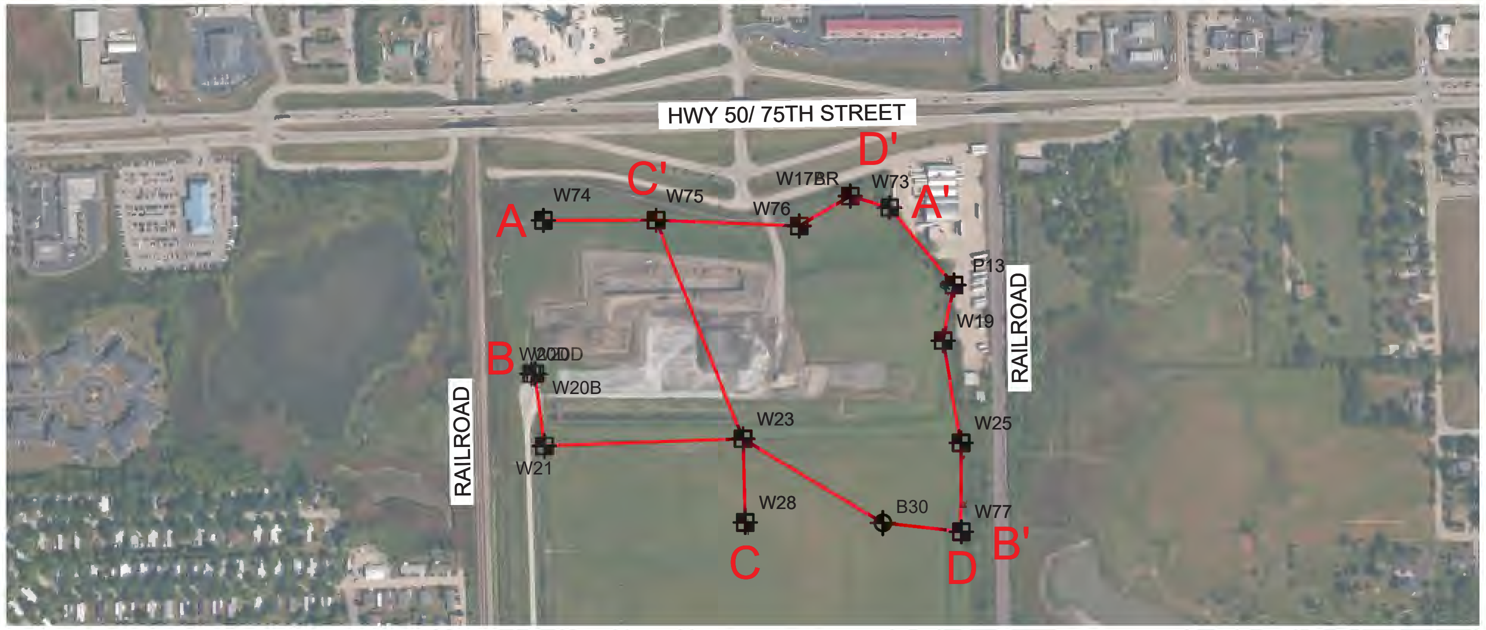
ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN
ADDENDUM REVISION 1
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL
PLEASANT PRAIRIE, WISCONSIN

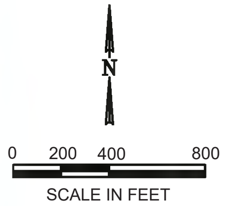
FIGURE 2-4

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

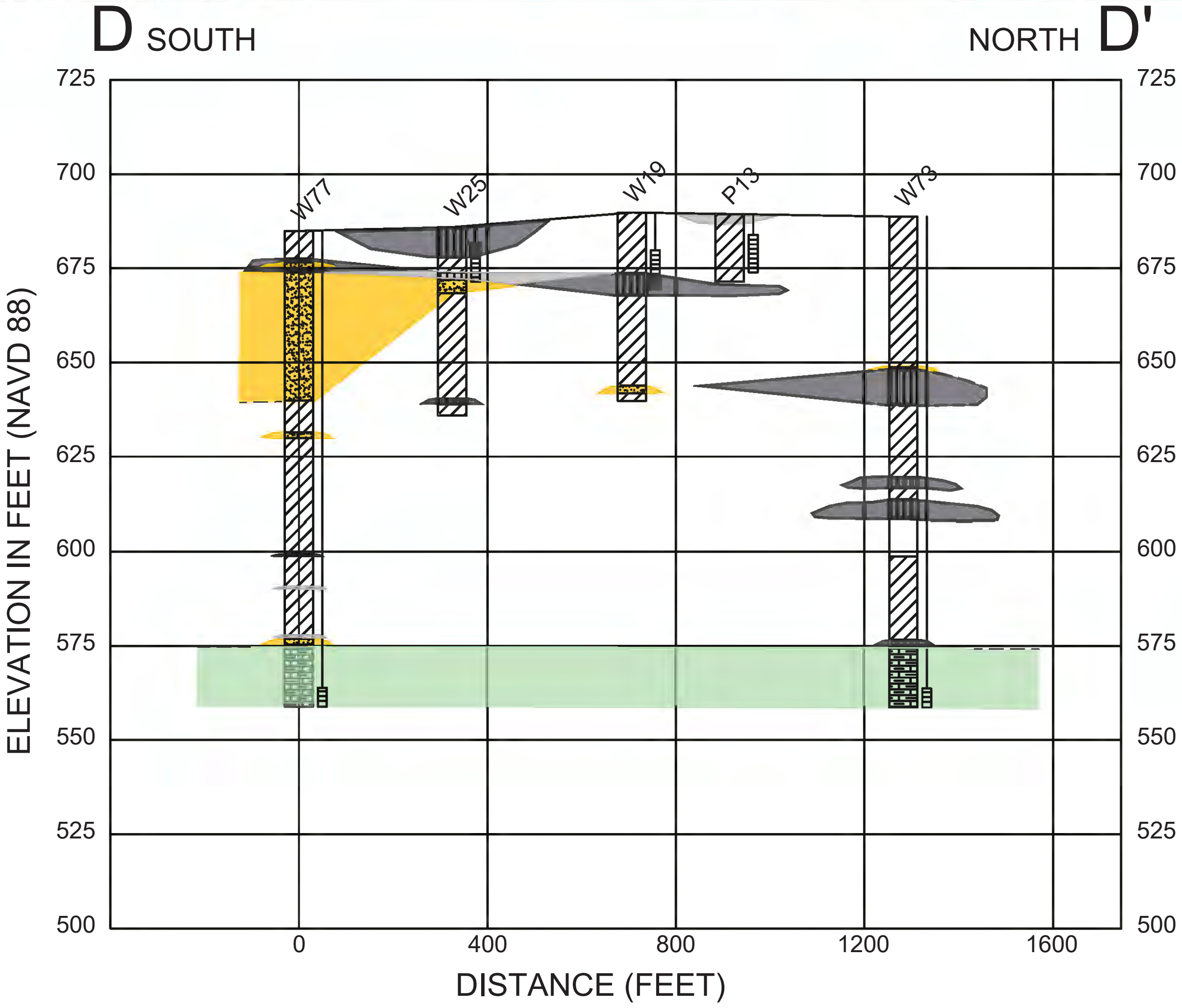
Y:\ACADData\Projects\16\1660\1-7-1\1660-171-B05.dwg



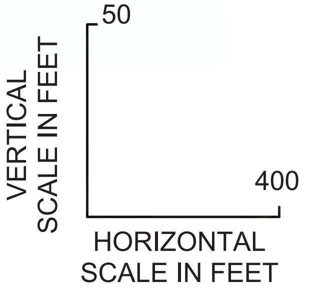


SOURCE NOTES:

1. DIGITAL ORTHOPHOTO FROM BING MAPS © 2012.
2. COORDINATE SYSTEM IS NAD27 WISCONSIN STATE PLANE, SOUTH ZONE, U.S. FOOT.



B30 ⊕	SOIL BORING LOCATION
W16D ⊞	MONITORING WELL LOCATION
C — C'	CROSS-SECTION TRANSECT
▨	SAND
▥	SILT
▨	CLAY
▨	GRAVEL
▦	DOLOMITE (BEDROCK)
☐	LOW/ NO RECOVERY
▤	WELL SCREEN
🟨	SAND/ GRAVEL
⬛	SILT
◻	SANDY CLAY/ SANDY SILT
🟩	DOLOMITE (BEDROCK)
– – – –	INFERRED CONTACT



VERTICAL EXAGGERATION = 8

PROJECT: ####

DATED: 12/2/2022

DESIGNER: CAWRSEAG

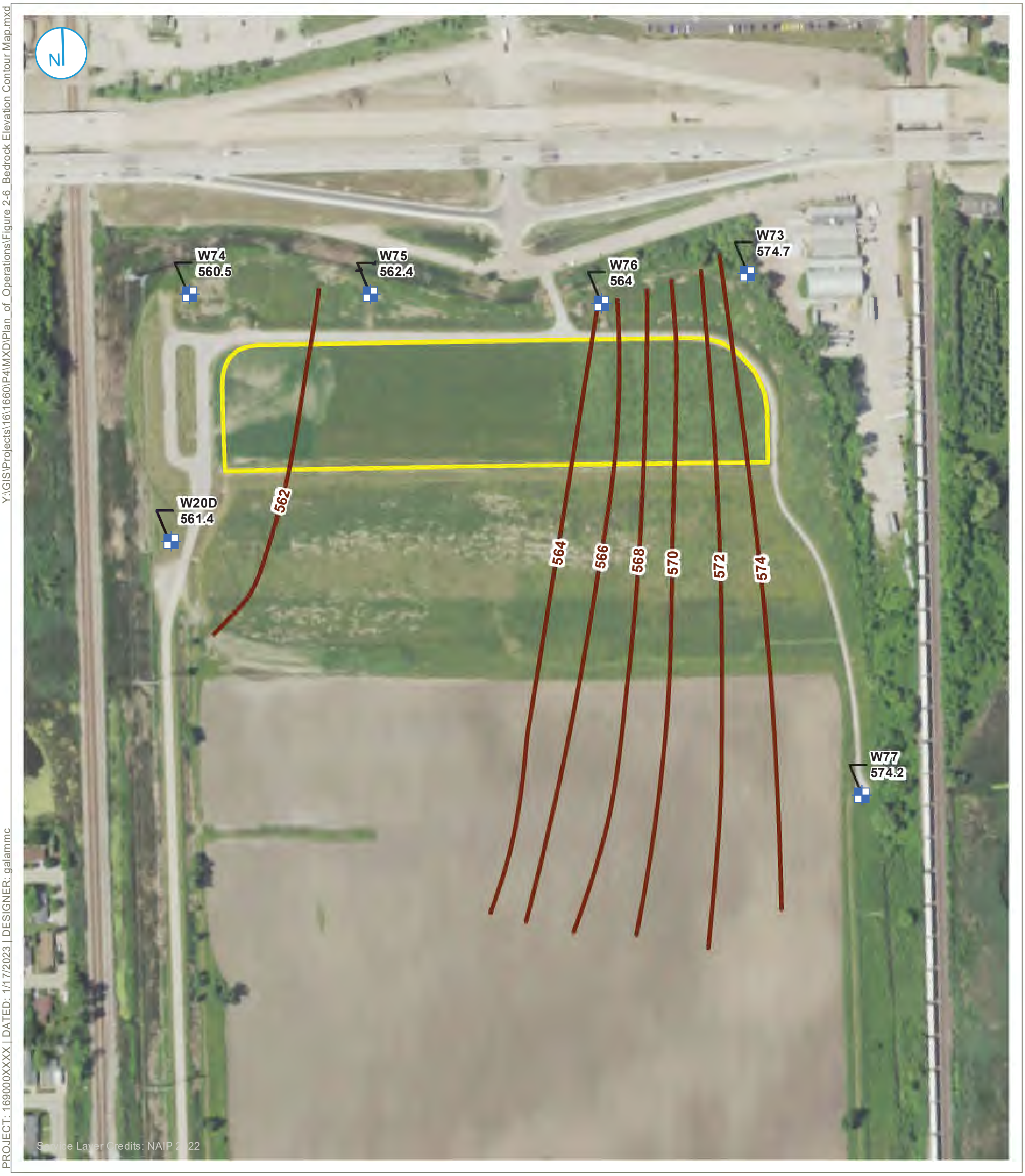
GEOLOGIC CROSS-SECTION D-D'

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN
ADDENDUM REVISION 1
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL
PLEASANT PRAIRIE, WISCONSIN

FIGURE 2-5

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL



Y:\GIS\Projects\16\1660\P4\MXD\Plan_of_Operations\Figure 2-6_Bedrock Elevation Contour Map.mxd

PROJECT: 169000XXXX | DATED: 1/17/2023 | DESIGNER: galarnmc

🟨	UNIT BOUNDARY
▣	BEDROCK UNIT MONITORING WELL LOCATION
━	BEDROCK ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)

BEDROCK ELEVATION CONTOUR MAP

FIGURE 2-6

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN
ADDENDUM REVISION 1
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL
PLEASANT PRAIRIE, WISCONSIN

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

Y:\GIS\Projects\16\1660\P4\MXD\Plan_of_Operations\Figure 2-7_GWE Contours 2204.mxd

PROJECT: 169000XXXX | DATED: 1/17/2023 | DESIGNER: galarnmc

▭ UNIT BOUNDARY

⊞ BEDROCK UNIT (UPPERMOST AQUIFER) CCR MONITORING WELL LOCATION

⊞ GLACIAL UNIT POTENTIAL CONTAMINANT PATHWAY CCR MONITORING WELL LOCATION (NOT USED FOR CONTOURING)

— GROUNDWATER ELEVATION CONTOUR (1-FT INTERVAL, NAVD 88)

- - INFERRED GROUNDWATER ELEVATION CONTOUR

→ GROUNDWATER FLOW DIRECTION

0 150 300 Feet

UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
APRIL 13, 2022

FIGURE 2-7

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN
ADDENDUM REVISION 1
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL
PLEASANT PRAIRIE, WISCONSIN

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

APPENDICES

APPENDIX A

BORING LOGS, WELL CONSTRUCTION, AND WELL DEVELOPMENT FORMS

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

GROUNDWATER MONITORING WELL AND POINT INFORMATION

Form 4400-089 (R 04/19)

Use the Groundwater Monitoring Well and Point Information Form to record identification, location and construction information for groundwater monitoring wells and any other sample "points," (e.g., gas probes, lysimeters, leachate collection systems, etc.), that are part of the environmental monitoring program. **NOTE:** Not all fields will be applicable to all point types. Only **one** coordinate reference system may be used per site. Allowable coordinate systems are listed below. (Coordinates for each system require a minimum number of digits as described below.) Local grid coordinates cannot be accepted. Identify the Coordinate Reference System, Datum and Method used.

Facility Name	County	Facility ID No. (FID)	License, Permit or Monitoring No.	Date	Completed By (Name and Firm)
WEPCO PLEASANT PRAIRIE LF	Kenosha	230056310	2786	01/11/2023	Nathaniel Keller, RAMBOLL

DNR Point ID No.	Point Name[1]	**WUWN**[2] (if app.)	Type	Status	Gradient	*Enf. Stds. Y/N.*	**Construction Date**	Elevations msl (ft)		Well Casing			Well Screen Length (ft)	Well (Pt) Total Length[5] (ft)	Coordinates[6,7,8,9]	
								Ground Surface	Well Top (of casing)	Type	**Diam**[3] **(in)**	**Length**[4] **(ft)**			**Y / Lat / Northing**	**X / Long / Easting**
	W20D	VQ580	12	A	U	Yes	03/04/2015	686.45	689.03	P	2	137.0	5	142.0	212,757.97	2,533,085.40
	W74	VQ578	12	A	D	Yes	03/03/2015	685.02	687.49	P	2	136.8	5	141.8	213,321.15	2,533,126.93
	W75	VQ577	12	A	D	Yes	03/23/2015	687.42	690.31	P	2	138.5	5	143.5	213,321.56	2,533,540.32
	W76	VQ576	12	A	D	Yes	03/24/2015	689.00	692.11	P	2	138.6	5	143.6	213,300.53	2,534,065.51
	W77	VQ575	12	A	U	Yes	03/19/2015	684.89	687.63	P	2	123.3	5	128.3	212,178.92	2,534,660.05

[1] Include previous name as well if one exists.

[2] Wisconsin Unique Well Number.

[3] **Well Casing Diameter measures inside diameter.**

[4] Length of well casing from top of casing to top of screen.

[5] Total length of well from top of casing to bottom of well. *Should equal sum of well casing length and screen length.*

[6] **Identify Coordinate Reference System (only one system may be used per site):**

○ **Lat/Long (Decimal Degrees) WGS84 (min. 8 digits total w/ 6 right of decimal, e.g., -89.123456)**

State Plane (min. 2 digits right of decimal)

○ North
○ Central
☒ South

○ Wisc. Transverse Mercator WTM91 (min. 2 digits right of decimal)

○ **Local County Coord. Sys. (WISCRS) (min. digits vary by county)**

[7] Identify Projection Datum and units*

☒ NAD83
○ NAD27
○ NAD83(91)
○ NAD83(11)
○ Other **Describe:** __________

Units used for State Plane, WTM or County Coord. Sys:

○ meters
● feet

*NOTE: A datum and units are not required for Lat/Long

[8] **Identify the Method Used to Determine the Coordinates:**

☒ GPS001-Survey grade
○ GPS003-Mapping grade/real-time differential correction
○ GPS004-Mapping grade/post processing
○ **SRV001-Classical terrestrial surveying techniques**
○ OTH001 (Other), Describe:

[9] **Y / Lat / Northing** describe the vertical axis.

X / Long / Easting describe the horizontal axis.

(include "-" where needed, e.g., -89.123456)

Remarks:

Completion of this form is mandatory under chs. 281, 289 and 292, Wis. Stats., and ss. NR 110.25, NR 507.14 and NR 716.15, Wis. Admin. Code

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

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

Facility/Project Name Pleasant Prairie Power Plant	License/Permit/Monitoring Number	Boring Number W20D

Boring Drilled By: Name of crew chief (first, last) and Firm Roy Buckenberger Cascade Drilling	Date Drilling Started 3/2/2015	Date Drilling Completed 3/4/2015	Drilling Method Rotory Sonic

WI Unique Well No. VQ580	DNR Well ID No.	Common Well Name W20D	Final Static Water Level Feet (NAVD88)	Surface Elevation 686.5 Feet (NAVD88)	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 212,758 N, 2,533,086 E [✓ S]/C/N
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location
Feet ☐ N ☐ S
Feet ☐ E ☐ W

Facility ID	County Kenosha	County Code 30	Civil Town/City/ or Village Pleasant Prairie

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 54		1 2	0 - 2.5' **FILL, LEAN CLAY:** CL, very dark grayish brown (10YR 3/2), 0-10% fine sand, 0-10% silt, trace fine gravel, trace gravel sized coal pieces, trace root debris, cohesive, low to medium plasticity, dry. 1' piece of black plastic, thickness of plastic grocery bag.	CL									Installed 6" schedule 40 permanent steel casing to 15' bgs.
			3 4	2.5 - 11' **FILL, LEAN CLAY:** CL, reworked till, yellowish brown (10YR 5/4) to yellowish brown (10YR 5/6), trace fine to coarse sand, trace fine to coarse gravel, cohesive, medium plasticity,stiff to very stiff (2.0-4.5+ tsf) dry.										
2 CS	120 100.8		5 6 7 8 9	5' grades to gray (10YR6/1), 10-20% silt, increasing silt content with depth, decreasing sand and gravel content with depth, medium plasticity, moist, 10-20% dark yellowish brown (10YR 4/6) mottling.	CL									
			10	10' high plasticity.										
			11 12 13	11 - 15' **FILL, SILT:** ML, gray (10YR 6/1), 0-10% clay, cohesive, nonplastic to low plasticity, moist, 0-10% dark yellowish brown (10YR 4/6) mottling.	ML									

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

Signature	Firm Natural Resource Technology 234 W. Florida Street, Floor 5, Milwaukee, WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

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

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W20D Use only as an attachment to Form 4400-122. Page 2 of 7

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			14		ML									
3 CS	240 154.8		15	15 - 19' **SILTY CLAY** CL/ML, brown (10YR 5/3), 30-40% silt, trace fine to coarse gravel, cohesive, low to medium plasticity, moist to wet.	CL/ML									
			19	19 - 30' **SILTY CLAY** CL/ML, **to CLAYEY SILT:** , gray (10YR 6/1), 40-60% silt, 40-60% clay, cohesive, medium to high plasticity, moist to wet.	CL/ML									
			30	30 - 34.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), cohesive, high plasticity, dry to moist.	CL									
			34.5	34.5 - 35' **POORLY-GRADED SAND:** SP, mostly fine sand, trace silt, dry.	SP									
4 CS	240 172.8		35	35 - 48.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine gravel, cohesive, high plasticity, dry to moist.	CL									

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W20D Use only as an attachment to Form 4400-122. Page 3 of 7

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			37 38 39 40 41 42 43 44 45 46 47 48	35 - 48.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine gravel, cohesive, high plasticity, dry to moist. *(continued)*	CL									
			49 50	48.5 - 50.7' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 10-20% silt, 5-25% fine sand to coarse gravel, cohesive, medium to high plasticity.	CL									
5 CS	240 188.4		51 52 53 54 55 56 57 58	50.7 - 94' **LEAN CLAY:** CL, grayish brown (10YR 5/2), till, trace fine gravel, cohesive, high plasticity, dry to moist. 54' - 54.2' some fine sand. 55' stiff (1.5-2.5 tsf).	CL									

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W20D Use only as an attachment to Form 4400-122. Page 4 of 7

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
				50.7 - 94' **LEAN CLAY:** CL, grayish brown (10YR 5/2), till, trace fine gravel, cohesive, high plasticity, dry to moist. *(continued)*										
			60											
			61											
			62											
			63											
			64											
			65											
			66											
			67											
			68	67.8' cobble (4" diameter).										
			69	68.6' - 68.9' increased gravel content.										
			70		CL									
			71											
			72											
			73											
			74											
6 CS	216 198		75											
			76											
			77											
			78											
			79											
			80											
			81											

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W20D Use only as an attachment to Form 4400-122. Page 5 of 7

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			82 83 84 85 86 87 88 89 90 91 92	50.7 - 94' **LEAN CLAY:** CL, grayish brown (10YR 5/2), till, trace fine gravel, cohesive, high plasticity, dry to moist. *(continued)*	CL									
7 CS	144 61.2		93	93' dolomite boulder.										
			94 95 96 97 98 99	94 - 100' **LEAN CLAY:** CL, No Recovery.	CL									Driller encountered boulder, converted to wash drilling, then drilled past boulder and clay. Stopped wash drilling at approximately 100' bgs and recovered 4.1' of clay from 100' to 105' bgs.
			100 101 102	100 - 111' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 10-20% gravel at 100' decreasing in gravel content with depth, cohesive, high plasticity, dry to moist.	CL									
			103 104	102.5' trace fine gravel.										

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Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W20D Use only as an attachment to Form 4400-122. Page 6 of 7

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
8 CS	240 192		105 106 107 108 109 110	100 - 111' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 10-20% gravel at 100' decreasing in gravel content with depth, cohesive, high plasticity, dry to moist. *(continued)*	CL									
			111	111 - 111.3' **SANDY LEAN CLAY:** s(CL), grayish brown (10YR 5/2), fine sand, cohesive, nonplastic to low plasticity, moist.	s(CL)									
			112 113 114 115 116 117 118 119 120 121	111.3 - 121.2' **LEAN CLAY:** to **POORLY-GRADED GRAVEL:** CL, grayish brown (10YR 5/2), 10-20% gravel, trace fine to medium sand, trace cobbles in top 1', cohesive, low plasticity, dry to moist.	CL									
			122	121.2 - 121.9' **POORLY-GRADED SAND WITH GRAVEL:** (SP)g, grayish brown (10YR 5/2), mostly medium sand, 20-30% gravel, moist.	(SP)g									
			123 124	121.9 - 125' **LEAN CLAY:** to **POORLY-GRADED GRAVEL:** CL, grayish brown (10YR 5/2), 10-20% gravel, trace fine to medium sand, cohesive, low plasticity, dry to moist. 122.5' lens of sand [1" thick, medium sand]. 123' lens of sand [1" thick, medium sand]. 123.5' lens of sand [2" thick, medium sand].	CL									
9 CS	180 128.4		125 126	125 - 140' **WEATHERED BEDROCK** BDX (LS), dolomite, gray (5Y 5/1), microcrystalline (trace crinoid stems), massive, trace pyrite recrystallizations, pitted.	BDX (LS)									

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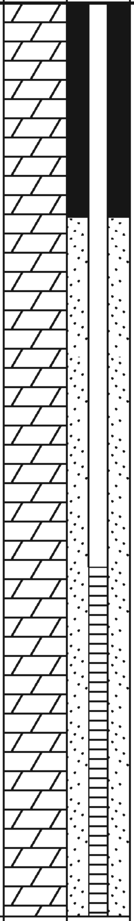
SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W20D   Use only as an attachment to Form 4400-122.   Page 7 of 7

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			128 129 130 131 132 133 134 135 136 137 138 139	125.1' - 129.5' moderate disintegration and decomposition. 125 - 140' **WEATHERED BEDROCK** BDX (LS), dolomite, gray (5Y 5/1), microcrystalline (trace crinoid stems), massive, trace pyrite recrystallizations, pitted. *(continued)* 127' - 127.5' mostly coarse gravel-sized pieces. 129.5' - 140' slightly disintegrated and decomposition.	BDX (LS)									
			140	140' End of Boring.										



State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

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

Page 1 of 4

Facility/Project Name We Energies	License/Permit/Monitoring Number 2786	Boring Number W73

Boring Drilled By: Name of crew chief (first, last) and Firm Jason Drabek Boart Longyear Company	Date Drilling Started 10/2/2013	Date Drilling Completed 10/2/2013	Drilling Method sonic

WI Unique Well No. VN433	DNR Well ID No. 292	Common Well Name W73	Final Static Water Level 662.3 Feet (NAVD88)	Surface Elevation 688.8 Feet (NAVD88)	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 213,368 N, 2,534,399 E Ⓢ/C/N
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location ☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County Kenosha	County Code 30	Civil Town/City/ or Village Pleasant Prairie

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram		Soil Properties: Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 10		0 – 5	0 - 5' **SILT:** ML, black top soil with roots. Transitions to clay, dry to moist.	ML									Poor recovery compacted sample
2 CS	60 32		5 – 10	5 - 15' **LEAN CLAY:** CL, yellowish brown (10YR 6/6), gray color increases with depth. By 15', clay is completely gray (10YR 4/1), unweathered.	CL									
3 CS	60 49		10 – 15											
4 CS	60 60		15 – 20	15 - 40' **LEAN CLAY:** CL, gray (10YR 4/1), medium to high plasticity, medium toughness, moist, trace coarse sand and fine to coarse gravel, (sub angular) Oak Creek FM Till.	CL									
5 CS	60 60		20 – 24											

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

Signature

Firm Natural Resource Tech. Inc.
234W Florida St. Milwaukee WI
Tel: 414-837-3607
Fax: 414.837-3608

Date Modified: 10/31/2013
Template: WDNR SBL 1998 - Project: 1861.GPJ

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

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Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W73 | Use only as an attachment to Form 4400-122. | Page 2 of 4

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram		Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
6 CS	60 48		26	15 - 40' **LEAN CLAY:** CL, gray (10YR 4/1), medium to high plasticity, medium toughness, moist, trace coarse sand and fine to coarse gravel, (sub angular) Oak Creek FM Till. *(continued)*			▼							
			28											
7 CS	60 55		30											
			32		CL									
				32.7 - 33' **SILTY CLAY** CL/ML, seam that contained 10% sand.	CL/ML									
			34											
8 CS	60 58		36											
			38											
				39' coarse gravel in clay is composed of mafic igneous rock.										
9 CS	120 108		40	40 - 40.5' **WELL-GRADED GRAVEL:** (GW)s, fine to coarse sand and gray (10YR 4/1), clay.	(GW)s									
			42	40.5 - 50' **SILT:** ML, grayish brown (2.5YR 5/1), dry, hard, trace coarse sub angular gravel, no plasticity, very little clay, gravel composed of dolomite and mafics. Ocassionaly laminated in very thin layers.										
			44											
			46		ML									
			48											
10 CS	120 105		50	50 - 69.2' **LEAN CLAY:** CL, gray (10YR 4/1), gray, moist medium plasticity, medium roughness, moist, trace coarse sand and fine to coarse gravel, (sub angular) Oak Creek FM Till. Silt content varies, but it behaves like clay.										
			52											
			54											
			56											
			58		CL									
11 CS	120 118		60											
			62											
			64											

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W73 Use only as an attachment to Form 4400-122. Page 3 of 4

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram		Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			66 68	50 - 69.2' **LEAN CLAY:** CL, gray (10YR 4/1), gray, moist medium plasticity, medium roughness, moist, trace coarse sand and fine to coarse gravel, (sub angular) Oak Creek FM Till. Silt content varies, but it behaves like clay. *(continued)*	CL									
12 CS	120 57		70	69.2 - 72' SILT: ML, gray (10YR 4/1), dry-moist, no plasticity, trace sand and gravel.	ML									
			72 74	72 - 75' **LEAN CLAY:** CL, gray (10YR 4/1), moist medium plasticity, medium roughness, moist, trace coarse sand and fine to coarse gravel, Oak Creek FM Till . Silt content varies, but it behaves like clay. 73' Large dolomite cobble (rock chips and hockey pucks) plugs core barrel and prevents full recovery.	CL									
			76 78	75 - 80' MH, Clayey Silt: low plasticity, low dilatency silt with clay, trace sand and gravel gray, moist.	MH									
13 CS	120 0		80 82 84 86 88	80 - 90' No recovery, core barrel was empty, ran casing down and tried to recover sample, but borehole is clean and open.										
14 CS	120 84		90 92 94 96	90 - 98' SILTY CLAY CL/ML, medium to low plasticity, no dilalency, no gravel, trace sand, moist, soft.	CL/ML									
15 CS	120 120		98 100 102 104	98 - 112' **LEAN CLAY:** CL, gray (10YR 4/1), very little silt, firm, gray lean clay no gravel, medium plasticity, medium toughness, moist. 99.7' 3" cobble of limestone in cutter head.	CL									

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W73 Use only as an attachment to Form 4400-122. Page 4 of 4

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram		Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			106 108	98 - 112' **LEAN CLAY:** CL, gray (10YR 4/1), very little silt, firm, gray lean clay no gravel, medium plasticity, medium toughness, moist. *(continued)*	CL									
16 CS	120 120		110 112	109' Clay becomes to soft, medium to low toughness. 110' Clay becomes firm again.										
				112 - 114' **SILT:** ML, gray (10YR 4/1), soft, trace sand and gravel moist.	ML									Driller notes top of rock is 115.5'. Started using wash water with rotary at 120'
			114	114 - 115.5' **WEATHERED BEDROCK** BDX (LS), dolomite and silt moist.	BDX (LS)									
			116 118	115.5 - 130' **WEATHERED BEDROCK** BDX (LS), gray (10YR 4/1), microcrystalline, with frequent vugs. Vugs range from 1-2 mm to 3 cm in length. Secondary mineralization within vugs is mostly dolomite, trace pyrite and possibly other iron minerals (block). 116' Vugs appear well interconnected at least in top 5'. Most vugs are open, not closed up with minerals. Vugs are still frequent down to 130'.										Bedrock cored with vibrocore and water. DTW is 32.3 and rising slowly
17 CS	120 110		120 122 124 126 128		BDX (LS)									Core is broken up into 3" sections in the bag. No vertical fractioning is apparent smalls fossils can be seen in the rock. Possibly a near reef deposit
			130	130' EOB.										

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

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

Page 1 of 9

Facility/Project Name Pleasant Prairie Power Plant	License/Permit/Monitoring Number	Boring Number W74

Boring Drilled By: Name of crew chief (first, last) and Firm Roy Buckenberger Cascade Drilling	Date Drilling Started 3/2/2015	Date Drilling Completed 3/3/2015	Drilling Method Rotory Sonic

WI Unique Well No. VQ578	DNR Well ID No.	Common Well Name W74	Final Static Water Level Feet (NAVD88)	Surface Elevation 685.0 Feet (NAVD88)	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 213,321 N, 2,533,127 E [✓ S]/C/N
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location
Feet ☐ N ☐ S
Feet ☐ E ☐ W

Facility ID	County Kenosha	County Code 30	Civil Town/City/ or Village Pleasant Prairie

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 46.8		0.5 1.0 1.5 2.0 2.5 3.0	0 - 3.5' **FILL, LEAN CLAY:** CL, yellowish brown (10YR 5/4), reworked clay, 0-10% fine to coarse sand and gravel, trace black silt sized material (possible ash), trace root debris, cohesive, medium plasticity, dry. 3' - 3.2' layer of fine to coarse sand-sized ash and black silt-sized ash.	CL	▨	▮ ▮							Installed 6" schedule 40 permanent steel casing to 15' bgs.
			3.5 4.0 4.5	3.5 - 5' **FILL, LEAN CLAY:** CL, very dark gray (10YR 3/1), fine gravel, trace root and woody debris, trace fine sand, cohesive, high plasticity, dry.	CL	▨	▮ ▮							
2 CS	120 116.4		5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5	5 - 8.6' **FILL, LEAN CLAY:** CL, gray (10YR 6/1), cohesive, high plasticity, dry, 10-15% dark yellowish brown (10YR 4/6) mottling.	CL	▨	▮ ▮							
			9.0 9.5	8.6 - 11.8' **FILL, LEAN CLAY:** CL, gray (10YR 5/1) , 10-20% increasing silt content with depth, trace fine sand, cohesive, medium to high plasticity, dry to moist, trace dark yellowish brown (10YR 4/6) mottling.	CL	▨	▮ ▮							

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

Signature

Firm Natural Resource Technology
234 W. Florida Street, Floor 5, Milwaukee, WI 53204
Tel: (414) 837-3607
Fax: (414) 837-3608

Date Modified: 4/30/2015
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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W74 Use only as an attachment to Form 4400-122. Page 2 of 9

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			10.0 10.5 11.0 11.5	8.6 - 11.8' **FILL, LEAN CLAY:** CL, gray (10YR 5/1) , 10-20% increasing silt content with depth, trace fine sand, cohesive, medium to high plasticity, dry to moist, trace dark yellowish brown (10YR 4/6) mottling. *(continued)*	CL									
3 CS	240 220.8		12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0	11.8 - 16.4' **LEAN CLAY:** CL, gray (10YR 5/1), 0-10% silt, cohesive, high plasticity, dry.	CL									
			16.5 17.0 17.5 18.0 18.5 19.0 19.5 20.0 20.5 21.0 21.5 22.0 22.5 23.0 23.5 24.0 24.5	16.4 - 25' **SILT:** ML, gray (10YR 5/1), 10-20% clay, cohesive, nonplastic, moist.	ML									
			25.0 25.5 26.0	25 - 26' **SANDY LEAN CLAY:** s(CL), gray (10YR 5/1), 10-30% fine sand, cohesive, low to medium plasticity, moist.	s(CL)									

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Boring Number W74 Use only as an attachment to Form 4400-122. Page 3 of 9

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			26.5	26 - 41' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 10-15% silt, trace fine to coarse sand and gravel, cohesive, high plasticity, dry to moist. *(continued)*	CL									
			27.0											
			27.5											
			28.0											
			28.5											
			29.0											
			29.5											
			30.0											
			30.5											
			31.0											
			31.5											
			32.0											
			32.5											
			33.0											
			33.5		CL									
			34.0											
			34.5											
4 CS	240 115.2		35.0											
			35.5											
			36.0											
			36.5											
			37.0											
			37.5											
			38.0											
			38.5											
			39.0											
			39.5											
			40.0											
			40.5											
			41.0	41 - 42.5' **SANDY SILT:** to **SILTY SAND:** s(ML), gray (10YR 5/1), 40-60% silt, 40-60% fine sand, trace coarse sand and fine gravel, moist to wet.										
			41.5											
			42.0		s(ML)									

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W74 Use only as an attachment to Form 4400-122. Page 4 of 9

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				42.5 - 43' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine to coarse sand and gravel, 10-15% silt, cohesive, high plasticity, dry to moist.	CL									
			43.0		(CL)s									
			43.5	43 - 43.5' **LEAN CLAY WITH SAND:** (CL)s, gray (10YR 5/1), 10-20% fine sand, cohesive, medium plasticity.										
			44.0											
			44.5	43.5 - 52.3' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 10-15% silt, cohesive, trace fine to coarse sand and gravel, high plasticity, dry to moist.										
			45.0											
			45.5											
			46.0											
			46.5											
			47.0											
			47.5											
			48.0		CL									
			48.5											
			49.0											
			49.5											
			50.0											
			50.5											
			51.0											
			51.5											
			52.0											
			52.5	52.3 - 53.3' **POORLY-GRADED SAND:** SP, gray (10YR 6/1), mostly very fine sand, 10-15% clay, dry to moist.	SP									
			53.0											
			53.5	53.3 - 112' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 10-15% silt, cohesive, trace fine to coarse sand and gravel, high plasticity, dry to moist.										
			54.0											
			54.5											
5 CS	240 93.6		55.0											
			55.5											55' - 65' bgs Low Recovery
			56.0		CL									
			56.5											
			57.0											
			57.5											
			58.0											
			58.5											

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W74 Use only as an attachment to Form 4400-122. Page 5 of 9

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			59.0	53.3 - 112' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 10-15% silt, cohesive, trace fine to coarse sand and gravel, high plasticity, dry to moist. *(continued)*										
			59.5											
			60.0											
			60.5											
			61.0											
			61.5											
			62.0											
			62.5											
			63.0											
			63.5											
			64.0											
			64.5											
			65.0											
			65.5											
			66.0											
			66.5											
			67.0		CL									
			67.5											
			68.0											
			68.5											
			69.0											
			69.5											
			70.0											
			70.5											
			71.0											
			71.5											
			72.0	72' 10-30% silt.										
			72.5											
			73.0											
			73.5											
			74.0											
			74.5											
			75.0											

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W74 Use only as an attachment to Form 4400-122. Page 6 of 9

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
6 CS	240 120			53.3 - 112' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 10-15% silt, cohesive, trace fine to coarse sand and gravel, high plasticity, dry to moist. *(continued)*										
			75.5											75' - 95' bgs Low Recovery
			76.0											
			76.5											
			77.0											
			77.5											
			78.0											
			78.5											
			79.0											
			79.5											
			80.0											
			80.5											
			81.0											
			81.5											
			82.0											
			82.5											
			83.0											
			83.5		CL									
			84.0											
			84.5											
			85.0											
			85.5											
			86.0											
			86.5											
			87.0											
			87.5											
			88.0											
			88.5											
			89.0											
			89.5											
			90.0											
			90.5											
			91.0											

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SOIL BORING LOG INFORMATION SUPPLEMENT
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Boring Number W74 Use only as an attachment to Form 4400-122. Page 7 of 9

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			92.0	53.3 - 112' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 10-15% silt, cohesive, trace fine to coarse sand and gravel, high plasticity, dry to moist. *(continued)*		▨								
			92.5											
			93.0											
			93.5											
			94.0											
			94.5											
7 CS	240 204		95.0											
			95.5											
			96.0											
			96.5											
			97.0											
			97.5											
			98.0											
			98.5											
			99.0											
			99.5		CL									
			100.0											
			100.5											
			101.0											
			101.5											
			102.0											
			102.5											
			103.0											
			103.5											
			104.0											
			104.5											
			105.0											
			105.5											
			106.0											
			106.5											
			107.0											
			107.5											

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SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W74 Use only as an attachment to Form 4400-122. Page 8 of 9

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			108.0	53.3 - 112' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 10-15% silt, cohesive, trace fine to coarse sand and gravel, high plasticity, dry to moist. *(continued)*										
			108.5											
			109.0											
			109.5											
			110.0	110' increasing fine sand content to 10-20%.	CL									
			110.5											
			111.0											
			111.5											
			112.0	112 - 115' **SILTY SAND:** SM, mostly fine sand, 20-40% silt, 10-20% clay, 5-10% fine to coarse gravel, trace cobbles, dry to moist.										
			112.5											
			113.0											
			113.5		SM									
			114.0											
			114.5											
8 CS	120 117.6		115.0	115 - 122.5' **SILTY SAND:** to **SANDY SILT:** SM, grayish brown (10YR 5/2), 40-60% very fine sand, 40-60% silt, trace fine to coarse sand and gravel, cohesive, nonplastic when mostly sand, low plasticity when mostly silt, dry.										
			115.5											
			116.0											
			116.5											
			117.0											
			117.5											
			118.0											
			118.5		SM									
			119.0											
			119.5											
			120.0	120' cobble.										
			120.5											
			121.0	121' increasing silt content and fine gravel.										
			121.5											
			122.0											
			122.5	122.5 - 124.5' **LEAN CLAY:** CL, till, brown (7.5YR 5/4), 10-25% fine sand, 10-20% silt, cohesive, 10-15% fine to coarse gravel, medium plasticity, hard (>4.5 tsf), dry.										
			123.0		CL									
			123.5											
			124.0											

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SOIL BORING LOG INFORMATION SUPPLEMENT

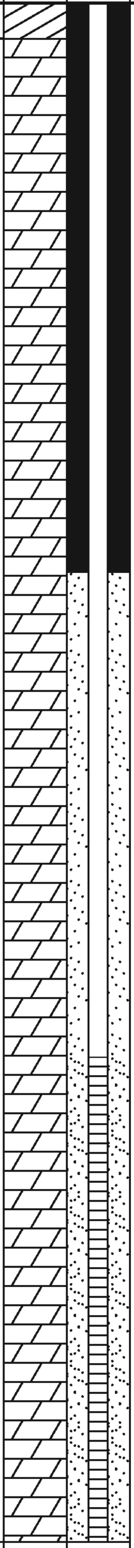
Form 4400-122A

Boring Number W74

Use only as an attachment to Form 4400-122.

Page 9 of 9

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
					CL									
			124.5	124.5 - 140' **WEATHERED BEDROCK** BDX (LS), dolomite, gray (5Y 5/1), microcrystalline (fossiliferous), massive, slightly to moderately disintegrated (trace pyrite recrystallizations, pitted).										
9 CS	24 4.8		125.0											124.5' - 125' 10-40% of recovered rock was silt-sized resulting from drilling process
			125.5											
			126.0											
			126.5											
10 CS	156 146.4		127.0											
			127.5											
			128.0											
			128.5											
			129.0											
			129.5											
			130.0											
			130.5											
			131.0											
			131.5											
			132.0		BDX (LS)									
			132.5											
			133.0											
			133.5											
			134.0											
			134.5											
			135.0											
			135.5											
			136.0											
			136.5											
			137.0											
			137.5											
			138.0											
			138.5											
			139.0											
			139.5											
			140.0	140' End of Boring.										



State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

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

Page 1 of 11

Facility/Project Name Pleasant Prairie Power Plant		License/Permit/Monitoring Number		Boring Number W75	
Boring Drilled By: Name of crew chief (first, last) and Firm Roy Buckenberger Cascade Drilling		Date Drilling Started 3/19/2015	Date Drilling Completed 3/23/2015		Drilling Method Rotory Sonic
WI Unique Well No. VQ577	DNR Well ID No.	Common Well Name W75	Final Static Water Level Feet (NAVD88)	Surface Elevation 687.4 Feet (NAVD88)	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 213,322 N, 2,533,541 E [✓ S] / C / N
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location
Feet ☐ N ☐ S
Feet ☐ E ☐ W

Facility ID	County Kenosha	County Code 30	Civil Town/City/ or Village Pleasant Prairie

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 32.4		0.5 1.0	0 - 1' **FILL, SILTY CLAY** CL/ML, very dark grayish brown (10YR 3/2), mostly lean clay, 30-40% organic silt, trace fine sand to coarse gravel, trace root debris, cohesive, medium plasticity, moist.	CL/ML									Installed 6" schedule 40 permanent steel casing to 15' bgs.
			1.5 2.0 2.5 3.0 3.5 4.0 4.5	1 - 5' **FILL, SILTY CLAY** CL/ML, light yellowish brown (2.5 6/4), mostly lean clay, 20-30% silt, trace fine sand to coarse gravel, cohesive, medium plasticity, dry to moist, trace gray (2.5Y 6/1) and olive yellow (2.5Y 6/8) mottling.	CL/ML									
2 CS	120 86.4		5.0 5.5 6.0	5 - 6.3' **FILL, LEAN CLAY:** CL, light olive brown (2.5Y 5/3), 10-20% silt, trace fine sand to coarse gravel, cohesive, high plasticity, moist, trace gray (2.5Y 6/1) and olive yellow (2.5Y 6/8) mottling.	CL									
			6.5 7.0 7.5 8.0	6.3 - 12.7' **FILL, LEAN CLAY:** CL, gray (2.5Y 6/1), trace silt, cohesive, high plasticity, moist, 10-30% olive yellow (2.5Y 6/8) mottling.	CL									

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

Signature

Firm Natural Resource Technology
234 W. Florida Street, Floor 5, Milwaukee, WI 53204
Tel: (414) 837-3607
Fax: (414) 837-3608

Date Modified: 4/30/2015
Template: WDNR SBL 1998 MKE ADDRESS DEPTH COLUMN - Project: P4 GINT LOGS.GPJ

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W75 Use only as an attachment to Form 4400-122. Page 2 of 11

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			8.5	6.3 - 12.7' **FILL, LEAN CLAY:** CL, gray (2.5Y 6/1), trace silt, cohesive, high plasticity, moist, 10-30% olive yellow (2.5Y 6/8) mottling. *(continued)*										
			9.0											
			9.5											
			10.0											
			10.5		CL									
			11.0											
			11.5	11.5' 10-20% silt-sized material [very dark gray (5Y 3/1)].										
			12.0											
			12.5	12.4' - 12.7' mostly very dark gray (5Y 3/1).										
			13.0	12.7 - 13.3' **LEAN CLAY:** CL, gray (5Y 5/1) to dark gray (5Y 4/1), cohesive, high plasticity, moist.	CL									
			13.5	13.3 - 20' **SILT:** to **LEAN CLAY:** ML, gray (5Y 5/1), mostly silt, 30-40% clay, cohesive, medium plasticity, moist.										
			14.0											
			14.5											
3 CS	120 105.6		15.0											
			15.5											
			16.0											
			16.5		ML									
			17.0											
			17.5											
			18.0											
			18.5											
			19.0											
			19.5											
			20.0	20 - 28.2' **POORLY-GRADED SAND WITH SILT:** to **SILTY SAND:** SP-SM, dark grayish brown (10YR 4/2), mostly fine to medium sand, 10-30% silt, trace coarse sand to fine gravel, moist to wet.										
			20.5											
			21.0		SP-SM									
			21.5											
			22.0											

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SOIL BORING LOG INFORMATION SUPPLEMENT
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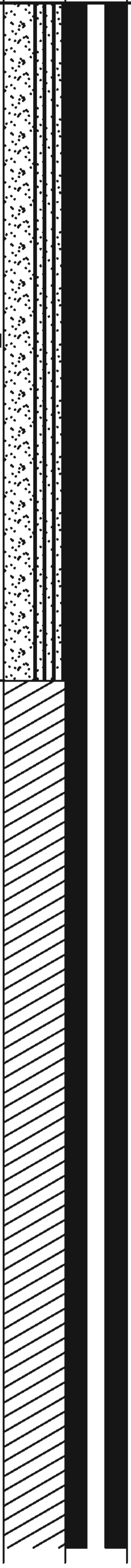

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			22.5 23.0 23.5 24.0 24.5	20 - 28.2' **POORLY-GRADED SAND WITH SILT:** to **SILTY SAND:** SP-SM, dark grayish brown (10YR 4/2), mostly fine to medium sand, 10-30% silt, trace coarse sand to fine gravel, moist to wet. *(continued)*										
4 CS	120 105.6		25.0 25.5 26.0 26.5 27.0 27.5 28.0	25' silty sand (20-40% silt).	SP-SM									
			28.5 29.0 29.5 30.0 30.5 31.0 31.5	28.2 - 57.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, medium stiff to stiff (0.5-1.5 tsf), dry to moist.										
			32.0 32.5 33.0 33.5 34.0 34.5		CL									
5 CS	240 213.6		35.0 35.5											

Boring Number W75

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Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			36.5	28.2 - 57.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, medium stiff to stiff (0.5-1.5 tsf), dry to moist. *(continued)*										
			37.0											
			37.5											
			38.0											
			38.5											
			39.0											
			39.5											
			40.0											
			40.5											
			41.0											
			41.5											
			42.0											
			42.5											
			43.0		CL									
			43.5											
			44.0											
			44.5											
			45.0											
			45.5											
			46.0											
			46.5											
			47.0											
			47.5											
			48.0											
			48.5											
			49.0											
			49.5											

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SOIL BORING LOG INFORMATION SUPPLEMENT
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Boring Number W75 Use only as an attachment to Form 4400-122. Page 5 of 11

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			50.0	28.2 - 57.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, medium stiff to stiff (0.5-1.5 tsf), dry to moist. *(continued)*										
			50.5											
			51.0											
			51.5											
			52.0											
			52.5											
			53.0											
			53.5		CL									
			54.0											
			54.5											
6 CS	240 216		55.0											
			55.5											
			56.0											
			56.5											
			57.0											
			57.5	57.5 - 59' **SILT:** ML, grayish brown (10YR 5/2), cohesive, nonplastic, moist.										
			58.0		ML									
			58.5											
			59.0	59 - 60.8' **SILTY CLAY** CL/ML, grayish brown (10YR 5/2), mostly lean clay, 10-30% silt, cohesive, medium to high plasticity, moist.										
			59.5											
			60.0		CL/ML									
			60.5											
			61.0	60.8 - 66' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, medium stiff to stiff (0.5 -1.5 tsf), dry to moist.										
			61.5											
			62.0		CL									
			62.5											
			63.0											
			63.5											

State of Wisconsin
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SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W75 Use only as an attachment to Form 4400-122. Page 6 of 11

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			64.0 64.5 65.0 65.5	60.8 - 66' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, medium stiff to stiff (0.5 -1.5 tsf), dry to moist. *(continued)*	CL									
			66.0 66.5 67.0 67.5 68.0 68.5 69.0 69.5	66 - 69.8' **SANDY SILT:** to **SILTY SAND:** s(ML), grayish brown (10YR 5/2), 40-60% silt, 40-60% very fine sand, noncohesive to cohesive, nonplastic, moist.	s(ML)									
			70.0 70.5 71.0 71.5 72.0 72.5	69.8 - 72.8' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, dry to moist. 70.4' - 71.1' lens of silt [grayish brown (10YR 5/2), cohesive, nonplastic, moist].	CL									
			73.0 73.5 74.0 74.5	72.8 - 75' **SILTY CLAY** CL/ML, grayish brown (10YR 5/2), mostly lean clay, 10-30% silt, cohesive, medium to high plasticity, moist.	CL/ML									
7 CS	240 212.4		75.0 75.5 76.0 76.5 77.0	75 - 79.2' **SANDY SILT:** to **SILTY SAND:** s(ML), grayish brown (10YR 5/2), 40-60% silt, 40-60% very fine sand, noncohesive to cohesive, nonplastic, moist.	s(ML)									

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W75 Use only as an attachment to Form 4400-122. Page 7 of 11

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			78.0	75 - 79.2' **SANDY SILT:** to **SILTY SAND:** s(ML), grayish brown (10YR 5/2), 40-60% silt, 40-60% very fine sand, noncohesive to cohesive, nonplastic, moist. *(continued)*										
			78.5		s(ML)									
			79.0											
			79.5	79.2 - 116.6' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, dry to moist.										
			80.0											
			80.5											
			81.0	80.6' - 80.9' lens of silt [grayish brown (10YR 5/2), cohesive, nonplastic, moist].										
			81.5											
			82.0											
			82.5											
			83.0											
			83.5											
			84.0											
			84.5											
			85.0	84.7' color change to dark grayish brown (10YR 4/2), stiff to very stiff (1.5-3.0 tsf).	CL									
			85.5											
			86.0											
			86.5											
			87.0											
			87.5											
			88.0											
			88.5											
			89.0											
			89.5											
			90.0											
			90.5											
			91.0											

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W75 Use only as an attachment to Form 4400-122. Page 8 of 11

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			91.5	79.2 - 116.6' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, dry to moist. *(continued)*										
			92.0											
			92.5											
			93.0											
			93.5											
			94.0											
			94.5											
8 CS	240 177.6		95.0											
			95.5											
			96.0											
			96.5											
			97.0											
			97.5											
			98.0		CL									
			98.5											
			99.0											
			99.5											
			100.0											
			100.5											
			101.0											
			101.5											
			102.0											
			102.5											
			103.0											
			103.5											
			104.0											
			104.5											
			105.0											

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SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W75 Use only as an attachment to Form 4400-122. Page 9 of 11

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			105.5 106.0 106.5 107.0 107.5 108.0 108.5 109.0 109.5 110.0 110.5 111.0 111.5	79.2 - 116.6' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, dry to moist. *(continued)*	CL	▨	■							
			112.0 112.5 113.0 113.5 114.0	111.8' - 112.2' lens of clayey sand [10-30% fine sand].		▨	■							
9 CS	228		114.5 115.0 115.5 116.0 116.5	114.5' - 115' lens of clayey sand [10-30% fine sand, 5-15% fine to coarse gravel].		▨	■							
			117.0 117.5 118.0 118.5	116.6 - 120.1' **SANDY LEAN CLAY:** s(CL), dark grayish brown (10YR 4/2), 10-30% fine to medium sand, increasing sand content with depth, trace coarse sand to fine gravel, cohesive, medium to high plasticity.	s(CL)	▨	■							

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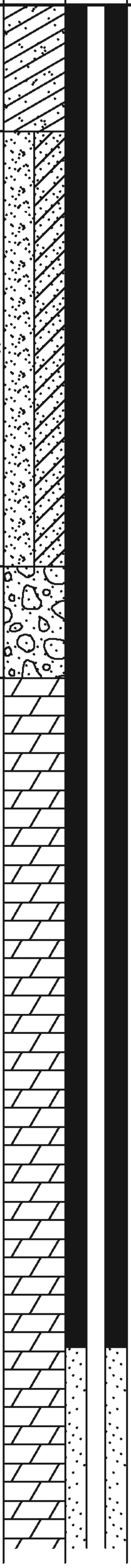
SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W75 Use only as an attachment to Form 4400-122. Page 10 of 11

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			119.5 120.0	116.6 - 120.1' **SANDY LEAN CLAY:** s(CL), dark grayish brown (10YR 4/2), 10-30% fine to medium sand, increasing sand content with depth, trace coarse sand to fine gravel, cohesive, medium to high plasticity. *(continued)*	s(CL)									
			120.5 121.0 121.5 122.0 122.5 123.0 123.5	120.1 - 124' **POORLY-GRADED SAND WITH CLAY:** to **POORLY-GRADED SAND WITH SILT:** SP-SC, gray (10YR 6/1), mostly fine to medium sand, 10-15% silt, 10-15% clay, trace coarse sand to coarse gravel, decreasing silt and clay content with depth, dry.	SP-SC									
10 CS	204 122.4		124.0 124.5	124 - 125' **WELL-GRADED GRAVEL:** GW, cobbles and boulders on top of bedrock (well-rounded lithics, dolomite gravel).	GW									
			125.0 125.5 126.0 126.5 127.0 127.5 128.0 128.5 129.0 129.5 130.0 130.5 131.0 131.5 132.0 132.5	125 - 141' **WEATHERED BEDROCK** BDX (LS), dolomite, microcrystalline[fossiliferous (crinoid stems)], massive, slightly decomposed [pale yellow (5Y 7/4) and light greenish gray (GLEY 1 7/10Y) discoloration], slightly to moderately disintegrated (pyrite recrystallizations, pitted).	BDX (LS)									



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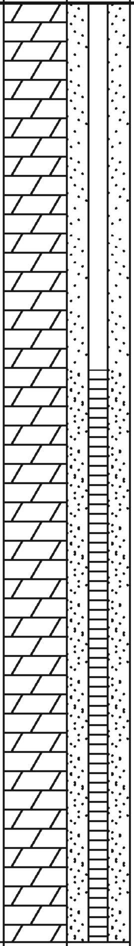
SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W75 Use only as an attachment to Form 4400-122. Page 11 of 11

Sample										Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			133.0 133.5 134.0 134.5 135.0 135.5 136.0 136.5 137.0 137.5 138.0 138.5 139.0 139.5 140.0 140.5 141.0	125 - 141' **WEATHERED BEDROCK** BDX (LS), dolomite, microcrystalline[fossiliferous (crinoid stems)], massive, slightly decomposed [pale yellow (5Y 7/4) and light greenish gray (GLEY 1 7/10Y) discoloration], slightly to moderately disintegrated (pyrite recrystallizations, pitted). *(continued)*	BDX (LS)									
				141' End of Boring.										

State of Wisconsin
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SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

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

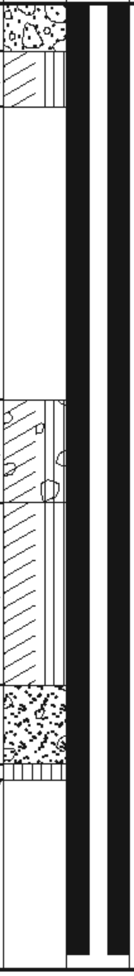
Facility/Project Name Pleasant Prairie Power Plant	License/Permit/Monitoring Number	Boring Number W76

Boring Drilled By: Name of crew chief (first, last) and Firm Roy Buckenberger Cascade Drilling	Date Drilling Started 3/20/2015	Date Drilling Completed 3/24/2015	Drilling Method Rotory Sonic

WI Unique Well No. VQ576	DNR Well ID No.	Common Well Name W76	Final Static Water Level Feet (NAVD88)	Surface Elevation 689.0 Feet (NAVD88)	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 213,301 N, 2,534,065 E [✓ S]/C/N
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location
Feet ☐ N ☐ S
Feet ☐ E ☐ W

Facility ID	County Kenosha	County Code 30	Civil Town/City/ or Village Pleasant Prairie



Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 15.6			0 - 0.6' **FILL, WELL-GRADED GRAVEL:** GW, gravel pad.	GW									Installed 6" schedule 40 permanent steel casing to 15' bgs.
			1	0.6 - 1.3' **FILL, SILTY CLAY** CL/ML, very dark grayish brown (10YR 3/2), 30-40% organic silt, trace fine sand to coarse gravel, trace root debris, cohesive, medium plasticity, moist.	CL/ML									
			2 3 4	1.3 - 5' No Recovery.										
2 CS	120 57.6		5 6	5 - 6.3' **FILL, SILTY CLAY** CL/ML, yellowish brown (10YR 5/6), 20-30% silt, 10-20% well-graded gravel, 5-15% well-graded sand.	CL/ML									
			7 8	6.3 - 8.6' **FILL, SILTY CLAY** CL/ML, reworked till, yellowish brown (10YR 5/6), 10-30% silt, trace fine sand to fine gravel, cohesive, medium to high plasticity, dry to moist, 10-20% yellowish brown (10YR 5/8) to gray (10YR 6/1) mottling. 6.4' - 7.5' laminations of black material (possible ash).	CL/ML									
			9	8.6 - 9.6' **POORLY-GRADED SAND WITH GRAVEL:** (SP)g, dark gray (10YR 4/1) to very dark gray (10YR 3/1), mostly medium sand, 5-15% fine to coarse gravel, moist.	(SP)g									
			10	9.6 - 9.8' **SILT:** ML, gray (10YR 5/1) to gray (10YR 6/1), trace fine sand to fine gravel, cohesive, low plasticity, dry, trace yellowish brown (10YR 5/4) mottling.	ML									
			11 12	9.8 - 15' No Recovery.										

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

Signature	Firm Natural Resource Technology 234 W. Florida Street, Floor 5, Milwaukee, WI 53204 Tel: (414) 837-3607 Fax: (414) 837-3608

Date Modified: 4/30/2015
Template: WDNR SBL 1998 MKE ADDRESS DEPTH COLUMN - Project: P4 GINT LOGS.GPJ

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

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W76 Use only as an attachment to Form 4400-122. Page 2 of 8

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			13 14	9.8 - 15' No Recovery. *(continued)*										
3 CS	120 108		15 16 17 18 19 20 21 22 23 24	15 - 121.7' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine to sand to fine gravel, cohesive, high plasticity, stiff to very stiff (1.5-2.5 tsf), dry to moist. 15.7' - 16' sandy clay with lenses of silt [brown (10YR 4/3), mostly lean clay, 20-30% fine to medium sand, 10-20% silt, 5-10% fine to coarse gravel, cohesive, medium plasticity, moist].	CL	▨								
4 CS	120 109.2		25 26 27 28 29 30 31 32	25' soft (<0.5 tsf).		▨								

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SOIL BORING LOG INFORMATION SUPPLEMENT
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Boring Number W76 Use only as an attachment to Form 4400-122. Page 3 of 8

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			33	15 - 121.7' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine to sand to fine gravel, cohesive, high plasticity, stiff to very stiff (1.5-2.5 tsf), dry to moist. *(continued)*										
			34											
5 CS	240 224.4		35											
			36											
			37											
			38											
			39											
			40											
			41	40.8' - 41.6' clay with lenses of silt [gray (10YR 5/1) to gray (10YR 6/1), 30-40% silt, 5-15% fine sand to coarse gravel, moist to wet]. 41.6' - 50.1' 5-10% silt.										
			42		CL									
			43											
			44											
			45											
			46	46' - 46.3' dark grayish brown (2.5Y 4/2). 46.3' 20-30% medium sand (1" layer).										
			47											
			48											
			49											
			50											
			51											
			52											

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W76 Use only as an attachment to Form 4400-122. Page 4 of 8

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
				15 - 121.7' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine to sand to fine gravel, cohesive, high plasticity, stiff to very stiff (1.5-2.5 tsf), dry to moist. *(continued)*										
			53											
			54											
6 CS	240 184.8		55	55' soft (<0.5 tsf).										
			56											
			57											
			58											
			59											
			60											
			61											
			62		CL									
			63											
			64											
			65											
			66											
			67											
			68											
			69											
			70											
			71											
			72											

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W76 Use only as an attachment to Form 4400-122. Page 5 of 8

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			73	15 - 121.7' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine to sand to fine gravel, cohesive, high plasticity, stiff to very stiff (1.5-2.5 tsf), dry to moist. *(continued)*										
			74											
7 CS	240 198		75	75' soft to medium stiff (0.5-1.0 tsf).										
			76											
			77	76.7' - 79' 5-10% silt.										
			78											
			79											
			80											
			81											
			82	82' 5-10% silt, increasing silt content with depth.	CL									
			83											
			84											
			85											
			86											
			87											
			88											
			89											
			90											
			91											
			92											

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W76 Use only as an attachment to Form 4400-122.

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			93	15 - 121.7' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine to sand to fine gravel, cohesive, high plasticity, stiff to very stiff (1.5-2.5 tsf), dry to moist. *(continued)*										
			94											
8 CS	240 229.2		95	95' no silt, no sand, no gravel. 95.1' - 115' soft to medium stiff (<1.0 tsf).										
			96											
			97											
			98											
			99											
			100											
			101											
			102		CL									
			103											
			104											
			105											
			106											
			107											
			108											
			109											
			110											
			111											
			112											

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SOIL BORING LOG INFORMATION SUPPLEMENT
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Boring Number W76 Use only as an attachment to Form 4400-122. Page 7 of 8

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			113	15 - 121.7' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine to sand to fine gravel, cohesive, high plasticity, stiff to very stiff (1.5-2.5 tsf), dry to moist. *(continued)*										
			114											
9 CS	120 123.6		115											
			116											
			117	117' trace silt, trace fine sand to fine gravel.	CL									
			118											
			119	118.5' - 121.7' 10-20% silt, increasing silt content with depth.										
			120											
			121											
			122	121.7 - 123' **SANDY LEAN CLAY WITH GRAVEL:** s(CL)g, gray (10YR 5/1) to gray (10YR 6/1), 20-30 % fine to medium sand, 10-20% coarse sand to coarse gravel, cohesive, medium plasticity, moist.	s(CL)g									
			123	123 - 124.1' **WELL-GRADED GRAVEL WITH SAND:** (GW)s, gray (10YR 5/1) to gray (10YR 6/1), mostly well-graded fine to coarse gravel, 5-10% cobbles, 5-15% fines (silt and clay), moist to wet.	(GW)s									
			124	124.1 - 125' **SANDY LEAN CLAY WITH GRAVEL:** to **SANDY SILT WITH GRAVEL:** s(CL)g, gray (10YR 5/1) to gray (10YR 6/1), mostly fines (clay > silt), 10-30% sand (mostly fine to medium), 10-20% fine to coarse gravel, cohesive, low to medium plasticity, dry.	s(CL)g									
10 CS	192		125											
			126											
			127	125 - 141' **WEATHERED BEDROCK** BDX (LS), dolomite, microcrystalline (trace crinoid fossils), massive, slightly to moderately decomposed [greenish gray (GLEY 1 5/10Y) and pale yellow (5Y 8/3) discolorations], slightly disintegrated (pitted, trace pyrite recrystallizations).										
			128		BDX (LS)									
			129											
			130											
			131											
			132											

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SOIL BORING LOG INFORMATION SUPPLEMENT
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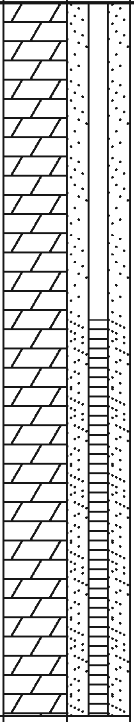
Boring Number W76 Use only as an attachment to Form 4400-122. Page 8 of 8

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			133 134 135 136 137 138 139 140	125 - 141' **WEATHERED BEDROCK** BDX (LS), dolomite, microcrystalline (trace crinoid fossils), massive, slightly to moderately decomposed [greenish gray (GLEY 1 5/10Y) and pale yellow (5Y 8/3) discolorations], slightly disintegrated (pitted, trace pyrite recrystallizations). *(continued)*	BDX (LS)									
			141	141' End of Boring.										

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SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

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

Facility/Project Name Pleasant Prairie Power Plant	License/Permit/Monitoring Number	Boring Number W77	
Boring Drilled By: Name of crew chief (first, last) and Firm Roy Buckenberger Cascade Drilling	Date Drilling Started 3/19/2015	Date Drilling Completed 3/19/2015	Drilling Method Rotory Sonic

WI Unique Well No. VQ575	DNR Well ID No.	Common Well Name W77	Final Static Water Level Feet (NAVD88)	Surface Elevation 684.9 Feet (NAVD88)	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 212,179 N, 2,534,660 E [✓ S]/C/N
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location
Feet ☐ N ☐ S
Feet ☐ E ☐ W

Facility ID	County Kenosha	County Code 30	Civil Town/City/ or Village Pleasant Prairie

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 34.8		0.5	0 - 0.7' **SILTY CLAY** CL/ML, very dark grayish brown (10YR 3/2), mostly lean clay, 30-40% organic silts, trace fine sand to coarse gravel, trace root debris, cohesive, medium plasticity, moist.	CL/ML									
			1.0 1.5	0.7 - 1.7' **SILTY CLAY** CL/ML, yellowish brown (10YR 5/6), mostly lean clay, 30-40% silt, trace fine sand to fine gravel, trace root debris, cohesive, medium plasticity, moist.	CL/ML									
			2.0 2.5 3.0 3.5 4.0 4.5	1.7 - 7.3' **SILTY CLAY** CL/ML, light olive brown (2.5Y 5/6), 20-30% silt, cohesive, high plasticity, moist, 10-20% light gray (2.5Y 7/1) and light olive brown (2.5Y 5/6) mottling.	CL/ML									
2 CS	120 115.2		5.0 5.5 6.0	5' - 6.3' trace silt.										
			6.5 7.0	6.3' - 6.5' medium sand and gravel.										

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

Signature

Firm Natural Resource Technology
234 W. Florida Street, Floor 5, Milwaukee, WI 53204
Tel: (414) 837-3607
Fax: (414) 837-3608

Date Modified: 4/30/2015
Template: WDNR SBL 1998 MKE ADDRESS DEPTH COLUMN - Project: P4 GINT LOGS.GPJ

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

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W77 Use only as an attachment to Form 4400-122. Page 2 of 11

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			7.5 8.0	7.3 - 8.3' **SILT:** ML, gray (2.5Y 6/1), 5-15% fine to coarse sand and fine gravel, cohesive, nonplastic to low plasticity, moist, 0-20% olive yellow (2.5Y 6/6) mottling.	ML									
			8.5 9.0 9.5	8.3 - 10' **POORLY-GRADED SAND:** SP, dark gray (2.5Y 4/1) to gray (2.5Y 5/1), mostly medium sand, trace coarse sand and fine gravel, moist.	SP									
			10.0 10.5	10 - 11' **SILT:** ML, gray (2.5Y 6/1), 5-15% fine to coarse sand and fine gravel, cohesive, nonplastic to low plasticity, moist, 0-20% olive yellow (2.5Y 6/6) mottling.	ML									
			11.0 11.5	11 - 45' **POORLY-GRADED SAND WITH SILT:** SP-SM, mostly medium sand, 5-15% coarse sand to coarse gravel, 10-15% silt, wet. 11.1' cobble (4" diameter).										
			12.0											
			12.5	12.4' - 12.7' lens of silt.										
			13.0	12.9' - 13' lens of silt.										
			13.5 14.0											
			14.5	14.5' cobble (2" diameter).										
3 CS	240 177.6		15.0	15' - 35' mostly medium to coarse sand with lenses of mostly medium sand.	SP-SM									
			15.5 16.0 16.5 17.0 17.5 18.0 18.5 19.0											

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W77 Use only as an attachment to Form 4400-122. Page 3 of 11

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
				11 - 45' **POORLY-GRADED SAND WITH SILT:** SP-SM, mostly medium sand, 5-15% coarse sand to coarse gravel, 10-15% silt, wet. *(continued)*										
			20.0											
			20.5											
			21.0											
			21.5											
			22.0											
			22.5											
			23.0											
			23.5											
			24.0											
			24.5											
			25.0											
			25.5		SP-SM									
			26.0											
			26.5											
			27.0											
			27.5											
			28.0											
			28.5											
			29.0											
			29.5											
			30.0											
			30.5											
			31.0											
			31.5											

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W77 Use only as an attachment to Form 4400-122. Page 4 of 11

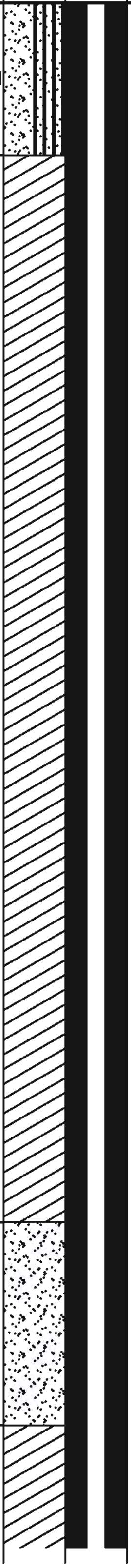
Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			32.0	11 - 45' **POORLY-GRADED SAND WITH SILT:** SP-SM, mostly medium sand, 5-15% coarse sand to coarse gravel, 10-15% silt, wet. *(continued)*										
			32.5											
			33.0											
			33.5	33.5' - 34.5' mostly medium sand.										
			34.0											
			34.5											
4 CS	240 212.4		35.0	35' - 45' mostly medium sand.										
			35.5											
			36.0											
			36.5											
			37.0											
			37.5		SP-SM									
			38.0											
			38.5	38.5' silt content increased to 10-20%.										
			39.0											
			39.5											
			40.0											
			40.5											
			41.0											
			41.5											
			42.0											
			42.5											
			43.0											
			43.5											

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W77 Use only as an attachment to Form 4400-122. Page 5 of 11



Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			44.0 44.5	11 - 45' **POORLY-GRADED SAND WITH SILT:** SP-SM, mostly medium sand, 5-15% coarse sand to coarse gravel, 10-15% silt, wet. *(continued)*	SP-SM									
			45.0 45.5 46.0 46.5 47.0 47.5 48.0	45 - 53.4' **LEAN CLAY:** CL, till, brown (10YR 5/3), 5-10% fine sand to fine gravel, 5-10% silt, cohesive, high plasticity, dry to moist.										
			48.5 49.0 49.5 50.0 50.5 51.0 51.5 52.0 52.5 53.0	48.3' - 49' lens of clayey sand with gravel [brown (10YR 5/3), mostly medium sand, 20-40% clay, 10-15% fine to coarse gravel, wet].	CL									
			53.5 54.0 54.5	53.4 - 55' **POORLY-GRADED SAND:** SP, gray (10YR 5/1), mostly medium sand, 5-10% coarse sand to coarse gravel, moist.	SP									
5 CS	120 98.4		55.0 55.5	55 - 57.5' **LEAN CLAY:** CL, till, brown (10YR 5/3), 5-10% fine sand to fine gravel, 5-10% silt, cohesive, high plasticity, very stiff (3.5-4.0 tsf), dry to moist.	CL									

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Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W77 Use only as an attachment to Form 4400-122. Page 6 of 11

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				55 - 57.5' **LEAN CLAY:** CL, till, brown (10YR 5/3), 5-10% fine sand to fine gravel, 5-10% silt, cohesive, high plasticity, very stiff (3.5-4.0 tsf), dry to moist. *(continued)*										
			56.5		CL									
			57.0											
			57.5	57.5 - 85.5' **LEAN CLAY:** CL, till, brown (10YR 5/3), trace fine sand to fine gravel, trace silt, cohesive, high plasticity, very stiff to hard (3.0-4.25 tsf), dry to moist.										
			58.0											
			58.5											
			59.0											
			59.5											
			60.0											
			60.5											
			61.0											
			61.5											
			62.0											
			62.5											
			63.0		CL									
			63.5											
			64.0											
			64.5											
6 CS	120 111.6		65.0	65' - 75' very stiff (2.0-3.0 tsf).										
			65.5											
			66.0											
			66.5											
			67.0											
			67.5											
			68.0											

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W77 Use only as an attachment to Form 4400-122. Page 7 of 11

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			68.5	57.5 - 85.5' **LEAN CLAY:** CL, till, brown (10YR 5/3), trace fine sand to fine gravel, trace silt, cohesive, high plasticity, very stiff to hard (3.0-4.25 tsf), dry to moist. *(continued)*										
			69.0											
			69.5											
			70.0											
			70.5											
			71.0											
			71.5											
			72.0											
			72.5											
			73.0											
			73.5											
			74.0		CL									
			74.5											
7 CS	240 201.6		75.0											
			75.5											
			76.0											
			76.5											
			77.0											
			77.5											
			78.0											
			78.5											
			79.0											
			79.5											
			80.0											

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SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W77 Use only as an attachment to Form 4400-122. Page 8 of 11

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			80.5	57.5 - 85.5' **LEAN CLAY:** CL, till, brown (10YR 5/3), trace fine sand to fine gravel, trace silt, cohesive, high plasticity, very stiff to hard (3.0-4.25 tsf), dry to moist. *(continued)*										
			81.0											
			81.5											
			82.0											
			82.5											
			83.0		CL									
			83.5											
			84.0	84' brown (10YR 4/3).										
			84.5											
			85.0											
			85.5	85.5 - 86' **SILT:** ML, grayish brown (10YR 5/2), 10-30% clay, cohesive, low to medium plasticity, moist.	ML									
			86.0	86 - 88' **LEAN CLAY:** CL, grayish brown (10YR 5/2), 10-20% silt, trace fine sand to fine gravel, cohesive, high plasticity, dry to moist.										
			86.5											
			87.0		CL									
			87.5											
			88.0	88 - 94' **SILTY CLAY** CL/ML, silty lean clay with sand, moslty lean clay, 20-30% silt, 10-20% fine sand, trace medium sand to fine gravel, cohesive, medium plasticity, moist.										
			88.5											
			89.0											
			89.5											
			90.0		CL/ML									
			90.5											
			91.0											
			91.5											
			92.0											

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W77 Use only as an attachment to Form 4400-122. Page 9 of 11

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			93.0	88 - 94' **SILTY CLAY** CL/ML, silty lean clay with sand, moslty lean clay, 20-30% silt, 10-20% fine sand, trace medium sand to fine gravel, cohesive, medium plasticity, moist. *(continued)*	CL/ML									
			93.5											
			94.0	94 - 95' **SANDY LEAN CLAY:** s(CL), grayish brown (10YR 5/2), mostly lean clay, 30-40% fine to medium sand, cohesive, medium plasticity, moist.	s(CL)									
			94.5											
8 CS	240 162		95.0	95 - 105.3' **SILTY CLAY** CL/ML, moslty lean clay, 20-30% silt, 10-20% fine sand, trace medium sand to coarse gravel, cohesive, medium plasticity, moist.	CL/ML									
			95.5											
			96.0											
			96.5											
			97.0											
			97.5											
			98.0											
			98.5											
			99.0											
			99.5											
			100.0											
			100.5											
			101.0											
			101.5											
			102.0	102' cobble (2" diameter).										
			102.5											
			103.0											
			103.5											
			104.0											
			104.5											

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Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

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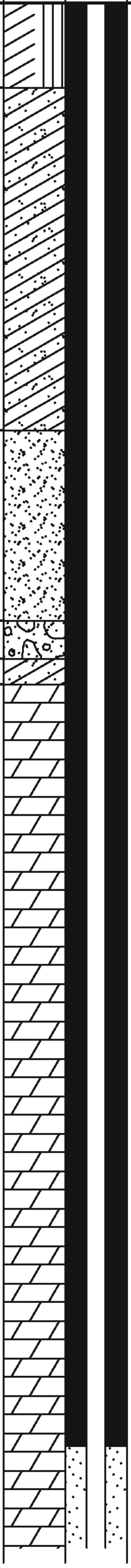

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			105.0	105' cobble (3" diameter).	CL/ML							
			105.5 106.0 106.5 107.0 107.5	105.3 - 108' **SANDY LEAN CLAY:** s(CL), grayish brown (10YR 5/2), mostly lean clay, 30-40% fine to medium sand, 5-10% coarse sand to coarse gravel, cohesive, medium plasticity, moist.	s(CL)							
			108.0 108.5 109.0	108 - 109.5' **POORLY-GRADED SAND:** SP, brown (10YR 5/3), mostly fine to medium sand, 5-15% medium sand to coarse gravel, moist.	SP							
			109.5	109.5 - 109.8' **WELL-GRADED GRAVEL WITH SAND:** (GW)s, mostly fine to coarse gravel, 10-30% fine to coarse sand, 10-15% silt [possible rock flour from drilling, light gray (10YR 7/1)], moist.	(GW)s							
9 CS	192 118.8		110.0	109.8 - 110' **SANDY LEAN CLAY:** s(CL), mostly lean clay, 20-30% silt, 10-20% fine sand, 5-15% fine to coarse gravel, cohesive, medium plasticity, moist.	s(CL)							
			110.5 111.0 111.5 112.0 112.5	110 - 126' **WEATHERED BEDROCK** BDX (LS), dolomite, white (5Y 8/1) to light gray (5Y 7/1), fossiliferous (crinoids), slightly to moderately decomposed [trace gray (GLEY 1 6/N) discolorations], slightly to moderately disintegrated (pitted, pyrite and black recrystallizations).								
			113.0 113.5 114.0 114.5 115.0 115.5 116.0 116.5	113' decrease in pyrite and black recrystallizations and discoloration.	BDX (LS)							

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

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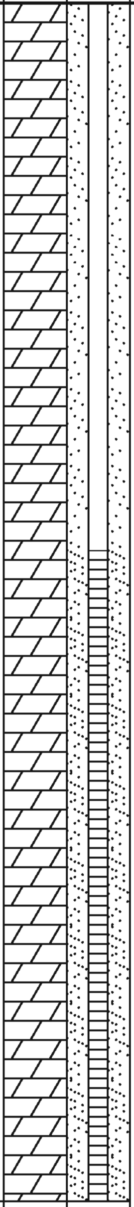


Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			117.0	110 - 126' **WEATHERED BEDROCK** BDX (LS), dolomite, white (5Y 8/1) to light gray (5Y 7/1), fossiliferous (crinoids), slightly to moderately decomposed [trace gray (GLEY 1 6/N) discolorations], slightly to moderately disintegrated (pitted, pyrite and black recrystallizations). *(continued)*										
			117.5											
			118.0											
			118.5											
			119.0											
			119.5											
			120.0											
			120.5											
			121.0											
			121.5		BDX (LS)									
			122.0											
			122.5											
			123.0											
			123.5											
			124.0											
			124.5											
			125.0											
			125.5											
			126.0	126' End of Boring.										

State of Wisconsin
Department of Natural Resources

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

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Pleasant Prairie Power Plant

Local Grid Location of Well: ______ ft. ☐ N. ☐ S. ______ ft. ☐ E. ☐ W.

Well Name: W20D

Facility License, Permit or Monitoring No.:

Local Grid Origin ☐ (estimated: ☐) or Well Location ☐

Lat. 42° 33' 51.4" Long. -87° 54' 15.1" or

Wis. Unique Well No.: VQ580

DNR Well Number:

Facility ID:

St. Plane 212,758 ft. N, 2,533,086 ft. E. [✓ S] / C / N

Date Well Installed: 03/04/2015

Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E ☐ W

Type of Well:

Well Installed By: (Person's Name and Firm)
Roy Buckenberger
Cascade Drilling

Distance from Waste/Source ______ ft.

Enf. Stds. Apply ☐

Location of Well Relative to Waste/Source:
u ☒ Upgradient s ☐ Sidegradient
d ☐ Downgradient n ☐ Not Known

Gov. Lot Number:

A. Protective pipe, top elevation 689.03 ft. (NAVD88)

B. Well casing, top elevation 688.41 ft. (NAVD88)

C. Land surface elevation 686.5 ft. (NAVD88)

D. Surface seal, bottom 684.5 ft. (NAVD88) or 2.0 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☒

13. Sieve analysis attached? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 5 0
Hollow Stem Auger ☐ 4 1
roto-sonic Other ☒

15. Drilling fluid used: Water ☒ 0 2 Air ☐ 0 1
Drilling Mud ☐ 0 3 None ☐ 9 9

16. Drilling additives used? ☐ Yes ☒ No

Describe ______

17. Source of water (attach analysis, if required):
n/a

E. Bentonite seal, top 562.5 ft. (NAVD88) or 124.0 ft.

F. Fine sand, top 556.5 ft. (NAVD88) or 130.0 ft.

G. Filter pack, top 554.5 ft. (NAVD88) or 132.0 ft.

H. Screen joint, top 551.5 ft. (NAVD88) or 135.0 ft.

I. Well bottom 546.5 ft. (NAVD88) or 140.0 ft.

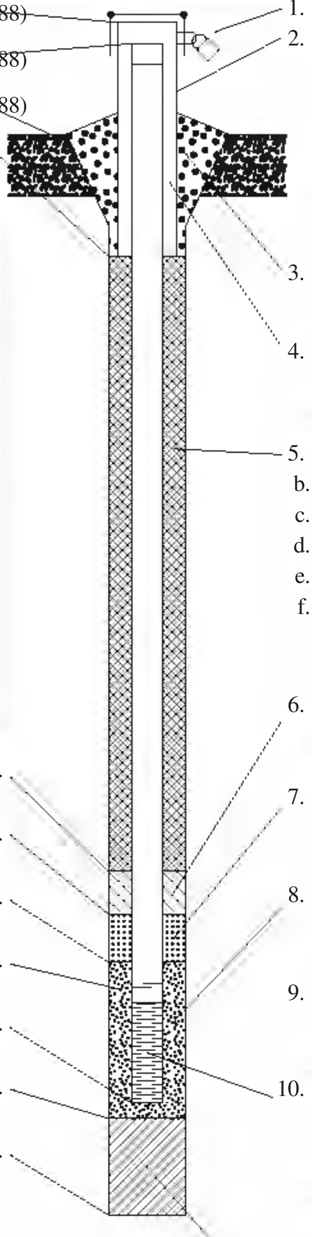
J. Filter pack, bottom 546.5 ft. (NAVD88) or 140.0 ft.

K. Borehole, bottom 546.5 ft. (NAVD88) or 140.0 ft.

L. Borehole, diameter 6.00 in.

M. O.D. well casing 2.38 in.

N. I.D. well casing 1.94 in.



1. Cap and lock? ☒ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 17.5 ft.
c. Material: Steel ☒ 0 4
Other ☐
d. Additional protection? ☒ Yes ☐ No
If yes, describe: 3 steel bollards/15' of 6" sch 40 steel casing

3. Surface seal: Bentonite ☒ 3 0
Concrete ☐ 0 1
Other ☐

4. Material between well casing and protective pipe:
Bentonite ☒ 3 0
Sand Other ☒

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 3 3
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 3 5
c. ____ Lbs/gal mud weight . . . Bentonite slurry ☐ 3 1
d. 30 % Bentonite . . . Bentonite-cement grout ☒ 5 0
e. ____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 0 1
Tremie pumped ☒ 0 2
Gravity ☐ 0 8

6. Bentonite seal: a. Bentonite granules ☐ 3 3
b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☒ 3 2
c. ______ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Granusil
b. Volume added ______ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint Sand and Gravel
b. Volume added ______ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 2 3
Flush threaded PVC schedule 80 ☒ 2 4
Other ☐

10. Screen material: Schedule 80 PVC
a. Screen Type: Factory cut ☒ 1 1
Continuous slot ☐ 0 1
Other ☐
b. Manufacturer Hole Products
c. Slot size: 0.010 in.
d. Slotted length: 5.0 ft.

11. Backfill material (below filter pack): None ☒ 1 4
Other ☐

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

Date Modified: 4/30/2015

Signature

Firm: Natural Resource Technology
234 W. Florida Street, Floor 5, Milwaukee, WI 53204
Tel: 414.837.3607
Fax: 414.837.3608

~~Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289,~~ 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

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

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: We Energies
Local Grid Location of Well: ______ft. ☐ N. ☐ S. ______ft. ☐ E. ☐ W.
Well Name: W73

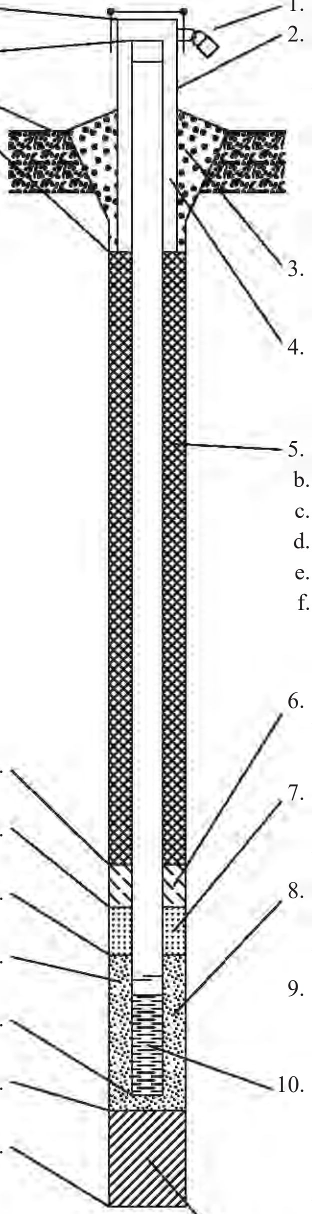
Facility License, Permit or Monitoring No.: 2786
Local Grid Origin ☐ (estimated: ☐) or Well Location ☒
Lat. ___° ___' ___" Long. ___° ___' ___" or
St. Plane 213,368 ft. N, 2,534,399 ft. E. [✓ S]/C/N
Wis. Unique Well No.: VN433
DNR Well Number: 292

Facility ID:
Date Well Installed: 10/02/2013

Section Location of Waste/Source: ___1/4 of ___ 1/4 of Sec. ___, T. ___ N, R. ___ ☐ E ☐ W
Type of Well: Well Code 12/pz
Well Installed By: (Person's Name and Firm) Jason Drabek, Boart Longyear Company

Distance from Waste/Source: 120 ft.
Enf. Stds. Apply ☒
Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☒ Downgradient n ☐ Not Known
Gov. Lot Number:

A. Protective pipe, top elevation 691.17 ft. MSL
B. Well casing, top elevation 690.79 ft. MSL
C. Land surface elevation 688.8 ft. MSL
D. Surface seal, bottom ______ ft. MSL or ______ ft.



12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☒

13. Sieve analysis attached? ☐ Yes ☐ No

14. Drilling method used: Rotary ☐ 5 0
Hollow Stem Auger ☐ 4 1
Sonic Other ☒

15. Drilling fluid used: Water ☒ 0 2 Air ☐ 0 1
Drilling Mud ☐ 0 3 None ☐ 9 9

16. Drilling additives used? ☐ Yes ☒ No

Describe ______

17. Source of water (attach analysis, if required): City of Kenosha

E. Bentonite seal, top ______ ft. MSL or ______ ft.
F. Fine sand, top 568.8 ft. MSL or 120.0 ft.
G. Filter pack, top 566.8 ft. MSL or 122.0 ft.
H. Screen joint, top 563.8 ft. MSL or 125.0 ft.
I. Well bottom 558.8 ft. MSL or 130.0 ft.
J. Filter pack, bottom 558.8 ft. MSL or 130.0 ft.
K. Borehole, bottom 558.8 ft. MSL or 130.0 ft.
L. Borehole, diameter 6.00 in.
M. O.D. well casing 2.38 in.
N. I.D. well casing 2.07 in.

1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
   a. Inside diameter: 6.0 in.
   b. Length: 7.0 ft.
   c. Material: Steel ☒ 0 4
   Bumper Posts Other ☐
   d. Additional protection? ☐ Yes ☒ No
   If yes, describe: ______
3. Surface seal: Bentonite ☒ 3 0
   Concrete ☐ 0 1
   Other ☐
4. Material between well casing and protective pipe:
   Bentonite ☒ 3 0
   Sand Other ☒
5. Annular space seal: a. Granular/Chipped Bentonite ☐ 3 3
   b. ______Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 3 5
   c. 116 Lbs/gal mud weight . . . Bentonite slurry ☒ 3 1
   d. ______% Bentonite . . . Bentonite-cement grout ☐ 5 0
   e. 16.7 Ft^3 volume added for any of the above
   f. How installed: Tremie ☐ 0 1
   Tremie pumped ☒ 0 2
   Gravity ☐ 0 8
6. Bentonite seal: a. Bentonite granules ☐ 3 3
   b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☒ 3 2
   c. ______ Other ☐
7. Fine sand material: Manufacturer, product name & mesh size
   a. Boart
   b. Volume added 2 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. Boart
   b. Volume added 7 ft^3
9. Well casing: Flush threaded PVC schedule 40 ☒ 2 3
   Flush threaded PVC schedule 80 ☐ 2 4
   Other ☐
10. Screen material: Schedule 80 PVC
   a. Screen Type: Factory cut ☒ 1 1
   Continuous slot ☐ 0 1
   Other ☐
   b. Manufacturer Boart Longyear
   c. Slot size: 0.100 in.
   d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☒ 1 4
   Other ☐

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

Date Modified: 10/31/2013

Signature

Firm: Natural Resource Technology
234 W. Florida Street, Floor 5, Milwaukee, WI 53204
Tel: 414.837.3607
Fax: 414.837.3608

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

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

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Pleasant Prairie Power Plant

Local Grid Location of Well: ______ ft. ☐ N. ☐ S. ______ ft. ☐ E. ☐ W.

Well Name: W74

Facility License, Permit or Monitoring No.:

Local Grid Origin ☐ (estimated: ☐) or Well Location ☐

Lat. 42° 33' 56.9" Long. -87° 54' 14.3" or

Wis. Unique Well No. VQ578

DNR Well Number:

Facility ID:

St. Plane 213,321 ft. N, 2,533,127 ft. E. [✓ S] / C / N

Date Well Installed: 03/03/2015

Type of Well:

Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E ☐ W

Well Installed By: (Person's Name and Firm)
Roy Buckenberger
Cascade Drilling

Distance from Waste/Source ______ ft.

Enf. Stds. Apply ☐

Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☒ Downgradient n ☐ Not Known

Gov. Lot Number:

A. Protective pipe, top elevation 687.49 ft. (NAVD88)

B. Well casing, top elevation 686.83 ft. (NAVD88)

C. Land surface elevation 685.0 ft. (NAVD88)

D. Surface seal, bottom 683.0 ft. (NAVD88) or 2.0 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☒

13. Sieve analysis attached? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 5 0
Hollow Stem Auger ☐ 4 1
roto-sonic Other ☒

15. Drilling fluid used: Water ☒ 0 2 Air ☐ 0 1
Drilling Mud ☐ 0 3 None ☐ 9 9

16. Drilling additives used? ☐ Yes ☒ No

Describe ______

17. Source of water (attach analysis, if required):
n/a

E. Bentonite seal, top 561.0 ft. (NAVD88) or 124.0 ft.

F. Fine sand, top 555.0 ft. (NAVD88) or 130.0 ft.

G. Filter pack, top 553.0 ft. (NAVD88) or 132.0 ft.

H. Screen joint, top 550.0 ft. (NAVD88) or 135.0 ft.

I. Well bottom 545.0 ft. (NAVD88) or 140.0 ft.

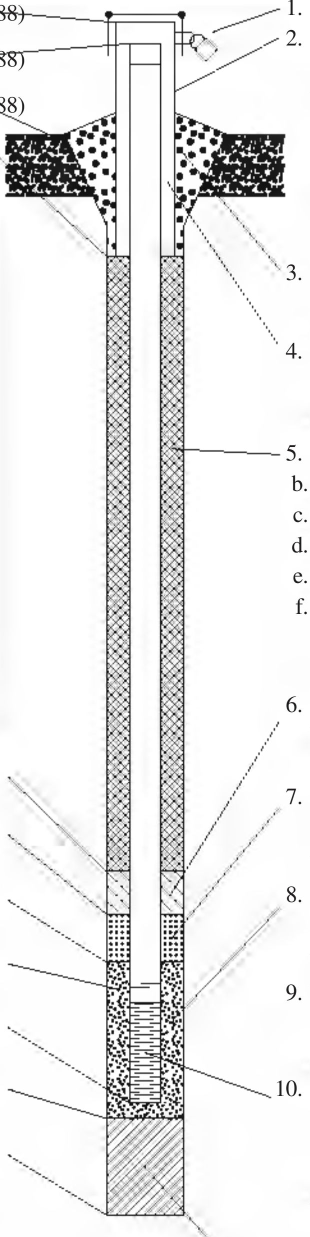
J. Filter pack, bottom 545.0 ft. (NAVD88) or 140.0 ft.

K. Borehole, bottom 545.0 ft. (NAVD88) or 140.0 ft.

L. Borehole, diameter 6.00 in.

M. O.D. well casing 2.38 in.

N. I.D. well casing 1.94 in.



1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
   - a. Inside diameter: 6.0 in.
   - b. Length: 17.5 ft.
   - c. Material: Steel ☒ 0 4; Other ☐
   - d. Additional protection? ☒ Yes ☐ No
     If yes, describe: 3 steel bollards/15' of 6" sch 40 steel casing
3. Surface seal: Bentonite ☒ 3 0; Concrete ☐ 0 1; Other ☐
4. Material between well casing and protective pipe: Bentonite ☒ 3 0; Sand Other ☒
5. Annular space seal:
   - a. Granular/Chipped Bentonite ☐ 3 3
   - b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 3 5
   - c. ____ Lbs/gal mud weight . . . Bentonite slurry ☐ 3 1
   - d. 30 % Bentonite . . . Bentonite-cement grout ☒ 5 0
   - e. ____ Ft^3 volume added for any of the above
   - f. How installed: Tremie ☐ 0 1; Tremie pumped ☒ 0 2; Gravity ☐ 0 8
6. Bentonite seal:
   - a. Bentonite granules ☐ 3 3
   - b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☒ 3 2
   - c. ______ Other ☐
7. Fine sand material: Manufacturer, product name & mesh size
   - a. Granusil
   - b. Volume added ______ ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   - a. Red Flint Sand and Gravel
   - b. Volume added ______ ft^3
9. Well casing: Flush threaded PVC schedule 40 ☐ 2 3; Flush threaded PVC schedule 80 ☒ 2 4; Other ☐
10. Screen material: Schedule 80 PVC
    - a. Screen Type: Factory cut ☒ 1 1; Continuous slot ☐ 0 1; Other ☐
    - b. Manufacturer: Hole Products
    - c. Slot size: 0.010 in.
    - d. Slotted length: 5.0 ft.
11. Backfill material (below filter pack): None ☒ 1 4; Other ☐

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

Date Modified: 4/30/2015

Signature

Firm: Natural Resource Technology
234 W. Florida Street, Floor 5, Milwaukee, WI 53204
Tel: 414.837.3607
Fax: 414.837.3608

~~Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289,~~ 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

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

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: Pleasant Prairie Power Plant

Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.

Well Name: W75

Facility License, Permit or Monitoring No.:

Local Grid Origin ☐ (estimated: ☐) or Well Location ☐

Lat. 42° 33' 56.8" Long. -87° 54' 8.8" or

St. Plane 213,322 ft. N, 2,533,541 ft. E. [✓ S]/C/N

Wis. Unique Well No.: VQ577

DNR Well Number:

Facility ID:

Date Well Installed: 03/23/2015

Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E ☐ W

Type of Well:

Well Installed By: (Person's Name and Firm)
Roy Buckenberger
Cascade Drilling

Distance from Waste/Source ____ ft.

Enf. Stds. Apply ☐

Location of Well Relative to Waste/Source:
u ☐ Upgradient s ☐ Sidegradient
d ☒ Downgradient n ☐ Not Known

Gov. Lot Number:

A. Protective pipe, top elevation 690.31 ft. (NAVD88)

B. Well casing, top elevation 689.91 ft. (NAVD88)

C. Land surface elevation 687.4 ft. (NAVD88)

D. Surface seal, bottom 685.4 ft. (NAVD88) or 2.0 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☒

13. Sieve analysis attached? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 5 0
Hollow Stem Auger ☐ 4 1
roto-sonic Other ☒

15. Drilling fluid used: Water ☒ 0 2 Air ☐ 0 1
Drilling Mud ☐ 0 3 None ☐ 9 9

16. Drilling additives used? ☐ Yes ☒ No

Describe ____

17. Source of water (attach analysis, if required):
n/a

E. Bentonite seal, top 563.4 ft. (NAVD88) or 124.0 ft.

F. Fine sand, top 556.4 ft. (NAVD88) or 131.0 ft.

G. Filter pack, top 554.4 ft. (NAVD88) or 133.0 ft.

H. Screen joint, top 551.4 ft. (NAVD88) or 136.0 ft.

I. Well bottom 546.4 ft. (NAVD88) or 141.0 ft.

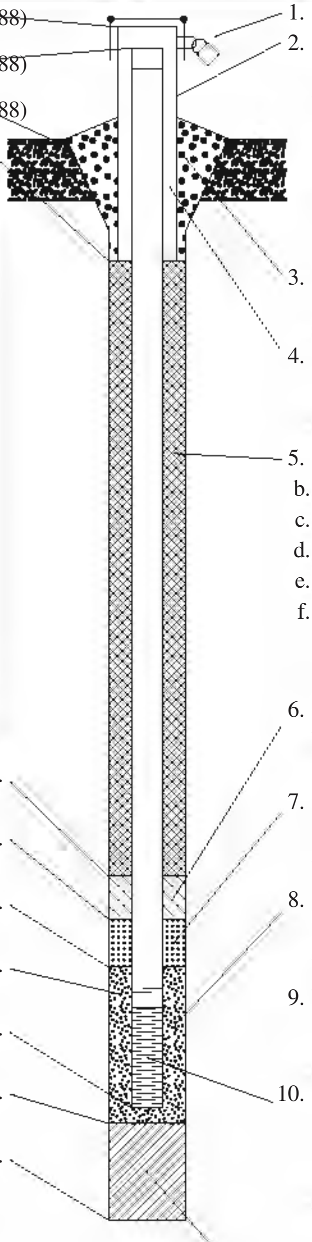
J. Filter pack, bottom 546.4 ft. (NAVD88) or 141.0 ft.

K. Borehole, bottom 546.4 ft. (NAVD88) or 141.0 ft.

L. Borehole, diameter 6.00 in.

M. O.D. well casing 2.38 in.

N. I.D. well casing 1.94 in.



1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
   a. Inside diameter: 4.0 in.
   b. Length: 5.0 ft.
   c. Material: Steel ☒ 0 4
   ____ Other ☐
   d. Additional protection? ☒ Yes ☐ No
   If yes, describe: 3 steel bollards/15' of 6" sch 40 steel casing
3. Surface seal: Bentonite ☒ 3 0
   Concrete ☐ 0 1
   ____ Other ☐
4. Material between well casing and protective pipe:
   Bentonite ☒ 3 0
   Sand Other ☒
5. Annular space seal: a. Granular/Chipped Bentonite ☐ 3 3
   b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 3 5
   c. ____ Lbs/gal mud weight . . . Bentonite slurry ☐ 3 1
   d. 30 % Bentonite . . . Bentonite-cement grout ☒ 5 0
   e. ____ Ft^3 volume added for any of the above
   f. How installed: Tremie ☐ 0 1
   Tremie pumped ☒ 0 2
   Gravity ☐ 0 8
6. Bentonite seal: a. Bentonite granules ☐ 3 3
   b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☒ 3 2
   c. ____ Other ☐
7. Fine sand material: Manufacturer, product name & mesh size
   a. Granusil
   b. Volume added ____ ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. Red Flint Sand and Gravel
   b. Volume added ____ ft^3
9. Well casing: Flush threaded PVC schedule 40 ☐ 2 3
   Flush threaded PVC schedule 80 ☒ 2 4
   ____ Other ☐
10. Screen material: Schedule 80 PVC
   a. Screen Type: Factory cut ☒ 1 1
   Continuous slot ☐ 0 1
   ____ Other ☐
   b. Manufacturer Hole Products
   c. Slot size: 0.010 in.
   d. Slotted length: 5.0 ft.
11. Backfill material (below filter pack): None ☒ 1 4
   ____ Other ☐

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

Date Modified: 4/30/2015

Signature

Firm
Natural Resource Technology
234 W. Florida Street, Floor 5, Milwaukee, WI 53204
Tel: 414.837.3607
Fax: 414.837.3608

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State of Wisconsin
Department of Natural Resources

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

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Pleasant Prairie Power Plant

Local Grid Location of Well: ______ ft. ☐ N. ☐ S. ______ ft. ☐ E. ☐ W.

Well Name: W76

Facility License, Permit or Monitoring No.:

Local Grid Origin ☐ (estimated: ☐) or Well Location ☐

Lat. 42° 33' 56.5" Long. -87° 54' 1.8" or

Wis. Unique Well No.: VQ576

DNR Well Number:

Facility ID:

St. Plane 213,301 ft. N, 2,534,065 ft. E. [✓ S] / C / N

Date Well Installed: 03/24/2015

Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E ☐ W

Type of Well:

Well Installed By: (Person's Name and Firm)
Roy Buckenberger
Cascade Drilling

Distance from Waste/Source ft.

Enf. Stds. Apply ☐

Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☒ Downgradient n ☐ Not Known

Gov. Lot Number:

A. Protective pipe, top elevation 692.11 ft. (NAVD88)

B. Well casing, top elevation 691.63 ft. (NAVD88)

C. Land surface elevation 689.0 ft. (NAVD88)

D. Surface seal, bottom 687.0 ft. (NAVD88) or 2.0 ft.

12. USCS classification of soil near screen:

GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☒

13. Sieve analysis attached? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 5 0
Hollow Stem Auger ☐ 4 1
roto-sonic Other ☒

15. Drilling fluid used: Water ☒ 0 2 Air ☐ 0 1
Drilling Mud ☐ 0 3 None ☐ 9 9

16. Drilling additives used? ☐ Yes ☒ No

Describe ____________

17. Source of water (attach analysis, if required):
n/a

E. Bentonite seal, top 566.0 ft. (NAVD88) or 123.0 ft.

F. Fine sand, top 558.0 ft. (NAVD88) or 131.0 ft.

G. Filter pack, top 556.0 ft. (NAVD88) or 133.0 ft.

H. Screen joint, top 553.0 ft. (NAVD88) or 136.0 ft.

I. Well bottom 548.0 ft. (NAVD88) or 141.0 ft.

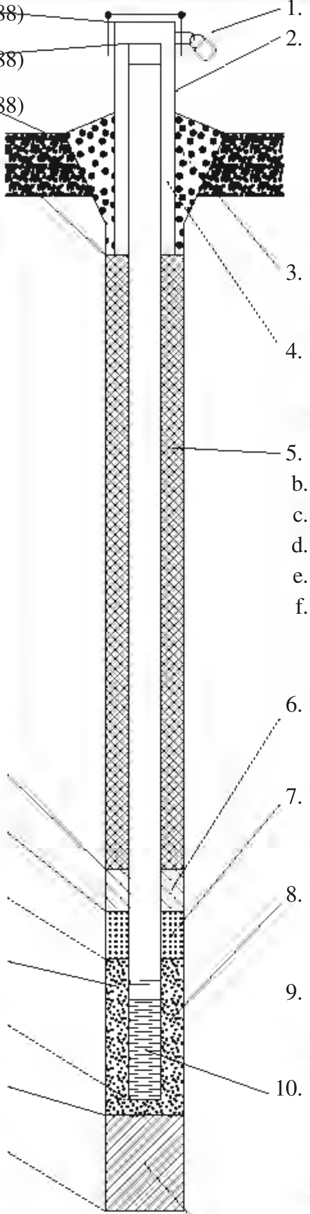
J. Filter pack, bottom 548.0 ft. (NAVD88) or 141.0 ft.

K. Borehole, bottom 548.0 ft. (NAVD88) or 141.0 ft.

L. Borehole, diameter 6.00 in.

M. O.D. well casing 2.38 in.

N. I.D. well casing 1.94 in.



1. Cap and lock? ☒ Yes ☐ No

2. Protective cover pipe:
   a. Inside diameter: 4.0 in.
   b. Length: 5.0 ft.
   c. Material: Steel ☒ 0 4
      Other ☐
   d. Additional protection? ☒ Yes ☐ No
      If yes, describe: 3 steel bollards/15' of 6" sch 40 steel casing

3. Surface seal: Bentonite ☒ 3 0
   Concrete ☐ 0 1
   Other ☐

4. Material between well casing and protective pipe:
   Bentonite ☒ 3 0
   Sand Other ☒

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 3 3
   b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 3 5
   c. ____ Lbs/gal mud weight . . . Bentonite slurry ☐ 3 1
   d. 30 % Bentonite . . . Bentonite-cement grout ☒ 5 0
   e. ____ Ft^3 volume added for any of the above
   f. How installed: Tremie ☐ 0 1
      Tremie pumped ☒ 0 2
      Gravity ☐ 0 8

6. Bentonite seal: a. Bentonite granules ☐ 3 3
   b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☒ 3 2
   c. ____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
   a. Granusil
   b. Volume added ____ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
   a. Red Flint Sand and Gravel
   b. Volume added ____ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 2 3
   Flush threaded PVC schedule 80 ☒ 2 4
   Other ☐

10. Screen material: Schedule 80 PVC
   a. Screen Type: Factory cut ☒ 1 1
      Continuous slot ☐ 0 1
      Other ☐
   b. Manufacturer Hole Products
   c. Slot size: 0.010 in.
   d. Slotted length: 5.0 ft.

11. Backfill material (below filter pack): None ☒ 1 4
    Other ☐

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

Date Modified: 4/30/2015

Signature

Firm: Natural Resource Technology
234 W. Florida Street, Floor 5, Milwaukee, WI 53204
Tel: 414.837.3607
Fax: 414.837.3608

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State of Wisconsin
Department of Natural Resources

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

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Pleasant Prairie Power Plant

Local Grid Location of Well: ______ft. ☐N. ☐S. ______ft. ☐E. ☐W.

Well Name: W77

Facility License, Permit or Monitoring No.:

Local Grid Origin ☐ (estimated: ☐) or Well Location ☐

Lat. 42° 33' 45.3" Long. -87° 53' 54.2" or

St. Plane 212,179 ft. N, 2,534,660 ft. E. [✓ S] / C / N

Wis. Unique Well No.: VQ575

DNR Well Number:

Facility ID:

Date Well Installed: 03/19/2015

Section Location of Waste/Source: ____1/4 of ____1/4 of Sec. ____, T. ____ N, R. ____ ☐E ☐W

Type of Well:

Well Installed By: (Person's Name and Firm) Roy Buckenberger, Cascade Drilling

Distance from Waste/Source ____ ft.

Enf. Stds. Apply ☐

Location of Well Relative to Waste/Source: u ☒ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known

Gov. Lot Number:

A. Protective pipe, top elevation 687.63 ft. (NAVD88)

B. Well casing, top elevation 687.23 ft. (NAVD88)

C. Land surface elevation 684.9 ft. (NAVD88)

D. Surface seal, bottom 682.9 ft. (NAVD88) or 2.0 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☒

13. Sieve analysis attached? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 5 0 Hollow Stem Auger ☐ 4 1 roto-sonic Other ☒

15. Drilling fluid used: Water ☒ 0 2 Air ☐ 0 1 Drilling Mud ☐ 0 3 None ☐ 9 9

16. Drilling additives used? ☐ Yes ☒ No

Describe ______

17. Source of water (attach analysis, if required): n/a

E. Bentonite seal, top 576.9 ft. (NAVD88) or 108.0 ft.

F. Fine sand, top 568.9 ft. (NAVD88) or 116.0 ft.

G. Filter pack, top 566.9 ft. (NAVD88) or 118.0 ft.

H. Screen joint, top 563.9 ft. (NAVD88) or 121.0 ft.

I. Well bottom 558.9 ft. (NAVD88) or 126.0 ft.

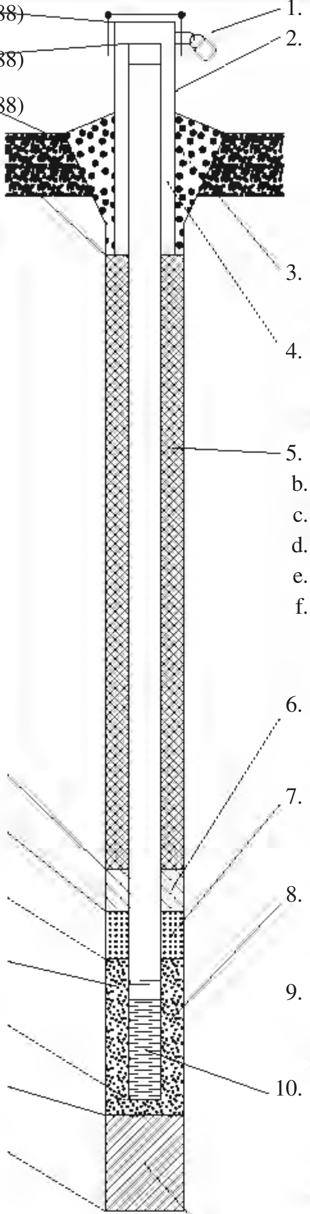
J. Filter pack, bottom 558.9 ft. (NAVD88) or 126.0 ft.

K. Borehole, bottom 558.9 ft. (NAVD88) or 126.0 ft.

L. Borehole, diameter 6.00 in.

M. O.D. well casing 2.38 in.

N. I.D. well casing 1.94 in.



1. Cap and lock? ☒ Yes ☐ No

2. Protective cover pipe:
   a. Inside diameter: 4.0 in.
   b. Length: 5.0 ft.
   c. Material: Steel ☒ 0 4 Other ☐
   d. Additional protection? ☒ Yes ☐ No
   If yes, describe: 3 steel bollards

3. Surface seal: Bentonite ☒ 3 0 Concrete ☐ 0 1 Other ☐

4. Material between well casing and protective pipe: Bentonite ☒ 3 0 Sand Other ☒

5. Annular space seal:
   a. Granular/Chipped Bentonite ☐ 3 3
   b. ____Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 3 5
   c. ____Lbs/gal mud weight . . . Bentonite slurry ☐ 3 1
   d. 30 % Bentonite . . . Bentonite-cement grout ☒ 5 0
   e. ____Ft^3 volume added for any of the above
   f. How installed: Tremie ☐ 0 1 Tremie pumped ☒ 0 2 Gravity ☐ 0 8

6. Bentonite seal: a. Bentonite granules ☐ 3 3
   b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☒ 3 2
   c. ______ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
   a. Granusil
   b. Volume added ______ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
   a. Red Flint Sand and Gravel
   b. Volume added ______ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 2 3 Flush threaded PVC schedule 80 ☒ 2 4 Other ☐

10. Screen material: Schedule 80 PVC
   a. Screen Type: Factory cut ☒ 1 1 Continuous slot ☐ 0 1 Other ☐
   b. Manufacturer Hole Products
   c. Slot size: 0.010 in.
   d. Slotted length: 5.0 ft.

11. Backfill material (below filter pack): None ☒ 1 4 Other ☐

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

Date Modified: 4/30/2015

Signature

Firm: Natural Resource Technology
234 W. Florida Street, Floor 5, Milwaukee, WI 53204
Tel: 414.837.3607
Fax: 414.837.3608

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

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

Facility/Project Name Pleasant Prairie Power Plant	County Kenosha	Well Name W20D

Facility License, Permit or Monitoring Number	County Code 30	Wis. Unique Well Number VQ580	DNR Well Number

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method:

surged with bailer and bailed	☐	4 1
surged with bailer and pumped	☐	6 1
surged with block and bailed	☐	4 2
surged with block and pumped	☐	6 2
surged with block, bailed, and pumped	☐	7 0
compressed air	☐	2 0
bailed only	☐	1 0
pumped only	☐	5 1
pumped slowly	☐	5 0
other Waterra pump surged/purged	☒	

3. Time spent developing well 480 min.

4. Depth of well (from top of well casing) 142.3 ft.

5. Inside diameter of well 1.94 in.

6. Volume of water in filter pack and well casing 30.8 gal.

7. Volume of water removed from well 94.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added not applicable

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

		Before Development	After Development
11. Depth to Water (from top of well casing)	a.	17.20 ft.	19.30 ft.
Date	b.	3/9/2015	3/9/2015
Time	c.	12:30 ☐ a.m. ☒ p.m.	04:30 ☐ a.m. ☒ p.m.
12. Sediment in well bottom		2.0 inches	0.0 inches
13. Water clarity		Clear ☐ 1 0 Turbid ☒ 1 5 (Describe) cloudy tan	Clear ☒ 2 0 Turbid ☐ 2 5 (Describe) clear

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Person's Name and Firm

Nicole Kron
Natural Resource Technology, Inc.

17. Additional comments on development:

During development pH, temperature, and conductivity were monitored with a water quality probe. Development completed when monitored water quality parameters stabilized.

Facility Address or Owner/Responsible Party Address

Name: Tim Muehlfeld
Firm: WE Energies
Street: 333 W. Everett Street
City/State/Zip: Milwaukee WI 53203

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

Signature:
Print Name: Nicole Kron
Firm: Natural Resource Technology

Template: WDNR WELL DEVELOP 1998 - Project: P4 GINT LOGS.GPJ

NOTE: See instructions for more information including a list of county codes and well type codes. Date Modified: 4/30/2015

P4 ASH LANDFILL
8-13-2013

BRANDSCHWELLS

- PERFORMED PUMP TESTS ON WELL NEST W17 WITH JAKE LWALCZAK OF NRT.
- NRT RENTED PUMPS AND TRANSDUCERS USED IN TESTS.
- W17A: STATIC D' = 13.59', TD' = 53.15' (MEASURED TO TOP OF PROTECTOR PIPE)
- W17B: STATIC D' = 13.23', TD = 42.20'
- W17C: STATIC D' = 5.84', TD = 17.30'
- A GRUNDFOS PUMP WAS INSTALLED IN W17A. PUMPED AT VARIOUS RATES (133 & 200 HZ). WELL DREW DOWN MINIMALLY AT 200HZ.)
- TESTING BEGAN AT ~1030; TESTING COMPLETED ~1530
- WHALE PUMP ALSO INSTALLED IN W17B ABOUT MIDWAY IN TESTING PERIOD.
- A DEFINITE CONNECTION WAS NOTED IN/BETWEEN W17A AND W17B.
- LEVELS ACTUALLY ROSE IN W17C. PRESSURE DIFFERENCES.
- T. MUEHLFELD, B. MEIKEL ON SITE TO MEET WITH A.W. OAKES FOR LANDFILL REDESIGN.
- WE CUT SILT FENCING TO GET TO WELL NEST
- SUNNY, TEMPS IN 70S.

P4 ASH LANDFILL
10/18, 22, 25/2013

BRANDSCHWELL

NEW WELLS (W17AR, W17BR, W17CR, W73) DEVELOPMENT:

WELL	DATE	STATIC DEPTH	COMMENTS
W17AR	10/18	13.59'	TD: 68.15'. BAILED TO BOT IN 15 BAILS. TURBID GRAY
	10/22	25.03'	BAILED TO BOTTOM IN (10) BAILS
	10/25	29.09'	BAILED TO BOTTOM IN 12 BAILS TURBID
W17BR	10/18	13.23'	BAILED TO BOTTOM IN (20) BAILS TURBID - GRAY TAN 44.10
	10/22	15.21'	BAILED TO BOTTOM IN 20 BAILS TURBID, GRAY
	10/25	14.94	BAILED TO BOTTOM IN 25 BAILS TURBID, GRAY
W17CR	10/18	17.46'	BAILED TO BOTTOM ~1 LITER POOR RECHARGE
	10/22	18.35'	SAME
	10/25	18.16'	SAME
W73	10/18	25.09'	INSTALLED PUMP. PURGED (15) GALLONS · TURBID)
	10/22	25.65'	PUMP SETTING 275 HZ = 3 GPM PURGED (20 GALLONS, MILKY
	10/25	25.63'	PURGED (20 GALLONS SLT MILKY

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

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

Facility/Project Name Pleasant Prairie Power Plant	County Kenosha		Well Name W74
Facility License, Permit or Monitoring Number	County Code 30	Wis. Unique Well Number VQ578	DNR Well Number

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method:

surged with bailer and bailed	☐	4 1
surged with bailer and pumped	☐	6 1
surged with block and bailed	☐	4 2
surged with block and pumped	☐	6 2
surged with block, bailed, and pumped	☐	7 0
compressed air	☐	2 0
bailed only	☐	1 0
pumped only	☐	5 1
pumped slowly	☐	5 0
other Waterra pump surged/purged	☒	

3. Time spent developing well 100 min.

4. Depth of well (from top of well casing) 142.9 ft.

5. Inside diameter of well 1.94 in.

6. Volume of water in filter pack and well casing 32.82 gal.

7. Volume of water removed from well 105.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added not applicable

10. Analysis performed on water added? ☒ Yes ☐ No
(If yes, attach results)

		Before Development	After Development
11. Depth to Water (from top of well casing)	a.	19.67 ft.	23.41 ft.
Date	b.	3/5/2015	3/5/2015
Time	c.	10:33 ☒ a.m. ☐ p.m.	12:13 ☐ a.m. ☒ p.m.
12. Sediment in well bottom		0.0 inches	0.0 inches
13. Water clarity		Clear ☐ 1 0 Turbid ☒ 1 5 (Describe) cloudy white	Clear ☒ 2 0 Turbid ☐ 2 5 (Describe) clear

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Person's Name and Firm

Patrick Hoefle
Natural Resource Technology, Inc.

17. Additional comments on development:

During development pH, temperature, and conductivity were monitored with a water quality probe. Development completed when monitored water quality parameters stabilized.

Facility Address or Owner/Responsible Party Address

Name: Tim Muehlfeld
Firm: WE Energies
Street: 333 W. Everett Street
City/State/Zip: Milwaukee WI 53203

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

Signature:
Print Name: Patrick Hoefle
Firm: Natural Resource Technology

Template: WDNR WELL DEVELOP 1998 - Project: P4 GINT LOGS.GPJ

NOTE: See instructions for more information including a list of county codes and well type codes. Date Modified: 4/30/2015

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

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

Facility/Project Name: Pleasant Prairie Power Plant
County: Kenosha
Well Name: W75
Facility License, Permit or Monitoring Number:
County Code: 30
Wis. Unique Well Number: VQ577
DNR Well Number:

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method:
   - surged with bailer and bailed ☐ 4 1
   - surged with bailer and pumped ☐ 6 1
   - surged with block and bailed ☐ 4 2
   - surged with block and pumped ☐ 6 2
   - surged with block, bailed, and pumped ☐ 7 0
   - compressed air ☐ 2 0
   - bailed only ☐ 1 0
   - pumped only ☐ 5 1
   - pumped slowly ☐ 5 0
   - other Waterra pump surged/purged ☒

3. Time spent developing well 165 min.

4. Depth of well (from top of well casing) 143.8 ft.

5. Inside diameter of well 1.94 in.

6. Volume of water in filter pack and well casing 32.7 gal.

7. Volume of water removed from well 165.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added not applicable

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

		Before Development	After Development
11. Depth to Water (from top of well casing)	a.	21.32 ft.	22.28 ft.
Date	b.	3/26/2015	3/26/2015
Time	c.	07:25 ☒ a.m. ☐ p.m.	10:10 ☒ a.m. ☐ p.m.
12. Sediment in well bottom		0.0 inches	0.0 inches
13. Water clarity		Clear ☐ 1 0 Turbid ☒ 1 5 (Describe) light tan	Clear ☒ 2 0 Turbid ☐ 2 5 (Describe) clear to cloudy

Fill in if drilling fluids were used and well is at solid waste facility:

	Before Development	After Development
14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Person's Name and Firm
Jacob Walczak
Natural Resource Technology, Inc.

17. Additional comments on development:

During development pH, temperature, and conductivity were monitored with a water quality probe. Development completed when monitored water quality parameters stabilized.

Facility Address or Owner/Responsible Party Address
Name: Tim Muehlfeld
Firm: WE Energies
Street: 333 W. Everett Street
City/State/Zip: Milwaukee WI 53203

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature:
Print Name: Jacob Walczak
Firm: Natural Resource Technology

Template: WDNR WELL DEVELOP 1998 - Project: P4 GINT LOGS.GPJ

NOTE: See instructions for more information including a list of county codes and well type codes.

Date Modified: 4/30/2015

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

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

Facility/Project Name Pleasant Prairie Power Plant	County Kenosha	Well Name W76

Facility License, Permit or Monitoring Number	County Code 30	Wis. Unique Well Number VQ576	DNR Well Number

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method:
   - surged with bailer and bailed ☐ 4 1
   - surged with bailer and pumped ☐ 6 1
   - surged with block and bailed ☐ 4 2
   - surged with block and pumped ☐ 6 2
   - surged with block, bailed, and pumped ☐ 7 0
   - compressed air ☐ 2 0
   - bailed only ☐ 1 0
   - pumped only ☐ 5 1
   - pumped slowly ☐ 5 0
   - other Waterra pump surged/purged ☒

3. Time spent developing well 195 min.

4. Depth of well (from top of well casing) 144.0 ft.

5. Inside diameter of well 1.94 in.

6. Volume of water in filter pack and well casing 32.5 gal.

7. Volume of water removed from well 195.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added not applicable

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

		Before Development	After Development
11. Depth to Water (from top of well casing)	a.	23.13 ft.	29.00 ft.
Date	b.	3/26/2015	3/26/2015
Time	c.	10:45 ☒ a.m. ☐ p.m.	02:00 ☐ a.m. ☒ p.m.
12. Sediment in well bottom		0.0 inches	0.0 inches
13. Water clarity		Clear ☐ 1 0 Turbid ☒ 1 5 (Describe) light tan	Clear ☒ 2 0 Turbid ☐ 2 5 (Describe) cloudy to clear

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Person's Name and Firm
Jacob Walczak
Natural Resource Technology, Inc.

17. Additional comments on development:
During development pH, temperature, and conductivity were monitored with a water quality probe. Development completed when monitored water quality parameters stabilized.

Facility Address or Owner/Responsible Party Address
Name: Tim Muehlfeld
Firm: WE Energies
Street: 333 W. Everett Street
City/State/Zip: Milwaukee WI 53203

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature:
Print Name: Jacob Walczak
Firm: Natural Resource Technology

Template: WDNR WELL DEVELOP 1998 - Project: P4 GINT LOGS.GPJ

NOTE: See instructions for more information including a list of county codes and well type codes. Date Modified: 4/30/2015

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

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

Facility/Project Name Pleasant Prairie Power Plant	County Kenosha		Well Name W77
Facility License, Permit or Monitoring Number	County Code 30	Wis. Unique Well Number VQ575	DNR Well Number

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method:

surged with bailer and bailed	☐	4 1
surged with bailer and pumped	☐	6 1
surged with block and bailed	☐	4 2
surged with block and pumped	☐	6 2
surged with block, bailed, and pumped	☐	7 0
compressed air	☐	2 0
bailed only	☐	1 0
pumped only	☐	5 1
pumped slowly	☐	5 0
other Waterra pump surged/purged	☒	

3. Time spent developing well 180 min.

4. Depth of well (from top of well casing) 128.4 ft.

5. Inside diameter of well 1.94 in.

6. Volume of water in filter pack and well casing 31 gal.

7. Volume of water removed from well 270.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added not applicable

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

		Before Development	After Development
11. Depth to Water (from top of well casing)	a.	16.99 ft.	18.80 ft.
Date	b.	3/24/2015	3/24/2015
Time	c.	10:15 ☒ a.m. ☐ p.m.	12:45 ☐ a.m. ☒ p.m.
12. Sediment in well bottom		1.1 inches	0.0 inches
13. Water clarity		Clear ☐ 1 0 Turbid ☒ 1 5 (Describe) light tan	Clear ☒ 2 0 Turbid ☐ 2 5 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Person's Name and Firm

Jacob Walczak
Natural Resource Technology, Inc.

17. Additional comments on development:

During development pH, temperature, and conductivity were monitored with a water quality probe. Development completed when monitored water quality parameters stabilized.

Facility Address or Owner/Responsible Party Address

Name: Tim Muehlfeld
Firm: WE Energies
Street: 333 W. Everett Street
City/State/Zip: Milwaukee WI 53203

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

Signature:
Print Name: Jacob Walczak
Firm: Natural Resource Technology

Template: WDNR WELL DEVELOP 1998 - Project: P4 GINT LOGS.GPJ

NOTE: See instructions for more information including a list of county codes and well type codes. Date Modified: 4/30/2015

APPENDIX B
SAMPLING AND ANALYSIS PLAN

Intended for
We Energies

Date
December 14, 2023

Project No.
1940104079

SAMPLING AND ANALYSIS PLAN REVISION 1

PLEASANT PRAIRIE POWER PLANT ASH LANDFILL

RAMBOLL Bright ideas. Sustainable change.

SAMPLING AND ANALYSIS PLAN REVISION 1
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL

Project name	**P4 Ash Landfill**
Project no.	**1940104079**
Recipient	**We Energies**
Document type	**Sampling and Analysis Plan**
Revision	**1**
Date	**December 14, 2023**
Prepared by	**Eric J. Tlachac, PE**
Checked by	**Nathaniel R. Keller, PG**
Approved by	**Nathaniel R. Keller, PG**
Description	**Updates to the Sampling and Analysis Plan**

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Nathaniel R Keller

Nathaniel R. Keller, PG
Technical Manager

Eric J. Tlachac

Eric J. Tlachac, PE
Senior Managing Engineer

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DOCUMENT REVISION RECORD

Issue No.	Date	Details of Revisions
Revision 0	January 30, 2023	• Original Document
Revision 1	December 14, 2023	• Revised Sec 1.3.1 to require use of a Wisconsin-certified laboratory for groundwater sample analysis. • Revised Sec 4.1.2 to require development of a potentiometric surface map and determination of groundwater flow rate and direction for each sampling event. • Revised Sec 7 to require the content referenced in Ch. NR 507.26(3)(b).

CONTENTS

TABLES (IN TEXT)

TABLES (ATTACHED)

FIGURES (ATTACHED)

ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

°C	degrees Centigrade
§	Section
%	percent
±	plus/minus
CCR	coal combustion residuals
Ch.	Chapter
CoC	chain-of-custody
DI	deionized
DOT	Department of Transportation
DQO	data quality objective
EDD	Electronic Data Deliverable
ES	Enforcement Standard
HASP	Health and Safety Plan
HNO_3	nitric acid
IATA	International Air Transport Association
IDW	investigative derived wastes
MDL	Method Detection Limit
mg/L	milligrams per liter
mL/min	milliliters per minute
MS/MSD	Matrix Spike/Matrix Spike Duplicate
mV	millivolts
NRT	Natural Resource Technology, Inc.
NTU	nephelometric turbidity unit
P4	Pleasant Prairie Power Plant
PAL	Preventive Action Limit
PPE	Personal Protective Equipment
QC	Quality Control
Ramboll	Ramboll Americas Engineering Solutions, Inc.
RCRA	Resource Conservation and Recovery Act
RL	Reporting Limit
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SSI	statistically significant increase
SSL	statistically significant level
µS/cm	microSiemens per centimeter
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
WDNR	Wisconsin Department of Natural Resources
Wis Adm Code	Wisconsin Administrative Code

1. INTRODUCTION

1.1 Background

This Sampling and Analysis Plan (SAP) was prepared by Ramboll Americas Engineering Solutions, Inc. (Ramboll) to document procedures and techniques that will be used to fulfill the groundwater sampling and analysis program requirements of the Chapter (Ch.) NR 507.15(3), Wisconsin Administrative Code (Wis Adm Code), established in August 2022. Certification of the monitoring system at We Energies Pleasant Prairie Power Plant (P4) Ash Landfill located in Pleasant Prairie, Wisconsin is provided in Attachment A.

Ch. NR 507.15(3) requires an owner or operator of a coal combustion residuals (CCR) unit to install a system of monitoring wells and specify procedures for sampling these wells. In addition, the owner or operator must specify methods for analyzing the groundwater data collected to detect a release from the unit. Chs. NR 507 and 508 establish criteria for detection monitoring, assessment monitoring and remedial action groundwater monitoring. Once a groundwater monitoring system and groundwater monitoring program have been established for a CCR unit, the owner or operator conducts detection monitoring. If an exceedance of Ch. NR 140 Preventive Action Limits (PALs) and/or Enforcement Standards (ESs), or Alternative Concentration Limits (ACLs) approved by Wisconsin Department of Natural Resources (WDNR), is detected in downgradient groundwater during detection monitoring, and WDNR does not concur with a false exceedance demonstration, then assessment monitoring is initiated. If an exceedance of Ch. NR 140 PALS and/or ESs, or ACLs approved by WDNR is detected in downgradient groundwater during assessment monitoring, and the exceedance cannot be attributed to another cause, then remedial action, including groundwater monitoring, is required.

As directly relevant to this SAP, Ch. NR 507 requires that the groundwater monitoring program include consistent sampling and analysis procedures that are designed to ensure monitoring results provide an accurate representation of groundwater quality at the required upgradient (background) and downgradient wells. Ch. NR 507.16 requires the owner or operator of the CCR unit to develop a sampling and analysis program that includes procedures and techniques for the following:

- Sample collection
- Sample preservation and shipment
- Analytical procedures
- Chain of custody control
- Quality assurance and quality control

1.2 Sampling Objectives

This SAP is intended to ensure that sample collection and analytical activities are conducted in accordance with acceptable protocols that meet data quality objectives (DQOs) as established by Ch. NR 507.16. The information presented in this SAP will enable field personnel to collect field samples and measurements in a manner that meet the project DQOs.

1.3 Sampling and Analysis Plan

1.3.1 Technical Approach

Table 1 provides a Sampling and Analysis Summary for the monitoring program at We Energies P4 Ash Landfill. Table 1 includes the number of samples to be collected during a monitoring event, parameters, analytical methods, field quality control samples, sample containers, required preservatives and sample hold time requirements. A Wisconsin Certified Laboratory, as defined in Ch. NR 140.05(4), is required to perform the analysis.

Table 2 provides a summary of information for each sampling location including well construction detail, screen placement and elevations of top of casing and screen position. In addition, the wells hydraulic position is identified as upgradient, downgradient or sidegradient to the monitored facility.

Figure 1 provides an overview of the site and the monitoring well system sampling locations.

1.3.2 Communication Strategy

This SAP provides a communication strategy, which identifies project communication flow between project managers, field personnel, and laboratories. Key decision-making process team members are identified by name and methods of contact. The communication hierarchy is visually depicted on Figure 2, Communication Flow Chart.

2. MONITORING WELLS

Site-specific hydrogeologic information was used to determine the number and location of monitoring wells at the Site; site-specific hydrogeologic information is archived in the facility's operating record. Refer to Table 2 for a summary of monitoring well information.

3. FIELD MOBILIZATION AND SITE ACCESS

Prior to initiating field activities, personnel will review the project goals, objectives and scope. The field sampling team will review the site-specific health and safety plan (HASP); We Energies' site safety requirements, sampling and analysis plan summary and field standard operating procedures (SOPs). If necessary, field activity area(s) reconnaissance may be performed to familiarize field staff with field conditions, identify access points, and locate monitoring wells.

3.1 Site Access

The appropriate point of contact (owner, operator, or designated representative) should be notified at least 24 hours before the sampling team arrives. If not already available, arrangements should be made to obtain the keys for the monitoring devices, and inquiries should be made as to the conditions at the facility (access, weather, operations that may affect sampling, etc.).

Personnel must check in with the We Energies authorized staff or security (if applicable) before entering the facility. Personnel must check-in with the site manager or sampling team leader before being allowed into the field activity area. Visitor information (e.g., affiliation, reason for visit, etc.) will be documented in the sign-in/out form maintained at the facility. Unauthorized visitors will not be allowed in field activity areas. Personnel entering the field activity area will review and act in accordance with the site-specific HASP.

3.2 Mobilization Activities

Mobilization activities include:

- Prepare a Site contact list, including the names of field team personnel and subcontractors, affiliation, and contact numbers for distribution to all field team members
- Receive permission to access privately and/or publicly owned properties, if required, to perform off-property investigations. Where feasible, off-property access will be coordinated within schedule constraints, such as limiting activities during school hours, peak business hours, etc.
- Evaluate access for accessibility to sampling locations with proposed equipment
- Coordinate subcontractors, which may include drillers, laboratories, surveyors, etc. and review scope of work, schedule, and discuss special equipment needs
- Acquire proper personal protective equipment (PPE)
- Review analytical requirements, request appropriate sample containers from the analytical laboratories, and discuss delivery/pickup of coolers, including weekend deliveries
- Secure and verify working conditions of field instruments in accordance with their respective SOPs
- Load appropriate equipment and supplies to perform the field activities
- Coordinate the management/disposal of investigative waste
- Prepare equipment staging areas

- Locate survey information or identifying the need to survey previous and/or proposed initial sampling locations

3.3 Site Safety

Field activities will be conducted in accordance with a Site-Specific HASP. The HASP is not part of this SAP and the personnel performing the groundwater sampling have the responsibility to provide the HASP to their staff and are responsible for knowing the HASP requirements.

4. SAMPLE COLLECTION PROCEDURES

4.1 Groundwater Sampling

4.1.1 Overview

This section describes groundwater sampling collection methods and requirements. Groundwater sampling is performed to determine if the CCR Unit is adversely impacting the upper-most aquifer (as defined in Ch. NR 500.03(246m)). The methods listed here are consistent with requirements of Ch. 507.16.

Groundwater will be sampled by low-flow methods and sampling activity details will be recorded on field forms as provided in Attachment B. Natural Resource Technology, Inc. (NRT) SOP 07-07-13 Low Flow Groundwater Sampling, provided in Attachment C, will be followed for low-flow groundwater sampling.

4.1.2 Water Level Elevation Readings

Groundwater elevation readings will be collected prior to the start of sample collection. If possible, all water level measurements will be collected within the same day. Dedicated sampling equipment (pumps and tubing) will be stored within the water column in a manner that allows water levels to be measured without removing the dedicated equipment. The equipment will remain in place during water level measurements. Groundwater elevation readings will be collected to the hundredth of a foot in accordance with the NRT SOP 07-07-05 Groundwater (and NAPL) Elevation Measurements, provided in Attachment C, and will be recorded in the field logbook and/or on the appropriate field form.

Measured groundwater elevations will be utilized to determine the rate and direction of groundwater flow for each sampling event and generate a potentiometric surface map.

4.1.3 Monitoring Well Groundwater Sampling

Groundwater samples will be collected using low-flow sampling techniques in accordance with United States Environmental Protection Agency (USEPA) and American Society for Testing and Materials guidelines. For assessment or corrective action monitoring, water level measurements and well sampling will generally be conducted beginning with wells containing the lowest concentration to wells with highest concentration to limit the possibility of cross-contamination.

4.1.3.1 Well Integrity

Well integrity will be evaluated and appropriately noted on the field form in accordance with NRT SOP 07 07-01 Well Integrity Evaluation and Maintenance, provided in Attachment C, prior to collection of field data. Significantly compromised monitoring wells should not be sampled and the scope deviation will be immediately discussed with the project manager for further well evaluation, repair and/or abandonment. A monitoring well evaluation form is included in Attachment B.

4.1.3.2 Low-Flow Sampling Equipment and Process

Low-flow sampling is synonymous with low-stress sampling; personnel conducting low-flow sampling must consider this and should be familiar with this sampling technique. The purpose of low-flow sampling is to collect a representative formation sample. This is accomplished through use of low discharge pumping rates which equates to the groundwater infiltration into the well. Pump discharge rates between 100 and 500 milliliters per minute (mL/min) are typical. Higher rates are possible in highly permeable formations. Low-flow sampling conditions have not been reached until the following conditions have been met:

- The water level within the well has stabilized during pumping
- The water being removed is from the screened interval
- The measurements of water quality indicators have stabilized

The following equipment is required to perform low-flow sampling:

- Dedicated positive displacement bladder pumps capable of withdrawal at a constant rate between 100 and 500 mL/min and can meet the designed lift requirements
- Multiprobe water quality meter equipped with a flow-through cell
- All necessary tubing required to connect the pump to the flow-through cell
- Electric water level indicator(s) capable of measurement to the hundredth of a foot
- A calibrated pail to collect purge water
- Low-flow sampling field forms (Attachment B) and field book

Low-flow groundwater sampling will be conducted in accordance with NRT SOP 07-07-13 Low Flow Groundwater Sampling (Attachment C). During well purging and throughout sample collection, field parameters are continually monitored and recorded using probes in a flow-through cell. The groundwater quality meter will be calibrated, operated and maintained according to NRT SOP 07-11-01 Field Instrument Calibration, Operation, and Maintenance, provided in Attachment C. Measurements will be recorded at a rate equivalent to the time required to fill the flow-through cell volume. Therefore, if the volume of the flow through cell is 500 mL/min and the pumping rate is 250 mL/min; one reading should be taken every 2 minutes. Stabilization criteria measurement time intervals are dependent on the flow rate. Stabilization is achieved when three consecutive readings have fallen within the ranges of the parameters in Table A below. Exceptions for one or more stabilization parameters are allowable under extreme sampling conditions (i.e., extreme heat or cold, very high turbidity, etc.).

Table A – Stabilization Parameters

Field Parameter	Stabilization Criterion
Specific Conductance	± 3% microSiemens per centimeter (µS/cm) @ 25 degrees centigrade (°C)
pH	±0.1 Standard Units (S.U.)
Temperature	±0.1 ºC or ±0.2 ºF
Dissolved Oxygen	±10% or ± 0.2 milligrams per liter (mg/L) whichever is greater
Eh or ORP	± 20 millivolts (mV)
Turbidity	<10 nephelometric turbidity units (NTUs) or ± 10% when turbidity is greater than 10 NTUs

Notes:
±= plus/minus
% = percent
Eh = Redox Potential
ORP = Oxidation-Reduction Potential

When stabilization is achieved, and prior to sample collection, the flow-through cell is disconnected, and laboratory containers are filled from the system tubing. The flow rate should not be adjusted following parameter stabilization or during sample collection.

4.1.3.3 Sample Collection

Once low-flow sampling conditions are met, sample collection may begin. The flow-through cell is removed, and the samples are collected directly from the pump discharge tubing at the same flow rate that was used during well purge stabilization. Samples will be placed in appropriate laboratory supplied containers and preserved in accordance with the analytical method requirements listed in Table 1. Samples will be collected in order of analyte stability, as summarized below:

- Non-filtered, non-preserved samples (Radium 226 and 228, sulfate, total dissolved solids, fluoride, chloride)
- Non-filtered, preserved samples (total metals)

During each sampling event, a duplicate sample may be collected from a randomly selected groundwater monitoring well. Field duplicate quality control samples will be collected by sequentially alternating filling between containers. Procedures for collecting groundwater samples are described in NRT SOPs 07 07 07 Groundwater Sampling (Attachment C) and 07-07-13 Low-Flow Groundwater Sampling, (Attachment C).

In the event that sample turbidity is not below 10 NTUs a sample filtered through a 0.45-micron filter may be collected (at the discretion of the project manager) for metals analysis in addition to the unfiltered sample. Both filtered and unfiltered samples will be submitted for metals analyses.

In cases where a well has been purged dry during stabilization (low yield wells), it will be necessary to let the water in the well recover (up to one or more days) before collecting the sample. If possible, let the well recover with enough volume to collect all analytical parameters. However, low-yield wells may not recover sufficiently within one day to collect all the necessary samples. Several days may be needed to collect all the necessary samples.

4.2 Field Documentation

4.2.1 Field Data Recording

Field activities will be documented in accordance with this SAP and NRT SOP 07-02-01B General Field Documentation, provided in Attachment C. Documentation will be completed through the use of field forms and/or a field notebook. Field forms provided in Attachment B include:

- Well Development and Groundwater Monitoring Field Form
- Monitoring Well Evaluation Checklist
- Field Sample Control Log
- Chain of Custody

Data generated in the field will be reduced and validated, as appropriate, before reporting. Data collected in the field will be scanned following completion of the sampling event (typically within 10 days), transmitted to the project or data manager.

Data collection will follow NRT SOP 01-03-01 Data Flow, provided in Attachment C, which describes the steps and responsibility associated with collecting, storing and checking data collected in the field and provided by the laboratory.

4.2.1.1 Data Tracking, Storage, and Retrieval

Field data forms and notes will be scanned and stored electronically in the project file and retrieved as described in NRT SOP 01-03-01 (Attachment C).

Samples sent to the laboratory for analysis may be tracked on the tracking form provided in NRT SOP 01 03-01 which verifies the following:

- Sample condition upon receipt
- Samples collected and submitted were received and logged-in
- Methods, analytes and reporting limits are appropriate
- Sample location correctly identified
- Quality control samples collected and identified
- Laboratory sample designation group identified
- Date of sample collection, receipt by laboratory and results due date
- Date of notification to project team
- Date of data import

4.2.1.2 Final Documentation Files

All final data, field notes, and other pertinent documents produced or delivered will be tracked and stored as required by NRT SOP 01-03-01 (Attachment C).

5. DECONTAMINATION

5.1 Overview

Decontamination procedures will be performed to remove chemical constituents from non-dedicated sampling equipment used during groundwater monitoring activities. Proper decontamination procedures prevent chemical constituents from being transferred between sampling location and being transported out of controlled areas.

5.2 Decontamination of Equipment

Cleaning and decontamination of all equipment shall occur at a designated field activity area, downgradient, and downwind from the clean equipment drying and storage areas. Decontamination procedures will be performed and documented in accordance with NRT SOP 07-04-09 (Attachment C).

5.2.1 Sampling Equipment

Non-dedicated sampling equipment will be washed with a solution of Alconox and potable water, triple rinsed with distilled water or ultrapure/de-ionized (DI) water and allowed to air dry. Equipment decontamination procedures will be minimized through the use of either dedicated or disposable sampling equipment. However, some sampling equipment will require decontamination, and these include at a minimum:

- Water level meter
- Flow through cell

Equipment decontamination procedures are described in NRT SOP 07-04-09 (Attachment C).

5.2.2 Sample Container Decontamination

Sample container decontamination is not required; the analytical laboratory will provide pre-cleaned and preserved (as applicable) containers for samples to be submitted for laboratory analysis. Sample containers will not be used if the container integrity is compromised in any manner, and arrangements will be made with the laboratory to get replacement container(s).

6. SAMPLE HANDLING

Sample labeling, handling and chain of custody (CoC) requirements are described in NRT SOPs 07 03 01 Sample Labeling, Logging, and Storage and 07-03-03 Chain-of-Custody, provided in Attachment C.

6.1 Sample Identification

Each sample will be assigned a unique sample identification number in accordance with this SAP and NRT SOP 07-03-01 (Attachment C). A unique 9-digit identification code will be assigned to each sample retained for analysis on all sites. This code will be formatted as a number series with the sample month (2-digit), date (2-digit), year (2-digit) followed by a consecutive sample number (3-digit). Example: The first sample collected on December 25, 2015 would be identified as 122515001. Consecutive sample numbers will indicate the individual sample sequence in the total set of samples collected. The consecutive numbers will continue throughout the sampling event (i.e., they do not reset to "001" each day). The sample location identification (well number) associated with the unique 9-digit code will be recorded on the sample control log.

6.2 Sample Container, Volume, Preservation and Holding Times

Groundwater will be containerized, preserved, and stored in accordance with this SAP and NRT SOP 07 04-05 Sample Volumes, Containers, Preservation, and Holding Times provided in Attachment C. Sample containers, volumes, preservatives, and holding times for groundwater samples are summarized on Table 1. Prior to initiating sampling activities, the analytical laboratory will verify sample container, volume, preservation, and holding times. The laboratory will provide the appropriate sample containers with preservatives.

6.3 Field Sampling Quality Control

Field quality control (QC) samples to be collected as described in the NRT SOP 07-04-07 Quality Control Samples provided in Attachment C. Field QC samples are:

- Field duplicates
- Field blanks
- Equipment blanks (if non-dedicated sampling equipment used)
- Matrix Spike/Matrix Spike Duplicates (MS/MSDs)

6.3.1 Field Duplicates

Field duplicate samples are collected to evaluate the precision of the whole method, from field sampling to laboratory analysis. Field duplicate samples shall be collected at the same time, using the same procedures and equipment, and in the same types of containers as the parent samples. They should be preserved in the same manner and submitted for the same analyses as the parent samples. Field duplicates will be collected at a ratio of one duplicate for every 10 parent samples.

6.3.2 Field Blanks

Field blanks are used to identify potential contamination of a sample by site contaminants from a source not associated with the sample collected (e.g., air-borne dust from a source not related to the samples). Field blanks shall be collected by pouring distilled or DI water directly into the appropriate sample containers at pre-designated locations at the site. They shall also be preserved in the same manner and submitted for the same analyses as investigative samples. After collection, field blanks are handled and treated in the same manner as investigative samples. One field blank will be collected per sampling event.

6.3.3 Equipment Blanks

Equipment blanks are also referred to as rinsate blanks or equipment rinsates. Equipment blanks are used to determine if non-dedicated equipment decontamination procedures are sufficient and there is no cross-contamination from one sample to another, and may be used to determine if dedicated equipment is free of measurable concentrations of constituents of potential concern. Equipment blanks shall be collected by pouring distilled or DI water onto or into the sampling equipment and directly filling the appropriate sample containers with the water that has contacted the sampling equipment. Equipment blanks are always collected after sampling equipment has been decontaminated and may be performed prior to collecting the first sample, after collecting highly impacted samples, and/or at the conclusion of sampling. After collection, equipment blanks are handled and treated in the same manner as investigative samples, unless noted otherwise in site-specific documents. One equipment blank will be collected per sampling event.

6.3.4 Matrix Spike/Matrix Spike Duplicates

MS/MSD samples are collected to evaluate the effect of sample matrix on analytical results and the precision and accuracy of laboratory procedures. As with field duplicate samples, MS/MSD samples should be collected at the same time, using the same procedures and equipment, and in the same types of containers as the parent samples. They shall also be preserved in the same manner and submitted for the same analyses as the parent samples. MS/MSD samples will be collected at a ratio of one MS/MSD sample per twenty parent samples collected.

6.4 Sample Custody

CoC procedures are required by USEPA guidance and will be conducted in accordance with the NRT SOP 07-03-03 (Attachment C). Samples collected must be maintained under secure conditions and documented through CoC procedures. A sample is under a person's custody if the following requirements are met:

- The sample is in the person's possession
- The sample is in the person's view after being in the person's possession
- The sample is in a secured location after being in the person's possession

Field personnel are responsible for the custody of samples until custody is transferred. Sample containers will be identified, tagged, handled and transported in accordance with the NRT SOP 07-03-05 (Attachment C). All samples must be accompanied by a CoC form at all times and a separate CoC will be completed for each sampling event and site.

When transferring the possession of samples, the individual relinquishing the sample will sign the “relinquished from” line on the CoC. If a team is involved in the sample collection, only one team member is required to sign the CoC. The receiving individual will then sign the CoC, noting the date and time the samples were received. This record documents the transfer of sample custody from the sampler to another person. The original CoC will accompany the sample shipment. A copy of the CoC will be retained to document the transfer of custody. The hard copy will be scanned and saved in the project file.

6.5 Sample Shipping

Transportation and shipping requirements are detailed in the NRT SOP 07-03-09 Packing and Shipment of Environmental Samples and Equipment, provided in Attachment C. Deviations from the packing and shipment SOP are allowable if the samples are delivered to the laboratory, alternately. Packing and shipment methods must preserve sample integrity and CoC, as well as follow applicable United States Department of Transportation (USDOT), International Air Transport Association (IATA) and carrier specific regulations and requirements. Samples collected during field investigations must be classified prior to shipment, as either environmental or dangerous goods samples.

As it pertains to groundwater sampling, the shipment of the following preserved samples is also not regulated provided the amount of preservative used does not exceed the amounts specified in 40 CFR 136.3. Specifically, 40 CFR 136.3(e) Table II, note 3, states: "For the preservation requirements of Table II, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials:

- Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater)

Pre-preserved sample containers received from a laboratory do not exceed this amount of preservative. As related to this groundwater monitoring, the aforementioned preservative (HNO_3) pertains to metals in groundwater samples.

7. LABORATORY ANALYTICAL PROCEDURES

Groundwater will be analyzed by a state or nationally certified laboratory using methods that provide the required reporting limits (RLs) for the requested analytes. Ch. NR 507 defines the parameters to be analyzed and include the following:

- Metals:
  - Antimony
  - Arsenic
  - Barium
  - Beryllium
  - Boron
  - Cadmium
  - Calcium
  - Chromium
  - Cobalt
  - Copper
  - Lead
  - Lithium
  - Manganese
  - Molybdenum
  - Selenium
  - Silver
  - Thallium
  - Zinc
- Inorganic Parameters:
  - Alkalinity
  - Chloride
  - Fluoride
  - Hardness
  - Nitrate + Nitrite, N
  - Sulfate
  - Total dissolved solids

- Field Parameters
  - Groundwater Elevation
  - pH
  - Specific Conductance
  - Temperature

Chs. NR 500 stipulates different phases of groundwater monitoring including:

- Baseline – NR 507 Appendix I, Tables 1, 1A, and 2 parameters for CCR waste, listed above, to be collected quarterly beginning the quarter following approval of the Environmental Sampling and Analysis Plan Addendum for the Plan of Operation for 8 rounds of groundwater sample collection.
- Detection Monitoring – Ch. NR 507 Appendix I, Tables 1, 1A, and 2 parameters for CCR waste, listed above to be collected semi-annually following Baseline sampling.
- Assessment Monitoring - Ch. NR 507 Appendix I, Tables 1, 1A, and 2 parameters for CCR waste and Ch. NR 507, Appendix I, Table 3 parameters for CCR waste, to be collected semi-annually.
- Leachate Monitoring – Ch NR 507 Appendix I, Table 4 to be collected semi-annually

The Sampling and Analysis Summary is provided on Table 1. Table 3, Summary of Groundwater Analytical Methods, provides the full Ch. NR 507 analyte list with method detection limits (MDLs) and RLs as well as the NR140.10 Preventive Action Limits (PALs) and Enforcement Standards (ESs). Analytical methods were selected based on providing RLs which are at or below the Ch. R140.10 PALs. Laboratories are required to analyze quality control samples which (depending on the analysis) may include:

- Initial calibration
- Initial calibration verification
- Continuing calibration verification
- Method blanks
- Serial dilution
- Interference check samples
- Initial and continuing calibration blanks
- Matrix spike and matrix spike duplicates
- Laboratory control samples

Refer to Tables 4, 5, 6 and 7 for laboratory quality control requirements including measurement performance criteria for the inorganics, metals, mercury and radium 226 and 228 analyses, respectively.

The analytical laboratory will provide We Energies and Ramboll a level 2 electronic data deliverable (EDD) containing the content required in Ch. NR 507.26(3)(b) in an agreed upon format which is compatible with Ramboll and We Energies' databases. Laboratory EDDs and PDF reports will be sent to Ramboll and We Energies within 10 business days, or as agreed upon with the laboratory. Once the Lab EDDs and PDF reports are received, a quality assurance and quality control (QA/QC) assessment will be completed. The QA/QC assessment will include reviewing incoming laboratory data to ensure requirements of this report, Ch. NR 507, and the site-specific requirements are met. Once the QA/QC assessment is complete, appropriate parties will be notified that the data results are ready for data storage and analysis or communicate if adjustments are needed as well as a timetable for completing needed corrections in accordance with Ch. NR 507 and the site-specific schedule.

8. DATA MANAGEMENT

Field and groundwater analytical data will be managed and stored by Ramboll according to the NRT Data Flow SOP 01-03-01. We Energies will also manage and store data on a separate duplicate database.

8.1 Field Data Exchange

Field data including field forms, sample control logs, CoCs and shipping information will be electronically scanned into a PDF for each sampling event. The compiled PDF will be distributed to the Ramboll data group and We Energies either by email or uploaded to the Ramboll Sharefile FTP site within 10 business days of the completion of the sampling event.

8.2 MANAGES Database

Groundwater data will be stored in the Electrical Power Research Institute (EPRI) MANAGES™ database which will be maintained at NRT by the NRT data group and independently by We Energies for their duplicate database.

8.3 Protocol for Data Exchange

Ramboll will import and maintain the field and analytical data in the MANAGES database; Ramboll will provide We Energies with copies of the database files for importing into their MANAGES database.

8.4 Data for Public Review

Groundwater data collected to satisfy requirements of Ch. NR 507.15(3) will be included in an Annual Groundwater and Corrective Action Report (Annual Report). Annual Groundwater Monitoring and Corrective Action Reports documenting the status of the groundwater monitoring and any corrective action implemented at the CCR landfill will be submitted to the WNDR by January 31 of the following year, and placed in the operating record and on the publicly accessible website as required by Ch. NR 506.17(2) and (3).

9. MANAGEMENT OF INVESTIGATIVE DERIVED WASTES (IDW)

Investigative Derived Wastes (IDW) including well purge water and decontamination solutions will be produced during sampling activities. The methodology for the management, storage, and disposal of the wastes is described below. Groundwater (purge water) handling, storage and disposal procedures will ensure that potential adverse environmental impacts associated with the waste do not occur, and that all wastes are transported, and disposed in accordance with local, state and/or federal regulations and in coordination with the We Energies facility.

9.1 Water and Decontamination Solutions

Water and decontamination solutions likely to be produced during monitoring activities include the following:

- Water from monitoring well development, low –flow sampling well purging, and sampling activities
- Decontamination solutions from field equipment, sampling equipment, and personal protective equipment

Disposal of water generated during well installation, development and sampling will be coordinated with the specific We Energies facility.

9.2 Personal Protective Equipment

Waste PPE will be stored in plastic garbage bags and disposed of in a dumpster with general refuse, unless otherwise specified by the We Energies facility.

10. REFERENCES

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ASTM International. 2005c. D5521-05 Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers. ASTM Book of Standards Volume 4.08.

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USEPA, 2004b, Improving Sampling, Analysis, and Data Management for Site Investigation and Cleanup, Office of Solid Waste, EPA-542-F-04-001a, www.epa.gov/tio, www.cluin.org, April 2004,

USEPA, 2007, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA/530/SW-846, 3rd Edition (Revision 0); November 1986; Revision 6, as amended: I (July 1992), II (September 1994), IIA (August 1993), IIB (January 1995), III (December 1996), IIIA (April 1998), IIIB (November 2004), IV (February 2007), U.S. Environmental Protection Agency, Washington D.C., 3500 pp.

USEPA, 2015, Disposal of Coal Combustion Residuals from Electric Utilities, Final Rule, 40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System, April 2015

TABLES

Table 1. Sampling and Analysis Summary

Sampling and Analysis Plan Revision 1
We Energies NR 507 Groundwater Monitoring
Pleasant Prairie Power Plant Ash Landfill, Pleasant Prairie, Wisconsin

Parameter	Analytical Method[1]	No. of Samples	Field Duplicates[2]	Field Blanks[3]	Equipment Blanks[3]	MS/MSD[4]	Total	Container Type	Minimum Volume[5]	Preservation (Cool to 4 °C for all samples)[6]	Sample Hold Time from Collection Date
Metals											
Mercury	245.7	6	1	1	NA	1	8	glass[7]	250 mL	none[8]	90 days
Metals (1)	200.7/200.8	6	1	1	NA	1	8	plastic	250 mL	HNO3 to pH<2	6 months
Inorganic Parameters											
Alkalinity	2320B	6	1	1	NA	1	8	plastic	500 mL	Cool to 4 °C	28 days
Chloride	300.0/9056	6	1	1	NA	1	8	plastic	500 mL	Cool to 4 °C	28 days
Fluoride	300.0/9056	6	1	1	NA	1	8	plastic	500 mL	Cool to 4 °C	28 days
Hardness	200.7/2340B	6	1	1	NA	1	8	plastic	500 mL	HNO3 to pH<2	28 days
Nitrate + Nitrite, N	300.0/9056	6	1	1	NA	1	8	plastic	500 mL	Cool to 4 °C	48 hours
Sulfate	300.0/9056	6	1	1	NA	1	8	plastic	500 mL	Cool to 4 °C	28 days
Total Dissolved Solids	SM 2540C	6	1	1	NA	1	8	plastic	500 mL	Cool to 4 °C	7 days
Other											
Radium 226	903.1	6	1	1	NA	1	8	plastic	1000 mL	Cool to 4 °C	NA
Radium 228	904	6	1	1	NA	1	8	plastic	1000 mL	Cool to 4 °C	NA
Field Parameters											
Dissolved Oxygen	SM 4500-O/405.1	6	NA	NA	NA	NA	6	flow-through cell	NA	none	immediately
Oxidation/Reduction Potential	SM 258/OB	6	NA	NA	NA	NA	6	flow-through cell	NA	none	immediately
pH	SM 4500-H+ B	6	NA	NA	NA	NA	6	flow-through cell	NA	none	immediately
Specific Conductance	SM 2510 B	6	NA	NA	NA	NA	6	flow-through cell	NA	none	immediately
Temperature	SM 2550	6	NA	NA	NA	NA	6	flow-through cell	NA	none	immediately
Turbidity[9]	EPA Method 180.1	6	NA	NA	NA	NA	6	hand-held turbidity meter[10]	NA	none	immediately

Notes:

(1) Metals = antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, lead, lithium, manganese, molybdenum, selenium, silver, thallium, zinc
°C = degrees Centigrade
HNO_3 = nitric acid
mL = milliliter
MS/MSD = matrix spike/matrix spike duplicate
NA = not applicable

1. Analytical methods, quality control, reporting limits and method detection limits will vary depending on the laboratory performing the work; methods utilized will meet the necessary reporting limits for the requested analytes.
2. Field duplicates will be collected at a frequency of one per group of 10 or fewer investigative water samples.
3. Field blanks will be collected at a rate of 1 per sampling event; Equipment blanks will be collected at a rate of 1 per sampling event if non-dedicated equipment is used.
4. Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples will be collected at a frequency of one per group of 20 or fewer investigative water samples. Laboratory to determine if additional QC sample volume required for this analysis.
5. Sample volume is estimated and will be determined by the laboratory.
6. Temperature blanks will be included at a frequency of one per cooler of samples shipped to the analytical laboratory.
7. Laboratory to provide mercury-free pre-tested bottles
8. Preservative to be added at Laboratory.
9. If turbidity exceeds 10 NTUs, a duplicate sample filtered through a 0.45 micron filter may be collected for metals analysis in addition to the unfiltered sample. Both samples would be submitted for analysis.
10. Separate hand held monitors or flow-through cell measurement can be used to measure turbidity, depending on the capability of the flow-through cell being used. A hand-held monitor is needed if the flow-through cell does not measure turbidity.

Table 2. Sample Location Summary

Sampling and Analysis Plan Revision 1
We Energies NR 507 Groundwater Monitoring
Pleasant Prairie Power Plant Ash Landfill, Pleasant Prairie, Wisconsin

Well ID	W20D	W73	W74	W75	W76	W77
Well Location Latitude	42°33'51.3592"	42°33'57.0560"	42°33'56.9099"	42°33'56.8116"	42°33'56.4738"	42°33'45.2513"
Well Location Longitude	-87°54'15.0776"	-87°53'57.3214"	-87°54'14.3343"	-87°54'08.8120"	-87°54'01.8036"	-87°53'54.2383"
Well Location Northing (State Plane)[1]	212757.968	213367.880	213321.151	213321.564	213300.531	212178.920
Well Location Easting (State Plane)[1]	2533085.395	2534399.356	2533126.925	2533540.318	2534065.505	2534660.047
Well Construction Material	PVC	PVC	PVC	PVC	PVC	PVC
Well Diameter (inches)	2	2	2	2	2	2
Top of Casing Well Elevation (ft)[2,3]	688.41	690.58	686.83	689.91	691.63	687.23
Well Depth (ft)[4]	140	130	140	141	141	126
Pump Intake Elevation (ft)[2,3]	563.01	551.28	557.83	550.01	550.83	546.23
Screen Length (ft)	5	5	5	5	5	5
Top of Screen Elevation (ft)[2,3]	551.45	563.66	550.02	551.42	553.00	563.89
Bottom of Screen Elevation (ft)[2,3]	546.45	558.66	545.02	546.42	548.00	558.89
Casing Length to Screen (ft)	136.96	126.92	136.81	138.48	138.64	123.33
Well Stick-up Above Ground Surface (ft)	1.96	1.92	1.81	2.48	2.64	2.33
Hydraulic Position of Well	upgradient	downgradient	downgradient	downgradient	downgradient	upgradient

Notes:

[O:KLT 9/28/15, C:SGW 10/2/15]

ft = feet
PVC = polyvinyl chloride

1. Horizontal datum is Wisconsin State Plane Coordinates South Zone, NAD 83.
2. Ground surface, top of protective cover pipe and top of well riser elevations for wells were surveyed by A.W. Oakes & Son, Inc. on March 16, 2015 and March 27, 2015.
3. Vertical datum assumed to be NAVD88.
4. Depth below ground surface (bgs).

Table 3. Summary of Groundwater Analytical Methods

Sampling and Analysis Plan Revision 1
We Energies NR 507 Groundwater Monitoring
Pleasant Prairie Power Plant Ash Landfill, Pleasant Prairie, Wisconsin

Constituent	CAS	Unit	Analytical Method(1,4)	PAL	ES	RL	MDL	USEPA MCL (2)
Metals								
Antimony	7440-36-0	µg/L	EPA 200.8	1.2	6	0.07	0.021	6
Arsenic	7440-38-2	µg/L	EPA 200.8	1	10	1.4	0.41	10
Barium	7440-39-3	µg/L	EPA 200.7	400	1000	0.93	0.28	2000
Beryllium	7440-41-7	µg/L	EPA 200.7	0.4	4	0.1	0.029	4
Boron	7440-42-8	µg/L	EPA 200.7	200	1000	11	3.2	NS
Cadmium	7440-43-9	µg/L	EPA 200.7	0.5	5	1.4	0.42	5
Calcium	7440-70-2	µg/L	EPA 200.7	NS	NS	87	26	NS
Chromium	7440-47-3	µg/L	EPA 200.7	10	100	1.7	0.51	100
Cobalt	7440-48-4	µg/L	EPA 200.7	8	40	3.7	1.1	NS
Copper	7440-50-8	µg/L	EPA 200.7	130	1300	10	3.4	1.3
Lead	7439-92-1	µg/L	EPA 200.8	1.5	15	0.037	0.011	15
Lithium	7439-93-2	µg/L	EPA 200.7	TBD	TBD	0.27	0.082	NS
Manganese	7439-96-5	µg/L	EPA 200.7	25	50	5	1.5	NS
Mercury	7439-97-6	µg/L	EPA 245.7	0.2	2	0.0024	0.00071	2
Molybdenum	7439-98-7	µg/L	EPA 200.7	8	40	3.7	1.1	NS
Selenium	7782-49-2	µg/L	EPA 200.8	10	50	2.2	0.67	50
Silver	7440-22-4	µg/L	EPA 200.7	10	50	10	3.2	NS
Thallium	7440-28-0	µg/L	EPA 200.8	0.4	2	0.032	0.01	2
Zinc	7440-66-6	µg/L	EPA 200.7	2500	5000	40	11.6	NS
Inorganics								
Alkalinity	--	mg/L	2320B	NS	NS	20	20	NS
Chloride	16887-00-6	mg/L	EPA 300.0 / EPA 9056	125	250	2	4	250 (3)
Fluoride	16984-48-8	mg/L	EPA 300.0 / EPA 9056	0.8	4	0.2	0.4	4
Hardness	--	mg/L	EPA 200.7 by 2340B	NS	NS	54	10	NS
Nitrate + Nitrite, N	--	mg/L	EPA 300.0 / EPA 9056	2	10	0.15	0.04	NS
Sulfate	14808-79-8	mg/L	EPA 300.0 / EPA 9056	125	250	2	4	250
Total Dissolved Solids	None	mg/L	SM 2540C	NS	NS	8.68	20	500
Other								
Radium 226	7440-14-4	pCi/L	903.1	NS	NS	1	NS	5
Radium 228	7440-14-4	pCi/L	904	NS	NS	1	NS	5
Field								
pH	NA	SU	SM 4500-H+ B	NS	NS	NA	NA	NS
Oxidation/Reduction Potential	NA	mV	SM 258/0B	NS	NS	NA	NA	NS
Dissolved Oxygen	NA	mg/L	SM 4500-O/405.1	NS	NS	NA	NA	NS
Temperature	NA	°C	SM 2550	NS	NS	NA	NA	NS
Turbidity	NA	NTU	EPA Method 180.1	NS	NS	NA	NA	NS
Specific Conductivity	NA	µS/cm	SM 2510 B	NS	NS	NA	NA	NS

Notes:
°C = degrees Centigrade
µg/L = micrograms per liter
µS/cm = microSiemens per centimeter
CAS = Chemical Abstract Number
ES = Enforcement Standard
MDL = method detection limit as established by the laboratory
mg/L = milligrams per liter
mV = milliVolt
NA = not applicable
NS = No standard
NTU = Nephelometric Turbidity Unit
PAL = Preventive Action Limit
pCi/L = picoCuries per liter
RL = Reporting limit as established by the laboratory
SM = Standard Methods for the Examination of Water and Wastewater
SU = standard units
TBD = to be determined

1. Analytical method numbers are from SW-846 unless otherwise indicated.
2. USEPA MCL = United States Environmental Protection Agency Maximum Contaminant Level.
3. Secondary standard.
4. Analytical methods, quality control, reporting limits and method detection limits will vary depending on the laboratory performing the work; methods utilized will meet the necessary reporting limits for the requested analytes

Table 4. Summary of Laboratory Quality Control Requirements - Inorganics (Alkalinity, Chloride, Fluoride, Hardness, Nitrate + Nitrite as N, Sulfate, and Total Dissolved Solids)

Sampling and Analysis Plan Revision 1
We Energies NR 507 Groundwater Monitoring
Pleasant Prairie Power Plant Ash Landfill, Pleasant Prairie, Wisconsin

Sampling Procedure	Analytical Methods[1]	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance
Low-flow groundwater	Alkalinity - 2320B Cl -, F-, SO_4- 300.0/9056, Hardness - EPA 200.7 by 2340B Nitrate + Nitrite, N - 300.0 / 9056 TDS - SM 2540C	Precision	RPD < 25% (or +/- 2 X RL if sample or duplicate is < 5 X RL) TDS - RPD <10%	Field Duplicate
		Accuracy and Precision	90-110%, RPD < 20%	Matrix Spike Matrix Spike Duplicate
		Accuracy	No detections exceeding the RL	Method Blank
		Accuracy	90 to 110% TDS - 80-120%, RPD <5%	Laboratory Control Sample
		Accuracy/Bias	r > 0.995	Initial Calibration
		Accuracy/Bias	%D = +/- 10%	ICV and CCV
		Accuracy/Bias	< reporting limit	ICB/CCB
		Field Completeness	100%	Data Completeness Check
		Analytical Completeness	95%	Data Completeness Check

Notes:
Cl = chloride
F = fluoride
%D = percent difference
CCB = Continuing Calibration Blank
CCV = Continuing Calibration Verification
ICB = Initial Calibration Blank
ICV = Initial Calibration Verification
RL = reporting limit
RPD = relative percent difference
SO_4 = sulfate
TDS = total dissolved solids

1. Analytical methods, quality control, reporting limits and method detection limits will vary depending on the laboratory performing the work; methods utilized will meet the necessary reporting limits for the requested analytes.

Table 5. Summary of Laboratory Quality Control Requirements - ICP-OES Metals and ICP-MS Metals

Sampling and Analysis Plan Revision 1
We Energies NR 507 Groundwater Monitoring
Pleasant Prairie Power Plant Ash Landfill, Pleasant Prairie, Wisconsin

Sampling Procedure	Analytical Method[1]	Data Quality Indicators	Measurement Performance Criteria (EPA 200.7)	Measurement Performance Criteria (EPA 200.8)	QC Sample and/or Activity Used to Assess Measurement Performance
Low-flow groundwater	EPA 200.7/200.8	Precision	RPD <25% (or +/- 2 x RL if sample or duplicate is <5 x RL)	RPD <25% (or +/- 2 x RL if sample or duplicate is <5 x RL)	Field Duplicate
		Accuracy and Precision	+/- 30%, RPD <20%	+/- 25%, RPD <20%	Matrix Spike/Matrix Spike Duplicate
		Accuracy	+/- MDL or <10% sample concentration	+/- MDL or <10% sample concentration	Method Blank
		Accuracy	+/- MDL or <10% sample concentration	+/- MDL or <10% sample concentration	Interference Check Sample
		Precision	+/- 10% original result	+/- 10% original result	Serial Dilution
		Accuracy	+/- 15%, <20 RPD	+/- 15%, <20 RPD	Laboratory Control Sample/ Laboratory Control Sample Duplicate
		Accuracy/Bias	r > 0.995	r > 0.995	Initial Calibration
		Accuracy/Bias	ICV +/- 5% , CCV +/- 10%	+/- 10%	ICV and CCV
		Accuracy/Bias	+/- MDL or <10% sample concentration	+/- MDL or <10% sample concentration	ICB/CCB
		Field Completeness	100%	100%	Data Completeness Check
		Analytical Completeness	95%	95%	Data Completeness Check

Notes:
%D = percent difference
< = less than
CCB = Continuing Calibration Blank
CCV = Continuing Calibration Verification
EPA = Environmental Protection Agency
ICB = Initial Calibration Blank
ICP-MS = inductively coupled plasma - mass spectrometry
ICP-OES = inductively coupled plasma - optical emission spectrometry
ICV = Initial Calibration Verification
MDL = method detection limit
QC = quality control
RL = reporting limit
RPD = relative percent difference

1. Analytical methods, quality control, reporting limits and method detection limits will vary depending on the laboratory performing the work; methods utilized will meet the necessary reporting limits for the requested analytes.

Table 6. Summary of Laboratory Quality Control Requirements - Mercury

Sampling and Analysis Plan Revision 1
We Energies NR 507 Groundwater Monitoring
Pleasant Prairie Power Plant Ash Landfill, Pleasant Prairie, Wisconsin

Sampling Procedure	Analytical Method[1]	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance
Low-flow groundwater	EPA 245.7	Precision	Not Specified	Field Duplicate
		Accuracy/Bias	< ML (5 ng/L) or 1/5 sample concentration	Field Blank
		Accuracy and Precision	63 - 111% Recovery, RPD <18%	Matrix Spike/Matrix Spike Duplicate
		Accuracy	<1.8 ng/L or <1/5 sample concentration	Method Blanks (2)
		Accuracy/Bias	Mean Calibration Factor (CFm) %RSD between individual CFx <15	Initial Calibration
		Accuracy/Bias	Recovery of lowest calibration standard must be 75 - 125%	Initial Calibration
		Accuracy/Bias	76 - 113% Recovery	Quality Control Standard (QCS)
		Accuracy/Bias	76 - 113% Recovery	On-Going Precision and Recovery Standard (OPR)
		Accuracy/Bias	+/- MDL or <10% sample concentration	System (rinse) blank
		Field Completeness	100%	Data Completeness Check
		Analytical Completeness	95%	Data Completeness Check

Notes:
%D = percent difference
%RSD = percent relative standard deviation
< = less than
EPA = Environmental Protection Agency
MDL = method detection limit
ML = method limit
ng/L = nanograms per liter
QC = quality control
RL = reporting limit
RPD = relative percent difference

1. Analytical methods, quality control, reporting limits and method detection limits will vary depending on the laboratory performing the work; methods utilized will meet the necessary reporting limits for the requested analytes.

Table 7. Summary of Laboratory Quality Control Requirements - Radium 226 and 228

Sampling and Analysis Plan Revision 1
We Energies NR 507 Groundwater Monitoring
Pleasant Prairie Power Plant Ash Landfill, Pleasant Prairie, Wisconsin

Sampling Procedure	Analytical Method[1]	Data Quality Indicators	Measurement Performance Criteria, Ra-226 Method 903.1	Measurement Performance Criteria, Ra-228 Method 904.0	QC Sample and/or Activity Used to Assess Measurement Performance
Low-flow groundwater	903.1 and 904.0	Precision	RPD < 32%	RPD < 36%	Field Duplicate
		Accuracy and Precision	71-136%, RPD < 32%	60-127%, RPD < 36%	Matrix Spike/Matrix Spike Duplicate
		Accuracy	No detections exceeding the RL or > 10X method blank result	No detections exceeding the RL or > 10X method blank result	Method Blank
		Accuracy	73-135%	60-135%	Laboratory Control Sample
		Sensitivity	NA	NA	RL adequacy check
		Accuracy/Bias	Cell constant < 10%	RSD < 5%	Initial Calibration
		Accuracy/Bias	NA	NA	ICV and CCV
		Accuracy/Bias	NA	NA	ICB/CCB
		Field Completeness	100%	100%	Data Completeness Check
		Analytical Completeness	95%	95%	Data Completeness Check

Notes:
%D = percent difference
< = less than
CCB = Continuing Calibration Blank
CCV = Continuing Calibration Verification
ICB = Initial Calibration Blank
ICV = Initial Calibration Verification
NA = not applicable
QC = quality control
RL = reporting limit
RPD = relative percent difference
RSD = relative standard deviation

1. Analytical methods, quality control, reporting limits and method detection limits will vary depending on the laboratory performing the work; methods utilized will meet the necessary reporting limits for the requested analytes.

Table 8. Goals for Precision, Accuracy, and Completion of Field Measurements

Sampling and Analysis Plan Revision 1
We Energies NR 507 Groundwater Monitoring
Pleasant Prairie Power Plant Ash Landfill, Pleasant Prairie, Wisconsin

Field Parameter	Precision Goal	Accuracy Goal	Completion Goal
Water Level	± 0.01 foot	± 0.01 foot	90%
pH	± 0.1 s.u.	± 0.1 s.u.	90%
Specific Conductance	± 100 µS/cm	± 100 µS/cm	90%
Temperature	± 10%	± 10%	90%
Oxidation/Reduction Potential	± 1.0 mV	± 1.0 mV	90%
Turbidity	± 1.0 NTU	± 1.0 NTU	90%
Dissolved Oxygen	± 0.3 mg/L	± 0.3 mg/L	90%

Notes:
% = percent
mg/L = Milligrams per liter
mV = Millivolt
NTU = Nephelometric Turbidity Units
s.u. = standard units
µS/cm = Micro Siemens per centimeter

FIGURES

Y:\GIS\Projects\16\1660\P4\MXD\2022Annual_GWM_CAR\Figure 1_GW Samp Well Loc_P4.mxd

PROJECT: 71202 | DATED: 1/20/2023 | DESIGNER: galarnmc

▭ UNIT BOUNDARY

🟦 NR 507 DOWNGRADIENT MONITORING WELL LOCATION

🟫 NR 507 UPGRADIENT MONITORING WELL LOCATION

🟩 NR 507 POTENTIAL CONTAMINANT PATHWAY MONITORING WELL LOCATION

0 150 300
Feet

NR 507 GROUNDWATER MONITORING SYSTEM

FIGURE 1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

SAMPLING AND ANALYSIS PLAN REVISION 1
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL
PLEASANT PRAIRIE, WISCONSIN

RAMBOLL

COMMUNICATION FLOW CHART

SAMPLING AND ANALYSIS PLAN REVISION 1
PLEASANT PRAIRIE POWER PLANT ASH LANDFILL
PLEASANT PRAIRIE, WISCONSIN

FIGURE 2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC

ATTACHMENTS

ATTACHMENT A
GROUNDWATER MONITORING SYSTEM CERTIFICATION

NATURAL
RESOURCE
TECHNOLOGY
ENVIRONMENTAL CONSULTANTS

234 W. FLORIDA STREET, FIFTH FLOOR
MILWAUKEE, WISCONSIN 53204
(P) 414.837.3607
(F) 414.837.3608

Mr. Tim Muehlfeld
We Energies
333 W. Everett Street – A231
Milwaukee, WI 53203

November 12, 2015
(1660)

RE: 40 CFR Part 257, Subpart D, Section 257.91(f) Groundwater Monitoring System Certification
We Energies Pleasant Prairie Power Plant (P4) Ash Landfill, Pleasant Prairie, WI

Dear Tim,

According to Title 40 Code of Federal Regulations (40 CFR) Part 257, Subpart D, Section 257.91(f); the owner or operator of a coal combustion residual (CCR) management unit must obtain a certification from a qualified professional engineer stating that the groundwater monitoring system at the CCR management unit has been designed and constructed to meet the requirements of Section 257.91. Further, Section 257.91 requires that the system monitor the uppermost aquifer and include a minimum of one updgradient and three downgradient monitoring wells, and that if the uppermost aquifer monitoring system includes the minimum number of wells the basis supporting use of the minimum must be documented. Also according to Section 257.91, all potential contaminant pathways must be monitored in addition to the uppermost aquifer.

A groundwater monitoring system that meets and exceeds the minimum requirements of Section 257.91 is designed for the We Energies Pleasant Prairie Power Plant (P4) Ash Landfill, including the following monitoring wells:

- Upgradient: W77, W20D
- Downgradient: W73, W74, W75, W76
- Potential Contaminant Pathway: W20B, W31B, W17BR

Provided herein, as required by Section 257.91(f), is certification from a qualified professional engineer and professional geologist that the groundwater monitoring system at We Energies P4 Ash Landfill meets the requirements of Section 257.91.

I, Glenn R. Luke, a qualified professional engineer, certify that the groundwater monitoring system at We Energies P4 Ash Landfill has been designed and constructed to meet the requirements set forth in Section 257.91 of the United States Environmental Protection Agency's Final Rule to Regulate the Disposal of Coal Combustion Residuals from Electric Utilities as Solid Waste under Subtitle D of the Resource Conservation and Recovery Act. This certification is based on review of documentation regarding the design, installation, development, and decommissioning of monitoring wells and piezometers and ancillary measurement, sampling, and analytical devices.

Glenn R. Luke

Glenn R. Luke, PE
Professional Engineer No. 42834-6
State of Wisconsin

I, Jacob J. Walczak, a qualified professional geologist, certify that the groundwater monitoring system at We Energies P4 Ash Landfill has been designed and constructed to meet the requirements set forth in Section 257.91 of the United States Environmental Protection Agency's Final Rule to Regulate the Disposal of Coal Combustion Residuals from Electric Utilities as Solid Waste under Subtitle D of the Resource Conservation and Recovery Act. This certification is based on review of documentation regarding the design, installation, development, and decommissioning of monitoring wells and piezometers and ancillary measurement, sampling, and analytical devices.

Jacob J. Walczak, PG
Professional Geologist No. 1328-13
State of Wisconsin

Please don't hesitate to contact us if you have any questions.

Sincerely,

NATURAL RESOURCE TECHNOLOGY, INC.

Glenn R. Luke, PE
Project Manager

Jacob J. Walczak, PG
Hydrogeologist

[1660 We Energies Monitoring System Certification - P4 Ash Landfill 151112]

ATTACHMENT B
FIELD AND DATA FORMS

WELL DEVELOPMENT AND GROUNDWATER MONITORING FIELD FORM

PROJECT INFORMATION

Site: ______________________ Client: ______________________

Project Number: ______________ Task #: __________ Start Date: ______________ Time: __________

Field Personnel: ______________________ Finish Date: ______________ Time: __________

WELL INFORMATION

Well ID: __________

Casing ID: __________ Inches

Screen Interval: __________

Borehole Diameter: __________ Inches

Filter Pack Interval: __________

EVENT TYPE

☐ Well Development

☐ Low-Flow / Low-Stress Sampling

☐ Well Volume Approach Sampling

☐ Other (Specify below)

____

PURGE INFORMATION

Purge Method: ☐ Bailer ☐ Pump

Bailer Type: n/a

Pump Type and Serial #: __________

Tube/Pump Intake Depth: __________

Stabilized Pumping Rate: __________

DEPTH MEASUREMENTS

	INITIAL		FINAL	
	Depth FT BTOC	Time (24-Hour)	Depth FT BTOC	Time (24-Hour)
LNAPL				
Groundwater				
DNAPL				
Casing Base				

VOLUME CALCULATION AND PRODUCTION INFORMATION

Volume Calculation Type: ☐ Well Casing ☐ Borehole

Volume Per Foot: __________

Standing Water Column: __________ feet

1 Well Volume: __________ Gallons 3 Well Volumes: __________ Gallons

5 Well Volumes: __________ Gallons 10 Well Volumes: __________ Gallons

Total Volumes Produced: __________ Gallons

Well Purged Dry? ☐ Yes ☐ No

Water Level Serial #: __________ Water Quality Probe Type and Serial # __________

WATER QUALITY INDICATOR PARAMETERS

Sampling Stage	Time (military)	Volume Removed (gallons)	Depth to Water (Feet)	Drawdown (Feet)	Temp (°C)	pH (SU)	SEC or Cond. (µs/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP (mV)	Visual Clarity
initial											
purge											

NOTES

ABBREVIATIONS

Cond. - Actual Conductivity
FT BTOC - Feet Below Top of Casing
na - Not Applicable
nm - Not Measured
ORP - Oxidation-Reduction Potential
SEC - Specific Electrical Conductance
SU - Standard Units
Temp - Temperature
°C - Degrees Celcius

WELL DEVELOPMENT AND GROUNDWATER MONITORING FIELD FORM

PROJECT INFORMATION

Site: ____________________ Client: ____________________

Project Number: ____________ Task #: ____________ Start Date: ____________ Time: ________

Field Personnel: ____________________ Finish Date: ____________ Time: ________

WELL INFORMATION

Well ID: ____________

Casing ID: ________ inches

EVENT TYPE

☐ Well Development ☐ Low-Flow / Low Stress Sampling

☐ Well Volume Approach Sampling ☐ Other (Specify):

WATER QUALITY INDICATOR PARAMETERS (continued)

Sampling Stage	Time (military)	Volume Removed (gallons)	Depth to Water (Feet)	Drawdown (Feet)	Temp. (°C)	pH (SU)	SEC or Cond. (µs/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP (mV)	Visual Clarity

NOTES (continued)

ABBREVIATIONS

Cond. - Actual Conductivity	ORP - Oxidation-Reduction Potential
FT BTOC - Feet Below Top of Casing	SEC - Specific Electrical Conductance
na - Not Applicable	SU - Standard Units
nm - Not Measured	Temp - Temperature
	°C - Degrees Celcius

Monitoring Well Evaluation Checklist

Site ______________________

Inspection Date __________

Well Number __________

	Yes	No	NA
Major wells repairs* required to maintain well integrity?			

Stick-up Monitoring Wells				**Comments**
1. Outer protective Casing	Yes	No	NA	
Not corroded				
Not dented				
Not cracked				
Not loose				
2. Inner casing	Yes	No	NA	
Not corroded				
Not dented				
Not cracked				
Not loose				
	Yes	No	NA	
3. Are there weep holes in outer casing?				
4. Weep holes able to drain?				
5. Is there a lockable cap present?				
6. Is there a lock present?				
7. Bumper posts in good condition?				
Flushmount Monitoring Wells	Yes	No	NA	
8. Can the lid be secured tightly?				
9. Does the lid have a gasket that seals?				
10. No water in the flushmount?				
11. Is the well cap lockable?				
12. Is there a lock present?				
All Monitoring Wells	Yes	No	NA	
Downhole Condition				
12. Water level measuring point clearly marked?				
13. No obstructions in well?				
14. No plant roots or vegetation in well?				
15. No sediment in bottom of well?				
If present, how much sediment?	ft			
16. Installed as total depth.	ft			
17. Measured total depth of well.	ft			
General Condition	Yes	No	NA	
18. Concrete pad installed?				
19 . Concrete pad				
Slope away form casing?				
Not deteriorated?				
Not heaved or below surrounding grade?				
20. No surface seal settling?				
21. Well clearly visible and labeled?				

Comments:

* Major well repair are those that require a subcontractor or separate mobilization to complete

P:\1600\1660\FED CCR Rule Groundwater Monitoring\We Energies Generic SAP\Appendices\Forms\Monitoring Well Evaluation Checklist

Field Sample Control Log
Sampling and Analysis Plan
We Energies CCR Rule Groundwater Monitoring
Site Name:____________

Project Name: ______________________

Project ID: ______________________

Task ID: ______________________

Analytical Laboratory: ________________________________

Geotechnical Laboratory: ________________________________

Field Staff ID(s): ________________________________

Month (2-digit)	Date (2-digit)	Year (2-digit)	Sample Number (3-digit)	Unique Sample ID	Sample Media	Sample Location	Sample Depth (feet)	QC Sample Information (duplicate, blank, etc)	COC Number	Notes (turnaround time, handling, etc.)

NATURAL RESOURCE TECHNOLOGY, INC.
234 W. FLORIDA STREET, 5th FLOOR
MILWAUKEE, WI 53204
TEL: 414.837.3607

CHAIN OF CUSTODY #_________

DATE: ____________________

PAGE: ________ **OF** ________

LABORATORY SAMPLES SUBMITTED TO:			
ADDRESS:			
CITY:			
TEL:		FAX:	E-MAIL

CLIENT PROJECT NAME	PROJECT NUMBER / TASK NUMBER:
PROJECT CONTACT:	QUOTE NO.:
SAMPLER(S): (SIGNATURE)	

TURNAROUND TIME

☐ STANDARD☐ 24 HR 48☐HR ☐72 HR ☐ 5 DAYS

Data Package: Level 2 Level 4

Preservatives: A = none, B= HCL, C = H_2S0_4, D = $HN0_3$, E = methanol, F = Sodium Bisulfate, G = zinc acetate, H = other

SPECIAL REQUIREMENTS

REQUESTED ANALYSIS

Method Number and Analytes

Preservation Code (pick letter)																				
Filtered (Yor N)																				

LAB USE ONLY	SAMPLE ID	QC SAMPLE	FIELD COMMENTS	SAMPLE		MATRIX	SAMPLE TYPE	SAMPLE INTERVAL (ft)		#Cont																				
				DATE	TIME			TOP	BOTTOM																					

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:

Electronic Sample Control Log
Sampling and Analysis Plan
We Energies CCR Rule Groundwater Monitoring
Site Name:____________

9 Digit Unique Sample ID	Sample Date	Sample Time	Sample Media	Sample Location(1)	Coordinate System	X Coordinate(2)	Y Coordinate(2)	QC Sample Information (duplicates, blanks, etc…)	Depth to Water (ft)	Well Top of Casing Elevation (ft)	Water Elevation (ft) (TOC elevation - Depth to water)	Laboratory	COC Number	Analytes Requested	Laboratory	COC Number	Analytes Requested	Notes

Notes:
1. Sample location names used in this field will be permanent and final, this sample name will appear on all figures and tables generated from the associated analytical data. Dashes should not be used when naming sample locations.
2. These coordinates are the final post-processed X and Y coordinates and may be entered only after the location data has been checked. These data will be entered immediately following the field work.
3. These are calculated fields and may be filled in immediately following the end of the field work.
4. 9 Digit unigue sample ID = month, day, year then consecutive numbering., June 16, 2015 first sample is 061615001

ATTACHMENT C
STANDARD OPERATING PROCEDURES

Prepared By:	THC/SGW	Date Prepared:	9/30/13
Corporate Officer:	BRH	Date Approved:	03/21/14

LOW-FLOW GROUNDWATER SAMPLING

1.1 Scope and Application

This Standard Operating Procedure (SOP) describes low-flow groundwater sampling methods and identifies routines to follow when collecting samples from monitoring wells. Guidance documents and SOPs published by the United States Environmental Protection Agency (USEPA) and ASTM International provide the foundation for this SOP. The procedure outlined below is intended to ensure that representative samples are collected in ways that are safe, technically defensible, easily replicated, appropriate for the selected analytical methods, and sensitive to site-specific conditions and hydrogeology. Refer to project specific documents for variances from this SOP.

1.2 Summary of Methods

This SOP describes the low-flow (low-stress or micro-purge) method used to purge and sample groundwater from monitoring wells.

1.2.1 Low-flow Method

Using the low-flow method, groundwater is purged (pumped) from a monitoring well at low flow rates that result in minimal drawdown. Depth to groundwater and groundwater quality parameters (field parameters) are monitored throughout the purging process. Pumping rates are adjusted to ensure groundwater entering the pump is from the screened formation and not from stagnant water in the well casing above the pump inlet. Samples are collected when drawdown and groundwater quality parameters stabilize within pre-determined criteria.

1.3 SOPs for Related Tasks

This SOP applies only to sampling groundwater from monitoring wells. Sampling methods for drinking water wells, surface water, pore water, leachate, and other liquid wastes are not described in this SOP.

However, this groundwater sampling SOP requires adherence to other SOPs for closely-related tasks, some of which are referenced herein:

- SOP 07-07-01 Well Integrity Evaluation
- SOP 07-07-05 Groundwater and Non-Aqueous Phase Liquid Elevation Measurement
- SOP 07-11-01 Equipment Calibration, Operation, and Maintenance
- SOP 07-04-09 Equipment Decontamination
- SOP 07-04-07 Quality Control Samples
- SOP 07-03-01 Sample Labeling and Storage
- SOP 07-03-03 Chain of Custody
- SOP 07-03-09 Shipping

2.1 Pre-mobilization Planning

Successful groundwater sampling requires planning for health and safety considerations, selecting and preparing sampling equipment, knowledge of laboratory analytical methods, field-sampling procedures, and attention to record-keeping requirements.

Planning for a groundwater sampling event includes the following basic components:

- Identify scope of work and project objectives
- Prepare a health and safety plan
- Coordinate laboratory analytical services
- Select purging and sampling methods and equipment
- Prepare field equipment
- Prepare necessary field documentation forms
- Coordinate disposal of investigative-derived waste (purge water)

2.1.1 Site-Specific Considerations

Knowledge of site conditions and previous sampling records/field notes is helpful. Select equipment and sampling methods to match the scope of work and site-specific data quality objectives.

When planning a sampling event, it is also important to understand the following site-specific information:

- Site access, security, and health and safety issues
- Known or unknown concentrations of compounds of concern
- Anticipated depth to water at individual wells
- Presence or absence of NAPLs and/or DNAPLs
- Purging methods (e.g. low flow, modified, other)
- Equipment selection (e.g. pumps, bailers, or a combination of both)
- Criteria for monitoring of field parameters
- Sampling order (typically from least to most contaminated wells)
- Requirements for field-filtering and field-preservation of samples
- Requirements for field and/or laboratory QA/QC samples
- Decontamination procedures
- Identification of short hold times or special sample handling requirements
- List of analytes and analytical methods
- Site-specific SOPs, methods, and/or record-keeping requirements

2.1.2 Health & Safety Plan, Personal Protective Equipment

Use of a site-specific Health and Safety Plan (HASP) and personal protection equipment (PPE) is mandatory for all sampling activities. NRT's Health & Safety Coordinator must approve the HASP and appropriate PPE prior to any on-site activities.

Level D protection, at minimum, is required for field activities involving groundwater sampling; however, PPE will vary according to possible levels of risk and exposure pathways. Additional protection, such as Tyvek® suits, splash guards, and/or respirators may be necessary. Use of field-screening devices, such as a photoionization detector (PID), for monitoring breathing zones and/or decontamination zones may also be appropriate. Attention to proper use of PPE and thorough decontamination of equipment that comes in contact with groundwater and/or the ground surface is also essential to preventing personal exposures and sample cross-contamination. Site-specific requirements may also necessitate the use of plastic sheeting and/or other work-area precautions to prevent releases, exposures, and cross-contamination during sampling.

When working in roadways, parking lots, and other high-traffic areas, wear high visibility clothing and use safety cones, signage, flashing signals, flaggers, or other safety precautions. Properly establish traffic control according to detailed instructions contained in Department of Transportation (DOT) traffic control handbooks/manuals. Obtain permits for work in right-of-ways, including permission to dispose of investigation derived waste (purge water) to public sanitary sewer or wastewater treatment facilities if called for in the site-specific sampling plan.

2.1.3 Laboratory Coordination

Provide the analytical laboratory with enough lead time to manage the project. Order sample containers, communicate billing, reporting information (e.g., level IV QC reporting), and field sampling dates prior to field work. Requests for quick turnaround require advanced notice.

Be sure to complete the following checklist when ordering and receiving sample containers:

- Confirm list of analytes
- Confirm methods of analysis and minimum required sample volume

- Determine whether samples are to be field-filtered and/or field-preserved
- Order extra containers as a contingency
- Count the number and type of containers received
- Discuss hold times and shipping and receiving procedures
- Determine whether special instructions are needed in writing on the chain of custody (COC)

Once the groundwater samples have been collected and shipped, make practice of calling the laboratory as a courtesy to provide anticipated arrival dates and numbers of samples. Identify samples with short hold times or that may contain exceptionally high concentrations of compounds of concern. Keep a copy of the signed COC that was shipped with the samples, and also keep any documentation of the laboratory's receipt of COCs. Include a specific list of the analytes requested on the COC as this is used by the lab to confirm the appropriate analyses have been completed and/or reported.

2.1.4 Field Equipment

Select sampling equipment necessary to achieve the data quality objectives for the project. Inspect, calibrate, and decontaminate all equipment prior to use in the field according to SOP 07-11-01 (Equipment Calibration, Operation, and Maintenance), and SOP 07-04-09 (Equipment Decontamination). The following list provides an overview of some of the items typically needed in the field:

- Health and Safety Plan (HASP)
- First Aid Kit
- PPE (minimum Level D)
- Scope of Work
- Site Maps
- Well Keys/Site Access Keys
- Mobile Phone
- Camera
- Calculator
- Field Log Book/Field Forms
- Tools
- Chain of Custody Forms

- Custody Seals
- Sample Containers
- Cooler and Ice
- Strapping Tape
- Permanent Markers/Pens
- Ziploc® Baggies
- Paper Towels
- Plastic Sheeting
- Garbage Bags
- Water Level Meter
- Weighted Steel Tape
- Oil-Water Meter
- Calibrated Buckets
- Alconox® Soap
- Brushes
- De-ionized (DI)/Potable Water
- Water Quality Meters
- Calibration Solutions
- Calibration Standards
- Meter Operation Manuals
- Flow-Through Cell
- Calibrated Beakers/Cups
- Tubing (HDPE, Tygon®, silicon)
- Disposable Filters (barrel filters)
- Bladder Pump
- Bladder Pump Control Box
- Safety Line for Bladder Pump
- Disposable Bladders
- Check Valves, Catch Plates
- Air Compressor
- Peristaltic Pump
- Submersible Pump (Whaler®, other)
- Extension Cords
- Hose Clamps
- Portable Battery (automotive/marine)
- Alligator Clips
- Electric Tape
- Generator and Gasoline

2.1.5 Field Forms

Field-records of all purging and sampling procedures are kept either in field notebooks or on site-specific field forms. Field notes for groundwater sampling may include observations and documentation of well inspection, water level, equipment calibration, purging and sampling information, sample control logs, and chain of custody. Record-keeping requirements are described Section 4.1.

2.1.6 Waste Disposal

Contaminated purge water will be discharged as directed in the site-specific sample plan. If disposal is required, it should be arranged prior to the sampling event. A waste profile and permission from regulatory authority and wastewater operator may be needed to dispose purge water to a sanitary sewer, wastewater treatment facility, landfill, or on-site disposal facility.

3.1 Groundwater Sampling Procedure

This SOP describes steps to follow when performing the low-flow method using bladder or peristaltic pumps.

Sampling generally proceeds in the following fashion:

- Establish a safe working zone
- Assess well condition
- Measure depth to groundwater
- Measure depth to well bottom (except in some cases)
- Measure thickness of any non-aqueous phase liquids (NAPLs or DNAPLs), if present
- Calculate well volumes
- Purge the well
- Collect samples

- Label and pack samples on ice for shipping
- Decontaminate equipment
- Complete all record-keeping requirements, including COC
- Ship samples

3.1.1 Well Integrity

Assess the condition of monitoring wells and protective casings prior to sampling activities. Measure depth to well bottom and compare measurement to previous measurements. The presence of obstructions and bent or broken casing (risers) must be considered before lowering pumps or other equipment into the well. Make note of, photograph, and repair, if possible, any damage to the monitoring well. Replace any missing locks or pressure caps prior to leaving the site. Include a well condition report as a part of the groundwater sampling field notes. Refer to SOP 07-07-01 (Well Integrity) for additional instructions.

3.1.2 Depth to Groundwater

Record the depth to groundwater to the nearest 0.01 ft, relative to the reference point at the top of well casing. A notch or permanent marking at the top of well casings (typically PVC) commonly marks the reference point. Measure depth to groundwater beginning at the least contaminated well and proceed to the most contaminated well. Decontaminate the water level meter (probe) with laboratory-grade soap and potable or deionized water between each well location. Refer to SOP 07-07-05 (Groundwater Elevation Measurements) and SOP 07-04-09 (Equipment Decontamination) for additional instructions.

Take time to monitor whether the measured depth to groundwater represents static groundwater elevation. Pressure caps may prevent some water columns from equilibrating with atmospheric pressure; be alert for this condition when pressure caps are very tight or produce an audible popping or hissing noise when removed. Record these observations in field notes and return to the well several times to make additional measurements to determine whether the water level has equilibrated.

Groundwater with elevated specific conductance (conductivity) may also interfere with the accuracy of water level measurement due to meter sensitivity. Adjust the sensitivity of the water level meter to make an accurate measurement, however, try to use a consistent sensitivity setting from well to well. When groundwater elevation contour maps are to be prepared, collect synoptic depth to groundwater measurements (e.g. collect measurements consecutively at every site well in the shortest period of time possible and prior to any sampling activities).

3.1.3 Depth to Bottom

Measurement of depth to well bottom is also made with a water level meter or with a measuring tape with a weighted bottom. Measure the depth to well bottom to nearest 0.01 ft relative to the reference point. Adjust measurements to account for the length of the water meter probe housing which extends below the water level sensor or for the length of weight below the bottom of the tape, if any. Decontaminate measuring tapes and water level probes and the full length of measuring tape that entered the well casing with laboratory grade soap and potable or de-ionized (DI) water according to SOP 07-04-09 (Equipment Decontamination), prior to use at other wells.

Depth to bottom measurements should be avoided in situations when performing the measurement stirs up sediment settled in the well sump. If possible, wait to take depth to well bottom measurement until after sampling is completed, and/or rely on past measurement of depth to well bottom to calculate well volumes. Note on field forms when historical depth to bottom measurements are used.

3.1.4 Thickness of NAPLs

Where immiscible liquids, such as petroleum non-aqueous phase liquid (NAPL), is present on the surface of the water column, an oil-interface probe (oil-water meter) is used to measure NAPL thickness. Differing patterns of audible alarms indicate “oil” as opposed to water. Record the depth to NAPL and depth to water relative to the reference point at the top of well casing. Decontaminate the probe and length of measuring tape that entered the well casing with laboratory grade soap and potable or DI water before use at another well. Refer to SOP 07-04-09 (Equipment Decontamination) for more instructions.

NAPL thickness can also be estimated using a bailer (glass or plastic). Slowly lower the bailer into the top of the water column. Do not allow the bailer to fill completely. Retrieve the bailer, place on a bailer stand, and measure the thickness of product in the bailer. Record the measurement as an estimate.

3.1.5 Purging and Pumping Equipment

Bladder pumps (e.g. Well Wizard®), and suction (peristaltic) pumps are preferred when performing the low-flow method. In some cases, use of a combination of equipment is appropriate, because the type of pump selected for purging may not be appropriate for sampling.

The material construction of pumps should also be considered with respect to potential interferences. For example, the use of polyvinyl chloride (PVC) and polyethylene is discouraged when the detected concentrations of organic compounds is anticipated to be at or near laboratory detection limits, because organics may leach in and out of these materials. Teflon® and Teflon®-lined sampling devices are preferred in these cases.

3.2 Purging and Sampling Using the Low-flow Method

Using the low-flow (low-stress, micro-purge) method, groundwater is purged at rates affecting minimal to no drawdown which effectively isolates stagnant water in the well casing (riser) above the pump inlet. Depth to groundwater and water quality parameters (field parameters) should be monitored throughout the purging process. Pumping rates are adjusted to ensure that flow of groundwater to the pump is from the saturated formation and not from stagnant water in the well casing. Samples are collected once drawdown and water quality parameters stabilize.

Purging for the low-flow method is performed using either a peristaltic (suction) pump, or a bladder pump. Tubing and bladders should be Teflon® or Teflon®-lined, although non-lined high-density polyethylene (HDPE) tubing is appropriate for many compounds of concern. In some situations, low-flow methods may be performed using other submersible pumps (e.g. Grundfos®, Whaler®, Proactive®) and inertia pumps (e.g. WaTerra®); see Section 3.2.3 for potential data quality implications.

3.2.1 Using a Peristaltic Pump

A peristaltic pump is used at the ground surface to apply a suction force to lift water from the well through small diameter tubing. Maximum lift for peristaltic pumps is in the range of 15 to 29 feet; and, pumping rates range from less than 50 milliliters per minute (mL/min) to several gallons per minute (gal/min). Peristaltic pumps exert reduced pressure on the pumped water which can result in degassing and volatilization of the sample. Changes in pressure can affect pH, oxidation reduction potential (ORP), and other gas-sensitive parameters (ASTM D6634-01[2006]). As a result, USEPA recommends that peristaltic pumps not be used for low-flow groundwater sampling when depth to water exceeds 15 feet, especially when collecting samples for analysis of volatile organic compounds (VOCs).

3.2.2 Using a Bladder Pump

A bladder pump uses compressed air to squeeze a flexible membrane (bladder) that is contained in a rigid housing. Groundwater enters the bladder under hydrostatic pressure through a check valve, and compressed air supplied via small diameter air line compresses the bladder which forces water from the bladder to the surface through a small diameter water return line (the compressed air does not contact the water). Flow rate and air line pressure are regulated via an electronic control box. Pressure is applied in timed cycles, allowing the bladder to refill and compress at intervals appropriate for the depth, hydraulic conductivity of the saturated formation, and desired flow rate. Lift capacity of the pump is directly related to the pressure of the drive gas source.

Representative groundwater samples can be obtained for all analytes in nearly all field conditions using a bladder pump. Low-flow sampling with a bladder pump reduces the possibility for degassing, agitation, and volatilization of the sample, as compared to peristaltic or submersible pumps.

3.2.3 Using Other Pumps

Other submersible pumps (e.g. Grundfos®, Whaler®, ProActive®) are commonly used to purge groundwater from monitoring wells (i.e. for the well volume method) or to accomplish well development. However, they are not always appropriate for low-flow sampling. Some studies show that using submersible pumps to collect groundwater samples for analysis of VOCs generates analytical data similar to that for bladder pumps; however, the valves used to restrict the flow of submersible pumps reduce pressure potentially resulting in degassing of the sample. Submersible pump impellers also cause heat and turbulent flow which can also result in changes in water chemistry. Pump failures may also release contaminants (oiled parts, plastics, etc) into a monitoring well. Due to these limitations, bladder pumps are recommended over submersible pumps for low flow sampling, particularly for VOCs.

3.2.4 Field Procedure

The objective of the low-flow method is to perform low-stress pumping of a monitoring well to clearly document that samples represent groundwater entering the well from the screened formation at the depth of the pump inlet. To do so, the sampler must place the pump inlet at the appropriate depth, pump in a manner that minimizes stress to the formation, and monitor drawdown and groundwater quality parameters at regular intervals.

The low-flow field method is performed according to the following steps:

- Assemble equipment, (e.g. pumps, tubing, flow through cell, water quality instruments)
- Clean (decontaminate) all down-hole equipment
- Calibrate water quality instruments
- Measure initial depth to groundwater
- Place pump/pump inlet tubing at appropriate depth in the screened interval
- Begin pumping at an initial rate (typically 100 mL/min or less)
- Calculate minimum purge volume (time intervals) for parameter readings
- Monitor water level drawdown and water quality parameters
- Adjust pumping rate to minimize/stabilize drawdown
- Continue pumping until drawdown and water quality parameters stabilize
- Collect samples

Preparation

Clean all non-dedicated down-hole equipment according to SOP 07-04-09 (Equipment Decontamination) prior to measuring initial depth to water or lowering a pump or inlet tubing into the well. Non-dedicated bladder pumps should be disassembled, cleaned, and re-assembled; also remove and clean pump gaskets, check valves, and inlet screens. Clean, calibrate, and test water quality instruments (probes) according to the manufacturer's instruction manuals. Document calibration results at the beginning of the day and periodically throughout the day, according to the site-specific work plan. Flow through cells and containers for purge water should be assembled prior to the start of pumping. Lengths of tubing should be measured to match the depth at which the pump or pump inlet will be deployed in the well. If dedicated tubing is used (i.e. tubing that is left hanging inside a well casing), inspect and replace tubing, if compromised.

Depth of Pump Inlet

The appropriate depth of pump or pump inlet tubing depends on the hydrogeology of the screened formation and well construction details:

- In cases where the screen intersects a single soil/rock material, the pump inlet should be placed at the midpoint of the well screen

- In cases where the screen intersects multiple layers of soil/rock material or fractured rock, the pump inlet should be placed at a depth intersecting the layer expected to have the highest hydraulic conductivity

- Where zones of contamination are known or assumed to occur at specific depths, the depth of pump inlet should match the depth of contamination. For example, petroleum compounds often accumulate in smear zones near the water table interface – pump inlets placed at the midpoint or near the bottom of well screen may not provide a representative sample in this instance.

- Do not place the pump inlet at or near the well bottom, because pumping near the well bottom can mobilize solids settled in the well sump.

- Do not place the pump inlet at or above the top of the well screen, because low-stress pumping would capture stagnant water in the well casing rather than formation water.

Pumping Rate

The initial pumping rate should be 100 mL/min or less. Lower hydraulic conductivity units (i.e. clay) should be pumped at lower initial flow rates; higher hydraulic conductivity units (i.e. sand) can be pumped at higher initial flow rates. Adjust the pumping rate to be as low as practicable, to achieve stabilization of water quality parameters without inducing significant drawdown (e.g. without pumping stagnant water from the well casing). Do not induce continuous drawdown. Pumping rates at which water level stabilization can be achieved range generally from 100 to 500 mL/min. Samples must not be collected using a pumping rate that exceeds the pumping rate at which stabilization was achieved. Conceptually, once flow rate and water quality parameters have stabilized, a direct connection to the aquifer has been established, and any changes or disruptions to flow rate could break that connection and result in stagnant water being included in the samples.

The optimal pumping rate that will achieve stabilization for drawdown and water quality parameters will be specific to each well. Do not attempt to pump every well at a site at the same pumping rate. Use historical sampling information to replicate pumping rates for specific wells, as appropriate.

Monitoring Drawdown

Depth to water in the monitoring well should be monitored at 1 to 2 minute intervals until water level stabilization occurs and periodically afterwards. Drawdown during the course of pumping and sampling should not exceed 25% of the distance between the top of screen and pump inlet. Also, the volume of water pumped that is attributable to drawdown (stagnant water pumped from the well casing) should not exceed 10% of the total volume of water pumped. Some wells, especially those screened in clay, may not achieve water level stabilization (i.e., the water level continues to drop even at flow rates less than 50 ml/min). If this occurs, contact the field leader and Project Manager to discuss alternative methods for sample collection such as completely purging the well and returning to collect the sample once the well has recovered, or using a passive sampling method.

Monitoring Water Quality Parameters

Water quality parameters that provide evidence that formation-quality water is being pumped include pH, temperature, conductivity (specific conductance), dissolved oxygen, and oxidation-reduction potential (redox, or ORP, also measured as Eh). Turbidity, discussed below, may also be a useful field parameter.

Record these parameters continuously (if possible) or at regular time intervals using a closed flow through cell or similar instrumentation. Use a small volume flow through cell and monitor the cell for air bubbles (leakage).

The frequency of water quality parameter measurements should be not less than the time needed to evacuate the volume of the in-line flow through cell. Also determine the volume of water contained in the pump (i.e. bladder volume) and discharge tubing. Consider increasing time intervals to account for these volumes, especially when pumping rates are slow and/or the depth to pump inlet is significant. In instances where water quality parameter stabilization occurs quickly, be sure to also allow enough time for individual water quality instruments to stabilize (check manufacturer's recommendations). Dissolved oxygen sensors, for example, typically take longer to stabilize than pH, temperature, conductivity, and ORP sensors.

Stabilization of water quality parameters is achieved when three consecutive readings, several minutes apart, fall within the criteria listed below. These criteria are consistent with ASTM D6771-02: however, they may not apply to all sites. Site-specific parameters and criteria may be established to account for variations in aquifer properties, groundwater chemistry, well hydraulics, and contaminant distribution.

Field-Measured Parameter Stabilization Criteria for Groundwater

Parameter	Stabilization Criteria
Conductance, Specific Electrical	+/- 3% µS/cm @ 25°C
Dissolved Oxygen	+/- 10% of reading or +/- 0.2 mg/L, whichever is greater
Oxidation-Reduction Potential	+/- 20 mV
pH	+/- 0.2 standard units
Temperature	+/- 0.1°C
Turbidity	<10 NTUs or ± 10% when turbidity is greater than 10 NTUs

Notes: µS/cm = micro Siemens per centimeter
°C = degrees Celsius
mg/L = milligrams per liter
mV = millivolts
NTUs = nephelometric turbidity units

Turbidity

Turbidity is indicative of the stress pumping places on the screened formation. Measure turbidity with the same frequency (time intervals) as other water quality parameters or, at a minimum, at the beginning of pumping and again prior to collecting a sample. Ideally, low-flow purging should proceed until turbidity is less than 10 NTU, however, turbidity greater than 10 NTU can be natural and unavoidable. Analytical bias can occur for samples collected with turbidity greater than natural conditions.

When turbidity increases during pumping, too much stress is being placed on the well – lower the pumping rate. If the turbidity remains high, stop pumping and allow the well to rest without removing the pump. Resume pumping at a low rate and monitor turbidity for stabilization. As noted above, natural turbidity may remain higher than targeted stabilization criteria.

To minimize initial turbidity, carefully lower pumps and tubing into the monitoring well to avoid stirring sediment that has settled at the well bottom. Turbidity and other water quality parameters will typically stabilize more quickly when using dedicated pumps.

3.2.5 Sampling

When using the low-flow method, disconnect the flow cell without shutting off the pump and collect samples directly from the discharge tubing using the same pumping rate as was used to achieve stabilization. Use tubing appropriate for the compounds of concern. Collect samples for analysis of the most sensitive parameters first, and collect samples requiring field filtration last. Sampling protocol is described in detail in Section 3.3.

Be aware of potential quality control issues when collecting samples using the low-flow method:

- Samples should not be collected using a pumping rate greater than the purging/stabilization rate
- Once stabilization has been achieved do not disrupt the connection to the groundwater in the formation by shutting off the pump or changing the flow rate

- When collecting samples for analysis of VOCs, pump at a rate less than 250 mL/min, and avoid aerating groundwater in pump tubing or flow through cell
- Some chemical constituents may leach to tubing
    - Teflon® or Teflon®-lined tubing is preferred for samples that will be analyzed for VOCs, SVOCs, pesticides, and PCBs
    - HDPE or polypropylene tubing may be used for metals and other organics
    - Siliclastic (silicon) tubing should be less than 1 foot in length (when used with peristaltic pumps and when used with barrel filters)
- Shade equipment and tubing to avoid direct sunlight and warm ambient air temperatures

Field Forms

Field forms or field notes should record the following information, in addition to site and well information, to document water level and water quality parameter stabilization during low-flow pumping and sampling:

- Type, make, and model of pumping and water quality instruments
- Equipment calibration (include copies of calibration certificates as appropriate)
- Decontamination procedures
- Depth of pump or pump inlet
- Volumes of flow through cell, discharge tubing, and pump (bladder)
- Initial pumping rate and time intervals
- Drawdown, stabilized water level, and pumping rate at stabilization
- Field-measured water quality data at regular time intervals during purging
- Time and pumping rates for all measurements
- Rate of pumping at time of sample collection

Section 4.1 describes in detail the record keeping requirements to follow when groundwater sampling.

Instrument Error

Instruments suspected of producing erroneous readings should be recalibrated. If the values obtained continue to be outside normal ranges, troubleshoot or replace the instrument. If the instrument cannot be replaced and provides data critical to performing and documenting the purging procedure, notify the Project Manager. Do not discard the samples, if collected. Flag any out of range data recorded in field notes using an asterisk and a written description of the occurrence. Deviation from standard field procedure, use of alternate equipment, or re-sampling may be required to determine whether anomalous readings were the result of mechanical or human error and to ensure documentation of the collection of an epresentative sample.

3.3 Collecting Samples

Representative samples are collected when the monitoring well is purged according to the requirements of the standard procedure and when the sample is appropriately collected, preserved, handled, shipped, and analyzed. Groundwater samples must be collected in the appropriate order, field-filtered and field-preserved according to analytical methods, accompanied with quality assurance/quality control (QA/QC) samples, immediately preserved on ice, and shipped with the appropriate chain-of-custody documentation.

3.3.1 Sampling Order

Collect samples according to analyte stability, as summarized below, unless otherwise specified in a site-specific work plan or field sampling plan:

- Volatile organic compounds (VOCs)
- Semi-volatile organic compounds (SVOCs)
- Non-filtered, non-preserved samples (e.g. PCBs, pesticides, sulfate)
- Non-filtered, preserved samples (e.g. phenols, nitrogen, total metals, organic carbon)
- Available cyanide (follow lab provide cyanide kit direction for collection of sample)

- Filtered, non-preserved samples (e.g. chromium IV)
- Filtered, preserved samples (e.g. dissolved metals)
- Miscellaneous parameters

In addition, collect samples for sulfate analysis before collecting sulfuric-acid preserved samples (e.g. nitrogen), and collect samples for nitrogen compound analysis before nitric-preserve samples (e.g. dissolved metals).

3.3.2 Filling Sample Containers

Observe the procedures and cautions below when filling sample containers:

- Take precautions when handling acid preservatives or opening containers pre-filled with acid preservatives, according to the site-specific Health & Safety Plan (HASP).
- Remove sample container lids carefully. Do not touch the inside of the lid or the Teflon® lid septum, and do not place the lid on the ground.
- If containers, lids, or Teflon® septum come in contact with the ground or any other contaminated surface, carefully rinse the object with sample water; replace septum facing the sample.
- Fill sample containers with the appropriate preservative, volume, and headspace.
- Do not allow discharge tubing to come in contact with the inside of the sample container.
- Minimize sample contact with the atmosphere and collect samples away from possible sources of cross-contamination such as vehicle or equipment exhaust.
- Overfill containers used for VOC analysis (40 ml HCL-preserved glass vials) to eliminate air bubbles. Slowly fill the vial until surface tension (convex water surface) is maintained at the top of the vial. Replace the cap gently and invert the vial to check for air bubbles. Open the vial and add more water to the existing sample, if necessary, to eliminate air bubbles. Do not empty the bottle and refill.

3.3.3 Field Filtering

Use an in-line disposable 0.45 micron (µm) filter, or equivalent, to filter groundwater samples for which the analytical method requires field-filtering. When using a pump, connect the filter directly to the pump discharge tubing, and pump a small volume of sample volume through the filter before beginning to fill the sample container. Collect a field/equipment blank whenever collecting field-filtered samples.

Follow these procedures when field-filtering groundwater samples:

- Filter samples immediately in the field; if field conditions prevent field-filtering, filter samples as soon as possible or instruct the analytical laboratory to filter samples upon receipt
- Use disposable filters (i.e. Geotech® barrel filters) to eliminate cross-contamination
- Do not re-use disposable filters
- Do not re-use temporary containers/pre-filtration containers.
- Note the size and material (i.e. 500 mL polyethylene carboy) of pre-filtration containers

3.3.4 Sample Preservatives and Hold Times

Samples are to be field-preserved, if necessary, immediately after filtering or immediately after sample collection if not filtered. Pre-measured volumes of preservatives should be added to the sample bottle prior to sampling. In most cases, laboratory-supplied containers are provided with pre-measured preservatives already placed in the containers. Arrange for timely shipment of samples with short hold times.

3.3.5 QA/QC Samples

SOP 07-04-07 (Quality Control Samples) describes the intended use and collection methods for quality control samples that should be used to evaluate field and laboratory quality control procedures and the precision, accuracy, representativeness, and comparability of data obtained from groundwater samples. Deviation from the Quality Control SOP should be clearly identified in site-specific Workplan, Field Sampling Plan (FSP), or Quality Assurance Project Plan (QAPP).

The following QA/QC samples should be considered and collected, as necessary:

QA/QC Sample Type	**Application**
Field Duplicate	Compares differences in analytical results for identical (duplicate) samples
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	Evaluates effect of sample matrix on analytical results
Trip Blank	Identifies contribution/introduction of contaminants during shipment/transport
Temperature Blank	Verifies proper sample transport temperature
Equipment Blank	Determines effectiveness of in-field decontamination procedures (also known as Rinseate Blank)
Field Blank	Identifies possible environmental cross-contamination

4.1 Record Keeping/Field Forms

Field-records of all purging and sampling procedures are kept either in NRT notebooks or on site-specific field forms. Electronic copies of field notes and should be made and saved to the project directory on NRT's electronic server (typically these notes are stored in the same folder as the laboratory analytical results). Sample control logs and sample identification numbers are to be completed and assigned according to SOP 07-03-01 (Sample Labeling and Storage) and SOP 07-03-05 (Sample Location, Identification, and Control).

4.1.1 Field Notebook

At a minimum, the following information should be recorded in a field notebook, on groundwater sampling forms, or on a site/project-specific groundwater sampling forms:

- Weather conditions
- Well condition
- Size, diameter, and well casing material
- Water level, relative to top of well casing
- Depth to bottom, or historical depth to bottom, relative to top of well casing
- Thickness and/or presence of any NAPLs

- Calculation of well volumes
- Time when purging begins
- Purge method (e.g. bailed, pumped)
- Initial color, odor, and clarity of purge water
- Initial water quality parameter data (e.g. pH, temperature, conductivity, ORP, turbidity)
- Time intervals, water levels, water quality parameters, pumping rate, and cumulative purge volumes (if low-flow sampling)
- Sample collection time
- Water quality parameters at the time of sample collection
- Number and type of sample containers
- Method and type of field-filtration and/or field-preservation
- Sample identification number and lab identification/chain of custody number
- Name and manufacturer of any equipment used
- Calibration results
- Description of decontamination procedures
- Total purge volume
- Location where purge water is disposed (e.g. discharge to ground or contained in drum)
- If drums are used, note the location and number of drums stored on site

4.1.2 Chain of Custody

The parameters to be analyzed are to be listed for each sample on the Chain-of-Custody (COC) as is described in SOP 07-03-03 (Chain of Custody). The COC should also clearly identify the specific USEPA-approved method of analysis to be performed on each sample, provide the specific list of analytes to be reported (e.g., list specific metals or aroclors to be reported), and provide any special instructions. For example, samples that require laboratory filtering, samples that contain known interferences with the analytical method, samples expected to contain unusually elevated concentrations of compounds, and samples with short hold times, should be clearly identified.

4.1.3 Packing and Shipping

Samples are to be placed on ice immediately after sample collection, and packed and shipped according to SOP 07-03-09 (Shipping). Samples are always shipped to the laboratory or any other facility under COC-procedure and using custody seals. When using a courier, obtain driver signatures on the COC. Ship groundwater samples in compliance with all applicable requirements for shipping hazardous and/or dangerous materials.

References

ASTM International, D4448-01 Standard Guide for Sampling Groundwater Monitoring Wells

ASTM International, D5903-96(2001) Standard Guide for Planning and Preparing for a Groundwater Sampling Event

ASTM International, D6089-97(2003)e1 Standard Guide for Documenting a Ground-Water Sampling Event

ASTM International, D6301-03 Practice for the Collection of Samples of Filterable and Nonfilterable Matter in Water

ASTM International, D6452-99(2005) Standard Guide for Purging Methods for Wells Used for Ground-Water Quality Investigations

ASTM International, D6564-00(2005) Standard Guide for Field Filtration of Ground-Water Samples

ASTM International, D6634-01 Guide for the Selection of Purging and Sampling Devices for Ground-Water Monitoring Wells

ASTM International, D6771-02 Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia, www.epa.gov/region4/sesd/eisopqam/eisopqam.html.

USEPA, 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Manager, Region 5 and Region 10, EPA 542-S-02-001.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

Prepared By:	TBN	Date Prepared:	10/21/13
Corporate Officer:	BRH	Date Approved:	11/22/13

GROUNDWATER and NAPL ELEVATION MEASUREMENTS

1.1 Scope and Application

This standard is applicable to the collection of groundwater and non-aqueous phase liquid (NAPL) elevation measurements. Refer to project-specific documents (workplans) for variances to this SOP.

1.2 Health and Safety Warnings

Follow Natural Resource Technology, Inc. (NRT) Health and Safety standard operating procedures when working with potentially hazardous material or with material of unknown origin. Project Health and Safety Plans will contain additional practices, if necessary, to mitigate site-specific hazards.

1.3 Preliminary Procedures

Specific measurements during a sampling event, such as water level and depth of well, and observations of well condition should be documented in a field book or field form. The well shall be visually inspected and any damage that could permit surface water infiltration into the well must be noted and documented in accordance with Well Integrity Evaluation and Maintenance SOP 07-07-01.

1.4 Groundwater Level Measurements

Measurement of the static water level is taken prior to well purging and sample withdrawal. The elevation of the groundwater is determined by the following equation:

Groundwater Elevation = Top of Casing Elevation - Depth to Water

Measurements will be in units consistent with the units and datum used to survey the measurement point on the well.

All well measurements must be made from the point at which the elevation was measured (e.g., top of well casing). This point must be noted in the comments section of field notes or forms. Measurements shall not be made relative to protective casings, which are subject to frost heave.

1.4.1 Groundwater and NAPL Elevation Measurements

If wells have not been equipped with dedicated systems containing static head sensors (pressure transducers) or similar devices, then a water level indicator or oil/water interface probe shall be used to determine the static level of water in the well and to measure the total depth of the well. An oil/water interface probe should not be used to collect water level readings from wells that do not contain NAPL. Lead weight water level indicators should not be used.

When the indicator probe contacts the water, dependent upon the model, a series of beeps or a continuous beep will sound. If using an oil water interface probe a different sound will indicate the presence of NAPL. The following steps are for measuring groundwater and NAPL:

1. When groundwater elevation contour maps are to be prepared, collect synoptic depth to groundwater measurements (e.g. collect measurements consecutively at every site well in the shortest period of time possible and prior to any sampling activities).
2. Done PPE as required by the HASP.
3. Clean the water level indicator or oil/water interface probe and cable in accordance with SOP 07-04-09. As with other activities it is preferred to start collecting readings from the cleanest wells and end with the most contaminated wells to reduce the risk of cross-contamination. Decontaminate the water level indicator (probe) with laboratory-grade soap and potable or deionized water between each well location.
4. If NAPL is known to be present in the well, it is recommended to place a piece of plastic sheeting and absorbent pads adjacent to the well to use as a clean work area. Cut a hole in the center of sheeting and place the sheet around the well.
5. If light or dense non-aqueous phase liquid (LNAPL or DNAPL) and/or an absorbent sock is present in the well (based on a review historical data, if available), place enough absorbent pads on the plastic sheet beside the well to absorb oil that may be present when the absorbent sock and oil/water interface probe is removed from the well.

6. Unlock and open the well cover while standing upwind of the well. Remove well cap. If PID readings are required by the workplan, insert the PID probe approximately 4 to 6 inches into the casing of the well headspace and cover with gloved hand. Record the PID reading on the field log.

7. Locate the measuring reference point on the well casing. If one is not found, initiate a reference point by notching the inner and outer casings with a hacksaw or by using a waterproof marker. All down-hole measurements will be taken from the reference points.

8. Take time to monitor whether the measured depth to groundwater represents static groundwater elevation. If the well is not vented, then pressure caps may prevent some water columns from equilibrating with atmospheric pressure; be alert for this condition (sometimes indicated by an audible popping or hissing noise when the cap is removed) in non-vented wells. Record these observations in field notes and return to the well as needed to make additional measurements to determine whether or not the water level has equilibrated.

9. If an absorbent sock is already in the well, note the presence of the sock on the log, remove the absorbent sock, and make a qualitative estimate of the volume of LNAPL present in the absorbent sock. Proceed to Step 12 after the well has equilibrated (wait up to 1 hour before measuring LNAPL thickness and water level).

10. Record the inside diameter of the well casing on the field log.

11. For wells that do not contain NAPL, measure the depth to water to the nearest 0.01 foot using a water level indicator. Confirm the measurement by gently raising and lowering the water level indicator to collect several readings, record the confirmed depth to water in the field notes.

12. At all locations containing LNAPL, except those monitoring wells containing highly viscous LNAPL (see note below), lower the oil/water interface probe into the well to determine the existence of any light immiscible layer. Carefully record the depths of the air/light-phase and light-phase/water interfaces (to the nearest 0.01 foot) to determine the thickness of the light-phase immiscible layer (if present). If no light-phase immiscible layer is present, record the depth of the air/water interface and inspect the probe for NAPL residue and note the presence/absence of the residue on the probe in the field notes. In the absence of an oil/water interface probe, NAPL thickness can also be estimated using a bailer (glass or plastic). Slowly lower the bailer into the top of the water column. For LNAPL measurements, do not allow the bailer to fill completely. For dense non-aqueous phase liquid (DNAPL) measurements allow the bailer to drop to the bottom of the well. Retrieve the bailer, place on a bailer stand, and measure the thickness of product in the bailer. Record the measurement as an estimate.

    Note: Use extreme caution when gauging monitoring wells with highly viscous LNAPL. Highly viscous LNAPL is difficult to remove from sampling equipment. To gauge viscous LNAPL depths, mark a section of PVC pipe at 1-foot intervals to estimate location of the pipe within the well and slowly lower pipe into the well until reaching the fluid/air interface. Mark the PVC pipe at the top of casing (TOC) and slowly remove. Measure difference between the uppermost limit of

LNAPL on the pipe (if present) and the mark made at the TOC. The difference is the top of LNAPL. To get depth to water, use two sections of PVC pipe that when put one inside the other will also fit down the 2-inch diameter well (e.g., ¾” diameter pipe inside a 1½” diameter pipe). Make sure that the ¾” pipe is at least 6 inches longer than the 1½” pipe). Tape the bottom of the two pipes such that the tape can be easily removed–but not lost into the bottom of the well, and can be lowered through the LNAPL/water interface. Slowly lower the two pipes into the well until reaching the bottom of the well. Push the ¾” pipe through the 1½” pipe to remove the tape and allow groundwater to enter pipes. Remove the ¾” diameter pipe and allow the water level to equilibrate inside the 1½” pipe (wait up to 1 hour before measuring). After allowing the well to equilibrate, gauge the water level in the well as detailed above.

13. At locations known to contain DNAPL it may not be appropriate to use an oil/water interface probe because DNAPL tends to be difficult to remove from equipment. It is recommended to use dedicated or disposable equipment for recording DNAPL thickness to reduce decontamination time and reduce the risk of cross contamination. DNAPL measurements should be collected after a groundwater sample is collected, if any. It is recommended to collect DNAPL measurements using the following method:

    a. Purchase a stainless steel hex nut from the hardware store.

    b. Tie the nut to the end of some white nylon rope.

    c. Carefully lower the rope and nut into the well stop as soon as the nut reaches the bottom of the well. Mark the rope at the top of the casing and carefully remove the rope and nut.

    d. Record the thickness of DNAPL staining on the white rope (this is DNAPL thickness). The measurement from the mark at the top of the casing to the top of the DNAPL staining is the depth to DNAPL measurement. Note that DNAPL may enter the well from any portion of the screened interval and accumulate in the bottom of the well, so this depth and thickness reading should not be used to make statements about the thickness and elevation of DNAPL in the formation around the well.

    e. The stainless steel nut and nylon rope should be disposed of as investigative derived waste along with gloves, paper towels, and oil absorbent materials in accordance with the HASP and/or workplan.

1.4.2 Depth of Well Measurements

This measurement is required at well construction to determine purge volumes and at least annually to evaluate well integrity. If sampling is conducted less frequently than once a year, well depth will be measured during each sampling event. Wells with dedicated pumps are exempt from this measurement. The depth of well, when not field measured, should be obtained from the Well Construction Log and noted on the Well Purge form and also noted in the comments section, as being "from the Well Construction Log".

Measurement of depth to well bottom is made with a water level meter or with a measuring tape with a weighted bottom. Measure the depth to well bottom to nearest 0.01-ft relative to the reference point. Adjust measurements to account for the length of the water meter probe housing which extends below the water level sensor or for the length of weight below the bottom of the tape, if any. Depth to bottom measurements should be avoided in situations when performing the measurement stirs up sediment settled in the well sump. If possible, wait to take depth to well bottom measurement until after sampling is completed, and/or rely on past measurement of depth to well bottom to calculate well volumes.

1. After recording the static water level and collecting groundwater samples (if any), unroll the cable or tape until it hits the bottom of the well
2. Slowly pull up the slack until slight tension is felt on the cable
3. Slowly raise and lower until a feel for the bottom is obtained
4. Record the total well depth measurement in field notebook or forms
5. Decontaminate the indicator and length of measuring tape used to collect the reading in accordance with SOP 07-04-09

1.6 References

ASTM Standard D3415, 1998 (2011), “Standard Practice for Identification of Waterborne Oils,” ASTM International, West Conshohocken, PA, 2011, DOI: 10.1520/D3415-98R11, www.astm.org

USEPA, Field Branches Quality System and Technical Procedures, Region 4, Science and Ecosystem Support Division, Athens, Georgia, http://www.epa.gov/region4/sesd/fbqstp/

Prepared By:	TBN	Date Prepared:	12/31/12
Corporate Officer:	BRH	Date Approved:	1/3/14

WELL INTEGRITY EVALUATION AND MAINTENANCE

1.1. Scope and Application

This standard is applicable to evaluation of well integrity and maintenance. A well integrity evaluation identifies wells that are not suitable for obtaining hydraulic and/or groundwater quality information because of their physical condition. The evaluation may involve both visual inspection and hydraulic testing. Results of the evaluation are used to determine whether or not a well is functional or requires rehabilitation (Section 1.6) or abandonment (SOP 07-05-07). Well integrity evaluations shall be completed on an "as needed" basis or may be scheduled as part of a project work plan or groundwater monitoring plan. Refer to project-specific documents for variances from this SOP.

1.2. Health and Safety Warnings

Follow Natural Resource Technology, Inc. (NRT) Health and Safety standard operating procedures when working with potentially hazardous material or with material of unknown origin. Project Health and Safety Plans will contain additional practices, if necessary, to mitigate site-specific hazards.

1.3. Equipment

- Site map with well locations
- Notebook, well inspection form, hydraulic test form, well construction logs, other field forms
- Digital camera
- Shovel
- Tape measure
- Electronic water level probe, pressure transducer, and automatic data logger

- Bailer with rope, suction pump, down-hole pump, or solid PVC or steel slug
- Personal protective equipment
- Calibrated bucket
- Differential Global Positioning System (DGPS) unit or equivalent GPS unit with sub-meter accuracy
- Groundwater elevation table, if available
- Monitoring Well Evaluation Checklist (Attachment A)

1.4. Physical Inspection

Each well location must be compared to the location shown on the site map. If necessary, resurvey and adjust the location on the map. The physical condition of the well is determined by visually inspecting the well and completing the monitoring well inspection form (attached). Specific items of concern are the visible well construction materials, the use of any substances in the well construction that may result in contamination of the well, the condition of surface seals, drainage from the well, and well security. Any damage that could permit surface water infiltration to the well will be noted. A photograph of each well may be taken, with a clearly visible well identification number, to document the inspection.

Depth to water and total well depth will be measured and compared with the well depth in the well construction log and depth to groundwater on the Groundwater Elevation Table. A bailer or slug will be lowered into the well to identify obstructions or damage to the well screen or casing that requires well maintenance or rehabilitation. Any sediment present at the bottom of the well will be noted.

If hydraulic conductivity testing was previously performed on the well, a single well aquifer test (SOP-07-07-11) may be performed to determine if silt has decreased the well hydraulic conductivity, indicating that well maintenance or rehabilitation may be necessary for collection of representative data. The results of the single well aquifer test will be compared to previous aquifer tests to determine if hydraulic conductivity has decreased.

1.5. Data Evaluation

The visual inspection and available aquifer test data will be used to identify any defects, inconsistencies, or other problems with the well. The boring/well construction logs will also be reviewed to assess the appropriateness of the installation relative to the intended use of the well.

Additionally, the construction log should be carefully reviewed for compliance with code requirements, such as state regulations. Any deviations should be noted and their significance evaluated with respect to the well's ability to achieve the desired data quality objective.

1.6. Well Maintenance and Rehabilitation

Deficiencies or damage will be evaluated on a case-by-case basis. Well maintenance or rehabilitation that cannot be implemented at the time of inspection will be implemented within a reasonable period of time. Well maintenance or rehabilitation may include, but is not limited to:

- Replacement of aboveground components
- Silt/sediment removal
- Well surging and redevelopment
- Biomass removal and/or cleaning with an approved biocide (well shock)
- Repair or replace well equipment (e.g., pumps)

If deficiency or damage cannot be corrected through well maintenance or rehabilitation, the well may be abandoned in accordance with SOP 07-05-07 and applicable federal, state, and local regulations. Abandoned wells critical to site activities and/or operations will be replaced.

1.7. Documentation

Inspection, maintenance, and rehabilitation activities will be recorded in a field log book and/or on the appropriate field forms.

1.8. References

ASTM Standard D6089, 1997 (2010), “Standard Guide for Documenting a Groundwater Sampling Event,” ASTM International, West Conshohocken, PA, 2010, DOI: 10.1520/D6089-97R10, www.astm.org

ASTM Standard D4448, 2001 (2007), “Standard Guide for Sampling Groundwater Monitoring Wells,” ASTM International, West Conshohocken, PA, 2007, DOI: 10.1520/D4448-01R07, www.astm.org

USEPA, Field Branches Quality System and Technical Procedures, Region 4, Science and Ecosystem Support Division, Athens, Georgia, http://www.epa.gov/region4/sesd/fbqstp/

ATTACHMENT A

MONITORING WELL EVALUATION CHECKLIST

Monitoring Well Evaluation Checklist

Site ______________________

Inspection Date __________

Well Number __________

Major wells repairs* required to maintain well integrity?	Yes	No	NA

Stick-up Monitoring Wells				**Comments**
1. Outer protective Casing	Yes	No	NA	
Not corroded				
Not dented				
Not cracked				
Not loose				

2. Inner casing	Yes	No	NA	
Not corroded				
Not dented				
Not cracked				
Not loose				
	Yes	No	NA	
3. Are there weep holes in outer casing?				
4. Weep holes able to drain?				
5. Is there a lockable cap present?				
6. Is there a lock present?				
7. Bumper posts in good condition?				

Flushmount Monitoring Wells	Yes	No	NA	
8. Can the lid be secured tightly?				
9. Does the lid have a gasket that seals?				
10. No water in the flushmount?				
11. Is the well cap lockable?				
12. Is there a lock present?				

All Monitoring Wells	Yes	No	NA	
Downhole Condition				
12. Water level measuring point clearly marked?				
13. No obstructions in well?				
14. No plant roots or vegetation in well?				
15. No sediment in bottom of well?				
If present, how much sediment?	ft			
16. Installed as total depth.	ft			
17. Measured total depth of well.	ft			

General Condition	Yes	No	NA	
18. Concrete pad installed?				
19 . Concrete pad				
Slope away form casing?				
Not deteriorated?				
Not heaved or below surrounding grade?				
20. No surface seal settling?				
21. Well clearly visible and labeled?				

Comments:

* Major well repair are those that require a subcontractor or separate mobilization to complete

\\pewfle\wdrive\Associations and Committees\Internal\QA Committee\NRT SOPs\07 Field Procedures\Revised SOPs\07-07 Groundwater Sampling and Measurement Procedures\07-07-01 Attachment_Monitoring Well Inspection Form

NATURAL
RESOURCE
TECHNOLOGY

Name:	Field Instrument Calibration, Operation, and Maintenance
Section:	Field Procedures
Number:	07-11-01
Revision:	0
Effective Date:	01/01/2014
Page:	1 of 3

Reviewed By:	JJW	Date Reviewed:	08-20-2012
Corporate Officer:	RHW	Date Approved:	12-02-2013

FIELD INSTRUMENT CALIBRATION, OPERATION, AND MAINTENANCE

1.1 Scope and Application

This procedure describes guidelines for the calibration, operation, and maintenance of field instruments.

1.2 Health and Safety Warnings

Follow Natural Resource Technology, Inc. (NRT) Health and Safety standard operating procedures when working with potentially hazardous material or with material of unknown origin. Project Health and Safety Plans will contain additional practices, if necessary, to mitigate site-specific hazards.

1.3 Equipment

- Measurement and testing equipment
- Instrument operation manual
- Instrument case and necessary appurtenances (e.g., battery charger and attachments)
- Calibration standards (e.g., standard gases and pH fluids)

1.4. Background

Instrument operators must be familiar with the operation of the field instrument being used. Operators will obtain appropriate training before using the instrument in the field. If user certification is required for an instrument, it must be obtained prior to using the instrument in the field.

Instruments must be uniquely identified, such as with a serial number, and that identifier will be recorded in the field notes. Manufacturer’s guides and/or operation manuals will be kept with the instruments for reference at all times.

1.5. Calibration

Field instruments must be calibrated according to the manufacturer's specifications prior to initial use. The instrument shall be recalibrated according to the following:

- The manufacturer's recommended calibration frequency
- After long periods of inactivity between uses
- When readings are observed above/below the instrument range
- If signs or evidence of equipment malfunction are observed

Daily calibration and recalibration activities will be recorded in the field logbook or on appropriate field forms. At a minimum, the following information will be recorded:

- Date and time of calibration
- Instrument make, model, and manufacturer
- Instrument identifier (e.g., serial number or unique inventory number)
- Calibration method
- Calibration standards used
- Any deviation from the manufacturer's recommended procedures or calibration frequency

1.6. Operation

Instruments will be operated in accordance with the manufacturer's instructions. Readings, malfunctions, and deviations from standard operating methods will be documented in the field logbook or on appropriate field forms.

1.7. Maintenance

Instruments will be maintained in accordance with the manufacturer’s recommendations. Malfunctioning instruments, or those scheduled for routine maintenance, will be clearly labeled to prevent further use until maintenance is completed. Rentals instruments are not to be maintained by NRT and it will be returned to the supplier if repair or maintenance is required. A replacement instrument will be requested if needed. Supporting calibration and maintenance documentation from the supplier will be scanned and saved in the project folder with associated field notes from the sampling event.

Maintenance for instruments owned by NRT will be tracked and recorded on a dedicated log that will contain the following information:

- Instrument make, model, and manufacturer
- Instrument identification (e.g., serial number or unique inventory number)
- Recommended maintenance and frequency
- Status (e.g., operational, out of service for repair/maintenance, not operational)
- Dates of status change
- Dates of inspection, maintenance, or repairs

Documentation of maintenance for NRT-owned equipment will be stored in a file in the warehouse which is maintained by the warehouse manager.

Prepared By:	THC	Date Reviewed:	7/31/2013
Corporate Officer:	BRH	Date Approved:	1/3/2014

GROUNDWATER SAMPLING

1.1 Scope and Application

This Standard Operating Procedure (SOP) describes commonly-used groundwater sampling methods and identifies routines to follow when collecting samples from monitoring wells. Guidance documents and SOPs published by the United States Environmental Protection Agency (USEPA) and ASTM International provide the foundation for this SOP. Procedures outlined below are intended to ensure that representative samples are collected in ways that are safe, technically defensible, easily replicated, appropriate for the selected analytical methods, and sensitive to site-specific conditions and hydrogeology. Refer to project-specific documents for variances from this SOP.

1.2 Summary of Methods

This SOP describes two methods that are most-commonly used to purge and sample groundwater from monitoring wells: 1) well volume method, and 2) low-flow (low-stress or micro-purge) method.

1.2.1 Well Volume Method

Using the well volume method, a pre-determined volume of groundwater is purged from the monitoring well to remove stagnant water from the well’s casing (riser pipe). Typically a minimum of 3 well volumes of groundwater is removed; however, modification (reduction) of the minimum number of purge volumes is acceptable when water quality parameters (field parameters) are monitored at regular intervals during purging. Samples are collected when the minimum purge volume has been removed and/or when water quality parameters stabilize within acceptable limits.

1.2.2 Low-flow Method

Using the low-flow method, groundwater is purged (pumped) from a monitoring well at low flow rates that result in minimal drawdown. Depth to groundwater and groundwater quality parameters (field parameters) are monitored throughout the purging process. Pumping rates are adjusted to ensure groundwater entering the pump is from the screened formation and not from stagnant water in the well casing above the pump inlet. Samples are collected when drawdown and groundwater quality parameters stabilize within pre-determined criteria.

1.3 SOPs for Related Tasks

This SOP applies only to sampling groundwater from monitoring wells. Sampling methods for drinking water wells, surface water, pore water, leachate, and other liquid wastes are not described in this SOP.

However, this groundwater sampling SOP requires adherence to other SOPs for closely-related tasks, some of which are referenced herein:

▪ SOP 07-07-01	Well Integrity Evaluation
▪ SOP 07-07-05	Groundwater and Non-Aqueous Phase Liquid Elevation Measurement
▪ SOP 07-11-01	Equipment Calibration, Operation, and Maintenance
▪ SOP 07-04-09	Equipment Decontamination
▪ SOP 07-04-07	Quality Control Samples
▪ SOP 07-03-01	Sample Labeling and Storage
▪ SOP 07-03-03	Chain of Custody
▪ SOP 07-03-09	Shipping

2.1 Pre-mobilization Planning

Successful groundwater sampling requires planning for health and safety considerations, selecting and preparing sampling equipment, knowledge of laboratory analytical methods, field-sampling procedures, and attention to record-keeping requirements.

Planning for a groundwater sampling event includes the following basic components:

- Identify scope of work and project objectives
- Prepare a health and safety plan
- Coordinate laboratory analytical services
- Select purging and sampling methods and equipment
- Prepare field equipment
- Prepare necessary field documentation forms
- Coordinate disposal of investigative-derived waste (purge water)

2.1.1 Site-Specific Considerations

Knowledge of site conditions and previous sampling records/field notes is helpful. Select equipment and sampling methods to match the scope of work and site-specific data quality objectives.

When planning a sampling event, it is also important to understand the following site-specific information:

- Site access, security, and health and safety issues
- Known or unknown concentrations of compounds of concern
- Anticipated depth to water at individual wells
- Presence or absence of NAPLs and/or DNAPLs
- Purging methods (e.g. well volume, low flow, modified, other)
- Equipment selection (e.g. pumps, bailers, or a combination of both)
- Criteria for monitoring of field parameters
- Sampling order (typically from least to most contaminated wells)
- Requirements for field-filtering and field-preservation of samples

- Requirements for field and/or laboratory QA/QC samples
- Decontamination procedures
- Identification of short hold times or special sample handling requirements
- List of analytes and analytical methods
- Site-specific SOPs, methods, and/or record-keeping requirements

2.1.2 Health & Safety Plan, Personal Protective Equipment

Use of a site-specific Health and Safety Plan (HASP) and personal protection equipment (PPE) is mandatory for all sampling activities. NRT's Health & Safety Coordinator must approve the HASP and appropriate PPE prior to any on-site activities.

Level D protection, at minimum, is required for field activities involving groundwater sampling; however, PPE will vary according to possible levels of risk and exposure pathways. Additional protection, such as Tyvek® suits, splash guards, and/or respirators may be necessary. Use of field-screening devices, such as a photoionization detector (PID), for monitoring breathing zones and/or decontamination zones may also be appropriate.

Attention to proper use of PPE and thorough decontamination of equipment that comes in contact with groundwater and/or the ground surface is also essential to preventing personal exposures and sample cross-contamination. Site-specific requirements may also necessitate the use of plastic sheeting and/or other work-area precautions to prevent releases, exposures, and cross-contamination during sampling.

When working in roadways, parking lots, and other high-traffic areas, wear high visibility clothing and use safety cones, signage, flashing signals, flaggers, or other safety precautions. Properly establish traffic control according to detailed instructions contained in Department of Transportation (DOT) traffic control handbooks/manuals. Obtain permits for work in right-of-ways, including permission to dispose of investigation derived waste (purge water) to public sanitary sewer or wastewater treatment facilities if called for in the site-specific sampling plan.

2.1.3 Laboratory Coordination

Provide the analytical laboratory with enough lead time to manage the project. Order sample containers, communicate billing, reporting information (e.g., level IV QC reporting), and field sampling dates prior to field work. Requests for quick turnaround require advanced notice.

Be sure to complete the following checklist when ordering and receiving sample containers:

- Confirm list of analytes
- Confirm methods of analysis and minimum required sample volume
- Determine whether samples are to be field-filtered and/or field-preserved
- Order extra containers as a contingency
- Count the number and type of containers received
- Discuss hold times and shipping and receiving procedures
- Determine whether special instructions are needed in writing on the chain of custody (COC)

Once the groundwater samples have been collected and shipped, make practice of calling the laboratory as a courtesy to provide anticipated arrival dates and numbers of samples. Identify samples with short hold times or that may contain exceptionally high concentrations of compounds of concern. Keep a copy of the signed COC that was shipped with the samples, and also keep any documentation of the laboratory's receipt of COCs. Include a specific list of the analytes requested on the COC as this is used by the lab to confirm the appropriate analyses have been completed and/or reported.

2.1.4 Field Equipment

Select sampling equipment necessary to achieve the data quality objectives for the project. Inspect, calibrate, and decontaminate all equipment prior to use in the field according to SOP 07-11-01 (Equipment Calibration, Operation, and Maintenance), and SOP 07-04-09 (Equipment Decontamination).

The following list provides an overview of some of the items typically needed in the field:

- Health and Safety Plan (HASP)
- First Aid Kit
- PPE (minimum Level D)
- Scope of Work
- Site Maps
- Well Keys/Site Access Keys
- Mobile Phone
- Camera
- Calculator
- Field Log Book/Field Forms
- Tools
- Chain of Custody Forms
- Custody Seals
- Sample Containers
- Cooler and Ice
- Strapping Tape
- Permanent Markers/Pens
- Ziploc® Baggies
- Paper Towels
- Plastic Sheeting
- Garbage Bags
- Water Level Meter
- Weighted Steel Tape
- Oil-Water Meter
- Calibrated Buckets
- Alconox® Soap
- Brushes
- De-ionized (DI)/Potable Water
- Water Quality Meters
- Calibration Solutions
- Calibration Standards
- Meter Operation Manuals

- Flow-Through Cell
- Calibrated Beakers/Cups
- Tubing (HDPE, Tygon®, silicon)
- Disposable Filters (barrel filters)
- Bladder Pump
- Bladder Pump Control Box
- Safety Line for Bladder Pump
- Disposable Bladders
- Check Valves, Catch Plates
- Air Compressor
- Peristaltic Pump
- Submersible Pump (Whaler®, other)
- Extension Cords
- Hose Clamps
- Portable Battery (automotive/marine)
- Alligator Clips
- Electric Tape
- Generator and Gasoline

2.1.5 Field Forms

Field-records of all purging and sampling procedures are kept either in field notebooks or on site-specific field forms. Field notes for groundwater sampling may include observations and documentation of well inspection, water level, equipment calibration, purging and sampling information, sample control logs, and chain of custody. Record-keeping requirements are described Section 4.1.

2.1.6 Waste Disposal

Contaminated purge water will be discharged as directed in the site-specific sample plan. If disposal is required, it should be arranged prior to the sampling event. A waste profile and permission from regulatory authority and wastewater operator may be needed to dispose purge water to a sanitary sewer, wastewater treatment facility, landfill, or on-site disposal facility.

3.1 Groundwater Sampling Procedure

This SOP describes steps to follow when performing the well volume method using bailers or submersible pumps, and the low-flow method using bladder or peristaltic pumps.

Sampling generally proceeds in the following fashion:

- Establish a safe working zone
- Assess well condition
- Measure depth to groundwater
- Measure depth to well bottom (except in some cases)
- Measure thickness of any non-aqueous phase liquids (NAPLs or DNAPLs), if present
- Calculate well volumes
- Purge the well, using either the well volume or low flow (low-stress/ micro-purge) method
- Collect samples
- Label and pack samples on ice for shipping
- Decontaminate equipment
- Complete all record-keeping requirements, including COC
- Ship samples

3.1.1 Well Integrity

Assess the condition of monitoring wells and protective casings prior to sampling activities. Measure depth to well bottom and compare measurement to previous measurements. The presence of obstructions and bent or broken casing (risers) must be considered before lowering pumps or other equipment into the well. Make note of, photograph, and repair, if possible, any damage to the monitoring well. Replace any missing locks or pressure caps prior to leaving the site. Include a well condition report as a part of the groundwater sampling field notes. Refer to SOP 07-07-01 (Well Integrity) for additional instructions.

3.1.2 Depth to Groundwater

Record the depth to groundwater to the nearest 0.01 ft, relative to the reference point at the top of well casing. A notch or permanent marking at the top of well casings (typically PVC) commonly marks the reference point. Measure depth to groundwater beginning at the least contaminated well and proceed to the most contaminated well. Decontaminate the water level meter (probe) with laboratory-grade soap and potable or deionized water between each well location. Refer to SOP 07-07-05 (Groundwater and Non-Aqueous Phase Liquid Elevation Measurement) and SOP 07-04-09 (Equipment Decontamination) for additional instructions.

Take time to monitor whether the measured depth to groundwater represents static groundwater elevation. Pressure caps may prevent some water columns from equilibrating with atmospheric pressure; be alert for this condition when pressure caps are very tight or produce an audible popping or hissing noise when removed. Record these observations in field notes and return to the well several times to make additional measurements to determine whether the water level has equilibrated.

Groundwater with elevated specific conductance (conductivity) may also interfere with the accuracy of water level measurement due to meter sensitivity. Adjust the sensitivity of the water level meter to make an accurate measurement, however, try to use a consistent sensitivity setting from well to well.

When groundwater elevation contour maps are to be prepared, collect synoptic depth to groundwater measurements (e.g. collect measurements consecutively at every site well in the shortest period of time possible and prior to any sampling activities).

3.1.3 Depth to Bottom

Measurement of depth to well bottom is also made with a water level meter or with a measuring tape with a weighted bottom. Measure the depth to well bottom to nearest 0.01 ft relative to the reference point. Adjust measurements to account for the length of the water meter probe housing which extends below the water level sensor or for the length of weight below the bottom of the tape, if any. Decontaminate measuring tapes and water level probes and the full length of measuring tape that entered the well casing with laboratory grade soap and potable or de-ionized (DI) water according to SOP 07-04-09 (Equipment Decontamination), prior to use at other wells.

Depth to bottom measurements should be avoided in situations when performing the measurement stirs up sediment settled in the well sump. If possible, wait to take depth to well bottom measurement until after sampling is completed, and/or rely on past measurement of depth to well bottom to calculate well volumes. Note on field forms when historical depth to bottom measurements are used.

3.1.4 Thickness of NAPLs

Where immiscible liquids, such as petroleum non-aqueous phase liquid (NAPL), is present on the surface of the water column, an oil-interface probe (oil-water meter) is used to measure NAPL thickness. Differing patterns of audible alarms indicate “oil” as opposed to water. Record the depth to NAPL and depth to water relative to the reference point at the top of well casing. Decontaminate the probe and length of measuring tape that entered the well casing with laboratory grade soap and potable or DI water before use at another well. Refer to SOP 07-04-09 (Equipment Decontamination) for more instructions.

NAPL thickness can also be estimated using a bailer (glass or plastic). Slowly lower the bailer into the top of the water column. Do not allow the bailer to fill completely. Retrieve the bailer, place on a bailer stand, and measure the thickness of product in the bailer. Record the measurement as an estimate.

3.1.5 Purging and Pumping Equipment

Purging for the well volume method can be accomplished with bailers and a variety of submersible pumps (e.g., Grundfos®, Whaler®, Proactive®), inertia (e.g., WaTerra®). Bladder pumps (e.g., Well Wizard®), and suction (peristaltic) pumps are preferred when performing the low-flow method. In some cases, use of a combination of equipment is appropriate, because the type of bailer or pump selected for purging may not be appropriate for sampling.

The material construction of bailers and pumps should also be considered with respect to potential interferences. For example, the use of polyvinyl chloride (PVC) and polyethylene is discouraged when the detected concentrations of organic compounds is anticipated to be at or near laboratory detection limits, because organics may leach in and out of these materials. Teflon® and Teflon®-lined sampling devices are preferred in these cases.

3.2 Purging and Sampling Using the Well Volume Method

Using the well volume method, a pre-determined volume of water is evacuated from the well using a pump or bailer. Typically a minimum of 3 to 5 well volumes of water is removed to evacuate stagnant water from the monitoring well casing (riser pipe) and filter pack. Minimum purge volume requirements vary based on project-specific and regulatory requirements. Modification (reduction) of the minimum number of purge volumes is acceptable when groundwater quality parameters (field parameters) are monitored at regular intervals during purging. Samples can be collected when parameters stabilize within acceptable limits or when minimum purge volumes have been achieved.

3.2.1 Well Volume Estimation

Purge volumes are calculated in the field and depend on the measured depth to groundwater, measured or historical depth to well bottom, and well casing diameter.

The following calculation is used to estimate one well volume:

$$\text{Volume} = \pi(r^2)(h)$$

Where: r = inside radius of well casing (ft.)
h = height of standing water column in well casing (ft.)
$\pi \approx 3.14$; and 1 $ft^3 \approx 7.48$ gal)

Estimating Common Well Volumes

Groundwater monitoring wells are commonly constructed of 2-inch diameter, Schedule 40 or Schedule 80 polyvinyl chloride (PVC) risers and screens. The conversion chart below can be also be used to estimate well volumes for PVC monitoring wells. The volume of water (gallons) per foot of water column is shown in the far right column of the chart. Commonly used conversions for 2-inch diameter Schedule 40 and Schedule 80 PVC are highlighted.

Wells other than monitoring wells, such as injection and extraction wells, wells with multiple casings, production wells, and drinking water wells are constructed with larger diameter PVC, stainless steel, or iron casing. Measure and use the inside diameter of casing material to estimate the well volume according to the calculations above.

Conversion Table for Common PVC Well Diameters

Nominal Casing Diameter (inch)	Casing Inside Diameter (inches)	Casing Inside Radius (inches)	Casing Inside Radius (feet)	Volume per Foot of Water Column (gal)
Schedule 40				
1	1.05	0.53	0.04	0.04
1.25	1.38	0.69	0.06	0.08
1.5	1.61	0.81	0.07	0.11
2	**2.07**	1.04	0.09	**0.163**
3	3.07	1.54	0.13	0.38
4	4.03	2.02	0.17	0.66
6	6.065	3.03	0.25	1.50
8	7.981	3.99	0.33	2.60
12	11.938	5.97	0.50	5.81
Schedule 80				
1	0.96	0.48	0.04	0.04
1.25	1.28	0.64	0.05	0.07
1.5	1.5	0.75	0.06	0.09
2	**1.94**	0.97	0.08	**0.153**
3	2.9	1.45	0.12	0.34
4	3.83	1.92	0.16	0.60

Borehole Volume Calculations

Borehole volume accounts for the volume of standing water in the well casing and the volume of water contained in the well's filter pack material. Calculations of borehole volume require knowledge of well construction – borehole diameter, height of filter pack and filter pack seal, inside and outside diameter of well casing, and assumed effective porosity of the filter pack material. Borehole volumes are most often used when drilling and developing wells, but in some instances it is useful to compare the number of well volumes removed during purging to an equivalent number of borehole volumes.

Several methods are commonly used to estimate borehole volume. The following calculations are one example of estimation of one borehole volume:

Borehole volume = well volume + volume of water in filter pack

Well volume = $\pi(r^2)(h)$
where: r = inside radius of well casing (ft)
h = height of standing water column in well casing (ft)

Volume of water in filter pack = $n[\pi(r_1)^2 - \pi\,(r_2)^2]\,h_{fp}$
where: n = effective porosity of filter pack material
r_1 = radius of borehole (ft)
r_2 = outside radius of well casing (ft)
h_{fp} = height of standing water in filter pack (ft)

3.2.2 Groundwater Quality Parameters

Water quality parameters (field parameters) are monitored periodically when performing a modified well volume method. Stagnant water in the well casing is determined to be completely purged from the well when water quality parameters stabilize. Often, parameters stabilize before 3 well volumes have been removed. However, purging more than one well volume may be necessary for water quality parameters to stabilize. If parameters do not stabilize after 3 well volumes have been removed, additional well volumes should be removed. If water quality parameters do not stabilize within 5 volumes, it is at the discretion of the project leader whether to collect a sample or to continue purging.

Record all water quality parameter data, at a minimum, beginning with the first well volume, and every well volume after. In cases where a pump is used, water quality data are recorded at regular intervals along with the time, pumping rate, and total purge volume. When purging water with a pump, an in-line flow-through cell should be used to collect water quality parameter data. When using a bailer, parameters should be checked periodically by placing the water quality instruments (probes/meters) in a beaker or cup containing each sample of purged water. When measuring in a beaker, atmospheric exposure may affect readings for oxidation reduction potential [ORP] and dissolved oxygen.

Samples are collected after a minimum of one well volume of groundwater has been purged from the well and parameters have stabilized. Alternatively, samples are collected after 3 to 5 well volumes are purged.

Stability for water quality parameters is achieved when parameter readings fall within the following criteria for three consecutive time intervals.

Field-Measured Parameter Stabilization Criteria for Groundwater[1]

Parameter	Stabilization Criteria
Conductance, Specific Electrical	+/- 3% µS/cm @ 25°C
Dissolved Oxygen	+/- 10% of reading or +/- 0.2 mg/L, whichever is greater
Oxidation-Reduction Potential	+/- 20 mV
pH	+/- 0.2 standard units
Temperature	+/- 0.1°C
Turbidity*	<10 NTUs or ± 10% when turbidity is greater than 10 NTUs

Notes: µS/cm = micro Siemens per centimeter
°C = degrees Celsius
mg/L = milligrams per liter
mV = millivolts
NTUs = nephelometric turbidity units

** Turbidity is an optional field parameter*

3.2.3 Purging Using a Bailer

Disposable or dedicated bailers are preferred when bailers are used for most purging and sampling scenarios, because they eliminate time needed to clean bailers and the possibility of cross contamination. However, if a non-dedicated, re-usable, bailer is used, the bailer must be washed with laboratory-grade soap and triple rinsed inside and out with DI water before purging or sampling according to SOP 07-04-09 (Equipment Decontamination).To minimize purge time, select the largest diameter bailer that will fit into the well and a length and weight of bailer that you can easily handle.

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[1] Stabilization criteria referenced here are consistent with ASTM D6771-02 *Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations*

Prior to deploying the bailer in the well, fasten nylon rope, preferably braided to the top of the bailer, and fasten the other end of the rope to the protective casing or some other object at the ground surface to prevent the loss of the rope and bailer down the well. Check the rope knots periodically during the bailing process, and re-tighten or re-fasten as needed.

Disposable Nitrile®, PVC, or latex gloves must be worn during bailing. Change gloves frequently when gloves become dirty or torn. At a minimum, wear new gloves when sampling, after decontaminating equipment, and when beginning work at a new well location.

Use the following procedure to manually deploy and retrieve the bailer to and from the water column:

- Slowly lower the bailer into the well until it contacts the water column
- Allow the bailer to fill with water until it becomes submerged
- Pull the bailer out of the well and coil the rope into a clean bucket or onto clean plastic sheeting
- Do not allow the bailer to come into contact with any surface other than your gloves, the inside of the well, clean plastic sheeting, or a dedicated bucket
- Pour water from the bailer into a calibrated bucket to keep track of the volume purged, and periodically pour water into a cup or beaker to monitor water quality parameters
- Continue bailing until the required volume of water is purged from the well or until water quality parameters stabilize
- Contain purged water, as necessary, for proper disposal
- Collect samples (see Section 3.4)
- Decontaminate equipment

3.2.4 Purging Using Submersible Pumps

Non-dedicated pumps and any non-dedicated tubing must be decontaminated using laboratory-grade soap and water according to SOP 07-04-09 (Equipment Decontamination) prior to lowering the pump and tubing into a well. Place gasoline-powered electrical generating equipment downwind of the well location to minimize the possibility for cross contamination. Disposable Nitrile®, PVC, or powderless latex gloves must be worn when handling down-hole equipment. At a minimum, wear new gloves when sampling, after decontaminating equipment, and when beginning work at a new well location.

Purging of the well involves the correct placement of the pump and turning it on:

- Slowly lower the equipment (pump, electrical cords, discharge tubing, safety line) into the well; use zip ties to bundle tubing and cords together to prevent it from tangling in the well or becoming stuck in a well joint
- Lower the pump to the depth of the well screen, if possible; for deep wells, lower the pump as deep as practical, depending on pump capacity
- Do not place the pump on the well bottom, to avoid stirring up sediment settled at the well bottom, and to avoid clogging the well with sediment
- Turn on the pump and record the pumping rate using a calibrated bucket and stopwatch
- When monitoring water quality parameters, use a flow through cell and water quality probes (sensors) to periodically collect parameter data; if not using a flow-through cell, periodically collect samples of purge water in a cup or beaker; note when parameter data are collected for samples exposed to the atmosphere
- Continue pumping until the required volume of water has been purged or water quality parameters stabilize
- Contain purge water, as necessary, for proper disposal
- Collect samples (see Section 3.4)
- Decontaminate equipme

3.2.4 Sampling

When purging and sampling with bailers, fill laboratory containers directly from the bailer using a bailer stand and bottom dischargers. Samples collected for VOC analysis are collected via VOC dischargers, which restrict the flow rate to prevent aeration. Samples that require field-filtering are first contained in a disposable carboy and then pumped through a barrel filter using a peristaltic pump.

When using submersible pumps, collect samples directly from the discharge tubing using a pumping rate not greater than the purging rate. If using a flow-through cell, disconnect it prior to sampling. Samples that require field-filtering can be filtered in-line using a filter connected directly to discharge tubing, or a disposable carboy may be used, as described above.

Use tubing appropriate for the compounds of concern. Collect samples for analysis of the most sensitive parameters first, and collect samples requiring field filtration last. Sampling protocol is described in detail in Section 3.4.

3.3 Purging and Sampling Using the Low-flow Method

Using the low-flow (low-stress, micro-purge) method, groundwater is purged at rates affecting minimal to no drawdown which effectively isolates stagnant water in the well casing (riser) above the pump inlet. Depth to groundwater and water quality parameters (field parameters) should be monitored throughout the purging process. Pumping rates are adjusted to ensure that flow of groundwater to the pump is from the saturated formation and not from stagnant water in the well casing. Samples are collected once drawdown and water quality parameters stabilize.

Purging for the low-flow method is performed using either a peristaltic (suction) pump, or a bladder pump. Tubing and bladders should be Teflon® or Teflon®-lined, although non-lined high-density polyethylene (HDPE) tubing is appropriate for many compounds of concern. In some situations, low-flow methods may be performed using other submersible pumps (e.g. Grundfos®, Whaler®, Proactive®) and inertia pumps (e.g. WaTerra®); see Section 3.3.3 for potential data quality implications.

3.3.1 Using a Peristaltic Pump

A peristaltic pump is used at the ground surface to apply a suction force to lift water from the well through small diameter tubing. Maximum lift for peristaltic pumps is in the range of 15 to 29 feet; and, pumping rates range from less than 50 milliliters per minute (mL/min) to several gallons per minute (gal/min). Peristaltic pumps exert reduced pressure on the pumped water which can result in degassing and volatilization of the sample. Changes in pressure can affect pH, oxidation reduction potential (ORP), and other gas-sensitive parameters (ASTM D6634-01[2006]). As a result, USEPA recommends that peristaltic pumps not be used for low-flow groundwater sampling when depth to water exceeds 15 feet, especially when collecting samples for analysis of volatile organic compounds (VOCs).

3.3.2 Using a Bladder Pump

A bladder pump uses compressed air to squeeze a flexible membrane (bladder) that is contained in a rigid housing. Groundwater enters the bladder under hydrostatic pressure through a check valve, and compressed air supplied via small diameter airline compresses the bladder which forces water from the bladder to the surface through a small diameter water return line (the compressed air does not contact the water). Flow rate and airline pressure are regulated via an electronic control box. Pressure is applied in timed cycles, allowing the bladder to refill and compress at intervals appropriate for the depth, hydraulic conductivity of the saturated formation, and desired flow rate. Lift capacity of the pump is directly related to the pressure of the drive gas source.

Representative groundwater samples can be obtained for all analytes in nearly all field conditions using a bladder pump. Low-flow sampling with a bladder pump reduces the possibility for degassing, agitation, and volatilization of the sample, as compared to peristaltic or submersible pumps.

3.3.3 Using Other Pumps

Other submersible pumps (e.g. Grundfos®, Whaler®, ProActive®) are commonly used to purge groundwater from monitoring wells (i.e. for the well volume method) or to accomplish well development. However, they are not always appropriate for low-flow sampling. Some studies show that using submersible pumps to collect groundwater samples for analysis of VOCs generates analytical data similar to that for bladder pumps; however, the valves used to restrict the flow of submersible pumps reduce pressure potentially resulting in degassing of the sample. Submersible pump impellers also cause heat and turbulent flow which can also result in changes in water chemistry. Pump failures may also release contaminants (oiled parts, plastics, etc) into a monitoring well. Due to these limitations, bladder pumps are recommended over submersible pumps for low flow sampling, particularly for VOCs.

3.3.4 Field Procedure

The objective of the low-flow method is to perform low-stress pumping of a monitoring well to clearly document that samples represent groundwater entering the well from the screened formation at the depth of the pump inlet. To do so, the sampler must place the pump inlet at the appropriate depth, pump in a manner that minimizes stress to the formation, and monitor drawdown and groundwater quality parameters at regular intervals.

The low-flow field method is performed according to the following steps:

- Assemble equipment, (e.g. pumps, tubing, flow through cell, water quality instruments)
- Clean (decontaminate) all down-hole equipment
- Calibrate water quality instruments
- Measure initial depth to groundwater
- Place pump/pump inlet tubing at appropriate depth in the screened interval
- Begin pumping at an initial rate (typically 100 mL/min or less)
- Calculate minimum purge volume (time intervals) for parameter readings
- Monitor water level drawdown and water quality parameters
- Adjust pumping rate to minimize/stabilize drawdown
- Continue pumping until drawdown and water quality parameters stabilize
- Collect samples

Preparation

Clean all non-dedicated down-hole equipment according to SOP 07-04-09 (Equipment Decontamination) prior to measuring initial depth to water or lowering a pump or inlet tubing into the well. Non-dedicated bladder pumps should be disassembled, cleaned, and re-assembled; also remove and clean pump gaskets, check valves, and inlet screens. Clean, calibrate, and test water quality instruments (probes) according to the manufacturer's instruction manuals. Document calibration results at the beginning of the day and periodically throughout the day, according to the site-specific work plan. Flow through cells and containers for purge water should be assembled prior to the start of pumping. Lengths of tubing should be measured to match the depth at which the pump or pump inlet will be deployed in the well. If dedicated tubing is used (i.e. tubing that is left hanging inside a well casing), inspect and replace tubing, if compromised.

Depth of Pump Inlet

The appropriate depth of pump or pump inlet tubing depends on the hydrogeology of the screened formation and well construction details:

- In cases where the screen intersects a single soil/rock material, the pump inlet should be placed at the midpoint of the well screen.
- In cases where the screen intersects multiple layers of soil/rock material or fractured rock, the pump inlet should be placed at a depth intersecting the layer expected to have the highest hydraulic conductivity.
- Where zones of contamination are known or assumed to occur at specific depths, the depth of pump inlet should match the depth of contamination. For example, petroleum compounds often accumulate in smear zones near the water table interface – pump inlets placed at the midpoint or near the bottom of well screen may not provide a representative sample in this instance.
- Do not place the pump inlet at or near the well bottom, because pumping near the well bottom can mobilize solids settled in the well sump.
- Do not place the pump inlet at or above the top of the well screen, because low-stress pumping would capture stagnant water in the well casing rather than formation water.

Pumping Rate

The initial pumping rate should be 100 mL/min or less. Lower hydraulic conductivity units (i.e. clay) should be pumped at lower initial flow rates; higher hydraulic conductivity units (i.e. sand) can be pumped at higher initial flow rates. Adjust the pumping rate to be as low as practicable, to achieve stabilization of water quality parameters without inducing significant drawdown (e.g. without pumping stagnant water from the well casing). Do not induce continuous drawdown. Pumping rates at which water level stabilization can be achieved range generally from 100 to 500 mL/min. Samples must not be collected using a pumping rate that exceeds the pumping rate at which stabilization was achieved. Conceptually, once flow rate and water quality parameters have stabilized, a direct connection to the aquifer has been established, and any changes or disruptions to flow rate could break that connection and result in stagnant water being included in the samples.

The optimal pumping rate that will achieve stabilization for drawdown and water quality parameters will be specific to each well. Do not attempt to pump every well at a site at the same pumping rate. Use historical sampling information to replicate pumping rates for specific wells, as appropriate.

Monitoring Drawdown

Depth to water in the monitoring well should be monitored at 1 to 2 minute intervals until water level stabilization occurs and periodically afterwards. Drawdown during the course of pumping and sampling should not exceed 25% of the distance between the top of screen and pump inlet. Also, the volume of water pumped that is attributable to drawdown (stagnant water pumped from the well casing) should not exceed 10% of the total volume of water pumped. Some wells, especially those screened in clay, may not achieve water level stabilization (i.e., the water level continues to drop even at flow rates less than 50 ml/min). If this occurs, contact the field leader and Project Manager to discuss alternative methods for sample collection such as completely purging the well and returning to collect the sample once the well has recovered, or using a passive sampling method.

Monitoring Water Quality Parameters

Water quality parameters that provide evidence that formation-quality water is being pumped include pH, temperature, conductivity (specific conductance), dissolved oxygen, and oxidation-reduction potential (redox, or ORP, also measured as Eh). Turbidity, discussed below, may also be a useful field parameter. Record these parameters continuously (if possible) or at regular time intervals using a closed flow through cell or similar instrumentation. Use a small volume flow through cell and monitor the cell for air bubbles (leakage).

The frequency of water quality parameter measurements should be not less than the time needed to evacuate the volume of the in-line flow through cell. Also determine the volume of water contained in the pump (i.e. bladder volume) and discharge tubing. Consider increasing time intervals to account for these volumes, especially when pumping rates are slow and/or the depth to pump inlet is significant. In instances where water quality parameter stabilization occurs quickly, be sure to also allow enough time for individual water quality instruments to stabilize (check manufacturer’s recommendations). Dissolved oxygen sensors, for example, typically take longer to stabilize than pH, temperature, conductivity, and ORP sensors.

Stabilization of water quality parameters is achieved when three consecutive readings, several minutes apart, fall within the criteria listed below. These criteria are consistent with ASTM D6771-02: however, they may not apply to all sites. Site-specific parameters and criteria may be established to account for variations in aquifer properties, groundwater chemistry, well hydraulics, and contaminant distribution.

Field-Measured Parameter Stabilization Criteria for Groundwater

Parameter	Stabilization Criteria
Conductance, Specific Electrical	+/- 3% µS/cm @ 25°C
Dissolved Oxygen	+/- 10% of reading or +/- 0.2 mg/L, whichever is greater
Oxidation-Reduction Potential	+/- 20 mV
pH	+/- 0.2 standard units
Temperature	+/- 0.1°C
Turbidity	<10 NTUs or ± 10% when turbidity is greater than 10 NTUs

Notes: µS/cm = micro Siemens per centimeter
°C = degrees Celsius
mg/L = milligrams per liter
mV = millivolts
NTUs = nephelometric turbidity units

Turbidity

Turbidity is indicative of the stress pumping places on the screened formation. Measure turbidity with the same frequency (time intervals) as other water quality parameters or, at a minimum, at the beginning of pumping and again prior to collecting a sample. Ideally, low-flow purging should proceed until turbidity is less than 10 NTU, however, turbidity greater than 10 NTU can be natural and unavoidable. Analytical bias can occur for samples collected with turbidity greater than natural conditions.

When turbidity increases during pumping, too much stress is being placed on the well – lower the pumping rate. If the turbidity remains high, stop pumping and allow the well to rest without removing the pump. Resume pumping at a low rate and monitor turbidity for stabilization. As noted above, natural turbidity may remain higher than targeted stabilization criteria.

To minimize initial turbidity, carefully lower pumps and tubing into the monitoring well to avoid stirring sediment that has settled at the well bottom. Turbidity and other water quality parameters will typically stabilize more quickly when using dedicated pumps.

3.3.5 Sampling

When using the low-flow method, disconnect the flow cell without shutting off the pump and collect samples directly from the discharge tubing using the same pumping rate as was used to achieve stabilization. Use tubing appropriate for the compounds of concern. Collect samples for analysis of the most sensitive parameters first, and collect samples requiring field filtration last. Sampling protocol is described in detail in Section 3.4.

Be aware of potential quality control issues when collecting samples using the low-flow method:

- Samples should not be collected using a pumping rate greater than the purging/stabilization rate
- Once stabilization has been achieved do not disrupt the connection to the groundwater in the formation by shutting off the pump or changing the flow rate
- When collecting samples for analysis of VOCs, pump at a rate less than 250 mL/min, and avoid aerating groundwater in pump tubing or flow through cell
- Some chemical constituents may leach to tubing
    - Teflon® or Teflon®-lined tubing is preferred for samples that will be analyzed for VOCs, SVOCs, pesticides, and PCBs
    - HDPE or polypropylene tubing may be used for metals and other organics
    - Siliclastic (silicon) tubing should be less than 1 foot in length (when used with peristaltic pumps and when used with barrel filters)
- Shade equipment and tubing to avoid direct sunlight and warm ambient air temperatures

Field Forms

Field forms or field notes should record the following information, in addition to site and well information, to document water level and water quality parameter stabilization during low-flow pumping and sampling:

- Type, make, and model of pumping and water quality instruments
- Equipment calibration (include copies of calibration certificates as appropriate)
- Decontamination procedures
- Depth of pump or pump inlet
- Volumes of flow through cell, discharge tubing, and pump (bladder)
- Initial pumping rate and time intervals
- Drawdown, stabilized water level, and pumping rate at stabilization
- Field-measured water quality data at regular time intervals during purging
- Time and pumping rates for all measurements
- Rate of pumping at time of sample collection

Section 4.1 describes in detail the record keeping requirements to follow when groundwater sampling.

Instrument Error

Instruments suspected of producing erroneous readings should be recalibrated. If the values obtained continue to be outside normal ranges, troubleshoot or replace the instrument. If the instrument cannot be replaced and provides data critical to performing and documenting the purging procedure, notify the Project Manager. Do not discard the samples, if collected. Flag any out of range data recorded in field notes using an asterisk and a written description of the occurrence. Deviation from standard field procedure, use of alternate equipment, or re-sampling may be required to determine whether anomalous readings were the result of mechanical or human error and to ensure documentation of the collection of a representative sample.

3.4 Collecting Samples

This section describes sampling protocol to follow when using either the well volume method or low-flow method. Representative samples are collected when the monitoring well is purged according to the requirements of the standard procedure and when the sample is appropriately collected, preserved, handled, shipped, and analyzed. Groundwater samples must be collected in the appropriate order, field-filtered and field-preserved according to analytical methods, accompanied with quality assurance/quality control (QA/QC) samples, immediately preserved on ice, and shipped with the appropriate chain-of-custody documentation.

3.4.1 Sampling Order

Collect samples according to analyte stability, as summarized below, unless otherwise specified in a site-specific work plan or field sampling plan:

- Volatile organic compounds (VOCs)
- Semi-volatile organic compounds (SVOCs)
- Non-filtered, non-preserved samples (e.g. PCBs, pesticides, sulfate)
- Non-filtered, preserved samples (e.g. phenols, nitrogen, total metals, organic carbon)
- Available cyanide (follow lab provide cyanide kit direction for collection of sample)
- Filtered, non-preserved samples (e.g. chromium IV)
- Filtered, preserved samples (e.g. dissolved metals)
- Miscellaneous parameters

In addition, collect samples for sulfate analysis before collecting sulfuric-acid preserved samples (e.g. nitrogen), and collect samples for nitrogen compound analysis before nitric-preserve samples (e.g. dissolved metals).

3.4.2 Filling Sample Containers

Observe the procedures and cautions below when filling sample containers:

- Take precautions when handling acid preservatives or opening containers pre-filled with acid preservatives, according to the site-specific Health & Safety Plan (HASP).
- Remove sample container lids carefully. Do not touch the inside of the lid or the Teflon® lid septum, and do not place the lid on the ground.
- If containers, lids, or Teflon® septum come in contact with the ground or any other contaminated surface, carefully rinse the object with sample water; replace septum facing the sample.
- Fill sample containers with the appropriate preservative, volume, and headspace.
- Do not allow discharge tubing to come in contact with the inside of the sample container.
- Minimize sample contact with the atmosphere and collect samples away from possible sources of cross-contamination such as vehicle or equipment exhaust.
- Overfill containers used for VOC analysis (40 ml HCL-preserved glass vials) to eliminate air bubbles. Slowly fill the vial until surface tension (convex water surface) is maintained at the top of the vial. Replace the cap gently and invert the vial to check for air bubbles. Open the vial and add more water to the existing sample, if necessary, to eliminate air bubbles. Do not empty the bottle and refill.

3.4.3 Field Filtering

Use an in-line disposable 0.45 micron (µm) filter, or equivalent, to filter groundwater samples for which the analytical method requires field-filtering. When using a pump, connect the filter directly to the pump discharge tubing, and pump a small volume of sample volume through the filter before beginning to fill the sample container. When using a bailer, water is often transferred from the bailer to a disposable carboy, and then pumped through a barrel filter using a pump, as described above. Collect a field/equipment blank whenever collecting field-filtered samples.

Follow these procedures when field-filtering groundwater samples:

- Filter samples immediately in the field; if field conditions prevent field-filtering, filter samples as soon as possible or instruct the analytical laboratory to filter samples upon receipt
- Use disposable filters (i.e. Geotech® barrel filters) to eliminate cross-contamination
- Do not re-use disposable filters
- Do not re-use temporary containers/pre-filtration containers
- Note the size and material (i.e. 500 mL polyethylene carboy) of pre-filtration containers

3.4.4 Sample Preservatives and Hold Times

Samples are to be field-preserved, if necessary, immediately after filtering or immediately after sample collection if not filtered. Pre-measured volumes of preservatives should be added to the sample bottle prior to sampling. In most cases, laboratory-supplied containers are provided with pre-measured preservatives already placed in the containers. Arrange for timely shipment of samples with short hold times.

3.4.5 QA/QC Samples

SOP 07-04-07 (Quality Control Samples) describes the intended use and collection methods for quality control samples that should be used to evaluate field and laboratory quality control procedures and the precision, accuracy, representativeness, and comparability of data obtained from groundwater samples. Deviation from the Quality Control SOP should be clearly identified in site-specific Workplan, Field Sampling Plan (FSP), or Quality Assurance Project Plan (QAPP).

The following QA/QC samples should be considered and collected, as necessary:

QA/QC Sample Type	Application
Field Duplicate	Compares differences in analytical results for identical (duplicate) samples
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	Evaluates effect of sample matrix on analytical results
Trip Blank	Identifies contribution/introduction of contaminants

	during shipment/transport
Temperature Blank	Verifies proper sample transport temperature
Equipment Blank	Determines effectiveness of in-field decontamination procedures (also known as Rinseate Blank)
Field Blank	Identifies possible environmental cross-contamination

4.1 Record Keeping/Field Forms

Field-records of all purging and sampling procedures are kept either in NRT notebooks or on site-specific field forms. Electronic copies of field notes and should be made and saved to the project directory on NRT's electronic server (typically these notes are stored in the same folder as the laboratory analytical results). Sample control logs and sample identification numbers are to be completed and assigned according to SOP 07-03-01 (Sample Labeling and Storage) and SOP 07-03-05 (Sample Location, Identification, and Control).

4.1.1 Field Notebook

At a minimum, the following information should be recorded in a field notebook, on groundwater sampling forms, or on a site/project-specific groundwater sampling forms:

- Weather conditions
- Well condition
- Size, diameter, and well casing material
- Water level, relative to top of well casing
- Depth to bottom, or historical depth to bottom, relative to top of well casing
- Thickness and/or presence of any NAPLs
- Calculation of well volumes
- Time when purging begins
- Purge method (e.g. bailed, pumped)
- Initial color, odor, and clarity of purge water
- Initial water quality parameter data (e.g. pH, temperature, conductivity, ORP, turbidity)
- Time intervals, water levels, water quality parameters, pumping rate, and cumulative purge volumes (if low-flow sampling)

- Sample collection time
- Water quality parameters at the time of sample collection
- Number and type of sample containers
- Method and type of field-filtration and/or field-preservation
- Sample identification number and lab identification/chain of custody number
- Name and manufacturer of any equipment used
- Calibration results
- Description of decontamination procedures
- Total purge volume
- Location where purge water is disposed (e.g. discharge to ground or contained in drum)
- If drums are used, note the location and number of drums stored on site

4.1.2 Chain of Custody

The parameters to be analyzed are to be listed for each sample on the Chain-of-Custody (COC) as is described in SOP 07-03-03 (Chain of Custody). The COC should also clearly identify the specific USEPA-approved method of analysis to be performed on each sample, provide the specific list of analytes to be reported (e.g., list specific metals or aroclors to be reported), and provide any special instructions. For example, samples that require laboratory filtering, samples that contain known interferences with the analytical method, samples expected to contain unusually elevated concentrations of compounds, and samples with short hold times, should be clearly identified.

4.1.3 Packing and Shipping

Samples are to be placed on ice immediately after sample collection, and packed and shipped according to SOP 07-03-09 (Shipping). Samples are always shipped to the laboratory or any other facility under COC-procedure and using custody seals. When using a courier, obtain driver signatures on the COC. Ship groundwater samples in compliance with all applicable requirements for shipping hazardous and/or dangerous materials.

References

ASTM International, D4448-01 Standard Guide for Sampling Groundwater Monitoring Wells

ASTM International, D5903-96(2001) Standard Guide for Planning and Preparing for a Groundwater Sampling Event

ASTM International, D6089-97(2003)e1 Standard Guide for Documenting a Ground-Water Sampling Event

ASTM International, D6301-03 Practice for the Collection of Samples of Filterable and Nonfilterable Matter in Water

ASTM International, D6452-99(2005) Standard Guide for Purging Methods for Wells Used for Ground-Water Quality Investigations

ASTM International, D6564-00(2005) Standard Guide for Field Filtration of Ground-Water Samples

ASTM International, D6634-01 Guide for the Selection of Purging and Sampling Devices for Ground-Water Monitoring Wells

ASTM International, D6771-02 Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia, www.epa.gov/region4/sesd/eisopqam/eisopqam.html.

USEPA, 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Manager, Region 5 and Region 10, EPA 542-S-02-001.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

Revised By:	DJV	Date Revised:	01-28-2013
Corporate Officer:	BRH	Date Approved:	05-29-2014

GENERAL FIELD DOCUMENTATION

1.1. Scope and Application

This field procedure is applicable to documentation of data obtained during field activities. Field data are recorded in field notebooks, field forms, and/or field electronic data recorders, providing means for recording all data collecting activities. Field representatives will use concise language for descriptive and detailed field entries to enable field activity reconstruction without reliance on the collector's memory. Refer to the project-specific documents for variances to this SOP.

1.2. Notebooks

Field notebooks are bound books permanently assigned to field personnel. The cover of each notebook will contain the following information:

- Person to whom the book is assigned
- Person’s contact information (phone number and email address)
- Office address and phone number
- Project name
- Project location
- Project number and task (if applicable)
- Book number

If a notebook is transferred to another staff person, notation should be made of the transfer with the date and appropriate signatures. To maintain integrity of the data collection process, bound notebooks must retain all pages; no pages are to be removed.

1.3. Field Forms

Hardcopy or electronic field forms may be used for data collection during field activities. All lines requiring information on the field forms are to be filled out completely. If information cannot be provided for a certain line, notes should be provided on why the information cannot be provided. It is not necessary to duplicate information recorded on field forms in field notebooks. Field notebooks should identify forms that were completed each day, as the forms constitute supplemental records to field notebook.

1.4. Daily Entries

Field measurements, observations, and information pertinent to a field activity is recorded legibly with non-erasable black ink. When weather prohibits using ink, a non-smear lead pencil may be used. Strive for objective, factual entries written in the field while fresh in the memory. The end of each entry and unfilled pages are identified by drawing a diagonal line through unused space on the page with the author’s signature.

At the beginning of each daily entry, the following information is recorded:

- Date
- Page number
- Start and end time
- Weather
- Field personnel present
- Level of personal protection equipment required and used
- Signature of the person making the entry
- Any instrument calibration details

At the completion of field activities, scan hardcopy pages and copy electronic information to the appropriate project folder.

1.4.1. Entry Changes

When necessary, make changes to hardcopy entries by crossing a single line through the error in a manner that avoids obscuring the original entry and entering the new information. Initial and date the entry change. If appropriate, note the reason for the change. Do not erase the original entry, and do not obscure so it cannot be read.

1.5. Form and Notebook Management

Scan and/or save field notes, whether hardcopy or electronic, to the project folder **at least** weekly and upon task completion. This step will minimize data loss should forms or notebooks be lost or destroyed.

1.6. References

ASTM D6089Standard Guide for Documenting a Groundwater Sampling Event

USEPA, 2010, Field Branches Quality System and Technical Procedures, Region 4, Science and Ecosystem Support Division, Athens, Georgia, http://www.epa.gov/region4/sesd/fbqstp/

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Section:	Business Management
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Page:	1 of 7

Prepared By:	JTB/SGW	Date Prepared:	02-13-2015
Corporate Officer:	DPK	Date Approved:	4-1-2015

DATA FLOW

1.1 Scope and Application

Natural Resource Technology, Inc. (NRT) is committed to continually improving the data flow process to make it efficient and consistent. This Standard Practice establishes policies and procedures concerning streamlining the flow, dissemination, and storage of field and laboratory analytical data, and outlines the roles and responsibilities of NRT staff.

1.2 Data Flow System

The Data Flow System was established for streamlining the process of receiving and filing field and analytical data and producing data deliverables. The benefit of this process is the ability to perform quality control checks at several steps during data processing, as well as standardization of electronic and hard copy filing. The data team is in part responsible for the quality control checks, electronic and hard copy filing, data import and production of data tables. The data team is responsible for the implementation of new standards as they apply to data management. Refer to Attachment A for a graphical representation of the Data Flow System.

1.3 Definitions

Several terms used in this Standard Practice may not be familiar to all staff that will use this document. The following terms are defined as follows:

- Super Tracker Table – Project-specific table of field and laboratory data compiled by the data group for tracking and importing data.
- Project–specific sampling documents – Documents compiled by the project team used to complete specific tasks. These may include but are not limited to the site-specific work plan, quality assurance project plan (QAPP), construction quality assurance project plan (CQAPP), and sampling summary.

- Import Summary – Report generated by the data group and includes a summary of the laboratory data sample designation groups that were brought into the NRT Enviro Data database.

- Quality Control – Set of procedures to ensure the quality of a service or product. It is a means of checking that samples were collected, analyzed and reported correctly.

- Quality Assurance - Maintenance of a desired level of quality in a service or product, especially by means of attention to every stage of the process of delivery or production.

- Level 2 Data Verification – Review of analytical data that includes holding times, analytical methods, surrogate recoveries, laboratory control sample recoveries, matrix spike and matrix spike duplicate recoveries and relative percent differences, method blank concentrations and reporting limits.

- Level 4 Data Validation – Comprehensive review of analytical data. This includes all of the Level 2 review items and recalculation of results, review of laboratory raw data, reconstructed ion chromatograms, initial and continuing calibration recoveries, initial and continuing blank concentrations, and other method-specific quality control data.

1.4 Roles and Responsibilities

Numerous individuals have roles and responsibilities in the collection and management of field, analytical and geotechnical data. No roles are more or less important than others and each contribute to the accurate and seamless approach to data management. Quality control is an especially important aspect of the data flow process and each staff member is responsible for some form of quality control. Staff and their responsibilities are described below.

1.4.1 Project Manager (PM)

PMs (or their designee) have responsibilities during all phases of data management which include the following:

- Generate a sampling summary form with a sampling summary matrix and server pathway for the project-specific sampling documents prior to the sampling event.

- Provide sample summary and anticipated level of QC necessary to Data Team.

- Review updated Super Tracker table (Attachment B) for conformance with the project-specific sampling documents:
    - Within 10 days of the completion of sample collection

    - Again when all analytical data is in-house
    - Bi-weekly for long-duration projects
- Coordinate third-party level 4 validation, if required, with the Data team and validation firm.
- Save level 4 validation files to project folder and review validation report. Data Team can assist with review.
- Review import summary report from the data team.
- Generate and send requests for data deliverables and mapping to the appropriate support team during any phase of the project.
- Review and finalize tables and figures.
- Define data quality objectives during kick-off meeting to explain roles/responsibilities, data schedules and sampling requirements.
- Return the GPS unit to the Mapping Team for post-processing (if required) of the sample coordinates information.
- If NRT did not collect any location information, submit a request to the company/individual who did the GPS data collection or survey and transmit it to the Mapping Team immediately upon receipt.

1.4.2 Field Staff

The field staff members for a given sampling event have the following responsibilities:

- Achieve a thorough and complete understanding of sampling and data requirements for the given project prior to mobilizing.
- Collect samples according to the sample summary provided by the PM, project-specific sampling documents, and the appropriate NRT standard field operating procedures. (NRT field operating procedures for sample collection and documentation are located at: W:\Operations\Standard Practices\Standard Operating Procedures\07 Field Procedures.)
- Complete field forms, chain of custody (COC), and sample control logs.
    - As a quality control (QC) check, the COC will be back-checked and initialed in the field by field staff who did not complete the COC, typically a team lead or other staff identified by PM in sampling event kick-off meeting.
- Send samples and completed COC to the laboratory according to NRT field SOPs.

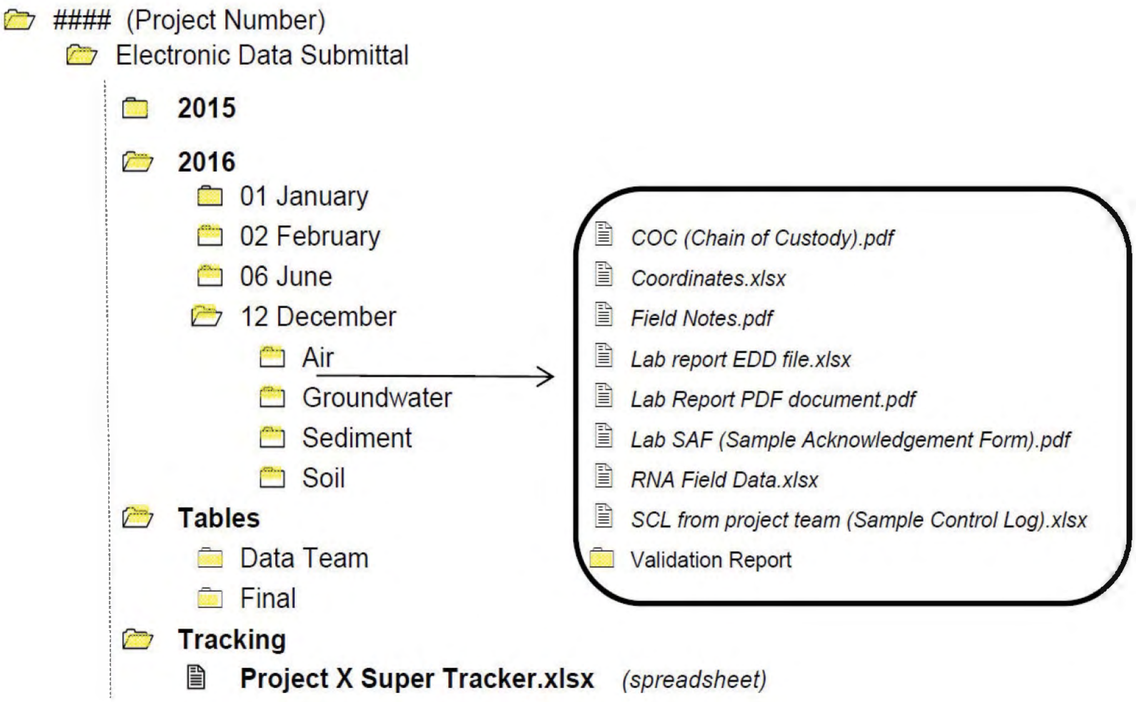
- Provide the PM with a copy of the field documentation when samples are being submitted for analysis or as soon as is possible (within 10 days of sample submission).

- Complete field documentation of the PDF formats (i.e. field forms, field notes, copy of COC) and of the electronic version of the sample control log (SCL).
    - Provide server locations (links) of completed documents to PM and Data Team:
        - Within 10 days of the end of the field sampling event
        - Bi-weekly for long-duration projects

1.4.3 Data Team

The data team members have the following responsibilities:

- Create folders on the server according to the following structure:



- #### (Project Number)
    - Electronic Data Submittal
        - **2015**
        - **2016**
            - 01 January
            - 02 February
            - 06 June
            - 12 December
                - Air
                - Groundwater
                - Sediment
                - Soil
        - **Tables**
            - Data Team
            - Final
        - **Tracking**
            - **Project X Super Tracker.xlsx** *(spreadsheet)*

- *COC (Chain of Custody).pdf*
- *Coordinates.xlsx*
- *Field Notes.pdf*
- *Lab report EDD file.xlsx*
- *Lab Report PDF document.pdf*
- *Lab SAF (Sample Acknowledgement Form).pdf*
- *RNA Field Data.xlsx*
- *SCL from project team (Sample Control Log).xlsx*
- Validation Report

- Create and maintain a Super Tracker table spreadsheet (Attachment B) according to project-specific sampling documents when the sample acknowledgment form is received from the laboratory and/or when field documentation is received. Update with electronic Sample Control Log (SCL) information and GPS coordinate data when available. The Super Tracker table is intended to capture all the information required to store data on the server.
- Receive electronic data deliverable (EDD) and lab report from laboratory, update Super Tracker table, save files on server and communicate the status of the data with the PM.
- Perform initial QC check on field data and notify project manager and field staff via e-mail of initial quality control check results.
- Perform Level 2 data verification (if requested) and communicate results to PM.
- Assist PM with Level 4 data validation coordination, if requested.
- Review level 4 validation reports and validated EDD for accuracy and completeness according to the USEPA National Functional Guidelines for Data Review and project-specific documents.
- Perform 10% check of EDD against the laboratory report. If errors are found, additional checking will be performed until the Data Team is confident the data is correct.
- Import data to the NRT Enviro Data database.
- Send import summary report to the PM. This report is generated by the Enviro Data system and is used to track what data has been loaded into the database.
- Generate requested data deliverables.

1.4.4 Mapping Team

The Mapping Team will work with the PM, field staff and the Data Team in the following capacities:

- Download GPS sample coordinates and perform data correction, if applicable.
- Provide corrected GPS coordinates to the data team or directly update Super Tracker table.
- Work with the project teams to clarify location / sample names / IDs.
- Generate requested figures.

1.4.5 Quality Control

Quality control is very important in the data flow process and:

- Is not the responsibility of any one person or group
- Is required of all staff members in some form
- Begins at the planning stages of the project and continues until a final report is issued

The Data Team will perform quality control on all field documentation and laboratory analytical results with the following steps:

- Reconcile the laboratory analytical report, the field data, with the provided project-specific sampling documents. Any discrepancies with field documentation or scope of work will be brought to the attention of the appropriate project level (i.e. field staff, project manager) for clarification.
- Perform Level 2 data verification (if requested by PM) of laboratory data integrity and its usability for its intended purpose. Issues regarding laboratory analysis and reporting will be brought to the attention of the project manager and the data team will work directly with the laboratory to resolve the issues.
- Log data discrepancies (i.e. missing field documentation, missing or late analytical data) into a publicly available Super Tracker table for project manager and staff to review.
- Complete quality control on the data before import into the analytical database to assure all NRT and project-specific standards are being met.

ATTACHMENT A

DATA FLOW CHART