Plan of Operation Modification
We Energies Caledonia Ash Landfill
Caledonia, Wisconsin
September 29, 2023

Appendix O

Environmental Sampling and Analysis Plan

GEI Consultants, Inc.

Intended for
We Energies

Date
December 12, 2023

Project No.
1940104079

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM REVISION 1

CALEDONIA ASH LANDFILL

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ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN
ADDENDUM REVISION 1
CALEDONIA ASH LANDFILL

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Checked by	**Nathaniel R. Keller, PG**
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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LICENSED PROFESSIONAL CERTIFICATIONS

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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Revision 0	January 27, 2023	• Original Document
Revision 1	December 12, 2023	• Revised Appendix D

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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' Oak Creek Power Plant (OCPP) Caledonia Ash Landfill (CAL) 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 CAL is located in the Village of Caledonia, Racine County, Wisconsin (**Figure 1-1**) and bordered primarily by industrial properties with vacant and residential properties generally located to the south and west. It was permitted in 1987and construction was completed in 1990; the site was also licensed in 1990. An additional cell was completed in 2010.

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

- Fill: Typically composed of silty clay fill or other materials.
- Unlithified Glacial Deposits: Primarily low hydraulic conductivity clays and silts of the Oak Creek Formation, which is approximately 160-175 feet thick across the site. Potentially discontinuous glaciofluvial sand and gravel deposits within the Oak Creek formation are most prevalent and thickest in the northern portion of the site and thin to the south. 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 150 feet below ground surface (bgs) across the site.

Groundwater quality at the CAL 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 Ch. NR 507 Table 2 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.

The proposed CCR monitoring network includes seven monitoring wells, 2 background (W46D and W48) and 5 downgradient monitoring wells (W08D, W09D, W10D, W49, and W50). Parameters specified in Ch. NR 507 Appendix I, Table 1A 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 Ch. NR 507 Appendix I, Tables 1A and 3 not previously analyzed per 40 CFR § 257 are currently being collected to complete eight rounds of sampling so results can be evaluated against Ch. NR 140 PALs and ESs or Alternative Concentration Limits (ACLs; WDNR, 2007), if appropriate.

Background monitoring wells W46D and W48 meet the background well criteria for ACLs for the following parameters:

- Boron, and
- Fluoride.

Exemptions to the Ch. NR 140 PALs are proposed for all Uppermost Aquifer monitoring wells (W08D, W09D, W10D, W46D, W48, W49, and W50), which also meet the ACL exemption criteria for the parameters referenced above as well as sulfate at W08D. In addition, PALs have also been calculated for calcium and total dissolved solids at the monitoring wells in accordance with Ch. NR 140.20.

Analytical results, field data, 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 (Addendum) was completed by Ramboll Americas Engineering Solutions, Inc. (Ramboll) as part of the Plan of Operation Modification for the We Energies' OCPP CAL to present a 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 CAL is located in Racine County, Wisconsin, Section 1 Township 4 North and Range 22 East in the Village of Caledonia approximately 3,600 feet west Lake Michigan (**Figure 1-1**). It is bordered by other OCPP ash landfills and vacant property to the north, the OCPP coal pile to the east, agricultural/vacant land to the south, and vacant land/residential property to the west.

1.3 Background

The CAL was originally permitted in 1987. The first phase of landfill development was constructed in 1990 and a license to operate the site was issued the same year. The permitted landfill area covers approximately 45 acres and provides a disposal capacity of 4,050,000 cubic yards of fly ash and other coal combustion products. The first six base cells were constructed with a 5-foot thick compacted clay liner and leachate collection system. A Plan of Operation Modification was approved on May 19, 2010, which changed the liner design for future cells to a composite liner consisting of a 4-foot thick compacted clay liner with a 60-mil HDPE geomembrane.

Base Cell 10 was constructed in 2010 with the composite liner described in the 2010 Plan Modification. Cell 10 was approved for operation on March 10, 2011. There are three additional cells included with the permit that will be constructed in the future as additional space is needed. There are currently approximately 1,800,000 cubic yards of ash and other coal combustion products in the CAL. The current available airspace is approximately 1,221,000 cubic yards, with an additional 1,029,000 cubic yards of permitted air space yet to be developed.

Groundwater quality at the CAL 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 NR 507 Table 2 and additional ions and metals and compared to Ch. NR 140, Wis Adm Code PALs and ESs. Monitoring under the current program has been performed at the site since approval was received from the Wisconsin Department of Natural Resources (WDNR) in a January 28, 2015 letter.

In 2015 and 2017, seven 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 40 CFR § 257 Appendix III are compared to statistically derived background concentrations.

2. GEOLOGY AND HYDROGEOLOGY

Significant investigation and analyses have been completed in the overlying glacial sediments and the Uppermost Aquifer at the CAL. The current monitoring well networks and locations are shown on **Figure 2-1**. Previous investigations included 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. Historic investigations (which occurred on the larger site periodically from the mid-1970’s to early 2010’s) and subsequent monitoring for the WDNR characterized the geology and water quality mostly in the glacial materials below the ash landfill, but information from the Silurian dolomite bedrock exists in limited areas.

With promulgation of 40 CFR § 257 in 2015, the current Uppermost Aquifer monitoring well network was installed to fulfill the rule requirements. Seven monitoring wells, including two background (W46D and W48) and five downgradient monitoring wells (W08D, W09D, W10D, W49, and W50), comprise the Uppermost Aquifer monitoring well network (**Table 2-1**). Wells were screened between approximately 495 and 525 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 near the CAL is generally to the east toward Lake Michigan. Groundwater flow within the bedrock is generally east - northeast towards Lake Michigan.

2.1.1 Hydrostratigraphic Units

Three hydrostratigraphic units have been identified at CAL based on stratigraphic relationships and common hydrogeologic characteristics. Unit cross-sections are presented in **Figures 2-2 through 2-6** and are summarized as follows:

- Fill
- Unlithified Glacial Deposits: Consists of clays and silts of the Oak Creek Formation, with isolated sand lenses; this unit is 160 to 170 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 2-7**. 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.

2.1.1.2 Unlithified Deposits

Extensive characterization of the unlithified deposits began in the 1970s and continued into the 2010s. The unlithified deposits, consisting of the Oak Creek Formation, are over 150 feet thick, and generally have low hydraulic conductivity, which ranges from 1x10^{-6} cm/s in shallow clay to 1x10^{-3} cm/sec in deeper sand lenses (WWC, 1993). The formation is primarily glacial till 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 2-6**) indicate most silt, sand, and gravel lenses are not laterally continuous beneath the CAL. An intermediate sand unit (NRT, 2013) generally occurs at an elevation between 600 and 650 ft, but was not encountered in W08D, W46D, or W50 and is limited to the northern portion of the landfill. 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 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 weathered material on top of competent bedrock. The Uppermost Aquifer was encountered in all borings advanced in 2015 and 2017 (W08D, W09D, W10D, W46D, W48, W49, and W50). The bedrock surface, contoured on **Figure 2-7**, indicates a shallow valley trending to the northwest. Bedrock was drilled using rotosonic methods which recovered core sections 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. Site-specific data for the Uppermost Aquifer collected from packer tests conducted during investigations for the Elm Road Generating Station (ERGS) indicated bedrock hydraulic conductivities ranged from $1x10^{-7}$ to $1x10^{-6}$ cm/s. Regional estimates of hydraulic conductivity in the Niagara Aquifer range between $1x10^{-4}$ and $1x10^{-2}$ 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 W08D, W09D, W10D, W46D, W48, W49, and W50 monitor groundwater flow in the Uppermost Aquifer. Groundwater elevations measured on May 4-5, 2022 were between approximately 654 and 657 feet NAVD88 and indicate a groundwater flow direction to the north and east (**Figure 2-8**), and these observations are generally consistent with previous monitoring events. Seasonal variation in the Uppermost Aquifer groundwater elevations occurs but generally groundwater elevations measured in the spring are up to five feet higher than those measured in the fall. Although elevations seasonally vary, the Uppermost Aquifer groundwater flow direction 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 (or 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 January 28, 2015), the monitoring well network (**Figure 2-1**) consists of 22 monitoring wells screened in the unlithified glacial sediments and these other sampling locations:

- 8A, 8B, 8C, 9A, 9B, 9C, 10A, 10C, 27RR, W32A, W32BR, W32C, W12D, 3AR, 3BR, 3CR, 16AR, 16BR, 16CR, W46A, W46B, W46C
- the leachate tank (LTANK)
- Sedimentation Basin

Semi-annual samples are collected in May and November and analyzed for the field and laboratory parameters listed in **Table A** below; the leachate tank sample parameters are listed in **Table B** below. The sedimentation basin is also sampled semi-annually and analyzed for temperature, total suspended solids, pH, and specific conductance.

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
Calcium	Potassium	
Magnesium	Sodium	
Inorganics (Dissolved)		
Alkalinity	Hardness	Sulfate
Chloride		

[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 (cont.)

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):

- calcium, chloride, magnesium, potassium, molybdenum, selenium, and sodium.

Most of these parameters have been analyzed since the mid to late-1980’s as wells were added to the network with Plan of Operation approvals. Molybdenum was added to the Ch. NR 507 monitoring program at the end of 2009.

Since 2015, there have been no exceedances reported for chloride, potassium, or selenium. The number of NR 140 PAL or ES exceedances for the other parameters from May 2015 to present (16 rounds) are summarized as follows (**Appendix B,** number of exceedances at a well in parentheses):

PAL Exceedances

- Calcium – W08A (6), W10A (1), W10C (3), W32A (8), W32BR (16), W32C (1)
- Magnesium – W10A (1), W32A (6), W32BR (16)
- Molybdenum – W16AR (16), W46C (16)
- Sodium – W08B (12), W08C (16), W16AR (2), W16BR (6), W32A (2), W32C (5)

ES Exceedances

- Molybdenum – W46C (16)

Review and evaluation of these parameter exceedances (specifically those with consistent [>5 events] exceedances) indicate concentrations may be elevated, but boron concentrations are stable to declining, which provides evidence the CAL is not the source of these constituents (**Appendix B**). Review of aerial photographs on Google Earth from 2000 to present indicates the following activities near the landfill:

- September 2006 – Hwy 32 has been widened and an access road built to the southwest corner of the CAL.
- September 2008 – Additional material added to the southern CAL screening berm.
- May 2010 – Portions of We Energies Trail are present along Hwy 32 and a large, gravel laydown is present south of the W32 nest.
- July 2011 – Former laydown area has been mostly removed, a soil stockpile is being covered with topsoil southeast of the W08 nest. A longer portion of the We Energies trail is present extending further south along Hwy 32.
- April 2017 – A large berm has been built south of the CAL separating the We Energies Trail from the CAL.

Earthwork and material placement (likely limestone/dolomite gravel) during these timeframes had the potential to expose soils and minerals to precipitation which may increase the leaching of the various constituents with PAL exceedances to shallow groundwater.

Significant work to characterize molybdenum in groundwater was performed at the OCPP (WDNR, 2013). Although molybdenum has been detected at concentrations above the PAL and ES, WDNR did not identify a relationship between monitoring wells with elevated boron and elevated molybdenum concentrations in the glacial units. In addition, regional information (Harkness et al, 2017) indicates molybdenum is likely naturally occurring as a result of groundwater interactions in the Silurian dolomite.

The similarity of molybdenum concentrations with regional levels and lack of elevated boron concentrations provide evidence that Non-Table 2 parameter concentrations are unrelated to the CAL. Based on this information, We Energies requests eliminating calcium, chloride, magnesium, potassium, molybdenum, selenium, and sodium from the monitoring parameter list. Monitoring will continue to be performed for the Table 2 parameters listed in Ch. NR 507 Appendix I.

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 CAL (**Figure 2-1**) consists of six monitoring wells installed within the uppermost aquifer; two background monitoring wells (W46D and W48) and four downgradient monitoring wells (W08D, W09D, W10D, W49, and W50).

Groundwater is being monitored 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 (SAP) for the Caledonia 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 as required by 40 C.F.R. § 257. Results from this sampling including baseline/background analyses in GEMS format have been attached to this submittal **Appendix C**.

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 (W46D and W48) and four downgradient monitoring wells (W08D, W09D, W10D, W49, and W50; **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 CAL. 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 D**).

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 Ch. NR 507 Appendix I, Tables 1A and 3. 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 PALs and ESs.

Copper, manganese, silver, zinc, alkalinity, hardness, and nitrate + nitrite, N are not required to be monitored under 40 CFR § 257. Data collection for baseline groundwater quality for these parameters are 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, 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 (May and November), groundwater will be collected from the CCR wells and sent to a Wisconsin certified laboratory for analysis of parameters summarized in **Table E,** below 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 Ch. NR 140 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 as 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 Ch. NR 140 PAL or ES (WDNR, 2007). Background wells W46D and W48 are unaffected by a release and their associated monitoring results for boron and fluoride 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, and fluoride, and at W08D for sulfate. Downgradient monitoring wells W08D, W09D, W10D, W49, and W50 meet 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 not detected in a well, one-half the detection limit was used in the calculation. PALs were also calculated for calcium and TDS in accordance with Ch. NR 140.20 (**Table 4-3**). Detailed calculation summary tables and outlier analysis are provided in **Appendix C-2** and the applicable ACLs and PALs are included in **Table 4-2 and 4-3**.

Data used in 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 **Appendix C-1**. In an effort to provide conservative ACL values, data were excluded from ACL calculations where the outlier increased the calculated 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. 3232.

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 program 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). 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 Ch. NR 506.17(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 determine if a source other than the CAL 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 4.7.1. 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 WDNR did not concur with an alternate source demonstration, remedial action options will be identified and evaluated in accordance with Ch. NR 722 to 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 listed for CCR landfills in Ch. NR 507 Appendix I 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 listed in Ch. NR 507 Appendix I, Tables 1A, 3, and 4 have not exceeded the groundwater protection standards in 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

Natural Resource Technology, Inc., 2013. Hydrogeology, Groundwater Quality, and Environmental Monitoring, Oak Creek Site, Oak Creek and Caledonia, Wisconsin. January 21, 2013

Natural Resource Technology, Inc., 2015. Sampling and Analysis Plan. We Energies, Pleasant Prairie Power Plant Ash Landfill. December 8, 2015.

R Core Team, 2022. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

STS Consultants, Ltd., 1997. Final Hydrogeologic Investigation Report. Pleasant Prairie Power Plan Ash Landfill, Pleasant Prairie, Wisconsin. April 4, 1997.

United States Geologic Survey (USGS), 1976. Ground-Water Resources and Geology of Walworth County, Wisconsin. Information Circular Number 34, November 1976.

Wisconsin Department of Natural Resources, 2007. How to Calculate Preventive Action Limits (PALs) and Alternative Concentration Limits (ACLs) for Solid Waste Facilities. PUB-WA-1105, Rev. 2007.

Woodward Clyde Consultants, July 1993. NR140 Groundwater Investigation, Oak Creek Property, South Oak Creek, Caledonia, North Oak Creek, Early Ash Disposal Areas, Oak Creek Power Plant, Oak Creek, Wisconsin. Prepared for Wisconsin Electric Power Company.

TABLES

TABLE 2-1. CCR GROUNDWATER MONITORING WELL INFORMATION
ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, WISCONSIN

Well Designation	Wisconsin Unique Well Number	Date Well Installed	Drilling Subcontractor	Drilling Method	Gradient Position	State Plane Northing	State Plane Easting	Latitude (decimal degrees)	Longitude (decimal degrees)	Ground Surface Elevation (ft MSL)	Top of Protective Cover Pipe Elevation (ft MSL)	Top of Well Riser Elevation (ft MSL)	Borehole Drilled Depth (ft bgs)	Borehole Bottom Elevation (ft MSL)	Depth to Top of Well Screen (ft bgs)	Depth to Well Bottom (ft bgs)	Top of Screen Elevation (ft MSL)	Well Bottom Elevation (ft MSL)	Depth to Top of Bedrock (ft bgs)	Top of Bedrock Elevation (ft MSL)
W08D	PI728	3/13/2015	Cascade Drilling	Sonic	downgradient	312,286.29	2,579,368.75	42.83621	-87.83965	695.55	698.71	698.28	185.0	510.6	180	185.0	515.6	510.6	167.5	528.1
W09D	PI727	3/12/2015	Cascade Drilling	Sonic	downgradient	313,274.14	2,579,467.21	42.83892	-87.83924	704.42	707.87	707.35	185.0	519.4	180	185.0	524.4	519.4	168.5	535.9
W10D	PI726	3/9/2015	Cascade Drilling	Sonic	downgradient	313,611.88	2,579,219.14	42.83985	-87.84015	700.95	703.67	703.10	180.0	521.0	175	180.0	526.0	521.0	164.0	537.0
W46D	PI725	3/11/2015	Cascade Drilling	Sonic	background	313,062.09	2,577,427.29	42.83840	-87.84685	698.96	701.82	701.26	205.0	494.0	197	202.0	502.0	497.0	185.0	514.0
W48	PI724	3/17/2015	Cascade Drilling	Sonic	upgradient	312,062.45	2,578,094.55	42.83564	-87.84441	713.24	716.36	715.88	191.0	522.2	186	191.0	527.2	522.2	175.0	538.2
W49	VR990	4/18/2017	Cascade Drilling	Sonic	downgradient	313,588.62	2,578,804.50	42.83987	-87.84187	715.04	718.04	717.49	195.0	520.0	190	195.0	525.0	520.0	180.0	535.0
W50	VR991	4/19/2017	Cascade Drilling	Sonic	downgradient	312,751.43	2,579,690.72	42.83751	-87.83865	692.43	695.20	694.68	175.0	517.4	170	175.0	522.4	517.4	158.0	534.4

Notes:
Ground surface, top of protective cover pipe and top of well riser elevations for wells installed in March 2015 were surveyed by Edgerton Contractors, Inc. (ECI) on March 30, 2015.
Wells W49 and W50 installed in April 2017 were surveyed by ECI on April, 28 2017. Elevation datum is referenced to Mean Sea Level (MSL) .
Horizontal datum is North American Datum (NAD) 1927 State Plane Wisconsin South (feet).
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.
Sonic = vibratory (i.e. roto-Sonic®)
bgs = below ground surface
ft = foot/feet

TABLE 4-1. SUMMARY OF GROUNDWATER SAMPLING PARAMETERS, METHODS, AND ANALYTICAL LIMITS

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, 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 REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, WISCONSIN

Location	Parameter	Units	Count	Mean	Median	Maximum	Minimum	Standard Deviation
W08D	Boron, total	mg/L	19	0.44	0.46	0.49	0.27	0.048
	Fluoride, total	mg/L	19	1.0	1.0	1.6	0.71	0.22
	Sulfate, total	mg/L	19	206	203	240	177	15.6
W09D	Boron, total	mg/L	23	0.40	0.39	0.45	0.35	0.02
	Fluoride, total	mg/L	19	1.35	1.3	1.6	1.2	0.10
W10D	Boron, total	mg/L	19	0.42	0.43	0.45	0.39	0.02
	Fluoride, total	mg/L	19	1.3	1.3	1.6	1.2	0.1
W46D	Boron, total	mg/L	19	0.38	0.38	0.41	0.33	0.02
	Fluoride, total	mg/L	19	1.2	1.1	4.0	0.25	0.8
W48	Boron, total	mg/L	19	0.38	0.37	0.42	0.34	0.02
	Fluoride, total	mg/L	19	0.89	0.92	1.0	0.24	0.17
W49	Boron, total	mg/L	13	0.44	0.44	0.47	0.41	0.02
	Fluoride, total	mg/L	13	1.4	1.4	1.9	1	0.21
W50	Boron, total	mg/L	13	0.52	0.51	0.54	0.49	0.02
	Fluoride, total	mg/L	13	1.2	1.2	1.4	0.99	0.1

Notes:
[1] ACL column may not sum due to rounding.
ACL = Alternative Concentration Limit
ES = Enforcement Standard
mg/L = milligrams per liter
NA = not applicable
PAL = Preventive Action Limit

TABLE 4-2. ACL CALCULATION TABLES

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, WISCONSIN

Location	Parameter	No. of Outliers Removed	Resulting Mean/ Std. Dev.	ACL (Mean + 2 Standard Deviations) [1]	Sen Slope (Units/year)	Normal / Log Normal	Percent of Non-Detects
W08D	Boron, total	1	0.45 / 0.025	**0.50**	0.007	No / No	0.00
	Fluoride, total	1	1.00 / 0.17	**1.35**	0.067	Yes / Yes	0.00
	Sulfate, total	0	NA	**236**	4.770	Yes / Yes	0.00
W09D	Boron, total	0	NA	**0.44**	0.007	Yes / Yes	0.00
	Fluoride, total	1	1.33 / 0.07	**1.48**	0.000	No / No	0.00
W10D	Boron, total	0	NA	**0.46**	0.004	Yes / Yes	0.00
	Fluoride, total	1	1.29 / 0.08	**1.46**	0.000	No / No	0.00
W46D	Boron, total	0	NA	**0.42**	0.002	Yes / Yes	0.00
	Fluoride, total	1	1.08 / 0.39	**1.86**	0.040	No / No	5.26
W48	Boron, total	0	NA	**0.42**	0.006	Yes / Yes	0.00
	Fluoride, total	1	0.93 / 0.05	**1.03**	0.000	No / No	5.26
W49	Boron, total	0	NA	**0.48**	0.007	Yes / Yes	0.00
	Fluoride, total	1	1.33 / 0.14	**1.60**	0.057	Yes / Yes	0.00
W50	Boron, total	0	NA	**0.56**	0.007	Yes / Yes	0.00
	Fluoride, total	0	NA	**1.41**	0.000	Yes / Yes	0.00

Notes:
[1] ACL column may not sum due to rounding.
ACL = Alternative Concentration Limit
ES = Enforcement Standard
mg/L = milligrams per liter
NA = not applicable
PAL = Preventive Action Limit

TABLE 4-2. ACL CALCULATION TABLES
ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, WISCONSIN

Location	Parameter	ES (mg/L)	Max > ES?	Mean > ES?	PAL (mg/L)	Mean > PAL?	Number Values > PAL	2 Values > PAL?
W08D	Boron, total	1	No	No	0.2	**Yes**	19	**Yes**
	Fluoride, total	4	No	No	0.8	**Yes**	16	**Yes**
	Sulfate, total	250	No	No	125	**Yes**	19	**Yes**
W09D	Boron, total	1	No	No	0.2	**Yes**	23	**Yes**
	Fluoride, total	4	No	No	0.8	**Yes**	19	**Yes**
W10D	Boron, total	1	No	No	0.2	**Yes**	19	**Yes**
	Fluoride, total	4	No	No	0.8	**Yes**	19	**Yes**
W46D	Boron, total	1	No	No	0.2	**Yes**	19	**Yes**
	Fluoride, total	4	No	No	0.8	**Yes**	16	**Yes**
W48	Boron, total	1	No	No	0.2	**Yes**	19	**Yes**
	Fluoride, total	4	No	No	0.8	**Yes**	18	**Yes**
W49	Boron, total	1	No	No	0.2	**Yes**	13	**Yes**
	Fluoride, total	4	No	No	0.8	**Yes**	13	**Yes**
W50	Boron, total	1	No	No	0.2	**Yes**	13	**Yes**
	Fluoride, total	4	No	No	0.8	**Yes**	13	**Yes**

Notes:

[1] ACL column may not sum due to rounding.

ACL = Alternative Concentration Limit
ES = Enforcement Standard
mg/L = milligrams per liter
NA = not applicable
PAL = Preventive Action Limit

TABLE 4-3. PAL CALCULATION TABLES
ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, 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					
W46D	27.4	2.3	34	52	52
W48	26.8	1.1	30	52	52
Downgradient Monitoring Wells					
W08D	51.8	2.9	61	77	77
W09D	18.8	0.8	21	44	44
W10D	21.3	0.9	24	46	46
W49	17.8	2.6	26	43	43
W50	28.5	1.5	33	54	54

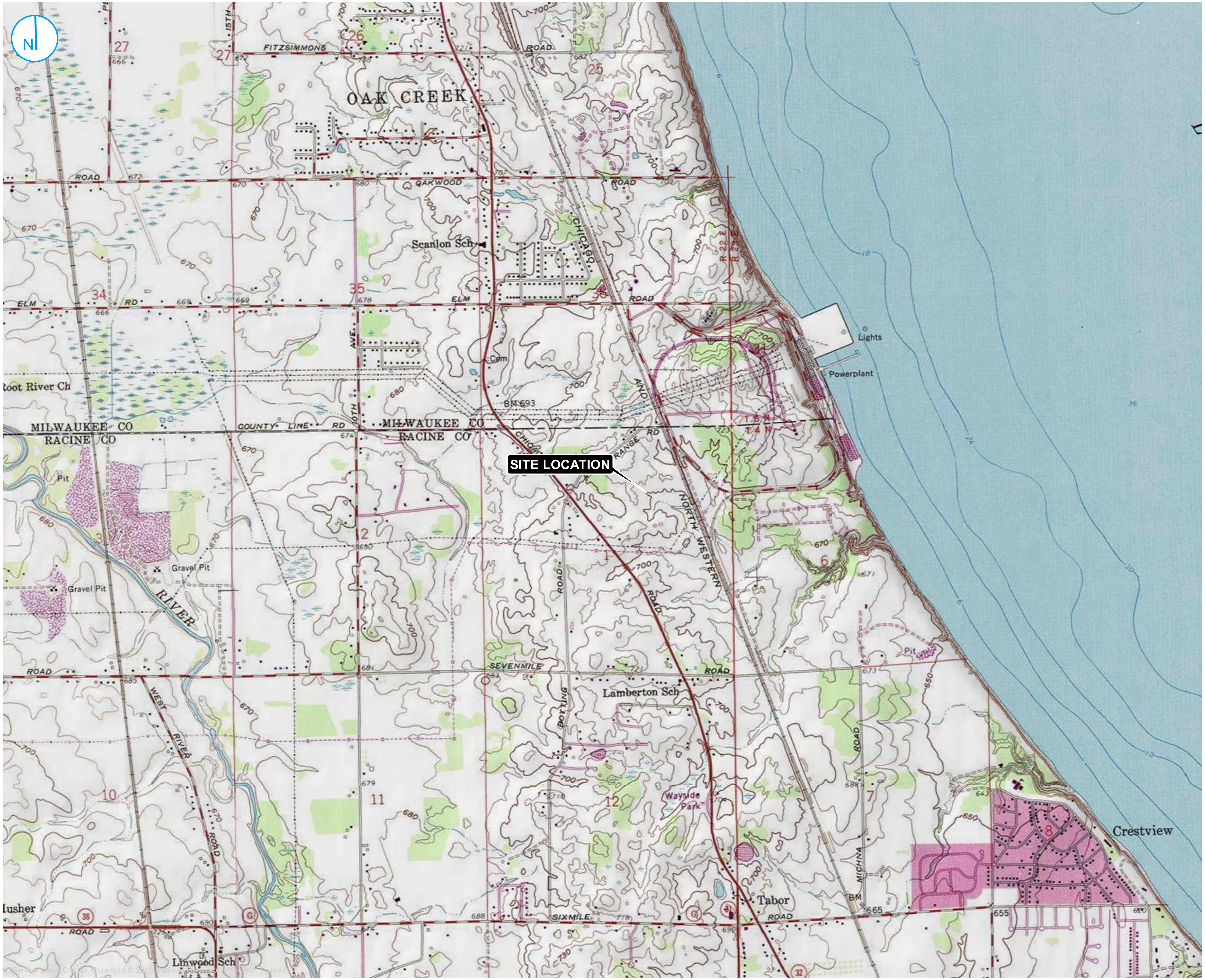
Total Dissolved Solids (mg/L)

Location ID	Mean	Standard Deviation	PAL Using 3 Standard Deviations	PAL Using NR 140 Table 3 Increment	Selected PAL
Background Monitoring Wells					
W46D	216.2	30	310	420	420
W48	230	22	300		430
Downgradient Monitoring Wells					
W08D	451	24	530	660	660
W09D	191	19	250	400	400
W10D	195	21	260	400	400
W49	205	19	270	410	410
W50	263	19	330	470	470

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

FIGURES

Y:\GIS\Projects\16\1660\CALEDONIA\MXD\SAP_Addendum\Figure 1-1_Site Location Map.mxd



0 1,000 2,000 Feet

SITE LOCATION MAP

**ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM
REVISION 1
CALEDONIA ASH LANDFILL**
CALEDONIA, WISCONSIN

FIGURE 1-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC

PROJECT: 169000XXXX | DATED: 1/23/2023 | DESIGNER: galammc

Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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

PROJECT: 169000XXXX | DATED: 1/23/2023 | DESIGNER: galarnmc

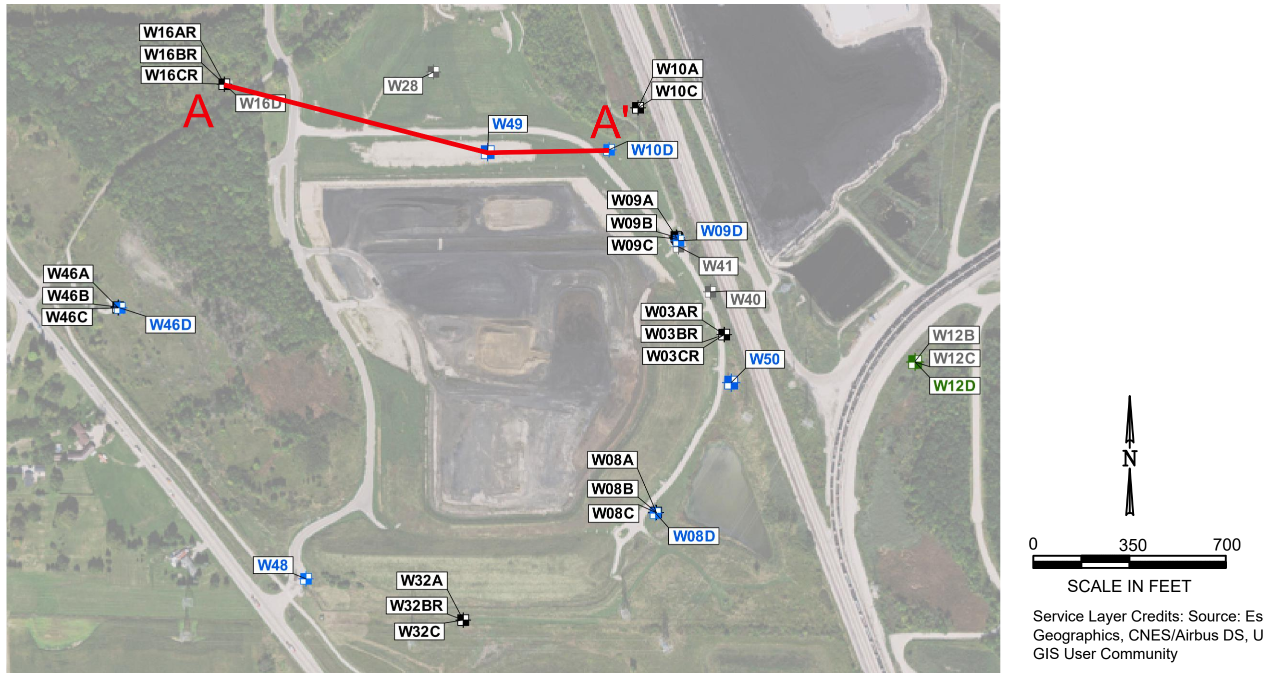
ACTIVE WELL NETWORKS MAP

ENVIRONMENTAL SAMPLING AND
ANALYSIS PLAN ADDENDUM
REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, WISCONSIN

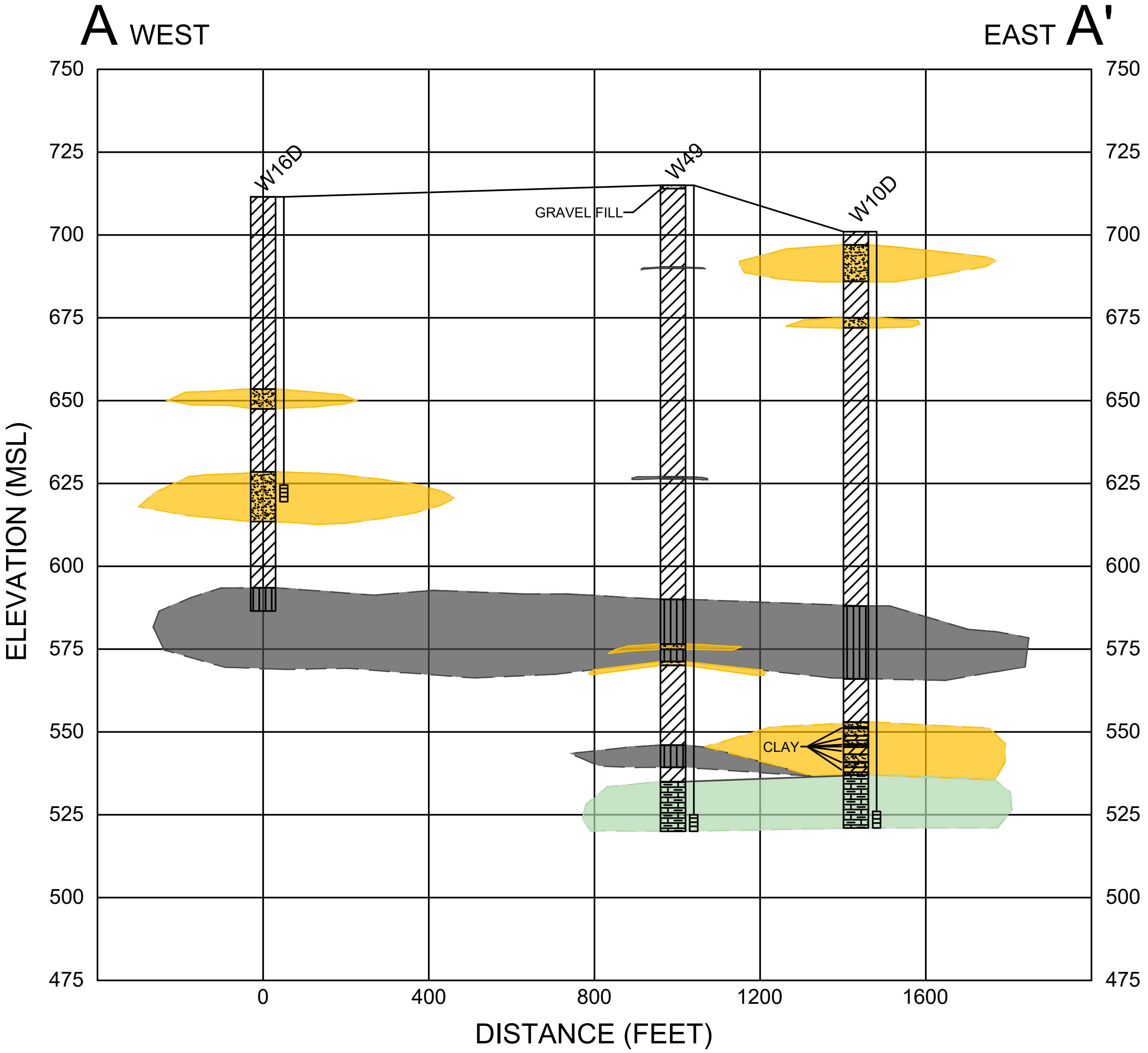
FIGURE 2-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC

Y:\ACAData\Projects\16\1660\1-1\Fig 2_Cross Section A-A.dwg

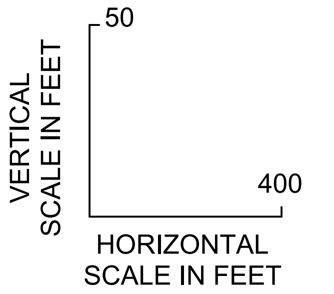


Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



W16D ⊕	MONITORING WELL LOCATION
A — A'	CROSS-SECTION TRANSECT
▩	SAND
▥	SILT
▨	CLAY
▦	DOLOMITE (BEDROCK)
☐	LOW/ NO RECOVERY
▤	WELL SCREEN
🟨	SAND
⬛	SILT
🟩	DOLOMITE (BEDROCK)

NOTES:
1. DASHED LINE INDICATES INFERRED CONTACT



VERTICAL EXAGGERATION = 8

GEOLOGIC CROSS-SECTION A-A'

ENVIRONMENTAL SAMPLING AND
ANALYSIS PLAN ADDENDUM
REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, WISCONSIN

FIGURE 2-2

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

DESIGNER: CAWRSEAG
DATED: 1/25/2023
PROJECT: 1940102327

Y:\ACADData\Projects\16\1660\1-1\Fig 3_Cross Section B-B.dwg

W16D ✚ MONITORING WELL LOCATION

B—B' CROSS-SECTION TRANSECT

▩ ASH

▒ SAND

▥ SILT

▨ CLAY

▦ DOLOMITE (BEDROCK)

☐ LOW/ NO RECOVERY

▤ WELL SCREEN

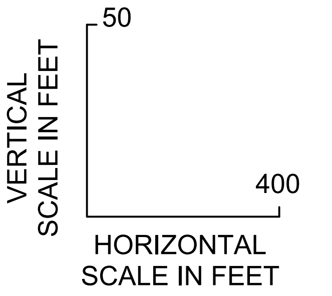
🟥 ASH

🟨 SAND

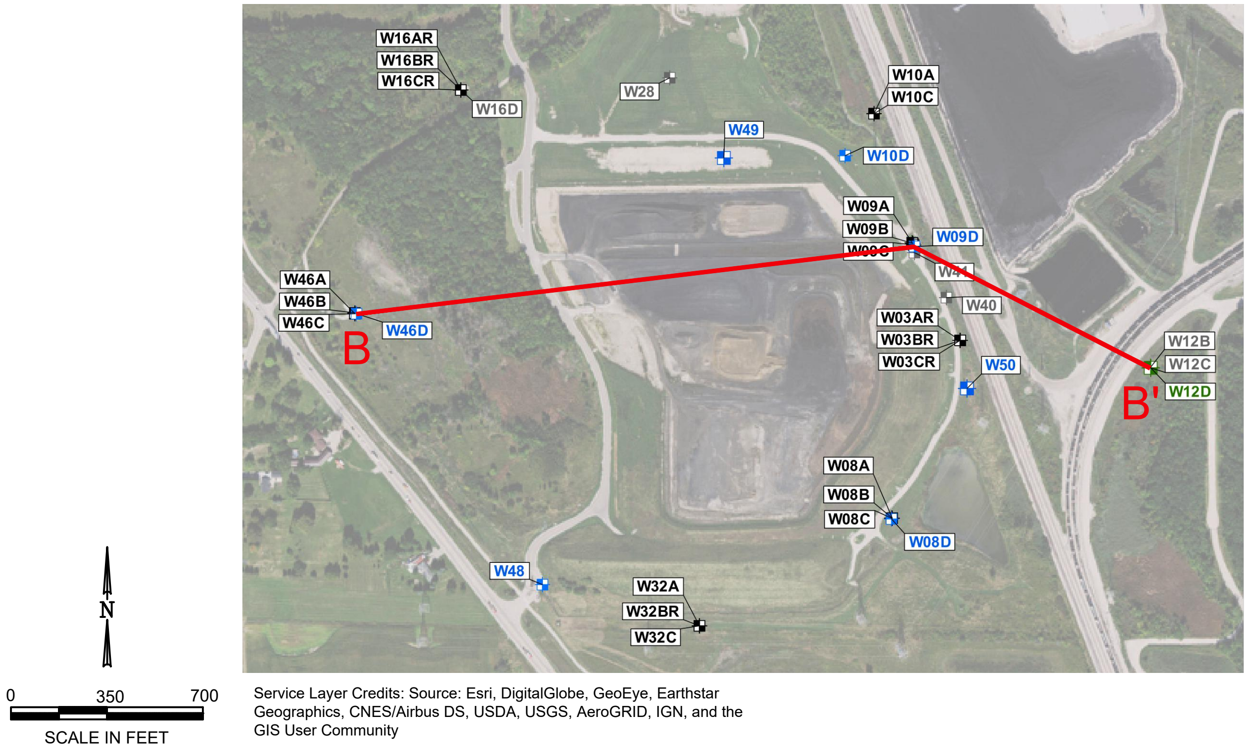
⬛ SILT

⬜ SANDY CLAY/ SANDY SILT

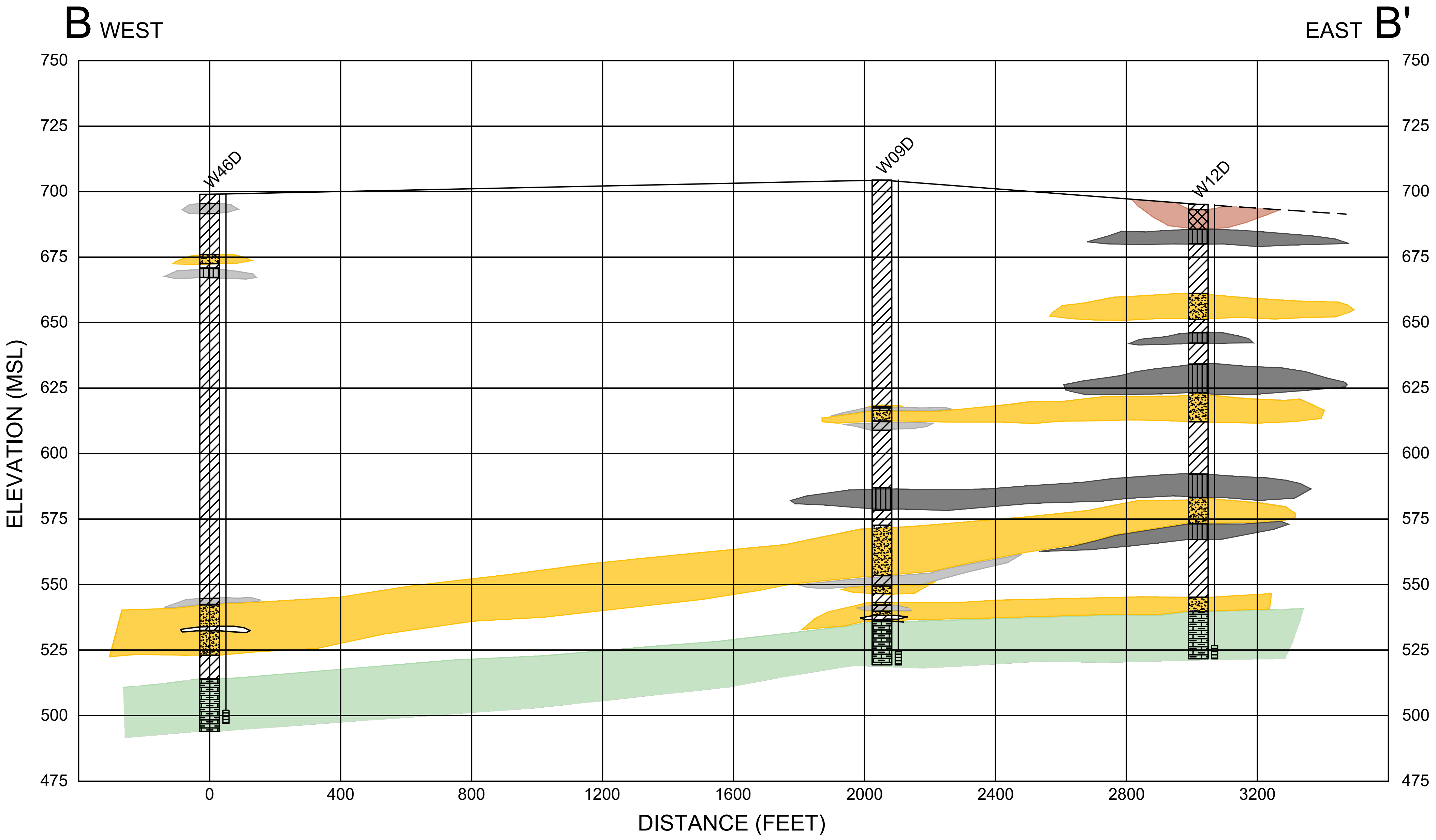
🟩 DOLOMITE (BEDROCK)



VERTICAL EXAGGERATION = 8



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



GEOLOGIC CROSS-SECTION B-B'

ENVIRONMENTAL SAMPLING AND
ANALYSIS PLAN ADDENDUM
REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, WISCONSIN

FIGURE 2-3

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

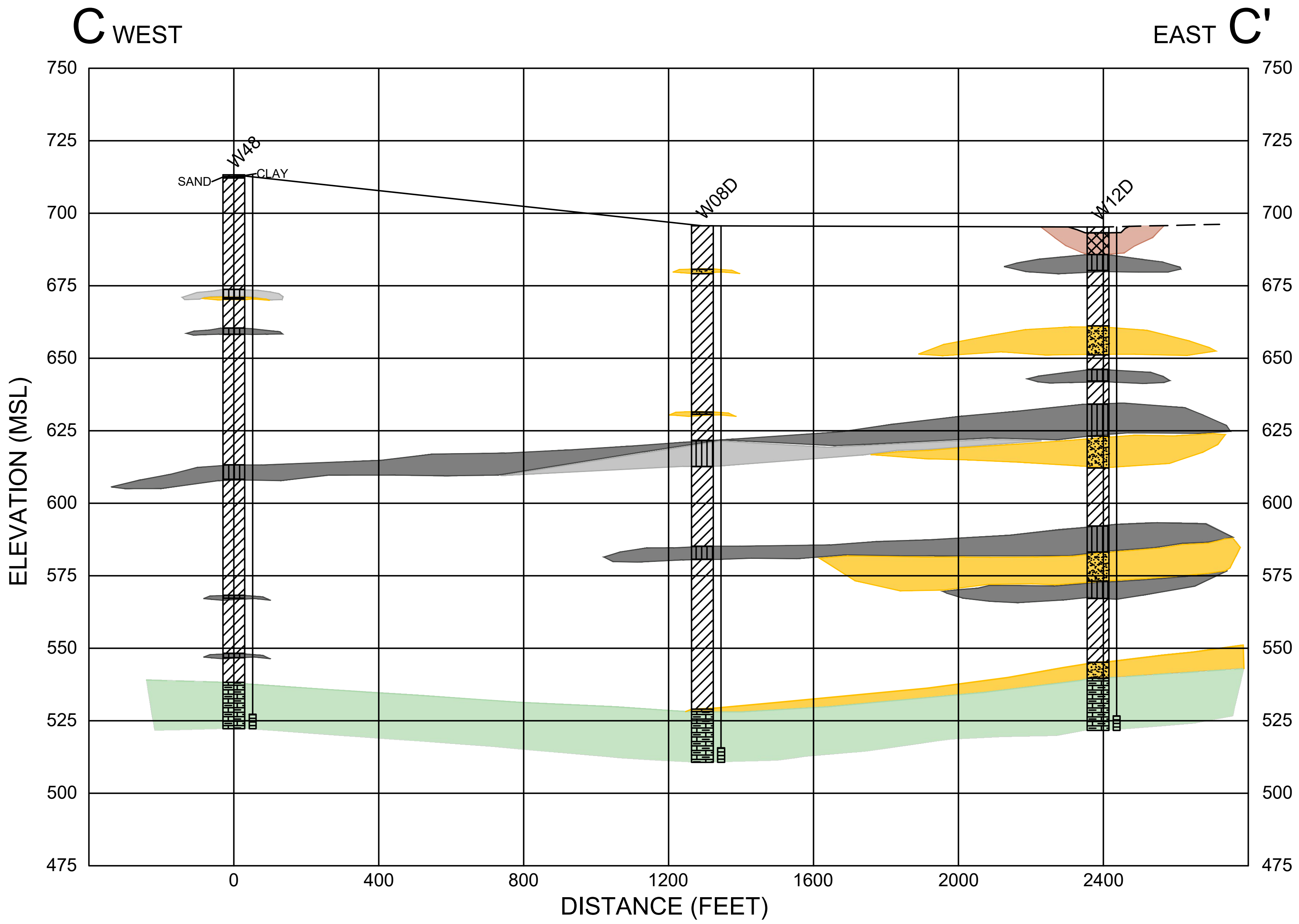
DESIGNER: CAWRSEAG

DATED: 1/25/2023

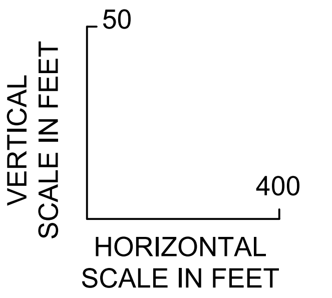
PROJECT: 1940102327

Y:\ACADData\Projects\16\1660\1-1\Fig 4_Cross Section C-C.dwg

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



W16D ✚ MONITORING WELL LOCATION
C—C' CROSS-SECTION TRANSECT
▩ ASH
▒ SAND
▥ SILT
▨ CLAY
▦ DOLOMITE (BEDROCK)
☐ LOW/ NO RECOVERY
▤ WELL SCREEN
🟫 ASH
🟨 SAND
⬛ SILT
⬜ SANDY CLAY/ SANDY SILT
🟩 DOLOMITE (BEDROCK)



VERTICAL EXAGGERATION = 8

GEOLOGIC CROSS-SECTION C-C'

ENVIRONMENTAL SAMPLING AND
ANALYSIS PLAN ADDENDUM
REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, WISCONSIN

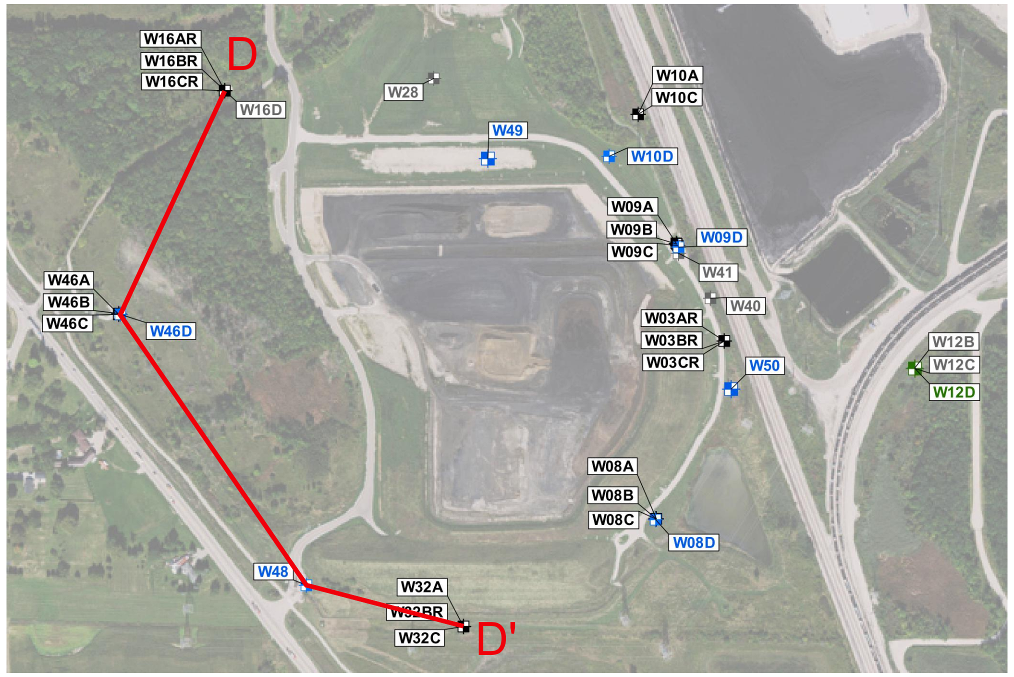
FIGURE 2-4

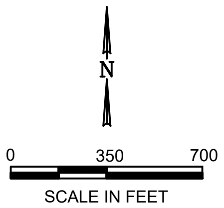
RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

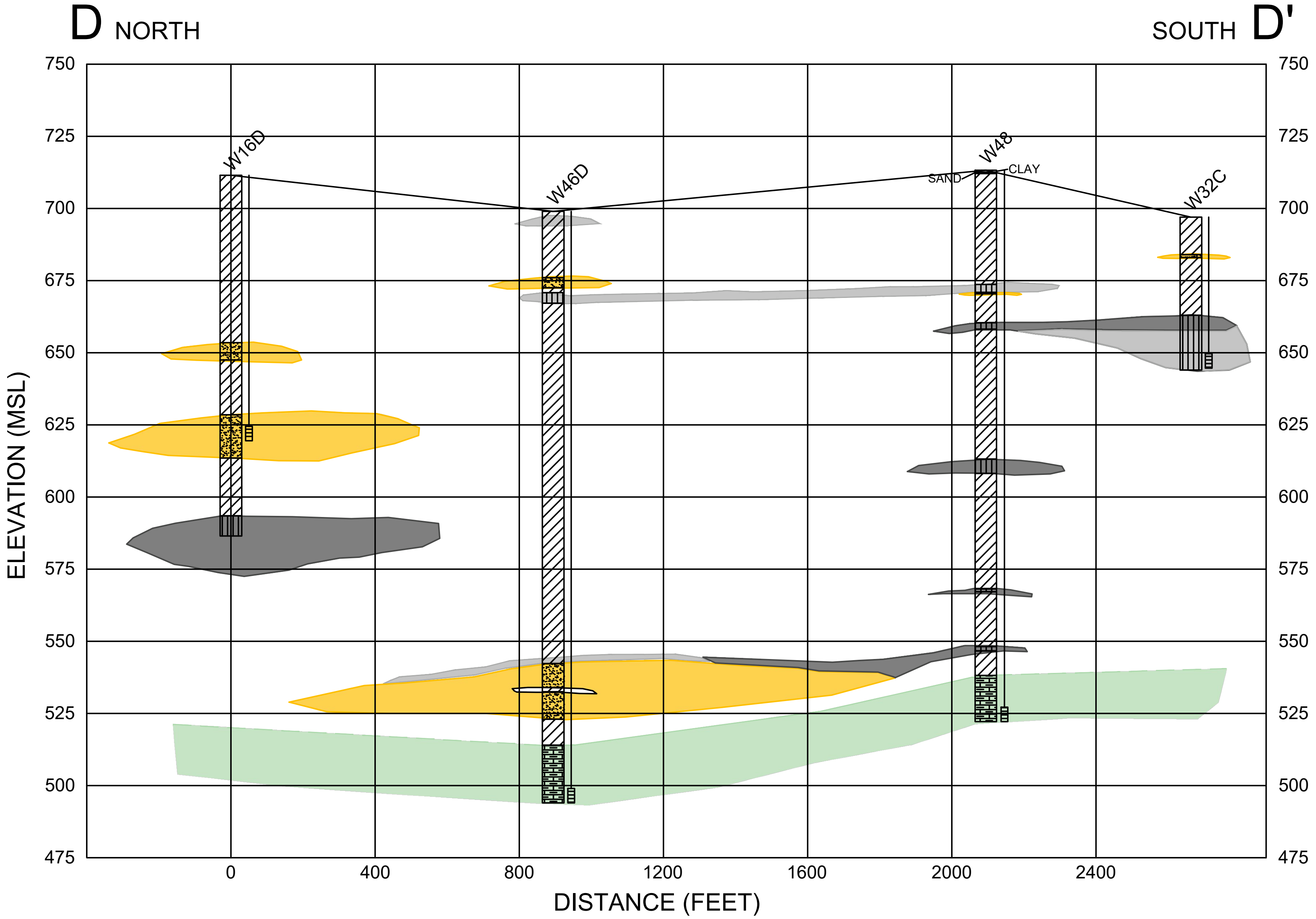
DESIGNER: CAWRSEAG
DATED: 1/25/2023
PROJECT: 1940102327

Y:\ACADData\Projects\16\1660\1-1\Fig 5_Cross Section D-D.dwg





Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



W16D
MONITORING WELL LOCATION

D—D' CROSS-SECTION TRANSECT

▨ SAND

▥ SILT

▨ CLAY

▦ DOLOMITE (BEDROCK)

☐ LOW/ NO RECOVERY

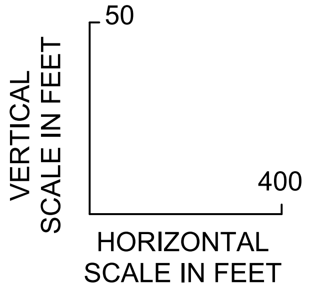
▥ WELL SCREEN

🟨 SAND

⬛ SILT

⬜ SANDY CLAY/ SANDY SILT

🟩 DOLOMITE (BEDROCK)



VERTICAL EXAGGERATION = 8

DESIGNER: CAWRSEAG

DATED: 1/25/2023

PROJECT: 1940102327

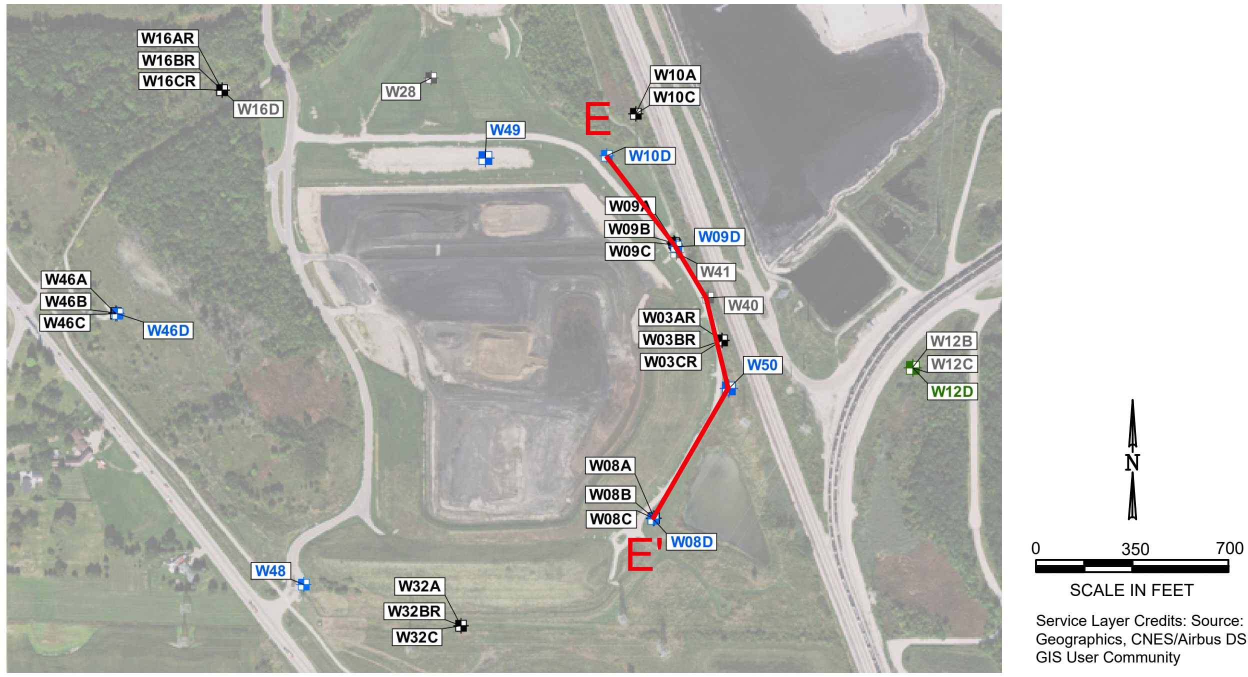
GEOLOGIC CROSS-SECTION D-D'

ENVIRONMENTAL SAMPLING AND
ANALYSIS PLAN ADDENDUM
REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, WISCONSIN

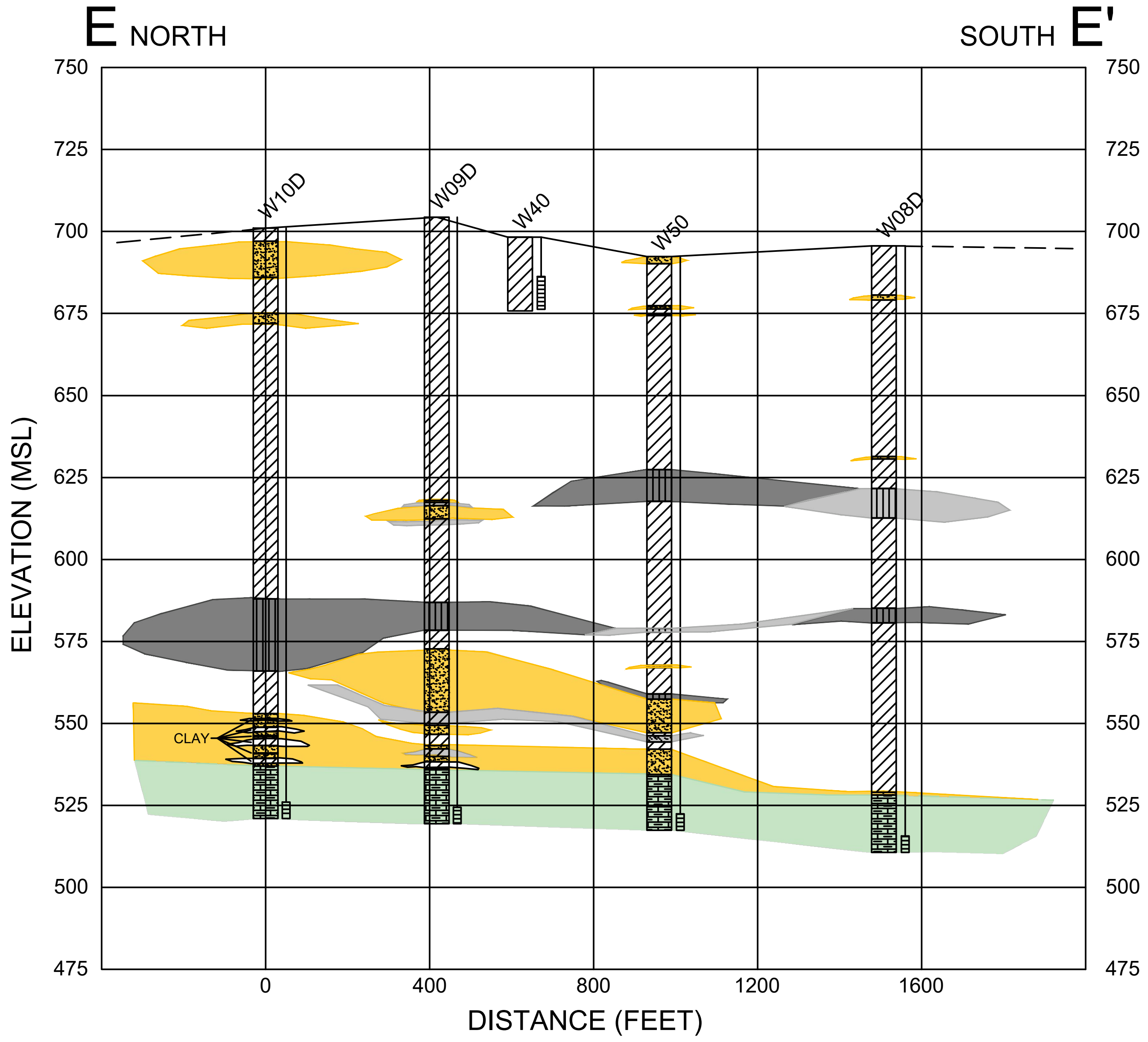
FIGURE 2-5

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

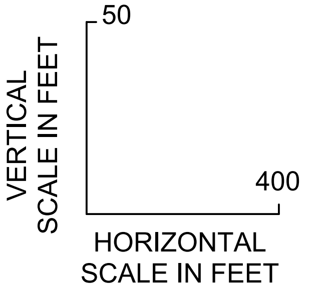
Y:\ACADData\Projects\16\1660\1-1\Fig 6_Cross Section E-E.dwg



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



W16D
- ⊕ MONITORING WELL LOCATION
- E—E' CROSS-SECTION TRANSECT
- ▩ SAND
- ▥ SILT
- ▨ CLAY
- ▦ DOLOMITE (BEDROCK)
- ☐ LOW/ NO RECOVERY
- ▤ WELL SCREEN
- 🟨 SAND
- ⬛ SILT
- ▒ SANDY CLAY/ SANDY SILT
- 🟩 DOLOMITE (BEDROCK)



VERTICAL EXAGGERATION = 8

GEOLOGIC CROSS-SECTION E-E'

ENVIRONMENTAL SAMPLING AND
ANALYSIS PLAN ADDENDUM
REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, WISCONSIN

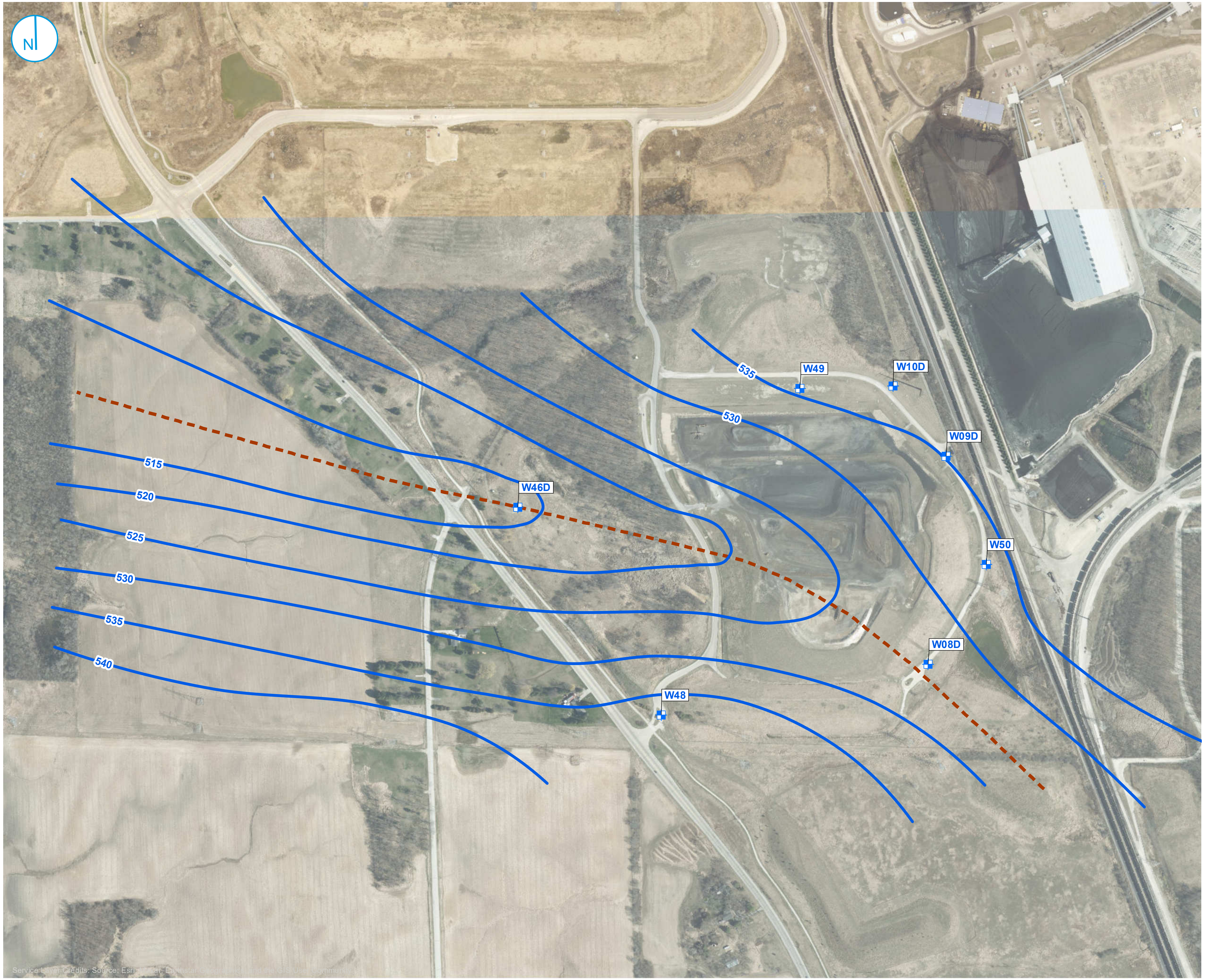
FIGURE 2-6

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

DESIGNER: CAWRSEAG
DATED: 1/25/2023
PROJECT: 1940102327

Y:\GIS\Projects\16\1660\CALEDONIA\MXD\SAP_Addendum\Figure 2-7_Bedrock Elevation Contour Map.mxd



- ⊞ BEDROCK UNIT (UPPERMOST AQUIFER) CCR MONITORING WELL LOCATION
- ━ TOP OF AQUIFER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)
- ╍ APPROXIMATE CENTERLINE OF BEDROCK VALLEY

0 225 450 Feet

BEDROCK ELEVATION CONTOUR MAP

ENVIRONMENTAL SAMPLING AND
ANALYSIS PLAN ADDENDUM
REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, WISCONSIN

FIGURE 2-7

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC

PROJECT: 169000XXXX | DATED: 1/23/2023 | DESIGNER: galarmmc

■ CCR RULE BACKGROUND MONITORING WELL LOCATION

■ CCR RULE DOWNGRADIENT MONITORING WELL LOCATION

■ CCR RULE UPGRADIENT MONITORING WELL LOCATION

— GROUNDWATER ELEVATION CONTOUR (1-FT CONTOUR INTERVAL, NAVD88)

0 150 300
Feet

UPPERMOST AQUIFER UNIT GROUNDWATER ELEVATION CONTOUR MAP
DETECTION MONITORING ROUND 10: MAY 4-5, 2022

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM
REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, WISCONSIN

FIGURE 2-8

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC

RAMBOLL

Y:\GIS\Projects\16\1660\CALEDONIA\MXD\SAP_Addendum\Figure 2-8_GW Contour Map May 2022.mxd

PROJECT: 169000XXXX | DATED: 1/23/2023 | DESIGNER: galarnmc

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 CALEDONIA LF	Racine	252108450	03232	01/25/2023	KYLE SCHAEFER, RAMBOLL

DNR Point ID No.	Point Name[1]	WUWN[2] (if app.)	Type	Status	Gradient	Enf. Stds. Y/N.	Construction Date	Elevations msl (ft) Ground Surface	Elevations msl (ft) Well Top (of casing)	Well Casing Type	Well Casing Diam[3] (in)	Well Casing Length[4] (ft)	Well Screen Length (ft)	Well (Pt) Total Length[5] (ft)	Coordinates[6,7,8,9] Y / Lat / Northing	Coordinates[6,7,8,9] X / Long / Easting
	W08D	PI728	12	A	D	Yes	03/13/2015	695.55	698.71	P	2	182.7	5	187.7	312,286.29	2,579,368.75
	W09D	PI727	12	A	D	Yes	03/12/2015	704.42	707.87	P	2	183.0	5	188.0	313,274.14	2,579,467.21
	W10D	PI726	12	A	D	Yes	03/09/2015	700.95	703.67	P	2	177.1	5	182.1	313,611.88	2,579,219.14
	W46D	PI725	12	A	X	Yes	03/11/2015	698.96	701.82	P	2	199.3	5	204.3	313,062.09	2,577,427.29
	W48	PI724	12	A	U	Yes	03/17/2015	713.24	716.36	P	2	188.7	5	193.7	312,062.45	2,578,094.55
	W49	VR990	12	A	D	Yes	04/18/2017	715.04	718.04	P	2	192.5	5	197.5	313,588.62	2,578,804.50
	W50	VR991	12	A	D	Yes	04/19/2017	692.43	695.20	P	2	172.3	5	177.3	312,751.43	2,579,690.72

[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 ☐

Page 1 of 8

Facility/Project Name Caledonia Ash Landfill	License/Permit/Monitoring Number	Boring Number W08D	
Boring Drilled By: Name of crew chief (first, last) and Firm Roy Buckenberger Cascade Drilling	Date Drilling Started 3/12/2015	Date Drilling Completed 3/13/2015	Drilling Method Rotory Sonic

WI Unique Well No. PI 728	DNR Well ID No.	Common Well Name W08D	Final Static Water Level Feet MSL	Surface Elevation 695.6 Feet MSL	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 312,286 N, 2,579,369 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 Racine	County Code 52	Civil Town/City/ or Village Caledonia

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	
1 CS	60 56.4		1 2	0 - 2.3' **FILL, SILTY CLAY** CL/ML, dark yellowish brown (10YR 4/4), mostly clay, 20-30% silt, 10-15% fine sand to fine gravel, trace root debris, cohesive, medium plasticity, dry to moist.	CL/ML									
2 CS	60 48		3 4 5 6 7 8 9	2.3 - 10' **FILL, LEAN CLAY:** CL, reworked till, yellowish brown (10YR 5/6), 10-20% silt, 5-10% fine sand, trace fine gravel, cohesive, medium plasticity, very stiff (2.5-3.0 tsf), dry, 10-20% gray (10YR 6/1) and yellowish brown (10YR 5/8) mottling, decreased mottling with depth.	CL									
3 CS	60 56.4		10 11 12	10 - 13' **LEAN CLAY:** CL, till, yellowish brown (10YR 5/4), 10-15% silt, trace fine sand to fine gravel, cohesive, medium plasticity, hard (>4.5 tsf), dry to moist, trace yellowish brown (10YR 5/8) mottling.	CL									
			13 14 15	13 - 15' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, very stiff (3.5 tsf), dry to moist, trace yellowish brown (10YR 5/8) 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 - Project: 1660 CALEDONIA LANDFILL GINT.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 W08D Use only as an attachment to Form 4400-122. Page 2 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
4 CS	240 213.6		16	15 - 16.5' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 6/1) to light brownish gray (10YR 6/2), mostly fine sand, 10-20% silt, wet.	SP-SM									
			17	16.5 - 64.2' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), cohesive, high plasticity, medium stiff (0.5-0.75 tsf), dry to moist, trace strong brown (7.5YR 5/6) mottling.										
			18											
			19											
			20											
			21											
			22											
			23											
			24											
			25											
			26											
			27											
			28		CL									
			29											
			30											
			31											
			32											
			33											
			34											
5 CS	240 214.8		35	35' medium stiff to stiff (0.5-1.5 tsf).										
			36											
			37											
			38											
			39											
			40											

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W08D Use only as an attachment to Form 4400-122. Page 3 of 8

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
			41	16.5 - 64.2' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), cohesive, high plasticity, medium stiff (0.5-0.75 tsf), dry to moist, trace strong brown (7.5YR 5/6) mottling. *(continued)*										
			42											
			43											
			44											
			45											
			46											
			47											
			48											
			49											
			50	50' stiff (1.5-2.0 tsf).										
			51											
			52		CL									
			53											
			54											
6 CS	120 118.8		55											
			56											
			57											
			58	57.4' - 58.6' trace silt laminations.										
			59	58.6' - 58.9' lens of silt [light brownish gray (10YR 6/2), cohesive, low plasticity, dry].										
			60											
			61											
			62											
			63											
			64											
			65	64.2 - 65' **POORLY-GRADED SAND:** SP, light brownish gray (10YR 6/2), mostly fine sand, trace	SP									

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W08D Use only as an attachment to Form 4400-122. Page 4 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
7 CS	120 152.4			silt, moist.										
			66	65 - 74' **LEAN CLAY:** CL, grayish brown (10YR 5/2), till, cohesive, high plasticity, dry to moist, trace strong brown (7.5YR 5/6) mottling.										
			67											
			68	67.5' trace silt laminations.										
			69		CL									
			70											
			71	71.1' - 71.6' lens of sandy silt to sand with sandy silt [light brownish gray (10YR 6/2), mostly fine sand, 10-30% silt, wet].										
			72											
			73											
			74	74 - 83' **SANDY SILT:** s(ML), gray (10YR 6/1) mostly silt, 30-40% very fine sand, cohesive, low plasticity, dry to moist.										
8 CS	120 159.6		75											
			76											
			77											
			78		s(ML)									
			79											
			80											
			81	81.1' grades into clay (till).										
			82											
			83	83 - 110.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 5-15% sand and gravel, 5-10% silt, cohesive, high plasticity, stiff to very stiff (1.0-1.5 tsf), dry to moist.										
			84											
9 CS	240 208.8		85	85' very stiff (2.5-3.5 tsf).										
			86		CL									
			87											
			88											
			89											
			90											

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W08D Use only as an attachment to Form 4400-122. Page 5 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
			91 92 93 94 95 96 97 98 99 100 101 102 103 104	83 - 110.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 5-15% sand and gravel, 5-10% silt, cohesive, high plasticity, stiff to very stiff (1.0-1.5 tsf), dry to moist. *(continued)*	CL									
10 CS	120 163.2		105 106 107 108 109 110											
			111 112 113 114 115	110.5 - 115' **SILT:** ML, gray (10YR 6/1), 10-20% clay, trace clay and fine sand at top 2' of interval, cohesive, nonplastic.	ML									

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SOIL BORING LOG INFORMATION SUPPLEMENT
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Boring Number W08D Use only as an attachment to Form 4400-122. Page 6 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	
11 CS	120 108			115 - 142.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 5-10% silt, trace fine sand to fine gravel, cohesive, high plasticity, stiff (1.0-2.0 tsf), dry to moist.										
			116											
			117											
			118											
			119											
			120	119.7' trace silt, very stiff (3.0-3.5 tsf).										
			121											
			122											
			123											
			124											
12 CS	180 168		125											
			126											
			127		CL									
			128											
			129											
			130											
			131											
			132											
			133											
			134	134' dark grayish brown (10YR 4/2), no silt, hard (>4.5 tsf), dry.										
			135											
			136											
			137											
			138											
			139											
			140											

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Boring Number W08D 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
13 CS	180 144		141 142	115 - 142.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 5-10% silt, trace fine sand to fine gravel, cohesive, high plasticity, stiff (1.0-2.0 tsf), dry to moist. *(continued)*	CL									
			143 144 145 146	142.5 - 146.9' **LEAN CLAY:** to **SILT:** CL, grayish brown (10YR 5/2), 20-30% silt, cohesive, medium plasticity, dry. 143.2' - 143.6' lens of silty sand [mostly fine sand, 20-30% silt, dry to moist]. 143.6' 30-40% silt.	CL									
			147 148 149 150 151 152 153 154	146.9 - 166.6' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, medium stiff to very stiff (0.5-2/0 tsf), dry to moist.										
14 CS	60 72		155 156 157 158 159	154.3' - 154.6' lens of poorly-graded sand with gravel [mostly medium sand, 10-20% medium sand to coarse gravel, moist to wet].	CL									
15 CS	108 146.4		160 161 162 163 164 165	160' cobble (4" diameter). 160.6' cobble (3" diameter). 161' cobble (4" diameter).										

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SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

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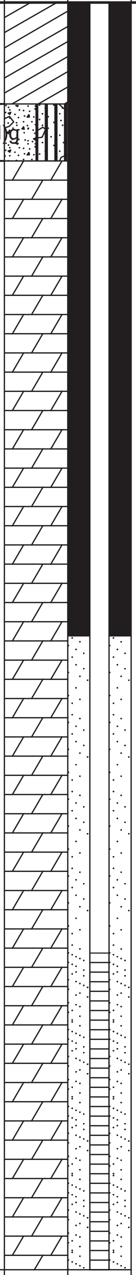

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			166	146.9 - 166.6' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, medium stiff to very stiff (0.5-2/0 tsf), dry to moist. *(continued)*	CL									
			167 168	166.6 - 167.5' **WELL-GRADED SAND WITH SILT AND GRAVEL:** (SW-SM)g, mostly fine to coarse sand, 10-20% silt, 10-15% fine to coarse gravel, parent material is highly decomposed dolomite bedrock (residual soil), dry to moist.	(SW-SM)g									
16 CS	192 132		169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184	167.5 - 185' **WEATHERED BEDROCK** BDX (LS), dolomite, white (10YR 8/1) to very pale brown (10YR 8/2), microcrystalline, massive, slightly decomposed [trace black laminations, trace olive yellow (5Y 6/6) and very dark greenish gray (GLEY 1 3/5G) discolorations], slightly disintegrated (trace recrystallizations, pitted).	BDX (LS)									
			185	185' 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 ☐

Page 1 of 12

Facility/Project Name Caledonia Ash Landfill			License/Permit/Monitoring Number	Boring Number W09D	
Boring Drilled By: Name of crew chief (first, last) and Firm Roy Buckenberger Cascade Drilling			Date Drilling Started 3/11/2015	Date Drilling Completed 3/12/2015	Drilling Method Rotory Sonic
WI Unique Well No. PI 727	DNR Well ID No.	Common Well Name W09D	Final Static Water Level Feet MSL	Surface Elevation 704.4 Feet MSL	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 313,274 N, 2,579,467 E [✓ S]/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 Racine	County Code 52	Civil Town/City/ or Village Caledonia

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 48			0 - 12.9' **FILL, LEAN CLAY:** CL, reworked till, yellowish brown (10YR 5/4), cohesive, medium plasticity, trace medium sand, coarse sand, and fine gravel, 5-10% fine sand, 10-20% silt, dry to moist, 10-15% light gray (10YR 7/1) mottling, 10-15% yellowish brown (10YR 5/8) mottling.		▨								
			0.5											
			1.0											
			1.5											
			2.0											
			2.5											
			3.0											
			3.5											
			4.0											
			4.5											
2 CS	120 120		5.0		CL									
			5.5											
			6.0											
			6.5											
			7.0											
			7.5											
			8.0											
			8.5											
			9.0											
			9.5											
			10.0											

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: 1660 CALEDONIA LANDFILL GINT.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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SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W09D Use only as an attachment to Form 4400-122. Page 2 of 12

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
			10.5	0 - 12.9' **FILL, LEAN CLAY:** CL, reworked till, yellowish brown (10YR 5/4), cohesive, medium plasticity, trace medium sand, coarse sand, and fine gravel, 5-10% fine sand, 10-20% silt, dry to moist, 10-15% light gray (10YR 7/1) mottling, 10-15% yellowish brown (10YR 5/8) mottling. *(continued)*										
			11.0											
			11.5		CL									
			12.0											
			12.5											
			13.0	12.9 - 39.4' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, dry to moist, trace yellowish brown (10YR 5/8) mottling.										
			13.5											
			14.0											
			14.5											
3 CS	240 187.2		15.0											
			15.5											
			16.0											
			16.5											
			17.0											
			17.5											
			18.0											
			18.5											
			19.0											
			19.5											
			20.0		CL									
			20.5											
			21.0											
			21.5											
			22.0											
			22.5											
			23.0											
			23.5											
			24.0											
			24.5											
			25.0											
			25.5											
			26.0											
			26.5											
			27.0											

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

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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
			28.0	12.9 - 39.4' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, dry to moist, trace yellowish brown (10YR 5/8) mottling. *(continued)*										
			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	120 112.8		35.0											
			35.5											
			36.0											
			36.5											
			37.0											
			37.5	37.1' - 37.3' silty lens [gray (10YR 6/1), 20-30% silt].										
			38.0											
			38.5											
			39.0	38.8' - 39.4' silty lens [gray (10YR 6/1), 20-30% silt].										
			39.5	39.4 - 42.5' **SILTY CLAY** CL/ML, gray (10YR 6/1), mostly lean clay, 30-40% silt, trace fine sand to fine gravel, cohesive, medium plasticity, dry.										
			40.0											
			40.5											
			41.0		CL/ML									
			41.5											
			42.0											
			42.5	42.5 - 86.4' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, stiff (1.5-2.0 tsf), no mottling, dry to moist.										
			43.0											
			43.5		CL									
			44.0											
			44.5											

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SOIL BORING LOG INFORMATION SUPPLEMENT

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Boring Number W09D   Use only as an attachment to Form 4400-122.

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	
5 CS	120 153.6		45.0	42.5 - 86.4' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, stiff (1.5-2.0 tsf), no mottling, dry to moist. *(continued)*										
			45.5											
			46.0											
			46.5											
			47.0											
			47.5											
			48.0											
			48.5											
			49.0											
			49.5											
			50.0											
			50.5											
			51.0											
			51.5											
			52.0											
			52.5											
			53.0		CL									
			53.5											
			54.0											
			54.5											
6 CS	240 228		55.0											
			55.5											
			56.0											
			56.5											
			57.0											
			57.5											
			58.0											
			58.5											
			59.0											
			59.5											
			60.0											
			60.5											
			61.0											
			61.5											

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W09D Use only as an attachment to Form 4400-122. Page 5 of 12

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
			62.0	42.5 - 86.4' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, stiff (1.5-2.0 tsf), no mottling, dry to moist. *(continued)*										
			62.5											
			63.0											
			63.5											
			64.0											
			64.5											
			65.0											
			65.5											
			66.0											
			66.5											
			67.0											
			67.5											
			68.0											
			68.5											
			69.0											
			69.5											
			70.0											
			70.5		CL									
			71.0											
			71.5											
			72.0											
			72.5											
			73.0											
			73.5	73.6' - 75.0' 5-15% silt.										
			74.0											
			74.5											
7 CS	240 214.8		75.0											
			75.5											
			76.0											
			76.5											
			77.0											
			77.5											
			78.0											
			78.5											

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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
			79.5 80.0 80.5 81.0 81.5 82.0 82.5 83.0 83.5 84.0 84.5 85.0 85.5 86.0	42.5 - 86.4' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, stiff (1.5-2.0 tsf), no mottling, dry to moist. *(continued)* 81.2' trace fine sand and silt laminations. 85.2' increased frequency of fine sand laminations.	CL									
			86.5	86.4 - 87' **SILTY SAND:** to **POORLY-GRADED SAND WITH SILT:** SM, light brownish gray (10YR 6/2), mostly fine sand, 10-30% silt, dry.	SM									
			87.0 87.5	87 - 88' **SANDY LEAN CLAY:** s(CL), light brownish gray (10YR 6/2), mostly lean clay, 20-30% fine sand, trace silt, cohesive, medium plasticity, dry.	s(CL)									
			88.0 88.5 89.0 89.5 90.0 90.5 91.0 91.5	88 - 92' **POORLY-GRADED SAND WITH SILT:** SP-SM, light brownish gray (10YR 6/2), mostly fine sand, 10-15% silt, moist. 91' - 91.5' mostly medium sand.	SP-SM									
			92.0 92.5 93.0	92 - 93.5' **SANDY LEAN CLAY:** s(CL), light brownish gray (10YR 6/2), mostly lean clay, 20-40% fine sand, cohesive, medium plasticity, dry to moist.	s(CL)									
8 CS	240 206.4		93.5 94.0 94.5 95.0 95.5 96.0	93.5 - 107' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 5-10% fine sand to fine gravel, cohesive, high plasticity, dry to moist, no mottling.	CL									

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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
			96.5	93.5 - 107' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 5-10% fine sand to fine gravel, cohesive, high plasticity, dry to moist, no mottling. *(continued)*										
			97.0											
			97.5											
			98.0											
			98.5											
			99.0											
			99.5											
			100.0											
			100.5											
			101.0											
			101.5		CL									
			102.0											
			102.5											
			103.0											
			103.5											
			104.0											
			104.5											
			105.0											
			105.5											
			106.0											
			106.5											
			107.0	107 - 117.5' **LEAN CLAY:** CL, till, brown (10YR 4/3), 5-10% fine sand to gravel, cohesive, hard (>4.5 tsf), high plasticity, dry.										
			107.5											
			108.0											
			108.5											
			109.0											
			109.5											
			110.0		CL									
			110.5											
			111.0											
			111.5											
			112.0											
			112.5											
			113.0											

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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
			113.5	107 - 117.5' **LEAN CLAY:** CL, till, brown (10YR 4/3), 5-10% fine sand to gravel, cohesive, hard (>4.5 tsf), high plasticity, dry. *(continued)*										
			114.0											
			114.5											
9 CS	120 115.2		115.0											
			115.5		CL									
			116.0											
			116.5											
			117.0											
			117.5	117.5 - 126' **SILT:** ML, gray (10YR 6/1), trace clay, trace very fine sand, cohesive, nonplastic, dry to moist.										
			118.0											
			118.5											
			119.0											
			119.5											
			120.0											
			120.5											
			121.0											
			121.5		ML									
			122.0											
			122.5											
			123.0											
			123.5											
			124.0											
			124.5											
10 CS	240 219.6		125.0											
			125.5											
			126.0	126 - 131.7' **LEAN CLAY:** to **SILT:** CL, grayish brown (10YR 5/2), mostly lean clay, 30-40% silt, trace sand, cohesive, high plasticity, dry to moist.										
			126.5											
			127.0											
			127.5											
			128.0		CL									
			128.5											
			129.0											
			129.5											
			130.0	130' increased sand to 10-15%.										

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
			131.0 131.5	126 - 131.7' **LEAN CLAY:** to **SILT:** CL, grayish brown (10YR 5/2), mostly lean clay, 30-40% silt, trace sand, cohesive, high plasticity, dry to moist. *(continued)*	CL									
			132.0 132.5 133.0 133.5 134.0 134.5 135.0 135.5 136.0 136.5	131.7 - 137' **CLAYEY SAND:** to **SANDY LEAN CLAY:** SC, grayish brown (10YR 5/2), 40-60% fine to medium sand, 40-60% clay, 5-10% fine gravel and coarse sand, cohesive, moist, fines are plastic.	SC									
			137.0 137.5 138.0 138.5 139.0	137 - 139.5' **POORLY-GRADED SAND:** SP, grayish brown (10YR 5/2), mostly medium sand, clayey lenses throughout, trace coarse sand and fine gravel, moist.	SP									
11 CS	240 208.8		139.5 140.0 140.5 141.0 141.5 142.0 142.5 143.0 143.5 144.0 144.5 145.0 145.5 146.0 146.5 147.0 147.5	139.5 - 151' **POORLY-GRADED SAND:** SP, grayish brown (10YR 5/2), mostly fine sand, trace silt, moist.	SP									

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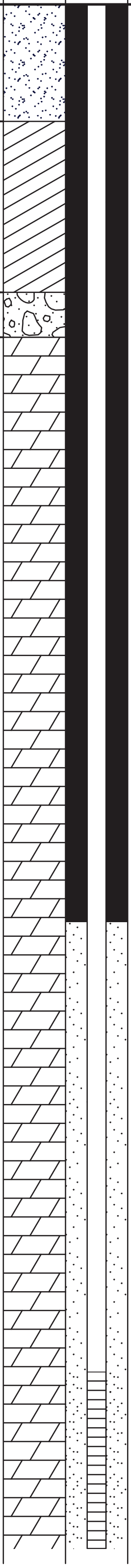
Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			148.0	139.5 - 151' **POORLY-GRADED SAND:** SP, grayish brown (10YR 5/2), mostly fine sand, trace silt, moist. *(continued)*										
			148.5											
			149.0											
			149.5		SP									
			150.0											
			150.5											
			151.0	151 - 155' **LEAN CLAY WITH SAND:** (CL)s, grayish brown (10YR 5/2), some fine sand laminations throughout, cohesive, high plasticity, moist.										
			151.5											
			152.0											
			152.5											
			153.0		(CL)s									
			153.5											
			154.0											
			154.5											
			155.0	155 - 157.8' **POORLY-GRADED SAND:** SP, gray (10YR 6/1), mostly fine to medium sand, 1-2" clay lenses throughout, moist.										
			155.5											
			156.0											
			156.5		SP									
			157.0											
			157.5											
			158.0	157.8 - 161.2' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2),10-20% fine sand to fine gravel, high plasticity, cohesive, stiff (1.5-2.0 tsf), dry to moist.										
			158.5											
			159.0											
			159.5		CL									
			160.0											
			160.5											
			161.0											
			161.5	161.2 - 162.2' **POORLY-GRADED SAND:** SP, mostly medium sand, 10-20% coarse sand and fine gravel, trace silt and clay.	SP									
			162.0											
			162.5	162.2 - 164.5' **SANDY LEAN CLAY:** s(CL), till, grayish brown (10YR 5/2), 20-30% fine sand, 10-15% gravel, cohesive, high plasticity, dry to moist. 162.3' - 162.4' lens of mostly coarse sand to fine gravel.										
			163.0											
			163.5		s(CL)									
			164.0											
			164.5		SP									

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W09D Use only as an attachment to Form 4400-122. Page 11 of 12



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
12 CS	36 36		165.0 165.5 166.0	164.5 - 166.1' **POORLY-GRADED SAND:** SP, light brownish gray (10YR 6/2), mostly medium sand, 10-20% coarse sand and gravel, wet. *(continued)*	SP									
			166.5 167.0 167.5 168.0	166.1 - 168' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 10-20% sand and gravel, decreasing sand and gravel with depth, cohesive, high plasticity, dry.	CL									
13 CS	204 108		168.5	168 - 168.5' **WELL-GRADED GRAVEL:** GW, mostly cobbles and coarse gravel.	GW									
			169.0 169.5 170.0 170.5 171.0 171.5 172.0 172.5 173.0 173.5 174.0 174.5 175.0 175.5 176.0 176.5 177.0 177.5 178.0 178.5 179.0 179.5 180.0 180.5 181.0 181.5	168.5 - 185' **WEATHERED BEDROCK** BDX (LS), dolomite, white (5Y 8/1) to light gray (5Y 7/1), trace crinoid stems, slight decomposition (discoloration), slight disintegration (trace recrystallizations, pitted).	BDX (LS)									Drillers lossed water from 178' - 185' bgs

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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
			182.5 183.0 183.5 184.0 184.5 185.0	168.5 - 185' **WEATHERED BEDROCK** BDX (LS), dolomite, white (5Y 8/1) to light gray (5Y 7/1), trace crinoid stems, slight decomposition (discoloration), slight disintegration (trace recrystallizations, pitted). *(continued)*	BDX (LS)									
				185' 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 ☐

Page 1 of 14

Facility/Project Name Caledonia Ash Landfill	License/Permit/Monitoring Number	Boring Number W10D

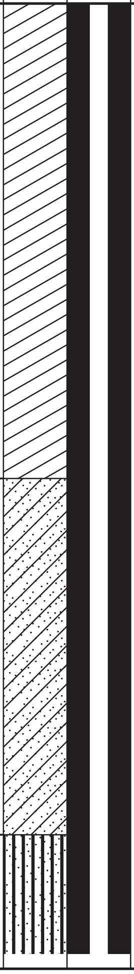
Boring Drilled By: Name of crew chief (first, last) and Firm Roy Buckenberger Cascade Drilling	Date Drilling Started 3/6/2015	Date Drilling Completed 3/9/2015	Drilling Method Rotory Sonic

WI Unique Well No. PI 726	DNR Well ID No.	Common Well Name W10D	Final Static Water Level Feet MSL	Surface Elevation 701.0 Feet MSL	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 313,612 N, 2,579,219 E [✓ S]/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 Racine	County Code 52	Civil Town/City/ or Village Caledonia

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	
1 CS	60 48		0.5 1.0 1.5 2.0 2.5 3.0 3.5	0 - 4' **LEAN CLAY:** CL, dark yellowish brown (10YR 4/6), trace gravel, trace root debris, trace fine to coarse sand, cohesive, medium plasticity, frozen, moist to dry.	CL									
2 CS	60 60		4.0 4.5 5.0 5.5 6.0 6.5	4 - 7' **CLAYEY SAND:** SC, dark yellowish brown (10YR 4/6), mostly fine to medium sand, 20-30% clay, trace gravel, moist. 4.5' clay increases to 40-50%.	SC									
			7.0 7.5 8.0	7 - 10' **SILTY SAND:** SM, dark yellowish brown (10YR 4/6), mostly fine sand, trace to little gravel, moist.	SM									



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: 1660 CALEDONIA LANDFILL GINT.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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SOIL BORING LOG INFORMATION SUPPLEMENT
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Boring Number W10D Use only as an attachment to Form 4400-122. Page 2 of 14

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
			8.5	7 - 10' **SILTY SAND:** SM, dark yellowish brown (10YR 4/6), mostly fine sand, trace to little gravel, moist. *(continued)*										
			9.0 9.5	9' 20-30% fine subangular gravel.	SM									
3 CS	60 60		10.0 10.5 11.0 11.5 12.0	10 - 12.3' **POORLY-GRADED SAND:** SP, dark yellowish brown (10YR 4/6), mostly medium to fine sand, clayey nodules (10-20% clay), trace gravel, wet.	SP									
			12.5 13.0 13.5 14.0 14.5	12.3 - 15' **SILTY SAND WITH GRAVEL:** (SM)g, dark brown (7.5YR 3/4), trace to little gravel, dry to moist.	(SM)g									
4 CS	240 240		15.0 15.5 16.0 16.5 17.0 17.5 18.0 18.5 19.0 19.5 20.0 20.5 21.0	15 - 26' **LEAN CLAY:** CL, till, dark grayish brown (10YR 4/2), trace gravel, cohesive, medium to high plasticity, dry to moist.	CL									

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Boring Number W10D Use only as an attachment to Form 4400-122. Page 3 of 14

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
			21.5	15 - 26' **LEAN CLAY:** CL, till, dark grayish brown (10YR 4/2), trace gravel, cohesive, medium to high plasticity, dry to moist. *(continued)* 22' - 22.5' lens of silty clay [20-30% silt, moist].										
			22.0											
			22.5											
			23.0											
			23.5		CL									
			24.0											
			24.5											
			25.0											
			25.5											
			26.0	26 - 29' **POORLY-GRADED SAND WITH SILT:** SP-SM, dark grayish brown (10YR 4/2), mostly very fine sand, moist.										
			26.5											
			27.0											
			27.5		SP-SM									
			28.0											
			28.5											
			29.0	29 - 110' **LEAN CLAY:** CL, till, dark grayish brown (10YR 4/2), trace gravel, cohesive, medium to high plasticity, dry to moist.										
			29.5											
			30.0											
			30.5											
			31.0											
			31.5											
			32.0		CL									
			32.5											
			33.0											
			33.5											
			34.0											
			34.5											

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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
5 CS	240 192		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 41.5 42.0 42.5 43.0 43.5 44.0 44.5 45.0 45.5 46.0 46.5 47.0 47.5 48.0	29 - 110' **LEAN CLAY:** CL, till, dark grayish brown (10YR 4/2), trace gravel, cohesive, medium to high plasticity, dry to moist. *(continued)* 35' very stiff (2.5-3.0 tsf).	CL	▨	▮ ▮							

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Boring Number W10D Use only as an attachment to Form 4400-122. Page 5 of 14

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
			48.5	29 - 110' **LEAN CLAY:** CL, till, dark grayish brown (10YR 4/2), trace gravel, cohesive, medium to high plasticity, dry to moist. *(continued)*										
			49.0											
			49.5											
			50.0											
			50.5											
			51.0											
			51.5											
			52.0											
			52.5											
			53.0											
			53.5											
			54.0											
			54.5		CL									
6 CS	240 236.4		55.0	55' no gravel, very stiff (3.0-4.0 tsf).										
			55.5											
			56.0											
			56.5											
			57.0											
			57.5											
			58.0											
			58.5											
			59.0											
			59.5											
			60.0											
			60.5											
			61.0											

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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
			61.5	29 - 110' **LEAN CLAY:** CL, till, dark grayish brown (10YR 4/2), trace gravel, cohesive, medium to high plasticity, dry to moist. *(continued)*										
			62.0											
			62.5											
			63.0											
			63.5											
			64.0											
			64.5											
			65.0											
			65.5											
			66.0											
			66.5											
			67.0											
			67.5											
			68.0		CL									
			68.5											
			69.0											
			69.5											
			70.0											
			70.5											
			71.0											
			71.5											
			72.0											
			72.5											
			73.0											
			73.5											
			74.0											
			74.5											

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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	
7 CS	240 201.6		75.0	29 - 110' **LEAN CLAY:** CL, till, dark grayish brown (10YR 4/2), trace gravel, cohesive, medium to high plasticity, dry to moist. *(continued)*										
			75.5	75' dark reddish gray (5YR 4/2), stiff to very stiff (1.0-3.0 tsf).										
			76.0											
			76.5											
			77.0	77' 10-20% olive brown (2.5Y 4/4) mottling.										
			77.5											
			78.0											
			78.5											
			79.0											
			79.5											
			80.0											
			80.5											
			81.0											
			81.5		CL									
			82.0											
			82.5											
			83.0											
			83.5											
			84.0											
			84.5											
			85.0	85' - 90' medium stiff to stiff (0.5-1.5 tsf).										
			85.5											
			86.0											
			86.5											
			87.0											
			87.5											
			88.0											

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Boring Number W10D   Use only as an attachment to Form 4400-122.   Page 8 of 14

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
			88.5	29 - 110' **LEAN CLAY:** CL, till, dark grayish brown (10YR 4/2), trace gravel, cohesive, medium to high plasticity, dry to moist. *(continued)*										
			89.0											
			89.5											
			90.0											
			90.5											
			91.0											
			91.5											
			92.0											
			92.5											
			93.0											
			93.5											
			94.0											
			94.5		CL									
8 CS	240 187.2		95.0											
			95.5											
			96.0	96' very hard (>4.5 tsf).										
			96.5											
			97.0											
			97.5											
			98.0											
			98.5											
			99.0											
			99.5											
			100.0											
			100.5											
			101.0											

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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
			101.5	29 - 110' **LEAN CLAY:** CL, till, dark grayish brown (10YR 4/2), trace gravel, cohesive, medium to high plasticity, dry to moist. *(continued)*										
			102.0											
			102.5											
			103.0											
			103.5											
			104.0											
			104.5											
			105.0											
			105.5		CL									
			106.0											
			106.5											
			107.0											
			107.5											
			108.0											
			108.5											
			109.0											
			109.5											
			110.0	110 - 113' **SILTY CLAY** CL/ML, 20-30% silt, silt increasing with depth, cohesive, medium plasticity, dry.										
			110.5											
			111.0											
			111.5		CL/ML									
			112.0											
			112.5											
			113.0	113 - 115' **SILT:** ML, 20-30% clay, cohesive, nonplastic, dry.										
			113.5											
			114.0		ML									
			114.5											

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Boring Number W10D

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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
					ML									
9 CS	120 111.6		115.0	115 - 135' **SILT:** to **LEAN CLAY:** ML, dark grayish brown (10YR 4/2), 30-50% clay, some intervals are mostly clay, trace fine subrounded gravel, cohesive, low to medium plasticity, dry.										
			115.5											
			116.0											
			116.5											
			117.0											
			117.5											
			118.0											
			118.5											
			119.0											
			119.5											
			120.0											
			120.5											
			121.0											
			121.5		ML									
			122.0											
			122.5											
			123.0											
			123.5											
			124.0											
			124.5											
10 CS	120 116.4		125.0	125' low plasticity, moist.										
			125.5											
			126.0											
			126.5											
			127.0											
			127.5											
			128.0											

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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	
			128.5	115 - 135' **SILT:** to **LEAN CLAY:** ML, dark grayish brown (10YR 4/2), 30-50% clay, some intervals are mostly clay, trace fine subrounded gravel, cohesive, low to medium plasticity, dry. *(continued)*										
			129.0											
			129.5											
			130.0											
			130.5											
			131.0											
			131.5		ML									
			132.0											
			132.5											
			133.0											
			133.5											
			134.0	134' increasing gravel content.										
			134.5											
11 CS	120 111.6		135.0	135 - 145' **LEAN CLAY:** CL, till, dark grayish brown (10YR 4/2), 10-20% silt, trace gravel, cohesive, medium plasticity, hard (>4.5 tsf), dry to moist.										
			135.5											
			136.0	135.7' - 135.9' sand lens [mostly fine to medium sand, trace gravel, wet].										
			136.5	136.5' - 136.8' sand lens [mostly fine to medium sand, wet].										
			137.0											
			137.5											
			138.0	138' - 138.3' sand lens [mostly fine sand, wet].	CL									
			138.5											
			139.0											
			139.5											
			140.0	140' dry.										
			140.5											
			141.0											

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Boring Number W10D 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
			141.5 142.0 142.5 143.0 143.5 144.0 144.5	135 - 145' **LEAN CLAY:** CL, till, dark grayish brown (10YR 4/2), 10-20% silt, trace gravel, cohesive, medium plasticity, hard (>4.5 tsf), dry to moist. *(continued)* 144' silt content increases to 30-50%.	CL									
12 CS	240 235.2		145.0 145.5 146.0 146.5 147.0 147.5	145 - 148' **LEAN CLAY:** CL, till, brown (7.5YR 5/3), cohesive, high plasticity, dry to moist. 145.7' - 146.2' lens of silty sand [gray (7.5YR 5/1), mostly fine sand, fines are cohesive, wet]. 146.3' - 146.6' lens of silty sand [gray (7.5YR 5/1), mostly fine sand, fines are cohesive, wet]. 147.2' - 147.5' lens of silty sand [gray (7.5YR 5/1), mostly fine sand, fines are cohesive, wet].	CL									First attempt at sampling 145' - 155' bgs resulted in low recovery. Material recovered on second attempt.
			148.0 148.5 149.0	148 - 149.5' **SILTY SAND:** to **SANDY SILT:** SM, gray (7.5YR 5/1), 40-60% fine sand, 40-60% silt, fines are cohesive, wet.	SM									
			149.5	149.5 - 150' **LEAN CLAY:** CL, brown (7.5YR 5/3), cohesive, high plasticity, dry to moist.	CL									
			150.0 150.5 151.0	150 - 151.3' **POORLY-GRADED SAND WITH SILT:** to **SILTY SAND:** SP-SM, gray (7.5YR 5/1), mostly fine sand, 10-30% silt, fines are cohesive, wet.	SP-SM									
			151.5 152.0	151.3 - 152.2' **POORLY-GRADED SAND:** SP, gray (7.5YR 5/1), mostly fine sand, trace silt, moist.	SP									
			152.5 153.0	152.2 - 153.5' **LEAN CLAY:** CL, gray (7.5YR 5/1), 5-15% fine sand, trace silt, cohesive, high plasticity.	CL									
			153.5 154.0 154.5	153.5 - 154.7' **POORLY-GRADED SAND:** SP, gray (7.5YR 5/1), mostly fine sand, trace silt, moist.	SP									

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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	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
			155.0	154.7 - 155' **LEAN CLAY:** CL, gray (7.5YR 5/1), 5-15% fine sand, trace silt, cohesive, high plasticity.	CL									
			155.5	155 - 155.6' **POORLY-GRADED SAND:** SP, gray (7.5YR 5/1), mostly fine sand, trace silt, moist.	SP									
			156.0 156.5 157.0 157.5	155.6 - 157.8' **LEAN CLAY:** CL, gray (10YR 5/1), 5-15% fine sand, 0.25" thick sandy lenses throughout, trace fine gravel, cohesive, high plasticity.	CL									
			158.0 158.5 159.0 159.5	157.8 - 160' **POORLY-GRADED SAND:** SP, gray (7.5YR 5/1), mostly fine sand, trace silt, moist.	SP									
			160.0	160 - 160.3' **LEAN CLAY:** CL, grayish brown (10YR 5/2), trace fine sand, cohesive, high plasticity, dry.	CL									
			160.5 161.0 161.5	160.3 - 161.7' **POORLY-GRADED SAND:** SP, gray (7.5YR 5/1), mostly fine sand, trace silt, moist.	SP									
			162.0 162.5 163.0	161.7 - 163.2' **LEAN CLAY:** CL, dark gray (10YR 4/1), trace fine gravel, cohesive, high plasticity, dry.	CL									
			163.5	163.2 - 164' **POORLY-GRADED SAND:** SP, gray (10YR 6/1), mostly fine sand, 10-20% fine to coarse gravel, 10-20% clay and silt, transitions to decomposed bedrock, dry.	SP									
			164.0 164.5	164 - 165' **WEATHERED BEDROCK** BDX (LS), light gray (5Y 7/1) to white (5Y 8/1), highly decomposed, well-graded silt to gravel sized pieces, dry.	BDX (LS)									
13 CS	180 90		165.0 165.5 166.0 166.5 167.0 167.5 168.0	165 - 180' **WEATHERED BEDROCK** BDX (LS), dolomite, gray (5Y 5/1), mostly well-graded gravel size pieces (fine to coarse) - broken from drilling, microcrystalline [fossiliferous (crinoid stems/brachiopods)], massive, slightly decomposed (trace pyrite recrystallizations), slightly to moderately disintegrated (pitted).	BDX (LS)									

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Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W10D

Use only as an attachment to Form 4400-122.

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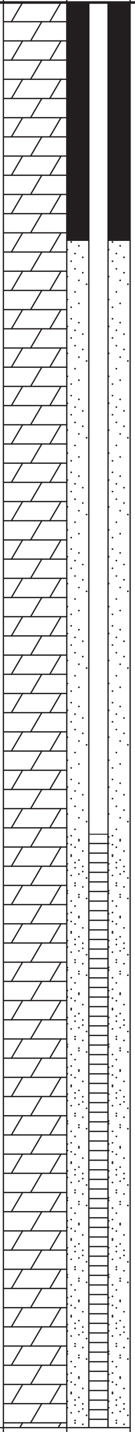
Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			168.5 169.0 169.5 170.0 170.5 171.0 171.5 172.0 172.5 173.0 173.5 174.0 174.5 175.0 175.5 176.0 176.5 177.0 177.5 178.0 178.5 179.0 179.5 180.0	165 - 180' **WEATHERED BEDROCK** BDX (LS), dolomite, gray (5Y 5/1), mostly well-graded gravel size pieces (fine to coarse) - broken from drilling, microcrystalline [fossiliferous (crinoid stems/brachiopods)], massive, slightly decomposed (trace pyrite recrystallizations), slightly to moderately disintegrated (pitted). *(continued)*	BDX (LS)									
				180' 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 10

Facility/Project Name: Caledonia Ash Landfill
License/Permit/Monitoring Number:
Boring Number: W46D
Boring Drilled By: Name of crew chief (first, last) and Firm: Roy Buckenberger, Cascade Drilling
Date Drilling Started: 3/10/2015
Date Drilling Completed: 3/11/2015
Drilling Method: Rotory Sonic
WI Unique Well No.: PI 725
DNR Well ID No.:
Common Well Name: W46D
Final Static Water Level: Feet MSL
Surface Elevation: 699.0 Feet MSL
Borehole Diameter: 6.0 inches
Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 313,062 N, 2,577,427 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: Racine
County Code: 52
Civil Town/City/ or Village: Caledonia

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
1 CS	60 67.2			0 - 0.9' **SILTY CLAY** CL/ML, dark grayish brown (2.5Y 4/2), 20-30% silt, trace fine sand, trace root debris, cohesive, medium plasticity, moist.	CL/ML									
			1 2 3 4	0.9 - 4.5' **SANDY LEAN CLAY:** to **CLAYEY SAND:** s(CL), light olive brown (2.5Y 5/3), mostly clay, 30-60% fine sand, trace silt, cohesive, low plasticity, trace fine gravel, moist, 10-20% olive yellow (2.5Y 6/8) mottling, 10-20% gray (2.5Y 6/1) mottling.	s(CL)									
2 CS	120 103.2		5 6	4.5 - 7' **LEAN CLAY:** CL, till, light yellowish brown (10YR 6/4), some silty lenses, trace fine gravel, cohesive, high plasticity, dry to moist, 10-15% dark yellowish brown (10YR 4/6) mottling. 5' no silty lenses, dry to moist.	CL									
			7 8 9 10 11 12 13	7 - 23' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), cohesive, high plasticity.	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 - Project: 1660 CALEDONIA LANDFILL GINT.GPJ

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W46D 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
3 CS	240 198		14 15 16 17 18 19 20 21 22	7 - 23' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), cohesive, high plasticity. *(continued)*	CL									
			23 24	23 - 24.5' **POORLY-GRADED SAND:** SP, gray (10YR 5/1), mostly fine sand, trace silt, dry to moist.	SP									
			25 26	24.5 - 26.5' **SILTY SAND:** SM, gray (10YR 6/1), mostly fine sand, 10-30% silt, dry to moist.	SM									
			27 28	26.5 - 28.2' **LEAN CLAY:** CL, gray (10YR 6/1), 10-30% silt, medium to high plasticity, cohesive, dry to moist.	CL									
			29 30 31	28.2 - 31.8' **SILT WITH SAND:** (ML)s, mostly silt, 10-30% fine sand, 10-20% clay, cohesive, medium plasticity, 2" fine sand lens at bottom.	(ML)s									
			32 33 34	31.8 - 66.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), high plasticity, cohesive, dry to moist.	CL									
4	240		35	35' dry.										

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W46D Use only as an attachment to Form 4400-122. Page 3 of 10

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
CS	240		36	31.8 - 66.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), high plasticity, cohesive, dry to moist. *(continued)*										
			37											
			38											
			39											
			40											
			41											
			42											
			43											
			44											
			45											
			46											
			47		CL									
			48											
			49											
			50											
			51											
			52											
			53											
			54											
5 CS	240 235.2		55											55' - 75' drilling water flowing out of nested wells, due to high water pressure (W46A/W46B)
			56											
			57											

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SOIL BORING LOG INFORMATION SUPPLEMENT
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Boring Number W46D 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
			58 59 60 61 62 63 64 65 66	31.8 - 66.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), high plasticity, cohesive, dry to moist. *(continued)*	CL									
			67 68	66.5 - 68.5' **SILTY CLAY** CL/ML, gray (10YR 6/1), mostly clay, 20-30% silt, cohesive, medium plasticity, dry.	CL/ML									
			69 70 71 72	68.5 - 72.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), mostly clay, high plasticity, cohesive, dry to moist. 70' increasing silt content with depth.	CL									
			73 74	72.5 - 75' **SILTY CLAY** CL/ML, gray (10YR 6/1), mostly clay, 20-30% silt, trace fine sand, cohesive, medium plasticity, moist to wet.	CL/ML									
6 CS	120 55.2		75 76 77 78 79	75 - 155' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace medium sand to fine gravel, cohesive, high plasticity, dry.	CL									75' - 85' drilling water slowly flowing out of nested wells (W46A/W46B) 75' - 85' Low Recovery

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SOIL BORING LOG INFORMATION SUPPLEMENT
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Boring Number W46D Use only as an attachment to Form 4400-122. Page 5 of 10

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
			80	75 - 155' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace medium sand to fine gravel, cohesive, high plasticity, dry. *(continued)*										
			81											
			82											
			83											
			84											
7 CS	120 106.8		85	85' grayish brown (10YR 5/2), 5-10% medium sand to fine gravel, high plasticity, hard (>4.5 tsf).										
			86											
			87											
			88											
			89											
			90											
			91		CL									
			92											
			93											
			94											
8 CS	120 104.4		95	95' decreased medium sand to fine gravel content to trace, very stiff (2.0-3.5 tsf).										
			96											
			97											
			98											
			99											
			100											
			101											

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W46D Use only as an attachment to Form 4400-122. Page 6 of 10

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	
				75 - 155' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace medium sand to fine gravel, cohesive, high plasticity, dry. *(continued)*										
			103											
			104											
9 CS	240 224.4		105	105' stiff (1.0-1.5 tsf).										
			106											
			107											
			108											
			109											
			110											
			111											
			112											
			113		CL									
			114											
			115											
			116											
			117											
			118	118' very stiff (2.0-3.5 tsf).										
			119											
			120											
				120.5' hard (4.25 to >4.5 tsf).										
			121											
			122											
			123											
			124											

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W46D

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
10 CS	120 169.2		125	75 - 155' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace medium sand to fine gravel, cohesive, high plasticity, dry. *(continued)* 125' stiff to very stiff (2.0-3.0 tsf).		▨								
			126			▨								
			127			▨								
			128	127.7' - 128' lens of silt [gray (10YR 6/1)]. 128' brown (10YR 4/3), some gravel, cohesive, nonplastic to low plasticity, hard (>4.5 tsf), moist.		▨								
			129			▨								
			130			▨								
			131			▨								
			132			▨								
			133			▨								
			134	133.3' - 133.5' lens of mostly medium sand [gray (10YR 6/1), some gravel and silt, moist].		▨								
11 CS	120 132		135	135' grayish brown (10YR 5/2), trace medium sand to fine gravel, cohesive, high plasticity, very stiff (3.0-4.25 tsf), dry.	CL	▨								
			136			▨								
			137			▨								
			138			▨								
			139			▨								
			140			▨								
			141			▨								
			142			▨								
			143	142.5' - 142.7' lens of silt [gray (10YR 6/1), dry].		▨								
			144			▨								
12 CS	240 187.2		145	145' medium stiff to stiff (0.75-1.5 tsf), no sand, no gravel.		▨								
			146			▨								

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W46D Use only as an attachment to Form 4400-122. Page 8 of 10

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
			147 148 149 150 151 152 153 154	75 - 155' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace medium sand to fine gravel, cohesive, high plasticity, dry. *(continued)*	CL									
			155 156	155 - 156.7' **SANDY LEAN CLAY:** s(CL), grayish brown (10YR 5/2), mostly clay, grades into mostly sand with depth, cohesive, medium to high plasticity, dry, 20-40% fine sand.	s(CL)									
			157 158	156.7 - 159.1' **CLAYEY SAND:** SC, grayish brown (10YR 5/2), mostly fine sand, 20-40% clay, fines are plastic, dry.	SC									
			159 160 161 162 163 164	159.1 - 165' **POORLY-GRADED SAND:** SP, grayish brown (10YR 5/2), mostly fine to medium sand, dry to moist. 162.6' mostly very fine sand, trace clay and silt.	SP									
13 CS	240 224.4		165 166	165 - 166.5' **LEAN CLAY:** CL, gray (10YR 5/1), cohesive, high plasticity, 20-30% silt, 10-20% fine sand, moist to wet.	CL									
			167 168	166.5 - 170' **SILTY SAND:** SM, gray (10YR 5/1) to gray (10YR 6/1), mostly fine sand, 10-30% silt, trace clay, moist to wet.	SM									

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SOIL BORING LOG INFORMATION SUPPLEMENT
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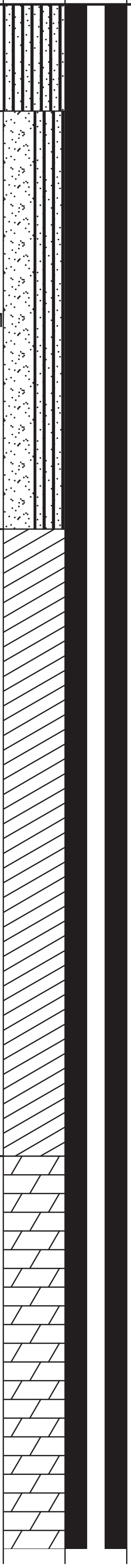
Boring Number W46D Use only as an attachment to Form 4400-122. Page 9 of 10

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	
			169	166.5 - 170' **SILTY SAND:** SM, gray (10YR 5/1) to gray (10YR 6/1), mostly fine sand, 10-30% silt, trace clay, moist to wet. *(continued)*	SM									
			170 171 172 173 174 175	170 - 176' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1) to gray (10YR 6/1), mostly fine sand, 10-20% silt, trace clay, moist to wet. 175' increasing clay content with depth to 20-30% at 176'.	SP-SM									
			176 177 178 179 180 181 182 183 184	176 - 185' **LEAN CLAY:** CL, till, gray (10YR 5/1), cohesive, high plasticity, 20-30% silt, no sand or gravel, dry. 181.3' - 181.8' lens of silt [gray (10YR 6/1), trace medium sand, cohesive, nonplastic, wet]. 183' - 183.6' lens of sand [well-graded sand, mostly medium-grained sand, 20-30% fine to coarse gravel]. 184.2' -184.3' lens of sand [gray (10YR 6/1), mostly fine sand, dry]. 184.4' - 185' lens of sand [gray(10YR 6/1), poorly-graded mostly very fine sand, trace medium sand, dry].	CL									
14 CS	180 93.6		185 186 187 188 189 190	185 - 205' **WEATHERED BEDROCK** BDX (LS), dolomite, white (5Y 8/1), trace greenish gray (GLEY 2 6/5BG) discoloration, slight disintegration (pitted).	BDX (LS)									



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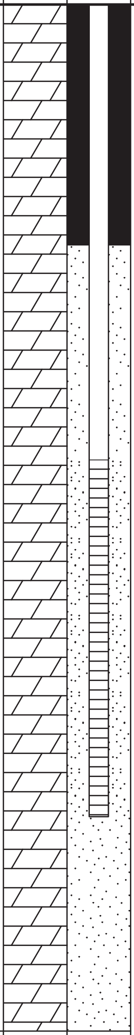
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W46D   Use only as an attachment to Form 4400-122.   Page 10 of 10

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
			191	185 - 205' **WEATHERED BEDROCK** BDX (LS), dolomite, white (5Y 8/1), trace greenish gray (GLEY 2 6/5BG) discoloration, slight disintegration (pitted). *(continued)*										
			192											
			193											
			194											
			195											
			196											
			197											
			198		BDX (LS)									
			199											
15 CS	60		200											Overdrilled, 202' - 205' backfilled with filter pack
			201											
			202											
			203											
			204											
			205	205' End of Boring.										

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SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

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

Page 1 of 11

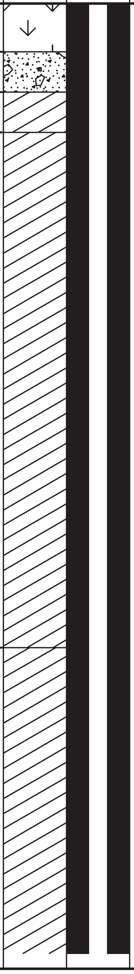
Facility/Project Name Caledonia Ash Landfill	License/Permit/Monitoring Number	Boring Number W48	
Boring Drilled By: Name of crew chief (first, last) and Firm Roy Buckenberger Cascade Drilling	Date Drilling Started 3/16/2015	Date Drilling Completed 3/17/2015	Drilling Method Rotory Sonic

WI Unique Well No. PI 724	DNR Well ID No.	Common Well Name W48	Final Static Water Level Feet MSL	Surface Elevation 713.2 Feet MSL	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 312,062 N, 2,578,095 E [✓ S]/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 Racine	County Code 52	Civil Town/City/ or Village Caledonia

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 40.8		0.5	0 - 0.6' **FILL, TOPSOIL:** CL, very dark gray (10YR 3/1), mostly lean clay, trace organic silt and root debris, cohesive, high plasticity, dry to moist.	CL									
			1.0	0.6 - 1.1' **FILL, WELL-GRADED SAND WITH GRAVEL:** (SW)g, light yellowish brown (10YR 6/4), mostly well-graded fine to medium sand, 10-20% fine to coarse gravel, 5-15% silt, moist.	(SW)g									
			1.5	1.1 - 1.6' **FILL, LEAN CLAY:** CL, dark yellowish brown (10YR 4/4), trace root debris, trace sand, trace silt, trace gravel, cohesive, high plasticity, moist.	CL									
			2.0 2.5 3.0 3.5 4.0 4.5	1.6 - 8' **FILL, LEAN CLAY:** CL, reworked till, yellowish brown (10YR 5/6), 10-20% silt, 5-10% fine to medium sand, trace gravel, cohesive, medium plasticity, hard (>4.5 tsf), 10YR 5/6, 10-20% gray (10YR 5/1) and yellowish brown (10YR 5/8) mottling, decreasing mottling with depth.	CL									
2 CS	60 46.8		5.0 5.5 6.0 6.5 7.0 7.5											
			8.0 8.5 9.0 9.5	8 - 15' **LEAN CLAY:** CL, till, yellowish brown (10YR 5/4), 10-15% silt, trace fine sand to fine gravel, cohesive, medium plasticity, very stiff to hard (>3.5 tsf), dry to moist, trace yellowish brown (10YR 5/8) mottling.										
3 CS	60 57.6		10.0 10.5 11.0 11.5		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: 1660 CALEDONIA LANDFILL GINT.GPJ

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SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W48 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	
			12.0	8 - 15' **LEAN CLAY:** CL, till, yellowish brown (10YR 5/4), 10-15% silt, trace fine sand to fine gravel, cohesive, medium plasticity, very stiff to hard (>3.5 tsf), dry to moist, trace yellowish brown (10YR 5/8) mottling. *(continued)*										
			12.5											
			13.0											
			13.5		CL									
			14.0											
			14.5											
4 CS	120 104.4		15.0	15 - 39.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, medium stiff to stiff (0.75-1.5 tsf), dry to moist, trace yellowish brown (10YR 5/8) mottling, mottling descreasing with depth.										
			15.5											
			16.0											
			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		CL									
			23.5											
			24.0											
			24.5											
5 CS	120 100.8		25.0	25' no mottling.										
			25.5											
			26.0											
			26.5											
			27.0											
			27.5											
			28.0											
			28.5											
			29.0											
			29.5											
			30.0											
			30.5											
			31.0											

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Boring Number W48 Use only as an attachment to Form 4400-122. Page 3 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	15 - 39.5' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, medium stiff to stiff (0.75-1.5 tsf), dry to moist, trace yellowish brown (10YR 5/8) mottling, mottling descreasing with depth. *(continued)* 32.5' stiff to very stiff (1.5-2.5 tsf).										
			32.5											
			33.0											
			33.5											
			34.0											
			34.5											
6	240		35.0											
CS	247.2		35.5		CL									
			36.0											
			36.5											
			37.0											
			37.5											
			38.0											
			38.5											
			39.0											
			39.5	39.5 - 42.3' **SANDY SILT:** s(ML), gray (10YR 6/1), mostly silt, 20-40% fine sand, cohesive, nonplastic, dry to moist.										
			40.0											
			40.5											
			41.0		s(ML)									
			41.5											
			42.0											
			42.5	42.3 - 42.8' **SILTY SAND:** SM, brown (10YR 5/3), mostly fine sand, 10-30% silt, dry to moist.	SM									
			43.0											
			43.5	42.8 - 52.8' **LEAN CLAY:** CL, till, trace fine sand to fine gravel, cohesive, high plasticity, stiff (1.5-2.0 tsf), dry to moist.										
			44.0											
			44.5											
			45.0											
			45.5											
			46.0											
			46.5											
			47.0		CL									
			47.5											
			48.0											
			48.5											
			49.0											
			49.5											
			50.0											
			50.5											
			51.0											

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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	
			51.5 52.0 52.5	42.8 - 52.8' **LEAN CLAY:** CL, till, trace fine sand to fine gravel, cohesive, high plasticity, stiff (1.5-2.0 tsf), dry to moist. *(continued)*	CL									
			53.0 53.5 54.0 54.5	52.8 - 55' **SILT:** ML, light brownish gray (10YR 6/2), cohesive, nonplastic, dry to moist.	ML									
7 CS	240 228		55.0 55.5 56.0 56.5 57.0 57.5	55 - 57.6' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, dry to moist.	CL									
			58.0 58.5 59.0 59.5 60.0 60.5 61.0 61.5 62.0 62.5 63.0 63.5 64.0 64.5 65.0	57.6 - 65.1' **SILTY CLAY** CL/ML, grayish brown (10YR 5/2), 10-30% silt, silt content increasing with depth, cohesive, high plasticity, dry to moist. 57.7' - 58.4' lens of silt [gray (10YR 6/1), cohesive, low plasticity, moist]. 61.3' - 61.4' lens of silt [gray (10YR 6/1), cohesive, low plasticity, moist]. 61.4' - 62.3' 40-50% silt. 62.3' - 63.3' lens of silt [gray (10YR 6/1), cohesive, low plasticity, moist].	CL/ML									
			65.5 66.0 66.5 67.0 67.5 68.0 68.5 69.0	65.1 - 69.4' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), trace fine sand to fine gravel, cohesive, high plasticity, stiff (1.5-2.0 tsf), dry to moist.	CL									
			69.5 70.0 70.5	69.4 - 75' **LEAN CLAY:** CL, till, gray (10YR 5/1), 5-15% silt, fine to coarse sand, and fine to coarse gravel, cohesive, medium plasticity, dry.	CL									

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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	
			71.0	69.4 - 75' **LEAN CLAY:** CL, till, gray (10YR 5/1), 5-15% silt, fine to coarse sand, and fine to coarse gravel, cohesive, medium plasticity, dry. *(continued)*										
			71.5											
			72.0											
			72.5											
			73.0	73' - 73.4' lens of silt [dry].	CL									
			73.5											
			74.0	74.1' - 74.5' lens of silt [dry].										
			74.5											
8 CS	120 109.2		75.0	75 - 100' **LEAN CLAY:** CL, till, dark gray (10YR 4/1), 5-10% silt, trace fine to coarse sand and fine gravel, cohesive, high plasticity, very stiff to hard (2.5-4.25 tsf), dry to moist.										
			75.5											
			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		CL									
			83.0											
			83.5											
			84.0											
			84.5											
9 CS	120 109.2		85.0	85' stiff to very stiff (1.0-2.5 tsf).										
			85.5											
			86.0											
			86.5											
			87.0											
			87.5											
			88.0											
			88.5											
			89.0											
			89.5											
			90.0											

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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
			91.0 91.5 92.0 92.5 93.0 93.5 94.0 94.5	75 - 100' **LEAN CLAY:** CL, till, dark gray (10YR 4/1), 5-10% silt, trace fine to coarse sand and fine gravel, cohesive, high plasticity, very stiff to hard (2.5-4.25 tsf), dry to moist. *(continued)*										
10 CS	120 106.8		95.0 95.5 96.0 96.5	95.1' - 95.7' lens of silt [grayish brown (10YR 5/2), cohesive, low plasticity]. 95.7' grayish brown (10YR 5/2), medium plasticity, hard (>4.5 tsf), dry.	CL									
			97.0 97.5 98.0 98.5 99.0 99.5	97' - 97.8' lens of silt [grayish brown (10YR 5/2), cohesive, low plasticity, dry].										
			100.0 100.5 101.0 101.5 102.0 102.5 103.0 103.5 104.0 104.5	100 - 105' **SILT:** ML, gray (10YR 6/1) to gray (10YR 5/1), mostly silt, cohesive, low plasticity, dry.	ML									
11 CS	240 222		105.0 105.5 106.0 106.5 107.0 107.5 108.0	105 - 108.2' **LEAN CLAY:** CL, till, dark gray (10YR 4/1), 5-10% silt, trace fine to coarse sand and fine gravel, cohesive, high plasticity, very stiff to hard, dry.	CL									
			108.5 109.0 109.5 110.0	108.2 - 115' **SILTY CLAY** CL/ML, grayish brown (10YR 5/2), mostly lean clay, 30-40% silt, trace fine sand to fine gravel, cohesive, medium to high plasticity, dry to moist.	CL/ML									

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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	
			110.5	108.2 - 115' **SILTY CLAY** CL/ML, grayish brown (10YR 5/2), mostly lean clay, 30-40% silt, trace fine sand to fine gravel, cohesive, medium to high plasticity, dry to moist. *(continued)* 110.3' grades to gray (10YR 5/1).										
			111.0											
			111.5											
			112.0											
			112.5		CL/ML									
			113.0											
			113.5											
			114.0											
			114.5											
			115.0	115 - 145' **LEAN CLAY:** CL, till, dark gray (10YR 4/1), 5-10% silt, trace fine to coarse sand and fine gravel, cohesive, high plasticity, very stiff (2.0-2.5 tsf), dry to moist.										
			115.5											
			116.0											
			116.5											
			117.0											
			117.5											
			118.0											
			118.5											
			119.0											
			119.5											
			120.0											
			120.5											
			121.0											
			121.5											
			122.0											
			122.5		CL									
			123.0											
			123.5											
			124.0											
			124.5											
12 CS	240 225.6		125.0											
			125.5											
			126.0											
			126.5											
			127.0											
			127.5											
			128.0											
			128.5											
			129.0											
			129.5											

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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
			130.0	115 - 145' **LEAN CLAY:** CL, till, dark gray (10YR 4/1), 5-10% silt, trace fine to coarse sand and fine gravel, cohesive, high plasticity, very stiff (2.0-2.5 tsf), dry to moist. *(continued)*										
			130.5											
			131.0											
			131.5											
			132.0											
			132.5											
			133.0											
			133.5											
			134.0											
			134.5											
			135.0											
			135.5											
			136.0											
			136.5											
			137.0											
			137.5		CL									
			138.0											
			138.5											
			139.0											
			139.5											
			140.0											
			140.5											
			141.0											
			141.5											
			142.0											
			142.5											
			143.0											
			143.5											
			144.0											
			144.5											
13 CS	240 194.4		145.0	145 - 146' **SILT:** ML, grayish brown (10YR 5/2), mostly silt, 5-10% very fine sand, cohesive, nonplastic, moist.										
			145.5		ML									
			146.0	146 - 165' **SILTY CLAY** CL/ML, grayish brown (10YR 5/2), mostly lean clay, 30-40% silt, trace fine sand to fine gravel, cohesive, medium to high plasticity, moist.										
			146.5											
			147.0											
			147.5		CL/ML									
			148.0											
			148.5											
			149.0											

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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	
			150.0 150.5 151.0 151.5 152.0 152.5 153.0 153.5 154.0 154.5 155.0 155.5 156.0 156.5 157.0 157.5 158.0 158.5 159.0 159.5 160.0 160.5 161.0 161.5 162.0 162.5 163.0 163.5 164.0 164.5	146 - 165' **SILTY CLAY** CL/ML, grayish brown (10YR 5/2), mostly lean clay, 30-40% silt, trace fine sand to fine gravel, cohesive, medium to high plasticity, moist. *(continued)*	CL/ML									
14 CS	120 102		165.0 165.5 166.0	165 - 166.5' **SILT:** ML, gray (10YR 5/1) to gray (10YR 6/1), 5-15% clay, trace very fine sand and fine gravel, cohesive, nonplastic to low plasticity, dry, 10YR 5/1 to 10YR 6/1, trace yellowish brown (10YR 5/8) mottling.	ML									
			166.5 167.0 167.5 168.0 168.5 169.0	166.5 - 175' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 10-20% silt, trace fine sand to fine gravel, cohesive, medium plasticity, very stiff to hard (3.5-4.5 tsf), dry.	CL									

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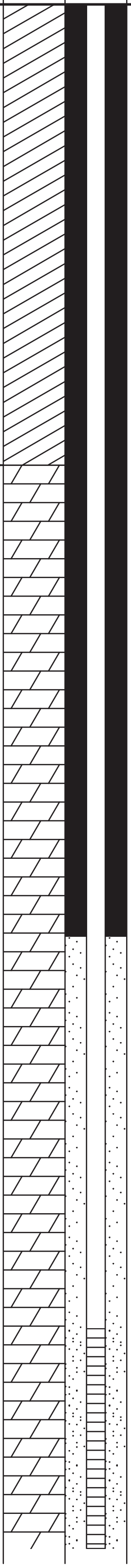
Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			169.5	166.5 - 175' **LEAN CLAY:** CL, till, grayish brown (10YR 5/2), 10-20% silt, trace fine sand to fine gravel, cohesive, medium plasticity, very stiff to hard (3.5-4.5 tsf), dry. *(continued)* 170' trace silt, medium to high plasticity.										
			170.0											
			170.5											
			171.0											
			171.5											
			172.0		CL									
			172.5											
			173.0											
			173.5											
			174.0											
			174.5											
15 CS	192 99.6		175.0	175 - 191' **WEATHERED BEDROCK** BDX (LS), dolomite, yellow (5Y 7/6), trace crinoid stems, massive, slight decomposition [very dark greenish gray (GLEY 1 5/5G) discoloration], slight disintegration (recrystallization, pitted).										
			175.5											
			176.0											
			176.5											
			177.0											
			177.5											
			178.0											
			178.5											
			179.0											
			179.5											
			180.0											
			180.5											
			181.0											
			181.5											
			182.0		BDX (LS)									
			182.5											
			183.0											
			183.5											
			184.0											
			184.5											
			185.0											
			185.5											
			186.0											
			186.5											
			187.0											
			187.5											
			188.0											
			188.5											

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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	
			189.0 189.5 190.0 190.5	175 - 191' **WEATHERED BEDROCK** BDX (LS), dolomite, yellow (5Y 7/6), trace crinoid stems, massive, slight decomposition [very dark greenish gray (GLEY 1 5/5G) discoloration], slight disintegration (recrystallization, pitted). *(continued)*	BDX (LS)									
			191.0	191' 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 ☐

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Facility/Project Name Caledonia Ash Landfill	License/Permit/Monitoring Number	Boring Number W49

Boring Drilled By: Name of crew chief (first, last) and Firm Roy Buckenberger Cascade Drilling	Date Drilling Started 4/17/2017	Date Drilling Completed 4/18/2017	Drilling Method Rotary Sonic

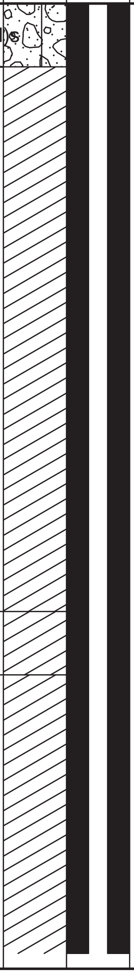
WI Unique Well No. VR 990	DNR Well ID No.	Common Well Name W49	Final Static Water Level Feet (NGVD29)	Surface Elevation 715.0 Feet (NGVD29)	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 313,589 N, 2,578,805 E [✓ S]/C/N
1/4 of 1/4 of Section , T N, R

Lat 42° 50' 23.54"
Long -87° 50' 30.74"

Local Grid Location
Feet ☐ N ☐ S
Feet ☐ E ☐ W

Facility ID	County Racine	County Code 52	Civil Town/City/ or Village Caledonia



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
1 CS	60 32.4		0 - 1	0 - 1' **FILL, WELL-GRADED GRAVEL WITH SILT AND SAND:** (GW-GM)s, grayish brown (10YR 5/2), mostly fine to coarse angular gravel, dry, constructed gravel pad.	(GW-GM)s									
			1 - 9.6	1 - 9.6' **FILL, LEAN CLAY:** CL, grayish brown (10YR 5/2), little yellowish brown (10YR 5/8) and light brownish gray (10YR 6/2) mottling, trace black (10YR 2/1) mottling, trace fine to coarse sand and fine subrounded gravel, trace root debris and woody debris, medium to high plasticity, hard (4.25 tsf), dry, reworked clay.	CL									
2 CS	120 120		5											
			9.6 - 10.6	9.6 - 10.6' **LEAN CLAY:** CL, brown (7.5YR 5/4), little to trace gray (7.5YR 6/1) and reddish yellow (7.5YR 6/6) mottling, trace fine to coarse sand and fine subrounded gravel, high plasticity, very stiff (3.0-3.5 tsf), dry.	CL									
			10.6 - 15	10.6 - 24.7' **LEAN CLAY:** CL, gray (10YR 5/1), few silt, trace fine to coarse sand and fine subrounded gravel, high plasticity, stiff (1.0-2.0 tsf), dry to moist.	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: 4/24/2017
Template: WDNR SBL 1998 MKE ADDRESS - Project: 1660 CALEDONIA LANDFILL GINT.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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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		Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
3 CS	120 120		16 17 18 19 20 21	10.6 - 24.7' **LEAN CLAY:** CL, gray (10YR 5/1), few silt, trace fine to coarse sand and fine subrounded gravel, high plasticity, stiff (1.0-2.0 tsf), dry to moist. *(continued)*	CL									
			22 23 24	21.5' - 22.5' little silt.										
			25	24.7 - 25' **SILT:** ML, grayish brown (10YR 5/2), cohesive, nonplastic to low plasticity, dry.	ML									
4 CS	240 195.6		26 27 28 29 30 31 32 33 34 35 36 37 38 39 40	25 - 79' **LEAN CLAY:** CL, gray (10YR 5/1) to grayish brown (10YR 5/2), trace fine to coarse sand and fine gravel, high plasticity, stiff (1.0-1.5 tsf), dry to moist.	CL									

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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		Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
5 CS	240 199.2		41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65	25 - 79' **LEAN CLAY:** CL, gray (10YR 5/1) to grayish brown (10YR 5/2), trace fine to coarse sand and fine gravel, high plasticity, stiff (1.0-1.5 tsf), dry to moist. *(continued)*	CL	▨								

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SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W49 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		Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
6 CS	240 210			25 - 79' **LEAN CLAY:** CL, gray (10YR 5/1) to grayish brown (10YR 5/2), trace fine to coarse sand and fine gravel, high plasticity, stiff (1.0-1.5 tsf), dry to moist. *(continued)*										
			66											
			67											
			68											
			69											
			70											
			71											
			72		CL									
			73											
			74											
			75											
			76											
			77											
			78											
			79	79 - 80' **CLAYEY SILT** ML/CL, grayish brown (10YR 5/2), some clay, cohesive, medium plasticity, dry.	ML/CL									
			80	80 - 88' **LEAN CLAY:** CL, gray (10YR 5/1) to grayish brown (10YR 5/2), few to little silt, trace fine to coarse sand and fine gravel, stiff (1.0-1.5 tsf), dry to moist.										
			81											
			82											
			83											
			84	84' trace silt.	CL									
7 CS	240 229.2		85											
			86											
			87											
			88	88 - 88.6' **SILT:** ML, grayish brown (10YR 5/2), cohesive, nonplastic to low plasticity, moist.	ML									
			89		CL									
			90											

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SOIL BORING LOG INFORMATION SUPPLEMENT
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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	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
				88.6 - 111.4' **LEAN CLAY:** CL, dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2), trace sand, high plasticity, firm to stiff (0.5-1.75 tsf), moist. *(continued)*										
			91											
			92											
			93											
			94											
			95											
			96											
			97											
			98											
			99											
			100											
			101		CL									
			102											
			103											
			104											
8 CS	240 254.4		105											
			106											
			107											
			108											
			109											
			110											
			111											
			112	111.4 - 125' **LEAN CLAY:** CL, dark grayish brown (10YR 4/2), trace to few fine to coarse sand and fine to coarse gravel, high plasticity, hard (>4.5 tsf), dry.										
			113		CL									
			114											
			115											

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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		Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			116 117 118 119 120 121 122 123 124	111.4 - 125' **LEAN CLAY:** CL, dark grayish brown (10YR 4/2), trace to few fine to coarse sand and fine to coarse gravel, high plasticity, hard (>4.5 tsf), dry. *(continued)* 115.6' cobble (3" diameter).	CL									
9 CS	240 238.8		125 126 127 128 129 130 131 132 133 134 135 136 137 138	125 - 138.5' **SILT:** ML, gray (10YR 5/1), trace clay, nonplastic to low plasticity, dry to moist. 135.1' few clay, low plasticity.	ML									
			139 140	138.5 - 140.1' **SILTY SAND:** SM, grayish brown (10YR 5/2), mostly fine sand, little silt, moist.	SM									

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Form 4400-122A

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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		Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			141 142	140.1 - 143.8' **SILT:** ML, grayish brown (10YR 5/2), moist.	ML									
			143	142.6' gray (10YR 5/1), few clay, low plasticity.										
			144	143.8 - 144.9' **SILTY SAND:** SM, grayish brown (10YR 5/2), mostly fine sand, little silt, moist.	SM									
10 CS	240 252		145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163	144.9 - 169' **LEAN CLAY:** CL, dark grayish brown (10YR 4/2), trace to little fine to coarse sand and gravel, high plasticity, very stiff to hard (3.5->4.5 tsf), dry.	CL									
			164 165	163.8' - 164.1' silt, grayish brown (10YR 5/2), moist.										

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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		Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
11 CS	180 187.2		166 167 168	144.9 - 169' **LEAN CLAY:** CL, dark grayish brown (10YR 4/2), trace to little fine to coarse sand and gravel, high plasticity, very stiff to hard (3.5->4.5 tsf), dry. *(continued)* 165' increasing silt content with depth, stiff to very stiff (1.5-2.25 tsf), increasing moisture content with depth.	CL									
			169 170 171 172 173 174 175	169 - 175.7' **SILT:** ML, gray (10YR 5/1), little clay, low to medium plasticity, moist. 174.8' wet.	ML									
			176 177 178 179	175.7 - 180' **LEAN CLAY:** CL, gray (10YR 5/1), trace to little fine to coarse sand and gravel, high plasticity, very stiff (2-2.75 tsf), dry to moist. 177.2' cobble (dolomite, 3" diameter). 179.3' little to some fine to coarse sand and gravel (some gravel is broken and weathered dolomite bedrock). 179.6' moist.	CL									
12 CS	180 14.4		180 181 182 183 184 185 186 187 188 189 190	180 - 195' **WEATHERED BEDROCK** BDX (DOL), gray (5Y 5/1), mostly well-graded fine to coarse gravel sized pieces (broken from drilling), microcrystalline, fossiliferous (crinoid stems), massive, slightly decomposed, slightly to moderately disintegrated (pitted).	BDX (DOL)									Drilling water return at approximately 180 feet below ground surface. Low Recovery. Alternating hard and soft drilling layers, bedrock washed out with return water.

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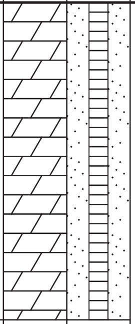
Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram		Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			191 192 193 194 195	180 - 195' **WEATHERED BEDROCK** BDX (DOL), gray (5Y 5/1), mostly well-graded fine to coarse gravel sized pieces (broken from drilling), microcrystalline, fossiliferous (crinoid stems), massive, slightly decomposed, slightly to moderately disintegrated (pitted). *(continued)*	BDX (DOL)									
				195' 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 ☐

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Facility/Project Name Caledonia Ash Landfill	License/Permit/Monitoring Number	Boring Number W50

Boring Drilled By: Name of crew chief (first, last) and Firm Roy Buckenberger Cascade Drilling	Date Drilling Started 4/18/2017	Date Drilling Completed 4/19/2017	Drilling Method Rotary Sonic

WI Unique Well No. VR 991	DNR Well ID No.	Common Well Name W50	Final Static Water Level Feet (NGVD29)	Surface Elevation 692.4 Feet (NGVD29)	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 312,751 N, 2,579,691 E [✓ S]/C/N
1/4 of 1/4 of Section , T N, R
Lat 42° 50' 15.05"
Long -87° 50' 19.14"
Local Grid Location
Feet ☐ N ☐ S
Feet ☐ E ☐ W

Facility ID	County Racine	County Code 52	Civil Town/City/ or Village Caledonia

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 57.6		0.5 1.0 1.5 2.0	0 - 2.2' **FILL, CLAYEY SAND WITH GRAVEL:** (SC)g, dark grayish brown (10YR 4/2), mostly well-graded sand, some clay, little well-graded fine gravel, few silt, moist, constructed road shoulder and gravel pad.	(SC)g								
			2.5 3.0 3.5 4.0 4.5 5.0	2.2 - 6.5' **FILL, LEAN CLAY:** CL, dark grayish brown (10YR 4/2), trace yellowish brown (5YR 5/8) mottling, little fine to coarse sand and subangular gravel, medium to high plasticity, very stiff to hard (3.0-4.5 tsf), dry to moist, reworked clay.	CL								
2 CS	120 72		5.5 6.0	5.5' some black (10YR 2/1) mottling and organics (surface material).									
			6.5 7.0 7.5	6.5 - 7.7' **FILL, LEAN CLAY:** CL, gray (10YR 4/1) with black (10YR 2/1) and yellowish red (5YR 5/8) mottling, little fine to coarse sand and gravel, high plasticity, stiff (1.5 tsf), dry to moist, reworked clay.	CL								
			8.0 8.5 9.0 9.5	7.7 - 15' **LEAN CLAY:** CL, gray (10YR 4/1), some yellowish brown (5YR 5/8) mottling, trace fine to coarse sand and root debris, trace fine gravel, high plasticity, stiff to very stiff (1.5-3.5 tsf), dry to moist.	CL								
			10.0 10.5 11.0	9.7' yellowish brown (10YR 5/4) with little yellowish brown (10YR 5/8) and trace light gray (10YR 7/2) mottling.									

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: 4/24/2017

Template: WDNR SBL 1998 MKE ADDRESS - Project: 1660 CALEDONIA LANDFILL GINT.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.

SOIL BORING LOG INFORMATION SUPPLEMENT

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Boring Number W50 Use only as an attachment to Form 4400-122. Page 2 of 10

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		Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			11.5 12.0 12.5 13.0 13.5 14.0 14.5	7.7 - 15' **LEAN CLAY:** CL, gray (10YR 4/1), some yellowish brown (5YR 5/8) mottling, trace fine to coarse sand and root debris, trace fine gravel, high plasticity, stiff to very stiff (1.5-3.5 tsf), dry to moist. *(continued)*	CL									
3 CS	120 138		15.0 15.5	15 - 16' **SILTY SAND WITH GRAVEL:** (SM)g, brownish yellow (10YR 6/6), mostly poorly-graded fine to medium sand, some silt, little coarse sand and gravel, wet.	(SM)g									
			16.0 16.5 17.0	16 - 17.5' **LEAN CLAY:** CL, gray (10YR 5/1) to dark gray (10YR 4/1), trace fine to coarse sand and gravel, high plasticity, stiff to hard (1.0-2.5 tsf), dry to moist.	CL									
			17.5	17.5 - 18' **SILTY SAND:** SM, browish yellow (10YR 6/6), mostly fine sand, little silt, wet.	SM									
			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	18 - 65' **LEAN CLAY:** CL, gray (10YR 5/1) to dark gray (10YR 4/1), trace fine to coarse sand and gravel, high plasticity, stiff to hard (1.0-2.5 tsf), dry to moist.	CL									
4 CS	240 243.6		25.0 25.5 26.0 26.5 27.0 27.5 28.0 28.5 29.0											

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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		Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			29.5	18 - 65' **LEAN CLAY:** CL, gray (10YR 5/1) to dark gray (10YR 4/1), trace fine to coarse sand and gravel, high plasticity, stiff to hard (1.0-2.5 tsf), dry to moist. *(continued)*										
			30.0											
			30.5											
			31.0											
			31.5											
			32.0											
			32.5											
			33.0											
			33.5											
			34.0											
			34.5											
			35.0											
			35.5											
			36.0											
			36.5											
			37.0											
			37.5											
			38.0											
			38.5		CL									
			39.0											
			39.5											
			40.0											
			40.5											
			41.0											
			41.5											
			42.0											
			42.5											
			43.0											
			43.5											
			44.0											
			44.5											
5 CS	240 213.6		45.0											
			45.5											
			46.0											
			46.5											
			47.0											
			47.5											

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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		Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			48.0	18 - 65' **LEAN CLAY:** CL, gray (10YR 5/1) to dark gray (10YR 4/1), trace fine to coarse sand and gravel, high plasticity, stiff to hard (1.0-2.5 tsf), dry to moist. *(continued)*										
			48.5											
			49.0											
			49.5	49.4' no to trace fine to coarse sand and gravel.										
			50.0											
			50.5											
			51.0											
			51.5											
			52.0											
			52.5											
			53.0											
			53.5											
			54.0											
			54.5											
			55.0											
			55.5											
			56.0											
			56.5		CL									
			57.0											
			57.5											
			58.0											
			58.5											
			59.0											
			59.5											
			60.0											
			60.5											
			61.0											
			61.5											
			62.0											
			62.5											
			63.0											
			63.5											
			64.0											
			64.5											
6 CS	240 216		65.0	65 - 74.7' **SILT:** ML, gray (10YR 5/1), trace clay, nonplastic to low plasticity, moist to wet, increasing from trace to few clay with depth.										
			65.5		ML									
			66.0											

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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		Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			66.5 67.0 67.5 68.0 68.5 69.0 69.5 70.0 70.5 71.0 71.5 72.0 72.5 73.0 73.5 74.0 74.5	65 - 74.7' **SILT:** ML, gray (10YR 5/1), trace clay, nonplastic to low plasticity, moist to wet, increasing from trace to few clay with depth. *(continued)*	ML									
			75.0 75.5 76.0 76.5 77.0 77.5 78.0 78.5 79.0 79.5	74.7 - 79.9' **LEAN CLAY:** CL, gray (10YR 5/1), some silt, medium plasticity, very soft to firm (0.0-1.0 tsf), moist to wet.	CL									
			80.0 80.5 81.0 81.5 82.0 82.5 83.0 83.5 84.0	79.9 - 85' **LEAN CLAY:** CL, gray (10YR 5/1), little silt, high plasticity, stiff (1.0-1.5 tsf), moist.	CL									

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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		Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			84.5	79.9 - 85' **LEAN CLAY:** CL, gray (10YR 5/1), little silt, high plasticity, stiff (1.0-1.5 tsf), moist. *(continued)*	CL									
7 CS	120 0		85.0	85 - 95' No Recovery.										
			85.5											
			86.0											
			86.5											
			87.0											
			87.5											
			88.0											
			88.5											
			89.0											
			89.5											
			90.0											
			90.5											
			91.0											
			91.5											
			92.0											
			92.5											
			93.0											
			93.5											
			94.0											
			94.5											
8 CS	240 164.4		95.0	95 - 105.4' **LEAN CLAY:** CL, gray (10YR 5/1), little silt, high plasticity, firm to stiff (0.5-1.25 tsf), moist.										
			95.5											
			96.0											
			96.5											
			97.0											
			97.5											
			98.0											
			98.5											
			99.0		CL									
			99.5											
			100.0											
			100.5											
			101.0											
			101.5											
			102.0											
			102.5											

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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		Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			103.0 103.5 104.0 104.5 105.0	95 - 105.4' **LEAN CLAY:** CL, gray (10YR 5/1), little silt, high plasticity, firm to stiff (0.5-1.25 tsf), moist. *(continued)*	CL									
			105.5 106.0 106.5 107.0 107.5 108.0 108.5 109.0 109.5 110.0 110.5 111.0 111.5 112.0 112.5	105.4 - 113.4' **LEAN CLAY:** CL, dark grayish brown (10YR 4/2), trace fine to coarse sand and gravel, high plasticity, hard (>4.5 tsf), dry.	CL									
			113.0	113' - 113.4' cobble (3-5" diameter).										
			113.5 114.0	113.4 - 114.3' **SANDY SILT:** s(ML), grayish brown (10YR 5/2), mostly silt, some very fine sand, low plasticity, dry.	s(ML)									
			114.5	114.3 - 114.5' **LEAN CLAY:** CL, gray (10YR 5/1), trace fine to coarse sand, high plasticity, very stiff (2.5-3.0 tsf), dry to moist.	CL									
9 CS	240 235.2		115.0 115.5	114.5 - 114.6' **SANDY SILT:** s(ML), grayish brown (10YR 5/2), some very fine sand, low plasticity, dry.	s(ML)									
			116.0 116.5 117.0 117.5 118.0	114.6 - 119.9' **LEAN CLAY:** CL, gray (10YR 5/1), trace fine to coarse sand, high plasticity, stiff (1.0-1.25 tsf), dry to moist.	CL									
			118.5 119.0 119.5	118.4' no to trace fine to coarse sand, soft (0.5 tsf).										
			120.0 120.5 121.0	119.9 - 124.7' **LEAN CLAY:** CL, dark grayish brown (10YR 4/2), few to little fine to coarse sand and gravel, high plasticity, hard (>4.5 tsf), dry, increasing sand and gravel content with depth.	CL									

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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		Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			121.5 122.0 122.5 123.0 123.5 124.0 124.5	119.9 - 124.7' **LEAN CLAY:** CL, dark grayish brown (10YR 4/2), few to little fine to coarse sand and gravel, high plasticity, hard (>4.5 tsf), dry, increasing sand and gravel content with depth. *(continued)* 122.9' gray (10YR 5/1).	CL									
			125.0	124.7 - 125.4' **CLAYEY SAND WITH GRAVEL:** (SC)g, gray (10YR 5/1), mostly well-graded fine to coarse sand, some clay, few to little gravel, dry.	(SC)g									
			125.5 126.0 126.5 127.0 127.5 128.0 128.5 129.0 129.5 130.0 130.5 131.0 131.5 132.0 132.5 133.0	125.4 - 133.4' **LEAN CLAY:** CL, dark grayish brown (10YR 4/2), trace to few fine to coarse sand and gravel, high plasticity, hard (>4.5 tsf), dry.	CL									
			133.5 134.0 134.5	133.4 - 135' **SILT:** ML, grayish brown (10YR 5/2), low to medium plasticity, dry. 134.5' dark grayish brown (10YR 4/2) clay laminations.	ML									
10 CS	240 228		135.0 135.5 136.0 136.5 137.0 137.5 138.0 138.5 139.0	135 - 139.2' **SILTY SAND:** SM, grayish brown (10YR 5/2), mostly poorly-graded fine sand, little silt (cohesive), moist. 135.9' - 137.3' decreased silt content to trace to few, dry.	SM									

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W50 Use only as an attachment to Form 4400-122. Page 9 of 10

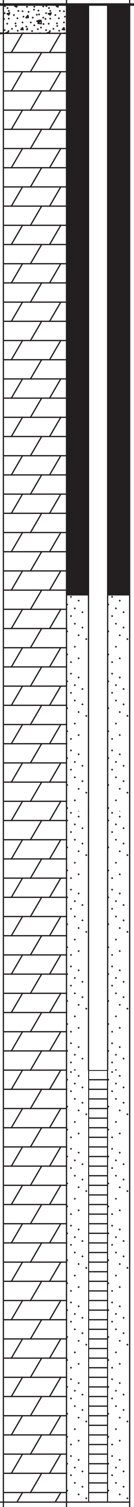
Sample			Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)	Blow Counts						Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			139.5 140.0	139.2 - 140.3' **SANDY SILT:** s(ML), grayish brown (10YR 5/2), mostly silt, some fine sand, nonplastic to low plasticity, wet. *(continued)*	s(ML) s(ML)								
			140.5 141.0 141.5 142.0 142.5 143.0 143.5	140.3 - 143.8' **POORLY-GRADED SAND WITH SILT:** SP-SM, grayish brown (10YR 5/2), mostly fine sand, trace to few silt, dry to moist.	SP-SM								
			144.0 144.5 145.0	143.8 - 145.3' **WELL-GRADED SAND:** SW, mostly medium to coarse sand (lithics), few subrounded fine to coarse gravel.	SW								
			145.5 146.0	145.3 - 146.2' **LEAN CLAY:** CL, dark grayish brown (10YR 4/2), trace fine to coarse sand and fine gravel, high plasticity, stiff to very stiff (1.0-2.5 tsf), dry to moist.	CL								
			146.5 147.0 147.5	146.2 - 147.8' **SANDY SILT:** s(ML), dark grayish brown (10YR 4/2), some fine to coarse sand, few clay, trace gravel, moist to wet.	s(ML)								
			148.0	147.8 - 148.1' **SILTY SAND:** SM, mostly well-graded fine to coarse sand, little silt, few fine gravel, trace clay,.	SM								
			148.5 149.0 149.5 150.0	148.1 - 150.3' **LEAN CLAY:** CL, dark grayish brown (10YR 4/2), trace fine to coarse sand and fine gravel, high plasticity, stiff (1.0 tsf), dry to moist.	CL								
11 CS	240 187.2		150.5 151.0 151.5 152.0 152.5 153.0 153.5 154.0 154.5 155.0 155.5 156.0 156.5 157.0 157.5	150.3 - 158' **WELL-GRADED SAND:** SW, mostly fine to coarse sand, trace silt, moist to wet, coarsening with depth. 150.9' - 151.2' clay lens (dark grayish brown (10YR 4/2), trace fine to coarse sand and fine gravel, high plasticity, stiff to very stiff (1.0-2.5 tsf), dry to moist). 151.2' mostly medium to coarse sand, some fine to coarse gravel. 151.3' cobble (2-3" diameter). 151.6' - 151.8' clay lens (dark grayish brown (10YR 4/2), trace fine to coarse sand and fine gravel, high plasticity, stiff to very stiff (1.0-2.5 tsf), dry to moist). 152.9' - 153.3' clay lens (dark grayish brown (10YR 4/2), trace fine to coarse sand and fine gravel, high plasticity, stiff to very stiff (1.0-2.5 tsf), dry to moist).	SW								

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W50 Use only as an attachment to Form 4400-122. Page 10 of 10

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		Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			158.0		SW									
			158.5 159.0 159.5 160.0 160.5 161.0 161.5 162.0 162.5 163.0 163.5 164.0 164.5 165.0 165.5 166.0 166.5 167.0 167.5 168.0 168.5 169.0 169.5 170.0 170.5 171.0 171.5 172.0 172.5 173.0 173.5 174.0 174.5	158 - 175' **WEATHERED BEDROCK** BDX (DOL), light gray (5Y 7/1), mostly 1-11" pieces (broken from drilling), microcrystalline, fossiliferous (trace crinoid stems and brachiopods shells), massive, slightly decomposed, slightly to moderately disintegrated (few to little pits, very pale brown (5Y 7/4) discoloration).	BDX (DOL)									Driller observed hard rock at approximately 158 feet below ground surface.
			175.0	175' 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: Caledonia Ash Landfill

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

Well Name: W08D

Facility License, Permit or Monitoring No.:

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

Lat. 42° 50' 10.4" Long. -87° 50' 22.7" or

Wis. Unique Well No.: PI 728

DNR Well Number:

Facility ID:

St. Plane 312,286 ft. N, 2,579,369 ft. E. [✓ S]/C/N

Date Well Installed: 03/13/2015

Section Location of Waste/Source

____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E ☐ W

Type of Well: Well Code 72/dp

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 698.71 ft. MSL

B. Well casing, top elevation 698.28 ft. MSL

C. Land surface elevation 695.6 ft. MSL

D. Surface seal, bottom 693.6 ft. MSL 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 530.6 ft. MSL or 165.0 ft.

F. Fine sand, top 520.6 ft. MSL or 175.0 ft.

G. Filter pack, top 518.6 ft. MSL or 177.0 ft.

H. Screen joint, top 515.6 ft. MSL or 180.0 ft.

I. Well bottom 510.6 ft. MSL or 185.0 ft.

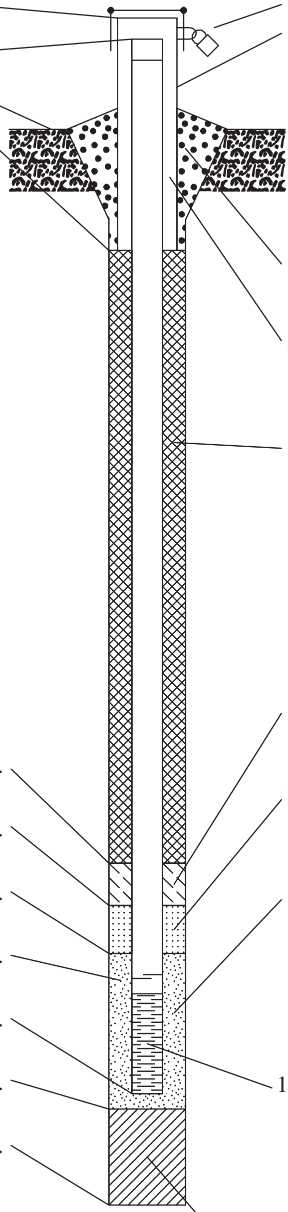
J. Filter pack, bottom 510.6 ft. MSL or 185.0 ft.

K. Borehole, bottom 510.6 ft. MSL or 185.0 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

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

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

Facility/Project Name: Caledonia Ash Landfill

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

Well Name: W09D

Facility License, Permit or Monitoring No.:

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

Lat. 42° 50' 20.1" Long. -87° 50' 21.3" or

St. Plane 313,274 ft. N, 2,579,467 ft. E. [✓ S]/C/N

Wis. Unique Well No.: PI 727

DNR Well Number:

Facility ID:

Date Well Installed: 03/12/2015

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

Type of Well: Well Code 72/dp

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 707.87 ft. MSL

B. Well casing, top elevation 707.35 ft. MSL

C. Land surface elevation 704.4 ft. MSL

D. Surface seal, bottom 702.4 ft. MSL 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 537.4 ft. MSL or 167.0 ft.

F. Fine sand, top 529.4 ft. MSL or 175.0 ft.

G. Filter pack, top 527.4 ft. MSL or 177.0 ft.

H. Screen joint, top 524.4 ft. MSL or 180.0 ft.

I. Well bottom 519.4 ft. MSL or 185.0 ft.

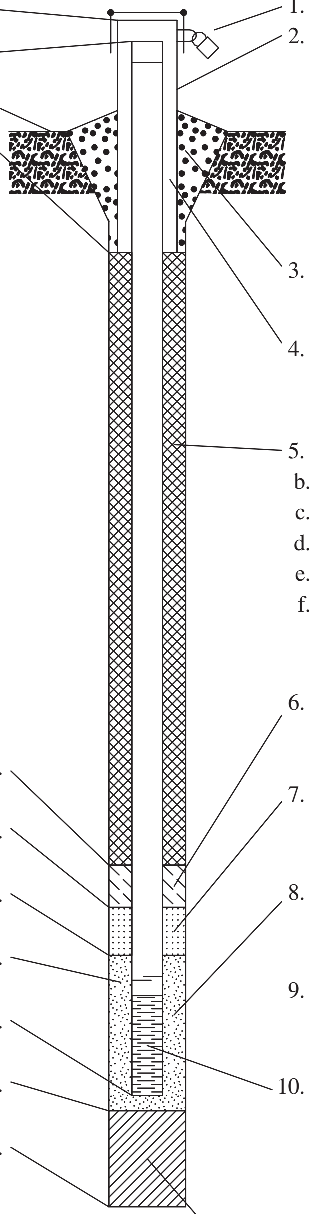
J. Filter pack, bottom 519.4 ft. MSL or 185.0 ft.

K. Borehole, bottom 519.4 ft. MSL or 185.0 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

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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: Caledonia Ash Landfill

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

Well Name: W10D

Facility License, Permit or Monitoring No.:

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

Lat. 42° 50' 23.5" Long. -87° 50' 24.5" or

Wis. Unique Well No.: PI 726

DNR Well Number:

Facility ID:

St. Plane 313,612 ft. N, 2,579,219 ft. E. Ⓢ/C/N

Date Well Installed: 03/09/2015

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

Type of Well: Well Code 72/dp

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 703.67 ft. MSL

B. Well casing, top elevation 703.10 ft. MSL

C. Land surface elevation 701.0 ft. MSL

D. Surface seal, bottom 699.0 ft. MSL 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 538.0 ft. MSL or 163.0 ft.

F. Fine sand, top 531.0 ft. MSL or 170.0 ft.

G. Filter pack, top 529.0 ft. MSL or 172.0 ft.

H. Screen joint, top 526.0 ft. MSL or 175.0 ft.

I. Well bottom 521.0 ft. MSL or 180.0 ft.

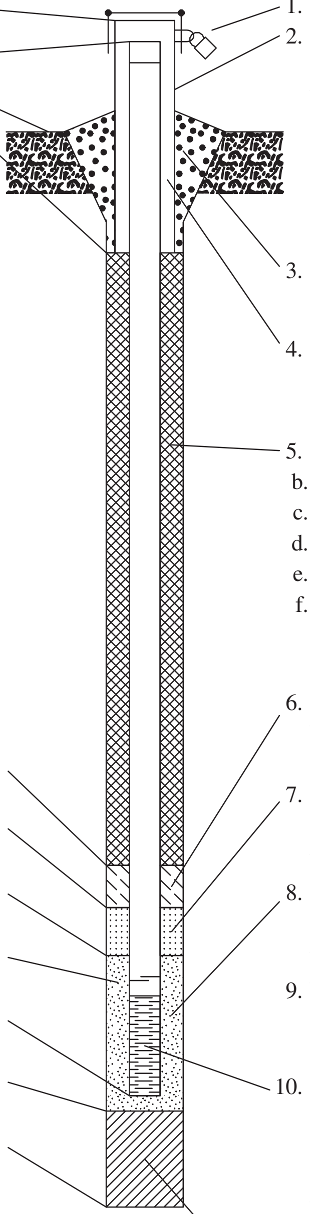
J. Filter pack, bottom 521.0 ft. MSL or 180.0 ft.

K. Borehole, bottom 521.0 ft. MSL or 180.0 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

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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: Caledonia Ash Landfill

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

Well Name: W46D

Facility License, Permit or Monitoring No.:

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

Lat. 42° 50' 18.2" Long. -87° 50' 48.7" or

Wis. Unique Well No.: PI 725

DNR Well Number:

Facility ID:

St. Plane 313,062 ft. N, 2,577,427 ft. E. [✓ S]/C/N

Date Well Installed: 03/11/2015

Section Location of Waste/Source: ____1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E ☐ W

Type of Well: Well Code 72/dp

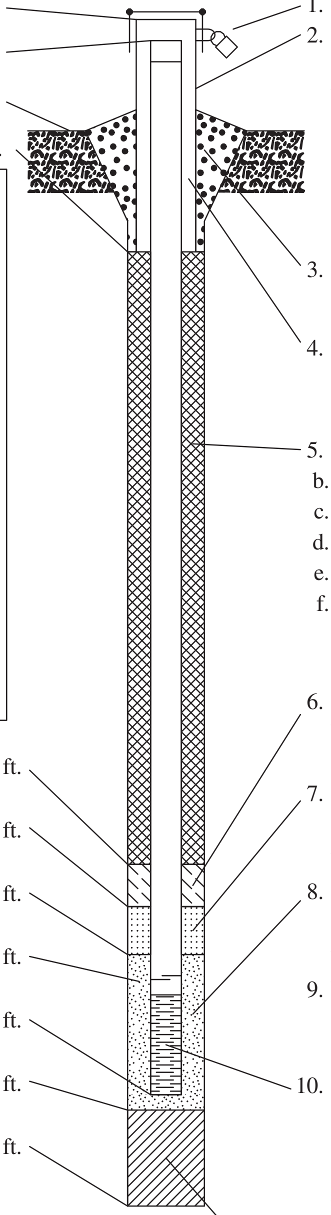
Well Installed By: (Person's Name and Firm): Roy Buckenberger, Cascade Drilling

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 701.82 ft. MSL

B. Well casing, top elevation 701.26 ft. MSL

C. Land surface elevation 699.0 ft. MSL

D. Surface seal, bottom 697.0 ft. MSL 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 515.0 ft. MSL or 184.0 ft.

F. Fine sand, top 507.0 ft. MSL or 192.0 ft.

G. Filter pack, top 505.0 ft. MSL or 194.0 ft.

H. Screen joint, top 502.0 ft. MSL or 197.0 ft.

I. Well bottom 497.0 ft. MSL or 202.0 ft.

J. Filter pack, bottom 494.0 ft. MSL or 205.0 ft.

K. Borehole, bottom 494.0 ft. MSL or 205.0 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

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

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: Caledonia Ash Landfill

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

Well Name: W48

Facility License, Permit or Monitoring No.:

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

Lat. 42° 50' 8.3" Long. -87° 50' 39.9" or

Wis. Unique Well No.: PI 724

DNR Well Number:

Facility ID:

St. Plane 312,062 ft. N, 2,578,095 ft. E. [✓ S]/C/N

Date Well Installed: 03/17/2015

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

Type of Well: Well Code 72/dp

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 716.36 ft. MSL

B. Well casing, top elevation 715.88 ft. MSL

C. Land surface elevation 713.2 ft. MSL

D. Surface seal, bottom 711.2 ft. MSL 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 539.2 ft. MSL or 174.0 ft.

F. Fine sand, top 532.2 ft. MSL or 181.0 ft.

G. Filter pack, top 530.2 ft. MSL or 183.0 ft.

H. Screen joint, top 527.2 ft. MSL or 186.0 ft.

I. Well bottom 522.2 ft. MSL or 191.0 ft.

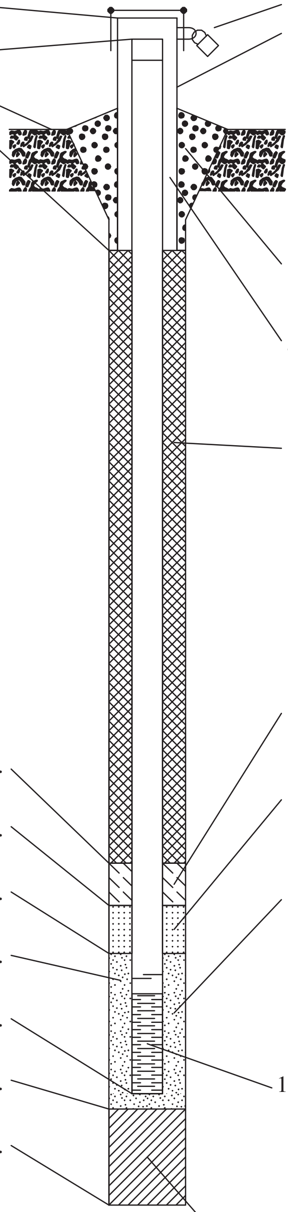
J. Filter pack, bottom 522.2 ft. MSL or 191.0 ft.

K. Borehole, bottom 522.2 ft. MSL or 191.0 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

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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: Caledonia Ash Landfill

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

Well Name: W49

Facility License, Permit or Monitoring No.:

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

Lat. 42° 50' 23.5" Long. -87° 50' 30.7" or

Wis. Unique Well No.: VR 990

DNR Well Number:

Facility ID:

St. Plane 313,589 ft. N, 2,578,805 ft. E. [✓ S]/C/N

Date Well Installed: 04/18/2017

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

Type of Well: Well Code 72/dp

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 718.04 ft. (NGVD29)

B. Well casing, top elevation 717.49 ft. (NGVD29)

C. Land surface elevation 715.0 ft. (NGVD29)

D. Surface seal, bottom 713.0 ft. (NGVD29) 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 537.0 ft. (NGVD29) or 178.0 ft.

F. Fine sand, top 530.0 ft. (NGVD29) or 185.0 ft.

G. Filter pack, top 528.0 ft. (NGVD29) or 187.0 ft.

H. Screen joint, top 525.0 ft. (NGVD29) or 190.0 ft.

I. Well bottom 520.0 ft. (NGVD29) or 195.0 ft.

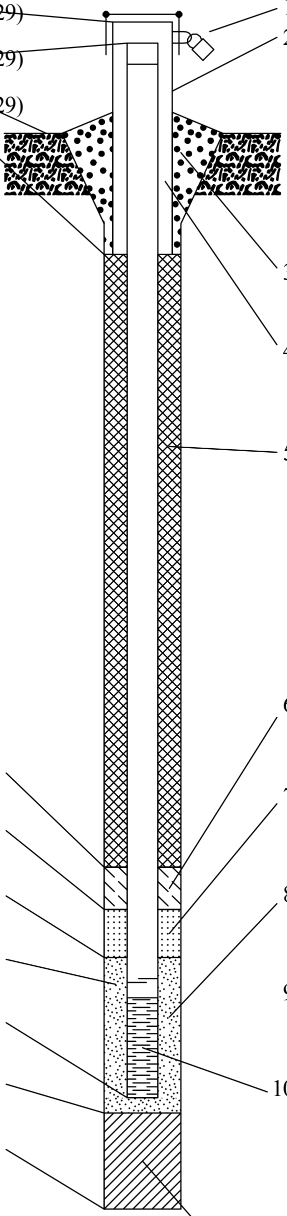
J. Filter pack, bottom 520.0 ft. (NGVD29) or 195.0 ft.

K. Borehole, bottom 520.0 ft. (NGVD29) or 195.0 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: 4/24/2017

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 ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: Caledonia Ash Landfill

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

Well Name: W50

Facility License, Permit or Monitoring No.:

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

Lat. 42° 50' 15.1" Long. -87° 50' 19.1" or

St. Plane 312,751 ft. N, 2,579,691 ft. E. [✓ S]/C/N

Wis. Unique Well No.: VR 991

DNR Well Number:

Facility ID:

Date Well Installed: 04/19/2017

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

Type of Well: Well Code 72/dp

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 695.20 ft. (NGVD29)

B. Well casing, top elevation 694.68 ft. (NGVD29)

C. Land surface elevation 692.4 ft. (NGVD29)

D. Surface seal, bottom 690.4 ft. (NGVD29) 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 536.4 ft. (NGVD29) or 156.0 ft.

F. Fine sand, top 527.9 ft. (NGVD29) or 164.5 ft.

G. Filter pack, top 525.4 ft. (NGVD29) or 167.0 ft.

H. Screen joint, top 522.4 ft. (NGVD29) or 170.0 ft.

I. Well bottom 517.4 ft. (NGVD29) or 175.0 ft.

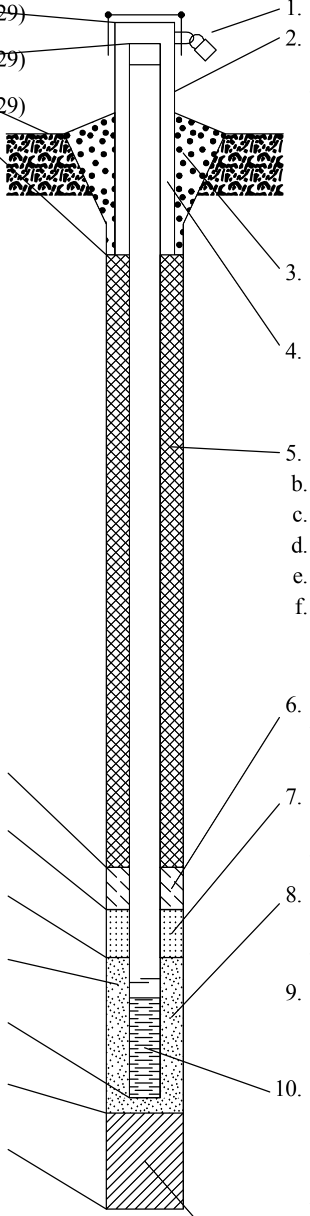
J. Filter pack, bottom 517.4 ft. (NGVD29) or 175.0 ft.

K. Borehole, bottom 517.4 ft. (NGVD29) or 175.0 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: 4/24/2017

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

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

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

Facility/Project Name	County	Well Name
Caledonia Ash Landfill	Racine	W08D

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well Number
	52	PI 728	

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 230 min.

4. Depth of well (from top of well casing) 187.5 ft.

5. Inside diameter of well 1.94 in.

6. Volume of water in filter pack and well casing 36.3 gal.

7. Volume of water removed from well 88.0 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.	45.19 ft.	150.28 ft.
Date	b.	3/18/2015	3/25/2015
Time	c.	08:25 ☒ a.m. ☐ p.m.	11:00 ☒ 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) clear to cloudy

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:

Partial development on 3/18/2015, removed 40 gallons. Removed 48 gallons on 3/25/2015. 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: 1660 CALEDONIA LANDFIL

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 Caledonia Ash Landfill	County Racine	Well Name W09D

Facility License, Permit or Monitoring Number	County Code 52	Wis. Unique Well Number PI 727	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 170 min.

4. Depth of well (from top of well casing) 187.4 ft.

5. Inside diameter of well 1.94 in.

6. Volume of water in filter pack and well casing 34.4 gal.

7. Volume of water removed from well 155.0 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.	54.69 ft.	54.80 ft.
Date	b.	3/18/2015	3/18/2015
Time	c.	07:45 ☒ a.m. ☐ p.m.	10:35 ☒ 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 (white)

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: 1660 CALEDONIA LANDFIL

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 ☐ Remediation/Redevelopment ☐ Waste Management ☒ Other ☐

Facility/Project Name: Caledonia Ash Landfill

County: Racine

Well Name: W10D

Facility License, Permit or Monitoring Number:

County Code: 52

Wis. Unique Well Number: PI 726

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: 175 min.

4. Depth of well (from top of well casing): 182.7 ft.

5. Inside diameter of well: 1.94 in.

6. Volume of water in filter pack and well casing: 34 gal.

7. Volume of water removed from well: 175.0 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.	51.45 ft.	53.55 ft.
Date	b.	3/17/2015	3/17/2015
Time	c.	02:45 ☐ a.m. ☒ p.m.	05:40 ☐ 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 (white)

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: 1660 CALEDONIA LANDFIL

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 Caledonia Ash Landfill	County Racine		Well Name W46D
Facility License, Permit or Monitoring Number	County Code 52	Wis. Unique Well Number PI 725	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 145 min.

4. Depth of well (from top of well casing) 203.1 ft.

5. Inside diameter of well 1.94 in.

6. Volume of water in filter pack and well casing 38.2 gal.

7. Volume of water removed from well 42.0 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.	47.18 ft.	148.56 ft.
Date	b.	3/25/2015	3/25/2015
Time	c.	02:40 ☐ a.m. ☒ p.m.	05:35 ☐ 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) light tan to milky white

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:

Purged well dry three times. 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: 1660 CALEDONIA LANDFIL

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 ☐ Remediation/Redevelopment ☐ Waste Management ☒ Other ☐

Facility/Project Name Caledonia Ash Landfill	County Racine	Well Name W48

Facility License, Permit or Monitoring Number	County Code 52	Wis. Unique Well Number PI 724	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 135 min.

4. Depth of well (from top of well casing) 194.9 ft.

5. Inside diameter of well 1.94 in.

6. Volume of water in filter pack and well casing 34.6 gal.

7. Volume of water removed from well 100.0 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.	60.68 ft.	63.40 ft.
Date	b.	3/25/2015	3/25/2015
Time	c.	11:45 ☒ 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) clear to cloudy

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: 1660 CALEDONIA LANDFIL

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 Caledonia Ash Landfill	County Racine	Well Name W49	
Facility License, Permit or Monitoring Number	County Code 52	Wis. Unique Well Number VR 990	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 surged/purged with pump	☒	

3. Time spent developing well 120 min.

4. Depth of well (from top of well casing) 197.0 ft.

5. Inside diameter of well 1.94 in.

6. Volume of water in filter pack and well casing 25.4 gal.

7. Volume of water removed from well 120.0 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.	62.70 ft.	63.03 ft.
Date	b.	4/20/2017	4/20/2017
Time	c.	07:30 ☒ a.m. ☐ p.m.	09:30 ☒ 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)

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: 1660 CALEDONIA LAN

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

Date Modified: 4/24/2017

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 Caledonia Ash Landfill	County Racine	Well Name W50

Facility License, Permit or Monitoring Number	County Code 52	Wis. Unique Well Number VR 991	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 surged/purged with pump	☒	

3. Time spent developing well 85 min.

4. Depth of well (from top of well casing) 176.9 ft.

5. Inside diameter of well 1.94 in.

6. Volume of water in filter pack and well casing 26.1 gal.

7. Volume of water removed from well 85.0 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.	39.28 ft.	39.36 ft.
Date	b.	4/20/2017	4/20/2017
Time	c.	10:10 ☒ a.m. ☐ p.m.	11:35 ☒ 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 brown	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: 1660 CALEDONIA LAN

NOTE: See instructions for more information including a list of county codes and well type codes. Date Modified: 4/24/2017

APPENDIX B

MODIFICATIONS TO CH. NR 507 MONITORING PROGRAM INFORMATION

Caledonia
Limit Exceptions (List)

Date Range: 05/01/2015 to 01/01/2023

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
PAL	Calcium, dissolved	00915	mg/L	W08A	05/07/2019	89.0000	0.0000	83.0000
					11/04/2019	85.0000	0.0000	83.0000
					11/09/2020	85.2000	0.0000	83.0000
					11/09/2021	85.9000	0.0000	83.0000
					05/04/2022	86.1000	0.0000	83.0000
					11/09/2022	83.6000	0.0000	83.0000
				W10A	11/09/2022	135.0000	0.0000	120.0000
				W10C	05/13/2015	96.0000	0.0000	92.0000
					05/14/2018	97.0000	0.0000	92.0000
					05/05/2022	97.2000	0.0000	92.0000
				W32A	11/14/2018	92.0000	0.0000	91.0000
					05/07/2019	93.0000	0.0000	91.0000
					11/05/2019	100.0000	0.0000	91.0000
					05/06/2020	92.0000	0.0000	91.0000
					11/10/2020	93.0000	0.0000	91.0000
					11/09/2021	99.2000	0.0000	91.0000
					05/05/2022	105.0000	0.0000	91.0000
					11/09/2022	102.0000	0.0000	91.0000
				W32BR	05/14/2015	150.0000	0.0000	130.0000
					11/12/2015	180.0000	0.0000	130.0000
					05/10/2016	150.0000	0.0000	130.0000
					11/15/2016	156.0000	0.0000	130.0000
					05/17/2017	150.0000	0.0000	130.0000
					11/14/2017	150.0000	0.0000	130.0000
					05/15/2018	150.0000	0.0000	130.0000
					11/14/2018	160.0000	0.0000	130.0000
					05/07/2019	150.0000	0.0000	130.0000
					11/05/2019	170.0000	0.0000	130.0000
					05/06/2020	150.0000	0.0000	130.0000
					11/10/2020	157.0000	0.0000	130.0000
					05/11/2021	146.0000	0.0000	130.0000
					11/09/2021	182.0000	0.0000	130.0000
					05/05/2022	159.0000	0.0000	130.0000

Caledonia
Limit Exceptions (List)

Date Range: 05/01/2015 to 01/01/2023

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
PAL	Calcium, dissolved	00915	mg/L	W32BR	11/09/2022	164.0000	0.0000	130.0000
				W32C	05/11/2021	114.0000	0.0000	110.0000
	Magnesium, dissolved	00925		W10A	11/09/2022	99.2000	0.0000	84.0000
				W32A	11/05/2019	84.0000	0.0000	82.0000
					05/06/2020	83.5000	0.0000	82.0000
					11/10/2020	83.3000	0.0000	82.0000
					11/09/2021	86.3000	0.0000	82.0000
					05/05/2022	92.7000	0.0000	82.0000
					11/09/2022	88.3000	0.0000	82.0000
				W32BR	05/14/2015	83.0000	0.0000	82.0000
					11/12/2015	99.0000	0.0000	82.0000
					05/10/2016	83.0000	0.0000	82.0000
					11/15/2016	90.2000	0.0000	82.0000
					05/17/2017	89.0000	0.0000	82.0000
					11/14/2017	90.0000	0.0000	82.0000
					05/15/2018	86.0000	0.0000	82.0000
					11/14/2018	89.0000	0.0000	82.0000
					05/07/2019	88.0000	0.0000	82.0000
					11/05/2019	93.0000	0.0000	82.0000
					05/06/2020	90.4000	0.0000	82.0000
					11/10/2020	93.2000	0.0000	82.0000
					05/11/2021	89.4000	0.0000	82.0000
					11/09/2021	106.0000	0.0000	82.0000
					05/05/2022	100.0000	0.0000	82.0000
					11/09/2022	99.9000	0.0000	82.0000
	Molybdenum, dissolved	01060	ug/L	W16AR	05/14/2015	30.000	0.000	8.000
					11/11/2015	30.000	0.000	8.000
					05/11/2016	33.000	0.000	8.000
					11/15/2016	28.100	0.000	8.000
					05/17/2017	24.000	0.000	8.000
					11/13/2017	23.000	0.000	8.000
					05/14/2018	30.000	0.000	8.000
					11/14/2018	19.000	0.000	8.000

Caledonia
Limit Exceptions (List)

Date Range: 05/01/2015 to 01/01/2023

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
PAL	Molybdenum, dissolved	01060	ug/L	W16AR	05/07/2019	30.000	0.000	8.000
					11/04/2019	29.000	0.000	8.000
					05/04/2020	27.400	0.000	8.000
					11/09/2020	28.000	0.000	8.000
					05/10/2021	25.700	0.000	8.000
					11/08/2021	27.100	0.000	8.000
					05/04/2022	24.600	0.000	8.000
					11/08/2022	22.000	0.000	8.000
				W46C	05/14/2015	77.000	0.000	8.000
					11/12/2015	85.000	0.000	8.000
					05/11/2016	84.000	0.000	8.000
					11/14/2016	80.400	0.000	8.000
					05/16/2017	77.000	0.000	8.000
					11/13/2017	71.000	0.000	8.000
					05/14/2018	71.000	0.000	8.000
					11/14/2018	72.000	0.000	8.000
					05/07/2019	72.000	0.000	8.000
					11/04/2019	74.000	0.000	8.000
					05/04/2020	77.000	0.000	8.000
					11/09/2020	74.300	0.000	8.000
					05/10/2021	75.600	0.000	8.000
					11/08/2021	75.500	0.000	8.000
					05/04/2022	76.800	0.000	8.000
					11/08/2022	77.900	0.000	8.000
	Sodium, dissolved	00930	mg/L	W08B	05/16/2017	22.000	0.000	18.000
					11/13/2017	20.000	0.000	18.000
					05/14/2018	26.000	0.000	18.000
					11/14/2018	26.000	0.000	18.000
					05/07/2019	19.000	0.000	18.000
					11/21/2019	22.000	0.000	18.000
					05/05/2020	19.800	0.000	18.000
					11/09/2020	23.500	0.000	18.000
					05/10/2021	21.700	0.000	18.000

Caledonia
Limit Exceptions (List)

Date Range: 05/01/2015 to 01/01/2023

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
PAL	Sodium, dissolved	00930	mg/L	W08B	11/09/2021	27.000	0.000	18.000
					05/04/2022	29.900	0.000	18.000
					11/09/2022	25.300	0.000	18.000
				W08C	05/13/2015	24.000	0.000	23.000
					11/12/2015	27.000	0.000	23.000
					05/10/2016	28.000	0.000	23.000
					11/15/2016	27.800	0.000	23.000
					05/16/2017	35.000	0.000	23.000
					11/13/2017	30.000	0.000	23.000
					05/14/2018	32.000	0.000	23.000
					11/14/2018	35.000	0.000	23.000
					05/07/2019	43.000	0.000	23.000
					11/04/2019	40.000	0.000	23.000
					05/05/2020	39.600	0.000	23.000
					11/10/2020	37.100	0.000	23.000
					05/10/2021	31.900	0.000	23.000
					11/09/2021	29.600	0.000	23.000
					05/04/2022	45.300	0.000	23.000
					11/09/2022	34.900	0.000	23.000
				W16AR	05/14/2015	190.000	0.000	170.000
					05/17/2017	180.000	0.000	170.000
				W16BR	05/14/2015	68.000	0.000	53.000
					05/11/2016	71.000	0.000	53.000
					11/15/2016	66.800	0.000	53.000
					05/17/2017	64.000	0.000	53.000
					05/14/2018	64.000	0.000	53.000
					11/14/2018	61.000	0.000	53.000
				W32A	05/05/2022	29.500	0.000	26.000
					11/09/2022	26.700	0.000	26.000
				W32C	05/14/2015	52.000	0.000	39.000
					05/15/2018	41.000	0.000	39.000
					05/07/2019	44.000	0.000	39.000
					11/10/2020	39.900	0.000	39.000

Caledonia
Limit Exceptions (List)

Date Range: 05/01/2015 to 01/01/2023

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
PAL	Sodium, dissolved	00930	mg/L	W32C	05/11/2021	43.000	0.000	39.000
ES	Molybdenum, dissolved	01060	ug/L	W46C	05/14/2015	77.000	0.000	40.000
					11/12/2015	85.000	0.000	40.000
					05/11/2016	84.000	0.000	40.000
					11/14/2016	80.400	0.000	40.000
					05/16/2017	77.000	0.000	40.000
					11/13/2017	71.000	0.000	40.000
					05/14/2018	71.000	0.000	40.000
					11/14/2018	72.000	0.000	40.000
					05/07/2019	72.000	0.000	40.000
					11/04/2019	74.000	0.000	40.000
					05/04/2020	77.000	0.000	40.000
					11/09/2020	74.300	0.000	40.000
					05/10/2021	75.600	0.000	40.000
					11/08/2021	75.500	0.000	40.000
					05/04/2022	76.800	0.000	40.000
					11/08/2022	77.900	0.000	40.000

CALCIUM EVALUATION

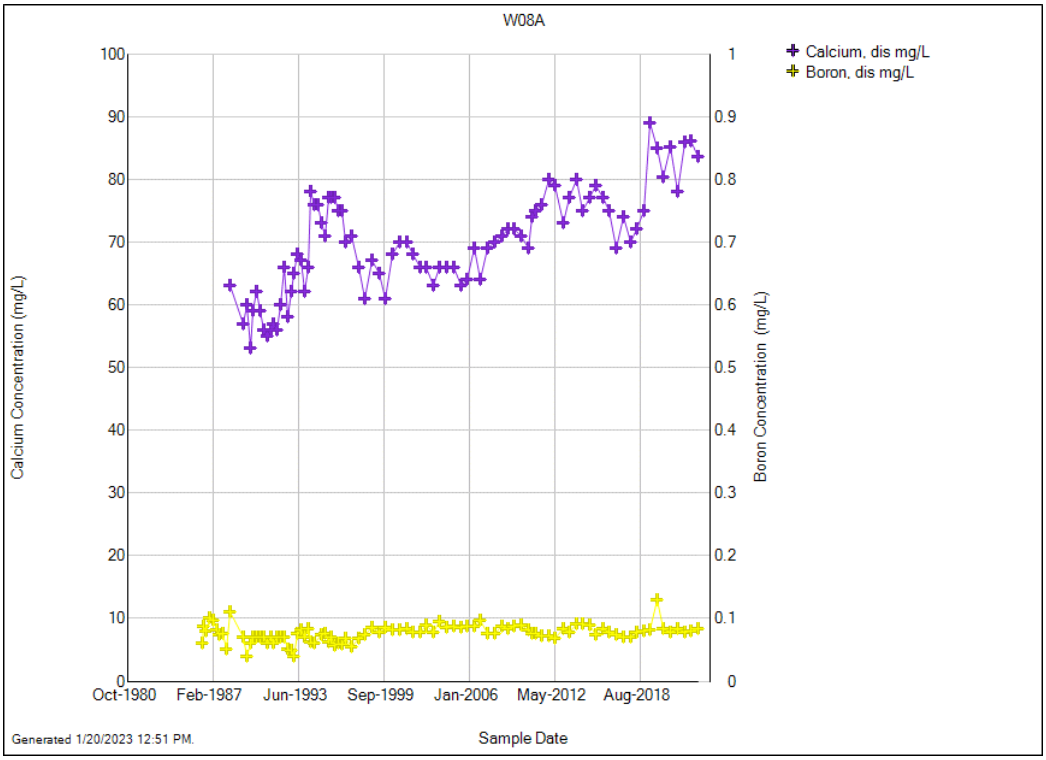

Figure A. Concentrations of calcium and boron in W08A.

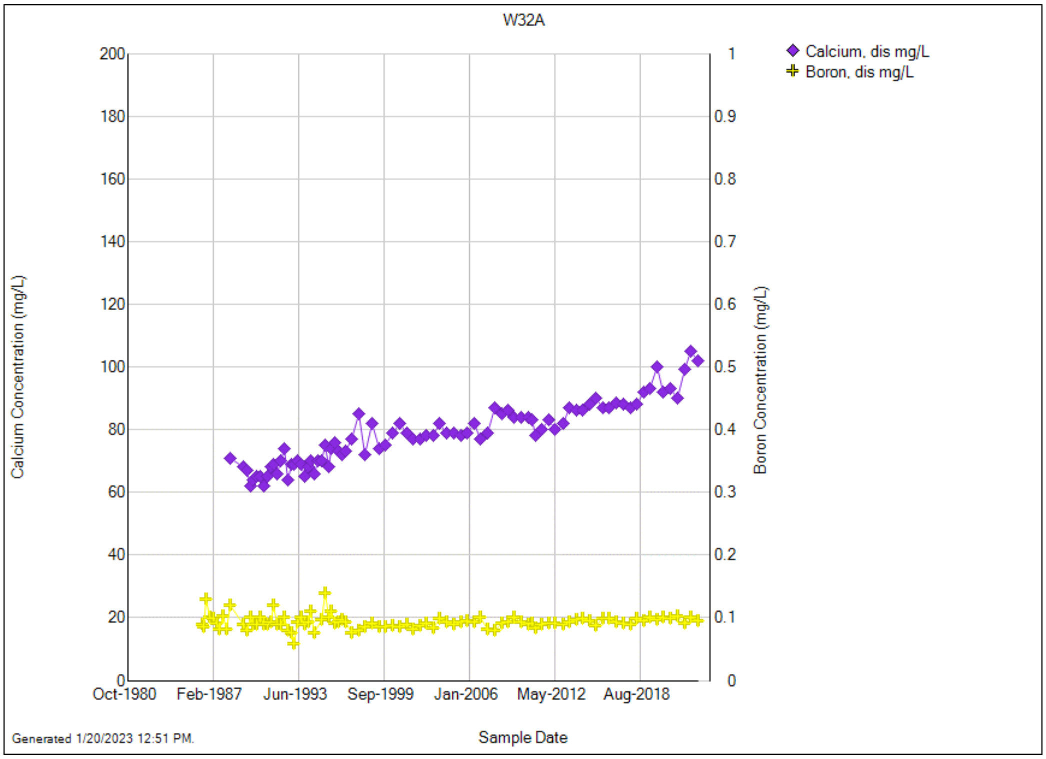

Figure B. Concentrations of calcium and boron in W32A.

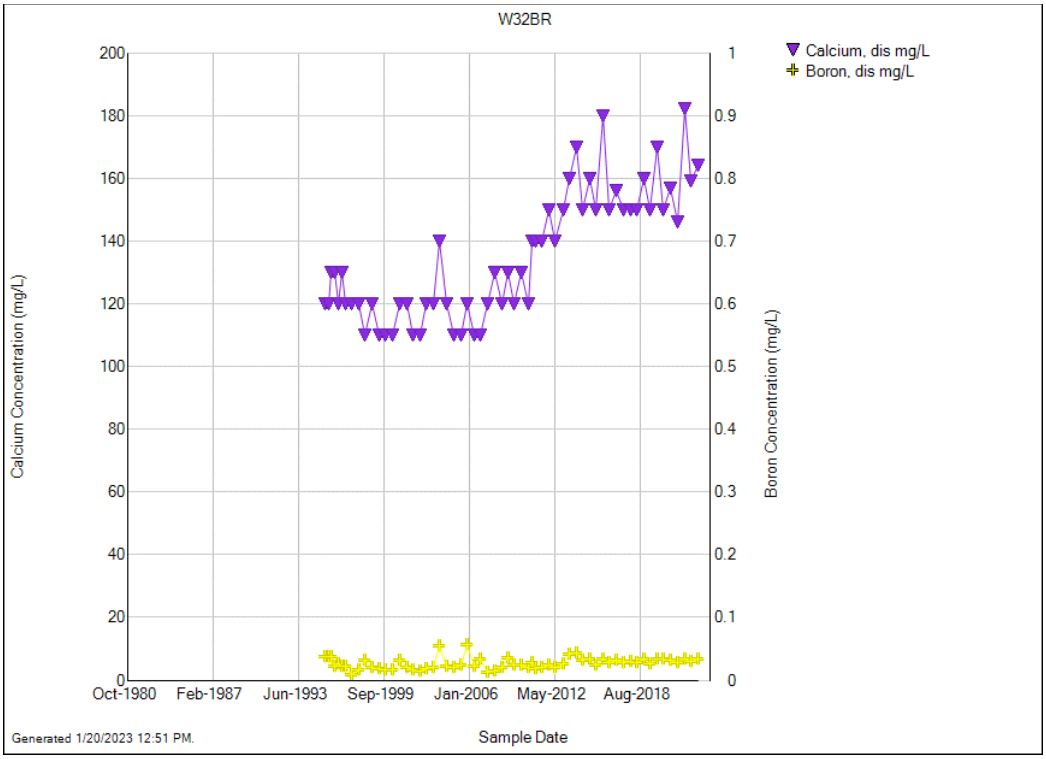

Figure C. Concentrations of calcium and boron in W32BR.

MAGNESIUM EVALUATION

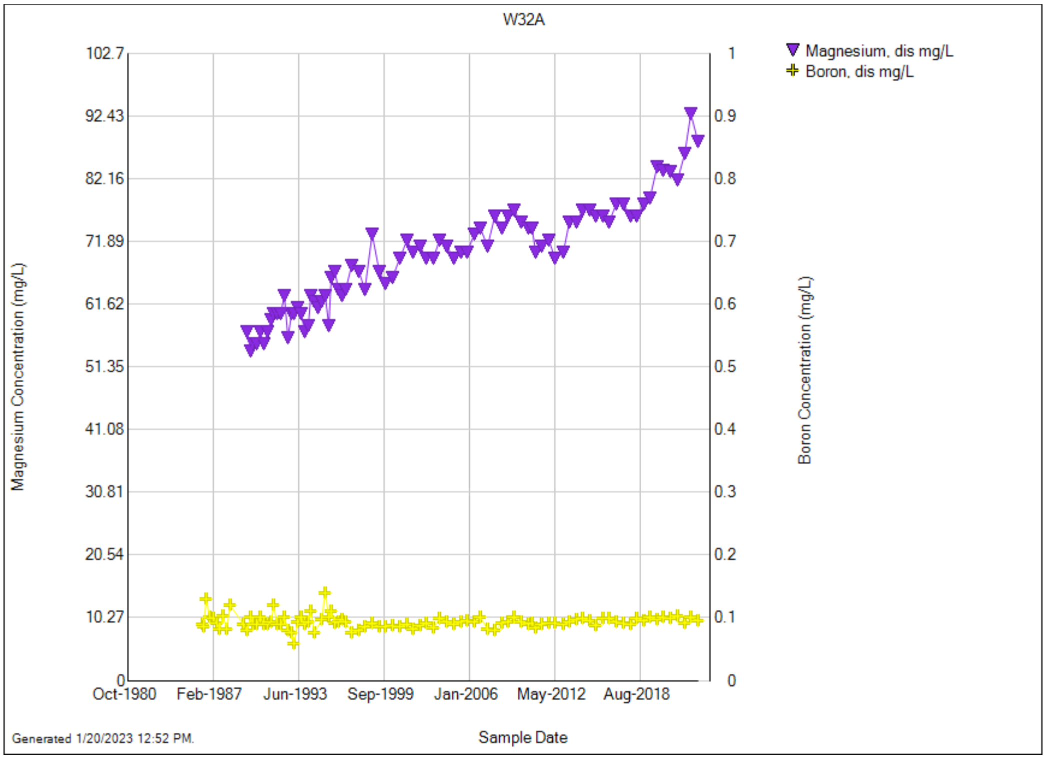

Figure D. Concentrations of magnesium and boron in W32A.

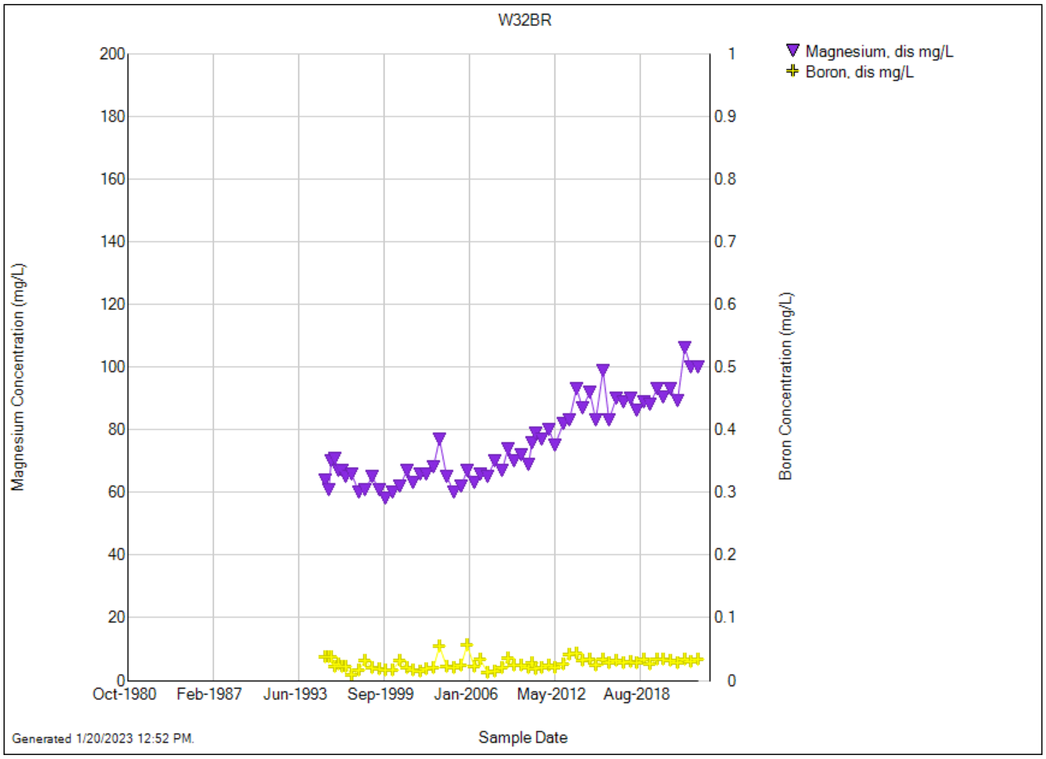

Figure E. Concentrations of magnesium and boron in W32BR.

MOLYBDENUM EVALUATION

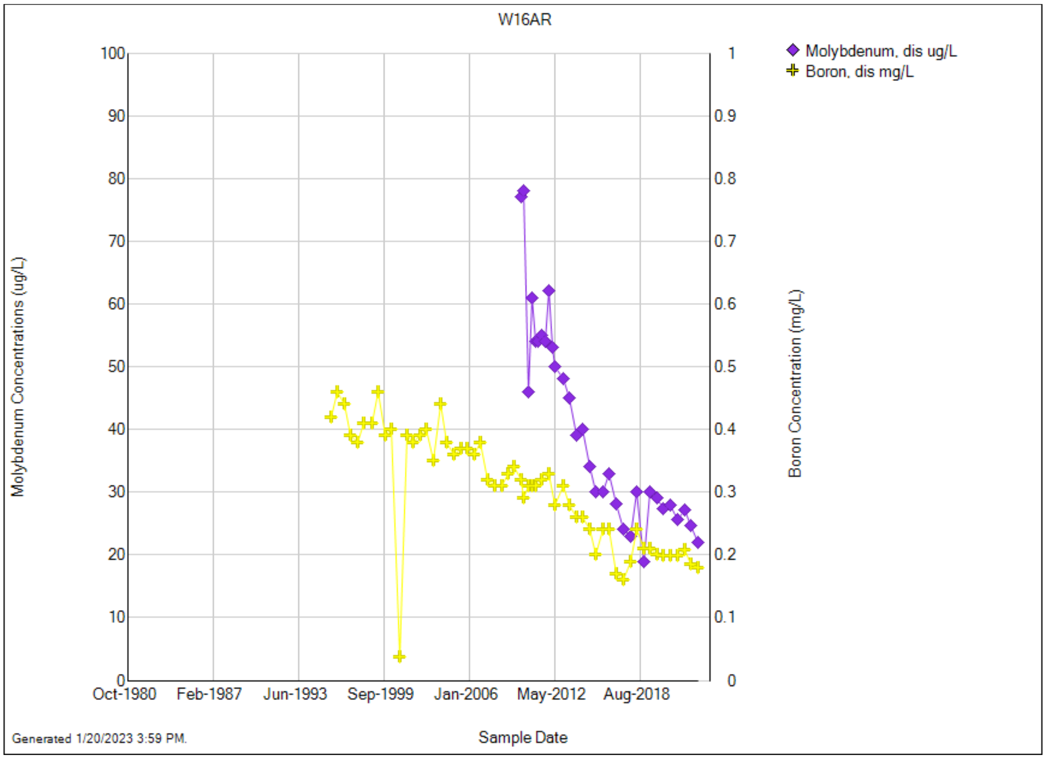

Figure F. Concentrations of molybdenum and boron in W16AR.

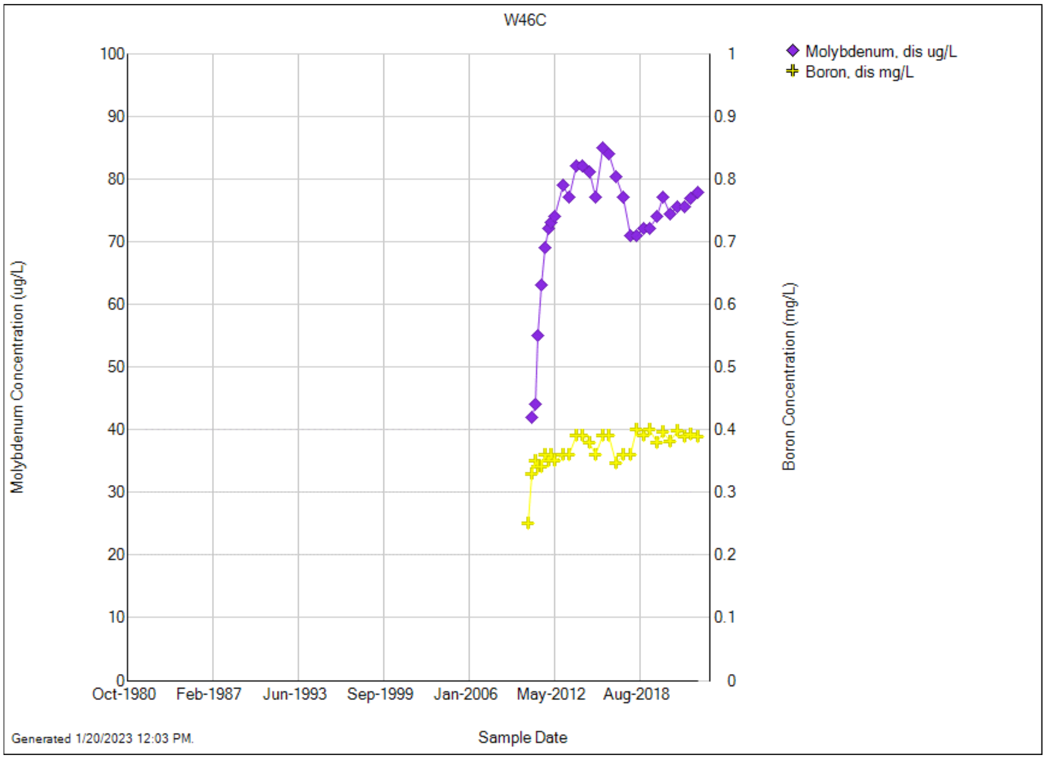

Figure G. Concentrations of molybdenum and boron in W46C.

SODIUM EVALUATION

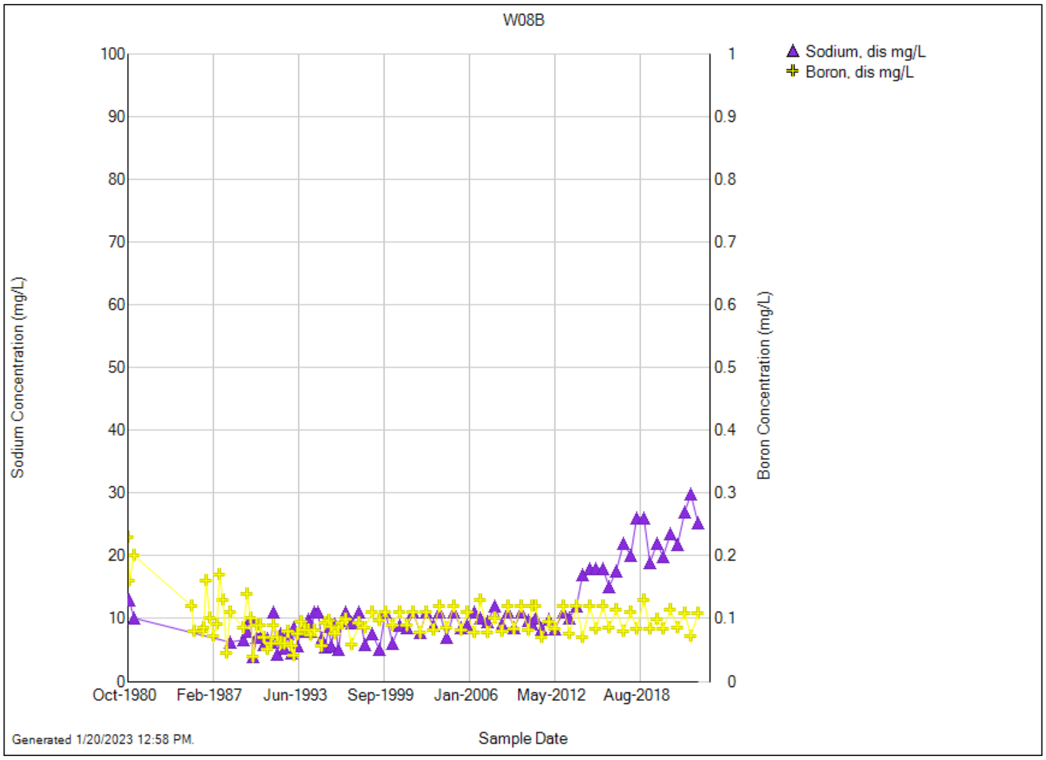

Figure H. Concentrations of sodium and boron in W08B.

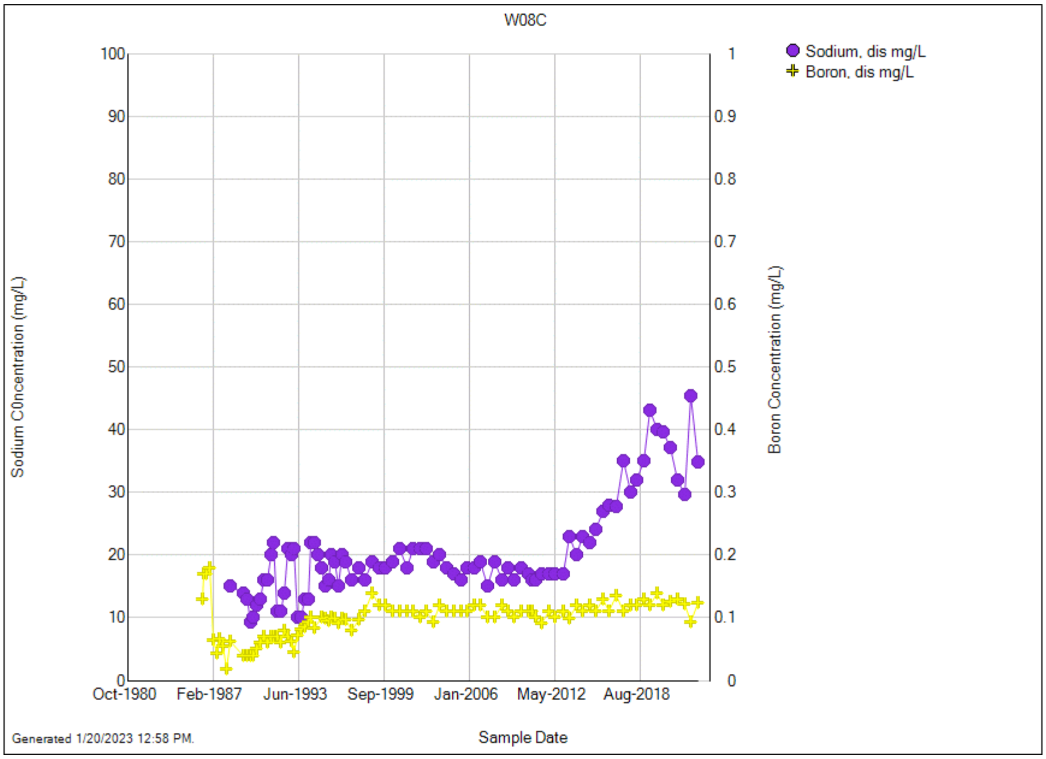

Figure I. Concentrations of sodium and boron in W08C.

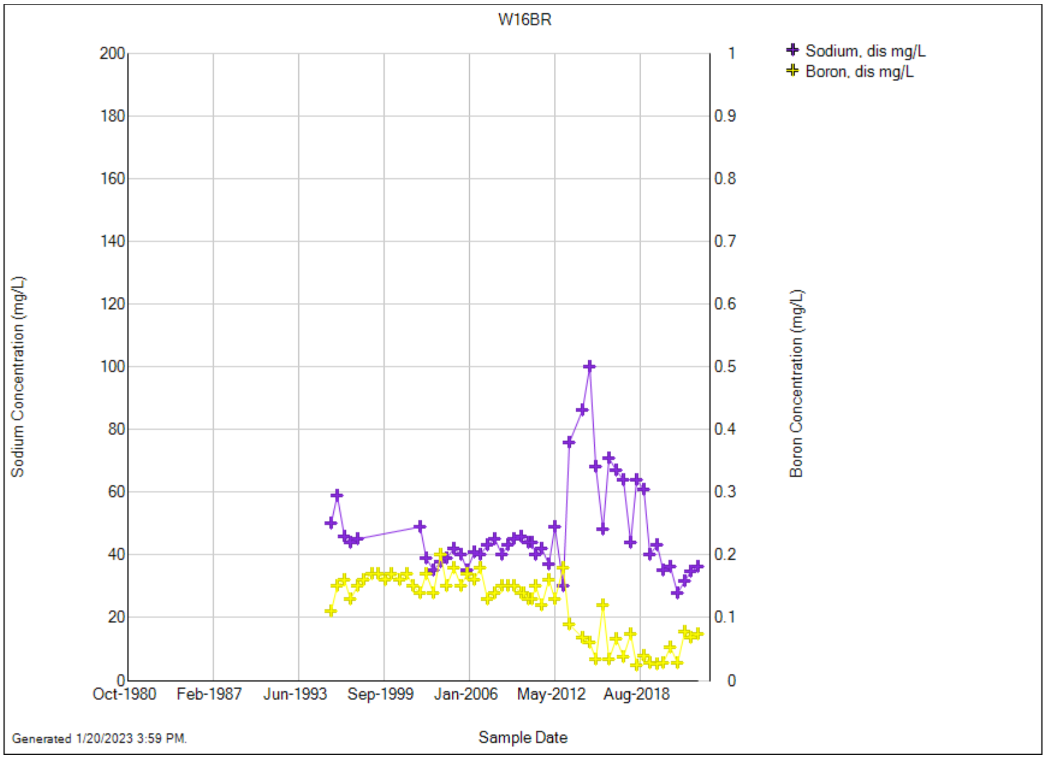

Figure J. Concentrations of sodium and boron in W16BR.

APPENDIX C
ACL INFORMATION

APPENDIX C-1

CCR MONITORING DATA (BASELINE AND DETECTION MONITORING ROUNDS 1-10) INCLUDING GEMS SUBMITTAL

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

Well Id	Date Sampled	Lab Id	Alkalinity, lab, mg/L	As, tot, mg/L	B, tot, mg/L	Ba, tot, mg/L	Be, tot, mg/L	Ca, tot, mg/L
W08D	11/11/2015	40124666006		0.001	0.407	0.095	<0.001	52.500
	2/16/2016	40128456003		0.001	0.426	0.089	<0.001	54.700
	5/11/2016	40132272002		0.001	0.472	0.092	<0.001	57.600
	8/30/2016	40137606003		0.000	0.402	0.085	<0.001	58.200
	11/14/2016	40142064003		0.000	0.457	0.085	<0.001	57.000
	2/8/2017	40145548002		0.000	0.420	0.077	<0.001	51.800
	5/15/2017	40150143005	160.000	0.000	0.470	0.077	<0.001	51.400
	8/22/2017	40155549007	153.000	0.000	0.450	0.072	<0.001	48.900
	11/14/2017	40161125002			0.456			49.100
	5/16/2018	AE27556			0.270			51.000
	11/14/2018	AE31851			0.450			50.000
	5/8/2019	AE37963			0.460			51.000
	11/4/2019	AE41843	160.000		0.440			48.000
	5/5/2020	AE45611			0.491			52.800
	11/10/2020	AE49635	150.000		0.481			50.800
	5/11/2021	AE53141			0.488			49.900
	11/9/2021	AE57087	155.000		0.450			49.800
	5/4/2022	AE60495			0.455			52.000
	11/7/2022	AE63530	158.000		0.460			48.600
W09D	11/11/2015	40124666005		0.001	0.379	0.046	<0.001	19.900
	2/16/2016	40128456004		0.001	0.404	0.043	<0.001	18.600
	5/11/2016	40132272003		0.001	0.389	0.044	<0.001	18.800
	8/30/2016	40137606004		0.001	0.350	0.047	<0.001	19.900
	11/14/2016	40142064004		0.001	0.389	0.047	<0.001	18.900
	2/8/2017	40145548003		0.001	0.370	0.046	<0.001	18.400

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Alkalinity, lab, mg/L	As, tot, mg/L	B, tot, mg/L	Ba, tot, mg/L	Be, tot, mg/L	Ca, tot, mg/L
W09D	2/8/2017							
	5/15/2017	40150143006	139.000	0.001	0.380	0.046	<0.001	17.900
	8/22/2017	40155549008	139.000	0.001	0.390	0.048	<0.001	17.700
	11/14/2017	40161125003			0.394			18.600
	5/16/2018	AE27554			0.410			19.000
	9/7/2018	AE30278			0.390			
	11/14/2018	AE31849			0.410			19.000
	3/5/2019	AE34023			0.390			
	5/8/2019	AE37960			0.410			18.000
	10/2/2019	AE40913			0.400			
	11/4/2019	AE41842	140.000		0.390			18.000
	5/5/2020	AE45609			0.429			19.000
	8/31/2020	AE48108			0.418			
	11/9/2020	AE49634	140.000		0.446			19.900
	5/11/2021	AE53142			0.435			18.000
	11/8/2021	AE57086	142.000		0.391			18.400
	5/4/2022	AE60494			0.402			20.700
	11/7/2022	AE63529	142.000		0.422			17.900
W10D	11/11/2015	40124666004		0.001	0.398	0.034	<0.001	22.700
	2/17/2016	40128456007		0.001	0.445	0.031	<0.001	23.300
	5/11/2016	40132272005		0.001	0.428	0.029	<0.001	21.600
	8/30/2016	40137606005		0.001	0.388	0.030	<0.001	21.800
	11/14/2016	40142064005		0.001	0.417	0.029	<0.001	21.600
	2/8/2017	40145548005		0.001	0.390	0.028	<0.001	20.500
	5/15/2017	40150143007	133.000	0.001	0.410	0.029	<0.001	20.300
	8/22/2017	40155549009	133.000	0.000	0.420	0.032	<0.001	20.700

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Alkalinity, lab, mg/L	As, tot, mg/L	B, tot, mg/L	Ba, tot, mg/L	Be, tot, mg/L	Ca, tot, mg/L
W10D	11/14/2017	40161125004			0.417			20.400
	5/16/2018	AE27553			0.430			21.000
	11/15/2018	AE31854			0.440			21.000
	5/8/2019	AE37959			0.440			21.000
	11/5/2019	AE41847	130.000		0.410			20.000
	5/4/2020	AE45607			0.441			21.300
	11/10/2020	AE49637	130.000		0.444			21.600
	5/11/2021	AE53143			0.440			21.400
	11/9/2021	AE57090	133.000		0.429			20.900
	5/5/2022	AE60497			0.412			22.900
	11/7/2022	AE63528	136.000		0.443			20.200
W46D	11/11/2015	40124666001		0.001	0.332	0.041	<0.001	31.000
	2/17/2016	40128456008		0.001	0.376	0.043	<0.001	35.900
	5/11/2016	40132272008		0.002	0.406	0.035	<0.001	33.200
	8/30/2016	40137606006		0.001	0.358	0.031	<0.001	30.300
	11/14/2016	40142064007		0.001	0.370	0.031	<0.001	29.600
	2/8/2017	40145548006		0.001	0.370	0.029	<0.001	28.400
	5/16/2017	40150143010	177.000	0.001	0.370	0.028	<0.001	25.900
	8/21/2017	40155549004	171.000	0.001	0.380	0.032	<0.001	28.100
	11/14/2017	40161125001			0.391			27.000
	5/15/2018	AE27550			0.400			27.000
	11/14/2018	AE31848			0.380			26.000
	5/8/2019	AE37956			0.370			27.000
	11/4/2019	AE41841	150.000		0.360			24.000
	5/4/2020	AE45604			0.409			25.900
	11/9/2020	AE49633	150.000		0.394			25.300

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Alkalinity, lab, mg/L	As, tot, mg/L	B, tot, mg/L	Ba, tot, mg/L	Be, tot, mg/L	Ca, tot, mg/L
W46D	11/9/2020							
	5/11/2021	AE53144			0.404			27.600
	11/8/2021	AE57085	170.000		0.385			26.100
	5/4/2022	AE60493			0.364			26.900
	11/7/2022	AE63526	164.000		0.368			24.600
W48	11/11/2015	40124666002		0.001	0.349	0.057	<0.001	27.200
	2/16/2016	40128456002		0.001	0.373	0.052	<0.001	24.900
	5/11/2016	40132272006		0.001	0.385	0.057	<0.001	26.700
	8/30/2016	40137606001		0.002	0.344	0.068	<0.001	28.100
	11/14/2016	40142064006		0.001	0.357	0.073	<0.001	26.500
	2/8/2017	40145548001		0.000	0.350	0.081	<0.001	26.300
	5/15/2017	40150143004	224.000	0.001	0.360	0.088	<0.001	25.100
	8/21/2017	40155549006	235.000	0.001	0.360	0.104	<0.001	27.300
	11/15/2017	40161125005			0.370			27.400
	5/16/2018	AE27551			0.390			27.000
	11/15/2018	AE31852			0.390			26.000
	5/8/2019	AE37957			0.380			27.000
	11/5/2019	AE41845	230.000		0.370			25.000
	5/4/2020	AE45605			0.403			27.600
	11/10/2020	AE49638	230.000		0.400			27.600
	5/11/2021	AE53145			0.416			28.600
	11/9/2021	AE57089	223.000		0.377			27.100
	5/5/2022	AE60499			0.370			28.400
	11/7/2022	AE63525	227.000		0.386			26.000
W49	6/21/2017	40152212001		0.003	0.420	0.048	<0.001	40.600
	8/22/2017	40155549012	135.000	0.001	0.410	0.031	<0.001	24.900

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Alkalinity, lab, mg/L	As, tot, mg/L	B, tot, mg/L	Ba, tot, mg/L	Be, tot, mg/L	Ca, tot, mg/L
W49	11/15/2017	40161125007			0.432			19.500
	5/16/2018	AE27557			0.440			18.000
	11/15/2018	AE31853			0.440			20.000
	5/8/2019	AE37958			0.450			16.000
	11/5/2019	AE41846	120.000		0.430			16.000
	5/5/2020	AE45608			0.463			17.700
	11/11/2020	AE49640	120.000		0.442			15.400
	5/12/2021	AE53149			0.469			16.000
	11/9/2021	AE57092	130.000		0.449			16.800
	5/5/2022	AE60500			0.444			17.900
	11/7/2022	AE63532	126.000		0.458			15.600
W50	6/2/2017	40151093001	167.000	0.003	0.500	0.049	<0.001	30.800
	8/22/2017	40155549013	144.000	0.002	0.500	0.034	<0.001	25.900
	11/15/2017	40161125008			0.490			26.200
	5/16/2018	AE27555			0.510			28.000
	11/15/2018	AE31855			0.520			27.000
	5/8/2019	AE37962			0.530			30.000
	11/5/2019	AE41848	150.000		0.490			28.000
	5/5/2020	AE45610			0.534			29.900
	11/11/2020	AE49639	130.000		0.540			29.800
	5/12/2021	AE53148			0.542			28.200
	11/9/2021	AE57091	145.000		0.510			28.400
	5/5/2022	AE60498			0.499			29.900
	11/7/2022	AE63531	148.000		0.541			28.900

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

Well Id	Date Sampled	Lab Id	Cd,tot, mg/L	Cl, tot, mg/L	Co, tot, mg/L	Copper, tot, ug/L	F, tot, mg/L	GW Elv, ft
W08D	11/11/2015	40124666006	<0.001	13.000	<0.001		1.000	648.070
	2/16/2016	40128456003	<0.001	11.500	<0.001		0.720	653.440
	5/11/2016	40132272002	<0.001	11.600	<0.001		0.760	653.680
	8/30/2016	40137606003	<0.001	10.400	<0.001		0.710	645.780
	11/14/2016	40142064003	<0.001	12.900	<0.001		1.100	651.290
	2/8/2017	40145548002	<0.001	11.000	<0.001		0.860	653.740
	5/15/2017	40150143005	<0.001	10.600	<0.001		0.910	654.680
	8/21/2017	40155549007						651.960
	8/22/2017	40155549007	<0.001	10.800	<0.001		1.100	
	11/14/2017	40161125002		11.900			1.100	
	5/16/2018	AE27556		10.000			0.960	655.040
	11/14/2018	AE31851		10.000			0.950	
	5/8/2019	AE37963		10.000			1.100	656.390
	11/4/2019	AE41843		10.000			1.000	656.230
	5/5/2020	AE45611		9.700			0.840	656.540
	11/10/2020	AE49635		10.000			1.300	654.870
	5/11/2021	AE53141		9.800			1.100	655.410
	11/9/2021	AE57087		9.800			1.300	652.140
	5/4/2022	AE60495		11.900			1.600	655.100
	11/7/2022	AE63530		9.500		<3.40	1.200	648.690
W09D	11/11/2015	40124666005	<0.001	4.600	<0.001		1.300	647.350
	2/16/2016	40128456004	<0.001	4.900	<0.001		1.300	652.740
	5/11/2016	40132272003	<0.001	4.900	<0.001		1.400	651.900
	8/30/2016	40137606004	<0.001	4.100	<0.001		1.300	644.750
	11/14/2016	40142064004	<0.001	3.900	<0.001		1.400	650.190

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Cd,tot, mg/L	Cl, tot, mg/L	Co, tot, mg/L	Copper, tot, ug/L	F, tot, mg/L	GW Elv, ft
W09D	11/14/2016							
	2/8/2017	40145548003	<0.001	4.000	<0.001		1.300	653.060
	5/15/2017	40150143006	<0.001	3.800	<0.001		1.400	652.930
	8/21/2017	40155549008						651.330
	8/22/2017	40155549008	<0.001	3.800	<0.001		1.300	
	11/14/2017	40161125003		4.900			1.400	
	5/16/2018	AE27554		3.400			1.200	654.670
	11/14/2018	AE31849		3.400			1.200	
	3/5/2019	AE34023						655.530
	5/8/2019	AE37960		3.700			1.300	655.880
	10/2/2019	AE40913						653.600
	11/4/2019	AE41842		3.600			1.300	655.740
	5/5/2020	AE45609		3.700			1.300	656.060
	8/31/2020	AE48108						654.230
	11/9/2020	AE49634		3.500			1.500	654.250
	5/11/2021	AE53142		3.700			1.400	654.660
	11/8/2021	AE57086		3.800			1.400	651.720
	5/4/2022	AE60494		6.500			1.600	655.020
	11/7/2022	AE63529		3.600		<3.40	1.300	652.920
W10D	11/11/2015	40124666004	<0.001	4.700	<0.001		1.200	646.380
	2/17/2016	40128456007	<0.001	6.300	<0.001		1.200	651.740
	5/11/2016	40132272005	<0.001	6.500	<0.001		1.300	650.950
	8/30/2016	40137606005	<0.001	4.700	<0.001		1.300	643.690
	11/14/2016	40142064005	<0.001	4.400	<0.001		1.400	649.410
	2/8/2017	40145548005	<0.001	4.300	<0.001		1.300	652.250
	5/15/2017	40150143007	<0.001	4.200	<0.001		1.400	651.900

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Cd,tot, mg/L	Cl, tot, mg/L	Co, tot, mg/L	Copper, tot, ug/L	F, tot, mg/L	GW Elv, ft
W10D	8/21/2017	40155549010						650.590
	8/22/2017	40155549009	<0.001	4.200	<0.001		1.300	
	11/14/2017	40161125004		4.300			1.400	
	5/16/2018	AE27553		3.500			1.200	653.970
	11/15/2018	AE31854		3.500			1.200	
	5/8/2019	AE37959		4.000			1.200	655.070
	11/5/2019	AE41847		3.700			1.200	654.850
	5/4/2020	AE45607		3.800			1.300	655.280
	11/10/2020	AE49637		4.000			1.500	653.690
	5/11/2021	AE53143		4.000			1.300	654.040
	11/9/2021	AE57090		4.000			1.300	651.080
	5/5/2022	AE60497		7.100			1.600	654.080
	11/7/2022	AE63528		3.900		<3.40	1.300	651.570
W46D	11/11/2015	40124666001	<0.001	6.100	<0.001		0.820	648.320
	2/17/2016	40128456008	<0.001	7.400	<0.001		0.740	653.560
	5/11/2016	40132272008	<0.001	10.100	<0.001		4.000	652.660
	8/30/2016	40137606006	<0.001	7.200	<0.001		2.300	645.510
	11/14/2016	40142064007	<0.001	9.600	<0.001		0.540	650.890
	2/8/2017	40145548006	<0.001	10.400	<0.001		<0.500	654.020
	5/16/2017	40150143010	<0.001	9.900	<0.001		1.100	653.990
	8/21/2017	40155549004	<0.001	10.600	<0.001		1.000	
		UNKNOWN						652.270
	11/14/2017	40161125001		6.800			1.200	
	5/15/2018	AE27550		6.000			1.100	653.680
	11/14/2018	AE31848		5.800			1.000	
	5/8/2019	AE37956		7.100			1.100	656.780

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Cd,tot, mg/L	Cl, tot, mg/L	Co, tot, mg/L	Copper, tot, ug/L	F, tot, mg/L	GW Elv, ft
W46D	11/4/2019	AE41841		5.000			1.100	656.660
	5/4/2020	AE45604		5.300			1.100	656.970
	11/9/2020	AE49633		4.800			1.300	655.100
	5/11/2021	AE53144		7.100			1.100	655.710
	11/8/2021	AE57085		5.600			1.200	652.570
	5/4/2022	AE60493		9.500			1.300	655.710
	11/7/2022	AE63526		6.800		<3.40	1.100	651.670
W48	11/11/2015	40124666002	<0.001	4.600	<0.001		0.900	649.820
	2/16/2016	40128456002	<0.001	5.000	<0.001		0.900	655.050
	5/11/2016	40132272006	<0.001	4.900	<0.001		0.980	653.980
	8/30/2016	40137606001	<0.001	4.100	<0.001		0.900	647.200
	11/14/2016	40142064006	<0.001	4.100	<0.001		0.990	652.060
	2/8/2017	40145548001	<0.001	4.000	<0.001		0.930	655.480
	5/15/2017	40150143004	<0.001	3.800	<0.001		0.950	656.090
	8/21/2017	40155549006	<0.001	3.800	<0.001		0.920	
		UNKNOWN						653.520
	11/15/2017	40161125005		4.100			1.000	
	5/16/2018	AE27551		3.500			0.850	657.010
	11/15/2018	AE31852		3.500			0.820	
	5/8/2019	AE37957		3.700			0.970	658.030
	11/5/2019	AE41845		3.500			0.880	657.780
	5/4/2020	AE45605		3.600			0.910	658.130
	11/10/2020	AE49638		3.700			1.000	655.930
	5/11/2021	AE53145		3.800			0.920	656.900
	11/9/2021	AE57089		3.800			0.970	653.610
	5/5/2022	AE60499		<2.200			<0.480	657.060

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Cd,tot, mg/L	Cl, tot, mg/L	Co, tot, mg/L	Copper, tot, ug/L	F, tot, mg/L	GW Elv, ft
W48	11/7/2022	AE63525		3.800		<3.40	0.960	655.110
W49	6/21/2017	40152212001	<0.001	6.500	0.002		1.200	649.154
	8/21/2017	UNKNOWN						650.894
	8/22/2017	40155549012	<0.001	6.300	<0.001		1.300	
	11/15/2017	40161125007		5.800			1.500	
	5/16/2018	AE27557		5.000			1.200	654.294
	11/15/2018	AE31853		4.900			1.000	
	5/8/2019	AE37958		4.600			1.400	655.454
	11/5/2019	AE41846		4.200			1.300	655.244
	5/5/2020	AE45608		4.200			1.300	655.544
	11/11/2020	AE49640		5.400			1.400	653.904
	5/12/2021	AE53149		4.200			1.400	654.384
	11/9/2021	AE57092		4.500			1.400	651.324
	5/5/2022	AE60500		7.300			1.900	654.454
	11/7/2022	AE63532		4.300		<3.40	1.500	652.494
W50	6/2/2017	40151093001	<0.001	6.500	<0.001		1.200	652.584
	8/21/2017	UNKNOWN						651.474
	8/22/2017	40155549013	<0.001	5.400	<0.001		1.200	
	11/15/2017	40161125008		5.800			1.300	
	5/16/2018	AE27555		5.400			1.100	655.804
	11/15/2018	AE31855		5.700			1.000	
	5/8/2019	AE37962		6.800			1.100	655.924
	10/3/2019	AE41032						654.364
	11/5/2019	AE41848		5.900			0.990	655.684
	5/5/2020	AE45610		5.600			1.100	656.084

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Cd,tot, mg/L	Cl, tot, mg/L	Co, tot, mg/L	Copper, tot, ug/L	F, tot, mg/L	GW Elv, ft
W50	11/11/2020	AE49639		5.500			1.300	653.634
	5/12/2021	AE53148		5.900			1.200	654.814
	11/9/2021	AE57091		6.000			1.200	651.694
	5/5/2022	AE60498		8.300			1.400	654.844
	11/7/2022	AE63531		5.800		<3.40	1.200	652.534

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

Well Id	Date Sampled	Lab Id	Hg, tot, mg/L	Li, tot, mg/L	Mo, tot, mg/L	Nitrite + Nitrate, mg/L	Pb, tot, mg/L	pH (field), STD
W08D	11/11/2015	40124666006	<0.000	0.009	0.028		<0.000	7.7
	2/16/2016	40128456003	<0.000	0.001	0.025		0.000	7.4
	5/11/2016	40132272002	<0.000	0.001	0.022		0.000	7.4
	8/30/2016	40137606003	<0.000	0.001	0.019		<0.000	7.6
	11/14/2016	40142064003	<0.000	0.001	0.032		<0.000	7.4
	2/8/2017	40145548002	<0.000	0.002	0.030		<0.000	7.9
	5/15/2017	40150143005	<0.000	0.002	0.038		<0.000	7.5
	8/22/2017	40155549007	<0.000	0.002	0.042		<0.000	6.9
	11/14/2017	40161125002						7.4
	5/16/2018	AE27556						7.3
	11/14/2018	AE31851						7.5
	5/8/2019	AE37963						7.5
	11/4/2019	AE41843						7.4
	5/5/2020	AE45611						7.5
	11/10/2020	AE49635						7.7
	5/11/2021	AE53141						7.5
	11/9/2021	AE57087						7.5
	5/4/2022	AE60495						7.4
	11/7/2022	AE63530				<0.021		7.7
W09D	11/11/2015	40124666005	<0.000	0.005	0.030		0.000	8.2
	2/16/2016	40128456004	<0.000	0.005	0.032		0.000	8.3
	5/11/2016	40132272003	<0.000	0.005	0.030		0.000	8.1
	8/30/2016	40137606004	<0.000	0.005	0.031		0.000	8.3
	11/14/2016	40142064004	<0.000	0.006	0.032		0.000	8.3
	2/8/2017	40145548003	<0.000	0.006	0.029		<0.000	8.2

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Hg, tot, mg/L	Li, tot, mg/L	Mo, tot, mg/L	Nitrite + Nitrate, mg/L	Pb, tot, mg/L	pH (field), STD
W09D	2/8/2017							
	5/15/2017	40150143006	<0.000	0.006	0.031		0.000	7.8
	8/22/2017	40155549008	<0.000	0.006	0.031		<0.000	7.7
	11/14/2017	40161125003						8.2
	5/16/2018	AE27554						7.9
	9/7/2018	AE30278						7.9
	11/14/2018	AE31849						8.0
	3/5/2019	AE34023						7.8
	5/8/2019	AE37960						8.2
	10/2/2019	AE40913						7.9
	11/4/2019	AE41842						7.9
	5/5/2020	AE45609						7.9
	8/31/2020	AE48108						7.9
	11/9/2020	AE49634						8.0
	5/11/2021	AE53142						8.2
	11/8/2021	AE57086						8.1
	5/4/2022	AE60494						7.8
	11/7/2022	AE63529				<0.021		7.9
W10D	11/11/2015	40124666004	<0.000	0.004	0.037		0.000	8.2
	2/17/2016	40128456007	<0.000	0.005	0.043		0.000	8.1
	5/11/2016	40132272005	<0.000	0.004	0.040		0.000	7.9
	8/30/2016	40137606005	<0.000	0.004	0.039		<0.000	8.1
	11/14/2016	40142064005	<0.000	0.004	0.042		<0.000	8.0
	2/8/2017	40145548005	<0.000	0.005	0.037		0.000	8.4
	5/15/2017	40150143007	<0.000	0.005	0.040		0.000	8.0
	8/22/2017	40155549009	<0.000	0.005	0.040		<0.000	7.9

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Hg, tot, mg/L	Li, tot, mg/L	Mo, tot, mg/L	Nitrite + Nitrate, mg/L	Pb, tot, mg/L	pH (field), STD
W10D	11/14/2017	40161125004						8.1
	5/16/2018	AE27553						7.6
	11/15/2018	AE31854						8.0
	5/8/2019	AE37959						8.1
	11/5/2019	AE41847						8.0
	5/4/2020	AE45607						7.8
	11/10/2020	AE49637						7.9
	5/11/2021	AE53143						8.1
	11/9/2021	AE57090						8.0
	5/5/2022	AE60497						7.9
	11/7/2022	AE63528				<0.021		7.7
W46D	11/11/2015	40124666001	<0.000	0.003	0.027		0.000	8.1
	2/17/2016	40128456008	<0.000	0.002	0.021		0.000	7.8
	5/11/2016	40132272008	<0.000	0.004	0.019		0.000	7.4
	8/30/2016	40137606006	<0.000	0.003	0.027		0.000	7.6
	11/14/2016	40142064007	<0.000	0.004	0.022		0.000	7.5
	2/8/2017	40145548006	<0.000	0.004	0.020		0.000	7.2
	5/16/2017	40150143010	<0.000	0.004	0.024		<0.000	7.2
	8/21/2017	40155549004	<0.000	0.004	0.016		<0.000	7.4
	11/14/2017	40161125001						7.6
	5/15/2018	AE27550						7.6
	11/14/2018	AE31848						7.6
	5/8/2019	AE37956						7.5
	11/4/2019	AE41841						7.5
	5/4/2020	AE45604						7.6
	11/9/2020	AE49633						7.6

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Hg, tot, mg/L	Li, tot, mg/L	Mo, tot, mg/L	Nitrite + Nitrate, mg/L	Pb, tot, mg/L	pH (field), STD
W46D	11/9/2020							
	5/11/2021	AE53144						7.5
	11/8/2021	AE57085						7.3
	5/4/2022	AE60493						7.0
	11/7/2022	AE63526				<0.021		7.1
W48	11/11/2015	40124666002	<0.000	0.005	<0.003		0.000	8.0
	2/16/2016	40128456002	<0.000	0.005	<0.003		0.000	8.0
	5/11/2016	40132272006	<0.000	0.005	<0.003		<0.000	7.9
	8/30/2016	40137606001	<0.000	0.006	<0.003		0.001	8.0
	11/14/2016	40142064006	<0.000	0.006	<0.001		<0.000	8.0
	2/8/2017	40145548001	<0.000	0.006	0.002		<0.000	8.2
	5/15/2017	40150143004	<0.000	0.006	0.002		0.000	8.0
	8/21/2017	40155549006	<0.000	0.007	<0.001		0.000	7.5
	11/15/2017	40161125005						7.9
	5/16/2018	AE27551						7.7
	11/15/2018	AE31852						7.8
	5/8/2019	AE37957						8.0
	11/5/2019	AE41845						7.8
	5/4/2020	AE45605						7.9
	11/10/2020	AE49638						7.9
	5/11/2021	AE53145						8.0
	11/9/2021	AE57089						7.9
	5/5/2022	AE60499						7.8
	11/7/2022	AE63525				<0.021		7.7
W49	6/21/2017	40152212001	<0.000	0.014	0.043		0.002	8.0
	8/22/2017	40155549012	<0.000	0.004	0.045		0.001	7.9

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Hg, tot, mg/L	Li, tot, mg/L	Mo, tot, mg/L	Nitrite + Nitrate, mg/L	Pb, tot, mg/L	pH (field), STD
W49	11/15/2017	40161125007						8.1
	5/16/2018	AE27557						7.8
	11/15/2018	AE31853						7.9
	5/8/2019	AE37958						8.3
	11/5/2019	AE41846						8.0
	5/5/2020	AE45608						7.7
	11/11/2020	AE49640						7.8
	5/12/2021	AE53149						8.4
	11/9/2021	AE57092						7.6
	5/5/2022	AE60500						7.8
	11/7/2022	AE63532				<0.021		8.1
W50	6/2/2017	40151093001	<0.000	0.005	0.028		0.001	6.9
	8/22/2017	40155549013	<0.000	0.003	0.037		<0.000	7.2
	11/15/2017	40161125008						7.8
	5/16/2018	AE27555						7.7
	11/15/2018	AE31855						7.8
	5/8/2019	AE37962						7.8
	10/3/2019	AE41032						7.0
	11/5/2019	AE41848						7.7
	5/5/2020	AE45610						7.5
	11/11/2020	AE49639						7.6
	5/12/2021	AE53148						7.4
	11/9/2021	AE57091						7.7
	5/5/2022	AE60498						7.6
	11/7/2022	AE63531				<0.021		7.6

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

Well Id	Date Sampled	Lab Id	Ra-226,228, tot, pCi/L	Sb, tot, mg/L	Se, tot, mg/L	Silver, tot, ug/L	SO4, tot, mg/L	Spec. Cond. (field), micromhos/cm
W08D	11/11/2015	40124666006	1.290	<0.000	0.000		181.000	760.000
	2/16/2016	40128456003	0.300	0.000	0.000		191.000	788.000
	5/11/2016	40132272002	1.150	0.000	<0.000		196.000	779.000
	8/30/2016	40137606003	1.550	<0.000	<0.000		177.000	697.000
	11/14/2016	40142064003	0.221	<0.000	<0.000		204.000	764.000
	2/8/2017	40145548002	0.987	0.000	<0.000		201.000	717.000
	5/15/2017	40150143005	0.531	<0.000	<0.000		204.000	796.400
	8/22/2017	40155549007	1.210	<0.000	<0.000		203.000	693.400
	11/14/2017	40161125002					222.000	789.600
	5/16/2018	AE27556					200.000	720.000
	11/14/2018	AE31851					210.000	767.000
	5/8/2019	AE37963					230.000	757.900
	11/4/2019	AE41843					200.000	789.000
	5/5/2020	AE45611					200.000	670.300
	11/10/2020	AE49635					220.000	726.680
	5/11/2021	AE53141					200.000	712.380
	11/9/2021	AE57087					219.000	748.000
	5/4/2022	AE60495					240.000	930.560
	11/7/2022	AE63530				<3.200	210.000	800.000
W09D	11/11/2015	40124666005	1.330	<0.000	<0.000		30.400	376.000
	2/16/2016	40128456004	0.238	0.000	<0.000		31.200	353.000
	5/11/2016	40132272003	0.000	0.000	<0.000		32.300	354.000
	8/30/2016	40137606004	0.387	0.000	<0.000		31.500	338.000
	11/14/2016	40142064004	0.154	0.000	<0.000		33.900	343.000
	2/8/2017	40145548003	1.170	<0.000	<0.000		33.500	327.000

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Ra-226,228, tot, pCi/L	Sb, tot, mg/L	Se, tot, mg/L	Silver, tot, ug/L	SO4, tot, mg/L	Spec. Cond. (field), micromhos/cm
W09D	2/8/2017							
	5/15/2017	40150143006	1.060	<0.000	<0.000		33.400	374.200
	8/22/2017	40155549008	0.438	<0.000	<0.000		31.800	333.200
	11/14/2017	40161125003					32.200	374.600
	5/16/2018	AE27554					32.000	342.000
	9/7/2018	AE30278						337.000
	11/14/2018	AE31849					34.000	349.000
	3/5/2019	AE34023						388.000
	5/8/2019	AE37960					37.000	354.500
	10/2/2019	AE40913						368.000
	11/4/2019	AE41842					33.000	365.000
	5/5/2020	AE45609					34.000	322.900
	8/31/2020	AE48108						347.000
	11/9/2020	AE49634					34.000	109788.000
	5/11/2021	AE53142					35.700	332.880
	11/8/2021	AE57086					33.200	291.000
	5/4/2022	AE60494					33.900	422.230
	11/7/2022	AE63529				<3.200	32.900	380.000
W10D	11/11/2015	40124666004	0.645	0.000	<0.000		38.800	382.000
	2/17/2016	40128456007	0.654	0.000	<0.000		43.000	376.000
	5/11/2016	40132272005	0.138	0.000	<0.000		46.000	383.000
	8/30/2016	40137606005	1.260	<0.000	<0.000		41.600	317.000
	11/14/2016	40142064005	0.394	<0.000	<0.000		44.000	358.000
	2/8/2017	40145548005	0.345	0.000	<0.000		41.700	330.000
	5/15/2017	40150143007	0.172	<0.000	<0.000		43.000	388.400
	8/22/2017	40155549009	0.397	<0.000	<0.000		40.800	349.100

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Ra-226,228, tot, pCi/L	Sb, tot, mg/L	Se, tot, mg/L	Silver, tot, ug/L	SO4, tot, mg/L	Spec. Cond. (field), micromhos/cm
W10D	11/14/2017	40161125004					44.500	386.300
	5/16/2018	AE27553					41.000	350.000
	11/15/2018	AE31854					43.000	362.000
	5/8/2019	AE37959					46.000	365.700
	11/5/2019	AE41847					40.000	383.000
	5/4/2020	AE45607					41.000	342.800
	11/10/2020	AE49637					44.000	360.410
	5/11/2021	AE53143					41.100	346.570
	11/9/2021	AE57090					40.600	353.000
	5/5/2022	AE60497					43.900	408.090
	11/7/2022	AE63528				<3.200	42.200	390.000
W46D	11/11/2015	40124666001	0.498	<0.000	<0.001		26.300	465.000
	2/17/2016	40128456008	0.443	0.000	<0.000		11.600	457.000
	5/11/2016	40132272008	0.067	0.000	<0.000		5.400	418.000
	8/30/2016	40137606006	0.947	0.000	<0.000		25.000	372.000
	11/14/2016	40142064007	0.368	0.000	<0.000		26.500	422.000
	2/8/2017	40145548006	0.312	0.000	<0.000		25.700	386.000
	5/16/2017	40150143010	0.502	0.000	<0.000		30.200	483.200
	8/21/2017	40155549004	0.424	0.000	<0.000		29.100	426.500
	11/14/2017	40161125001					34.500	422.700
	5/15/2018	AE27550					33.000	397.000
	11/14/2018	AE31848					36.000	394.000
	5/8/2019	AE37956					37.000	416.200
	11/4/2019	AE41841					35.000	403.000
	5/4/2020	AE45604					35.000	373.400
	11/9/2020	AE49633					35.000	118444.000

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Ra-226,228, tot, pCi/L	Sb, tot, mg/L	Se, tot, mg/L	Silver, tot, ug/L	SO4, tot, mg/L	Spec. Cond. (field), micromhos/cm
W46D	11/9/2020							
	5/11/2021	AE53144					33.100	392.210
	11/8/2021	AE57085					17.700	393.000
	5/4/2022	AE60493					36.700	491.760
	11/7/2022	AE63526				<3.200	34.400	430.000
W48	11/11/2015	40124666002	0.622	0.000	<0.000		2.300	462.000
	2/16/2016	40128456002	0.206	0.000	<0.000		3.000	436.000
	5/11/2016	40132272006	0.501	<0.000	<0.000		2.600	428.000
	8/30/2016	40137606001	0.908	0.001	0.001		<2.000	373.000
	11/14/2016	40142064006	0.534	<0.000	<0.000		<1.000	430.000
	2/8/2017	40145548001	0.215	0.000	<0.000		1.300	396.000
	5/15/2017	40150143004	1.010	<0.000	<0.000		<1.000	459.400
	8/21/2017	40155549006	0.497	0.000	<0.000		<1.000	444.500
	11/15/2017	40161125005					<1.000	460.100
	5/16/2018	AE27551					0.620	431.000
	11/15/2018	AE31852					0.560	441.000
	5/8/2019	AE37957					2.500	440.700
	11/5/2019	AE41845					<0.140	461.000
	5/4/2020	AE45605					0.740	418.200
	11/10/2020	AE49638					0.380	436.540
	5/11/2021	AE53145					<0.440	419.530
	11/9/2021	AE57089					<0.440	427.000
	5/5/2022	AE60499					<2.200	487.780
	11/7/2022	AE63525				<3.200	0.470	450.000
W49	6/21/2017	40152212001	0.680	0.001	0.001		44.900	375.840
	8/22/2017	40155549012	0.746	0.000	0.000		46.100	368.300

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			Ra-226,228, tot, pCi/L	Sb, tot, mg/L	Se, tot, mg/L	Silver, tot, ug/L	SO4, tot, mg/L	Spec. Cond. (field), micromhos/cm
W49	11/15/2017	40161125007					51.600	365.600
	5/16/2018	AE27557					47.000	348.000
	11/15/2018	AE31853					43.000	370.000
	5/8/2019	AE37958					54.000	354.800
	11/5/2019	AE41846					50.000	378.000
	5/5/2020	AE45608					22.000	317.100
	11/11/2020	AE49640					46.000	386.230
	5/12/2021	AE53149					49.700	357.970
	11/9/2021	AE57092					37.800	337.000
	5/5/2022	AE60500					36.700	390.580
	11/7/2022	AE63532				<3.200	50.000	380.000
W50	6/2/2017	40151093001	0.482	0.001	0.000		51.300	426.700
	8/22/2017	40155549013	0.742	<0.000	<0.000		75.200	436.300
	11/15/2017	40161125008					80.800	467.400
	5/16/2018	AE27555					75.000	446.000
	11/15/2018	AE31855					76.000	467.000
	5/8/2019	AE37962					83.000	471.500
	10/3/2019	AE41032						525.620
	11/5/2019	AE41848					73.000	488.000
	5/5/2020	AE45610					60.000	401.800
	11/11/2020	AE49639					75.000	456.710
	5/12/2021	AE53148					78.000	474.890
	11/9/2021	AE57091					81.400	260.000
	5/5/2022	AE60498					81.000	534.970
	11/7/2022	AE63531				<3.200	67.000	510.000

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

Well Id	Date Sampled	Lab Id	TDS, mg/L	Temp (Celcius), degrees C	Tl, tot, mg/L	Zinc, tot, ug/L
W08D	11/11/2015	40124666006	432.000	11.100	<0.000	
	2/16/2016	40128456003	460.000	7.210	0.000	
	5/11/2016	40132272002	446.000	10.200	<0.000	
	8/30/2016	40137606003	484.000	13.100	<0.000	
	11/14/2016	40142064003	510.000	10.500	<0.000	
	2/8/2017	40145548002	454.000	9.180	<0.000	
	5/15/2017	40150143005	448.000	11.420	<0.000	
	8/22/2017	40155549007	444.000	14.560	<0.000	
	11/14/2017	40161125002	416.000	10.450		
	5/16/2018	AE27556	440.000	13.000		
	11/14/2018	AE31851	430.000	9.600		
	5/8/2019	AE37963	440.000	9.540		
	11/4/2019	AE41843	430.000	10.000		
	5/5/2020	AE45611	450.000	9.900		
	11/10/2020	AE49635	410.000	13.350		
	5/11/2021	AE53141	448.000	12.890		
	11/9/2021	AE57087	472.000	14.000		
	5/4/2022	AE60495	480.000	10.240		
	11/7/2022	AE63530	482.000	12.000		<11.60
W09D	11/11/2015	40124666005	202.000	11.100	<0.000	
	2/16/2016	40128456004	198.000	9.940	<0.000	
	5/11/2016	40132272003	194.000	10.400	<0.000	
	8/30/2016	40137606004	206.000	8.300	0.000	
	11/14/2016	40142064004	206.000	10.600	0.000	
	2/8/2017	40145548003	192.000	9.440	<0.000	

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			TDS, mg/L	Temp (Celcius), degrees C	Tl, tot, mg/L	Zinc, tot, ug/L
W09D	2/8/2017					
	5/15/2017	40150143006	200.000	11.170	<0.000	
	8/22/2017	40155549008	208.000	12.480	<0.000	
	11/14/2017	40161125003	170.000	10.450		
	5/16/2018	AE27554	180.000	11.500		
	9/7/2018	AE30278		12.100		
	11/14/2018	AE31849	160.000	10.200		
	3/5/2019	AE34023		8.600		
	5/8/2019	AE37960	190.000	10.050		
	10/2/2019	AE40913		11.000		
	11/4/2019	AE41842	150.000	11.000		
	5/5/2020	AE45609	160.000	9.500		
	8/31/2020	AE48108		11.000		
	11/9/2020	AE49634	82.000	11.100		
	5/11/2021	AE53142	206.000	10.780		
	11/8/2021	AE57086	186.000	18.000		
	5/4/2022	AE60494	214.000	10.300		
	11/7/2022	AE63529	212.000	11.000		<11.60
W10D	11/11/2015	40124666004	222.000	10.600	<0.000	
	2/17/2016	40128456007	190.000	8.000	<0.000	
	5/11/2016	40132272005	206.000	10.100	<0.000	
	8/30/2016	40137606005	232.000	11.300	<0.000	
	11/14/2016	40142064005	210.000	10.200	<0.000	
	2/8/2017	40145548005	192.000	9.610	0.000	
	5/15/2017	40150143007	196.000	10.890	<0.000	
	8/22/2017	40155549009	222.000	12.390	<0.000	

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			TDS, mg/L	Temp (Celcius), degrees C	Tl, tot, mg/L	Zinc, tot, ug/L
W10D	11/14/2017	40161125004	180.000	10.140		
	5/16/2018	AE27553	180.000	11.200		
	11/15/2018	AE31854	160.000	10.000		
	5/8/2019	AE37959	190.000	9.830		
	11/5/2019	AE41847	180.000	10.000		
	5/4/2020	AE45607	190.000	9.810		
	11/10/2020	AE49637	150.000	10.920		
	5/11/2021	AE53143	204.000	10.270		
	11/9/2021	AE57090	212.000	12.000		
	5/5/2022	AE60497	180.000	9.860		
	11/7/2022	AE63528	218.000	10.000		<11.60
W46D	11/11/2015	40124666001	230.000	11.100	<0.000	
	2/17/2016	40128456008	244.000	8.500	<0.000	
	5/11/2016	40132272008	218.000	11.000	<0.000	
	8/30/2016	40137606006	256.000	12.600	<0.000	
	11/14/2016	40142064007	260.000	10.900	<0.000	
	2/8/2017	40145548006	114.000	9.860	<0.000	
	5/16/2017	40150143010	230.000	12.730	<0.000	
	8/21/2017	40155549004	232.000	13.720	<0.000	
	11/14/2017	40161125001	196.000	10.610		
	5/15/2018	AE27550	200.000	10.700		
	11/14/2018	AE31848	140.000	10.000		
	5/8/2019	AE37956	210.000	9.900		
	11/4/2019	AE41841	200.000	11.000		
	5/4/2020	AE45604	170.000	9.900		
	11/9/2020	AE49633	200.000	10.880		

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			TDS, mg/L	Temp (Celcius), degrees C	Tl, tot, mg/L	Zinc, tot, ug/L
W46D	11/9/2020					
	5/11/2021	AE53144	230.000	11.650		
	11/8/2021	AE57085	206.000	15.000		
	5/4/2022	AE60493	254.000	10.700		
	11/7/2022	AE63526	216.000	12.000		<11.60
W48	11/11/2015	40124666002	254.000	10.700	0.000	
	2/16/2016	40128456002	222.000	10.000	<0.000	
	5/11/2016	40132272006	224.000	10.600	<0.000	
	8/30/2016	40137606001	242.000	11.100	0.001	
	11/14/2016	40142064006	238.000	10.600	<0.000	
	2/8/2017	40145548001	224.000	9.720	0.000	
	5/15/2017	40150143004	236.000	11.620	<0.000	
	8/21/2017	40155549006	254.000	11.600	0.000	
	11/15/2017	40161125005	244.000	10.350		
	5/16/2018	AE27551	200.000	11.300		
	11/15/2018	AE31852	130.000	9.600		
	5/8/2019	AE37957	220.000	10.060		
	11/5/2019	AE41845	190.000	10.000		
	5/4/2020	AE45605	210.000	10.300		
	11/10/2020	AE49638	220.000	11.270		
	5/11/2021	AE53145	236.000	11.060		
	11/9/2021	AE57089	256.000	13.000		
	5/5/2022	AE60499	198.000	10.400		
	11/7/2022	AE63525	280.000	11.000		<11.60
W49	6/21/2017	40152212001	236.000	12.300	0.001	
	8/22/2017	40155549012	216.000	14.580	0.000	

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

			TDS, mg/L	Temp (Celcius), degrees C	Tl, tot, mg/L	Zinc, tot, ug/L
W49	11/15/2017	40161125007	210.000	10.390		
	5/16/2018	AE27557	180.000	12.800		
	11/15/2018	AE31853	170.000	9.500		
	5/8/2019	AE37958	210.000	9.870		
	11/5/2019	AE41846	180.000	12.000		
	5/5/2020	AE45608	190.000	8.500		
	11/11/2020	AE49640	230.000	7.300		
	5/12/2021	AE53149	210.000	12.360		
	11/9/2021	AE57092	204.000	13.000		
	5/5/2022	AE60500	204.000	10.560		
	11/7/2022	AE63532	220.000	12.000		<11.60
W50	6/2/2017	40151093001	270.000	13.280	0.000	
	8/22/2017	40155549013	256.000	12.640	0.000	
	11/15/2017	40161125008	260.000	10.530		
	5/16/2018	AE27555	250.000	12.600		
	11/15/2018	AE31855	220.000	9.900		
	5/8/2019	AE37962	270.000	9.530		
	10/3/2019	AE41032	260.000	15.070		
	11/5/2019	AE41848	260.000	11.000		
	5/5/2020	AE45610	240.000	9.700		
	11/11/2020	AE49639	250.000	9.810		
	5/12/2021	AE53148	278.000	11.220		
	11/9/2021	AE57091	272.000	14.000		
	5/5/2022	AE60498	298.000	9.960		
	11/7/2022	AE63531	292.000	12.000		<11.60

Caledonia CCR
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 11/11/1900 to 11/07/2022

Lab Methods:

APPENDIX C-2
ACL CALCULATION TABLES AND OUTLIER SUMMARY

TABLE C-2. ACL CALCULATION TABLES
ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, WISCONSIN

Location	Parameter	Units	Count	Mean	Median	Maximum	Minimum	Standard Deviation	No. of Outliers Removed	Resulting Mean/ Std. Dev.	ACL (Mean + 2 Standard Deviations) [1]	Sen Slope (Units/year)	Normal / Log Normal	Percent of Non-Detects
W08D	Boron, total	mg/L	19	0.44	0.46	0.49	0.27	0.048	1	0.45 / 0.025	**0.50**	0.007	No / No	0.00
	Fluoride, total	mg/L	19	1.0	1.0	1.6	0.71	0.22	1	1.00 / 0.17	**1.35**	0.067	Yes / Yes	0.00
	Sulfate, total	mg/L	19	206	203	240	177	15.6	0	NA	**236**	4.770	Yes / Yes	0.00
W09D	Boron, total	mg/L	23	0.40	0.39	0.45	0.35	0.02	0	NA	**0.44**	0.007	Yes / Yes	0.00
	Fluoride, total	mg/L	19	1.35	1.3	1.6	1.2	0.10	1	1.33 / 0.07	**1.48**	0.000	No / No	0.00
W10D	Boron, total	mg/L	19	0.42	0.43	0.45	0.39	0.02	0	NA	**0.46**	0.004	Yes / Yes	0.00
	Fluoride, total	mg/L	19	1.3	1.3	1.6	1.2	0.1	1	1.29 / 0.08	**1.46**	0.000	No / No	0.00
W46D	Boron, total	mg/L	19	0.38	0.38	0.41	0.33	0.02	0	NA	**0.42**	0.002	Yes / Yes	0.00
	Fluoride, total	mg/L	19	1.2	1.1	4.0	0.25	0.8	1	1.08 / 0.39	**1.86**	0.040	No / No	5.26
W48	Boron, total	mg/L	19	0.38	0.37	0.42	0.34	0.02	0	NA	**0.42**	0.006	Yes / Yes	0.00
	Fluoride, total	mg/L	19	0.89	0.92	1.0	0.24	0.17	1	0.93 / 0.05	**1.03**	0.000	No / No	5.26
W49	Boron, total	mg/L	13	0.44	0.44	0.47	0.41	0.02	0	NA	**0.48**	0.007	Yes / Yes	0.00
	Fluoride, total	mg/L	13	1.4	1.4	1.9	1	0.21	1	1.33 / 0.14	**1.60**	0.057	Yes / Yes	0.00
W50	Boron, total	mg/L	13	0.52	0.51	0.54	0.49	0.02	0	NA	**0.56**	0.007	Yes / Yes	0.00
	Fluoride, total	mg/L	13	1.2	1.2	1.4	0.99	0.1	0	NA	**1.41**	0.000	Yes / Yes	0.00

Notes:

[1] ACL column may not sum due to rounding.

ACL = Alternative Concentration Limit
ES = Enforcement Standard
mg/L = milligrams per liter
NA = not applicable
PAL = Preventive Action Limit

TABLE C-2. ACL CALCULATION TABLES

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN REVISION 1
CALEDONIA ASH LANDFILL
CALEDONIA, WISCONSIN

Location	Parameter	ES (mg/L)	Max > ES?	Mean > ES?	PAL (mg/L)	Mean > PAL?	Number Values > PAL	2 Values > PAL?
W08D	Boron, total	1	No	No	0.2	**Yes**	19	**Yes**
	Fluoride, total	4	No	No	0.8	**Yes**	16	**Yes**
	Sulfate, total	250	No	No	125	**Yes**	19	**Yes**
W09D	Boron, total	1	No	No	0.2	**Yes**	23	**Yes**
	Fluoride, total	4	No	No	0.8	**Yes**	19	**Yes**
W10D	Boron, total	1	No	No	0.2	**Yes**	19	**Yes**
	Fluoride, total	4	No	No	0.8	**Yes**	19	**Yes**
W46D	Boron, total	1	No	No	0.2	**Yes**	19	**Yes**
	Fluoride, total	4	No	No	0.8	**Yes**	16	**Yes**
W48	Boron, total	1	No	No	0.2	**Yes**	19	**Yes**
	Fluoride, total	4	No	No	0.8	**Yes**	18	**Yes**
W49	Boron, total	1	No	No	0.2	**Yes**	13	**Yes**
	Fluoride, total	4	No	No	0.8	**Yes**	13	**Yes**
W50	Boron, total	1	No	No	0.2	**Yes**	13	**Yes**
	Fluoride, total	4	No	No	0.8	**Yes**	13	**Yes**

Notes:
[1] ACL column may not sum due to rounding.
ACL = Alternative Concentration Limit
ES = Enforcement Standard
mg/L = milligrams per liter
NA = not applicable
PAL = Preventive Action Limit

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

Boron, total, mg/L
Location: W08D

Mean of all data: 0.44
Standard Deviation of all data: 0.048
Largest Observation Concentration of all data: Xn = 0.49
Test Statistic, high extreme of all data: Tn = 1.0
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	0.41	False		
02/16/2016	0.43	False		
05/11/2016	0.47	False		
08/30/2016	0.40	False		
11/14/2016	0.46	False		
02/08/2017	0.42	False		
05/15/2017	0.47	False		
08/22/2017	0.45	False		
11/14/2017	0.46	False		
05/16/2018	0.27	False	-1	
11/14/2018	0.45	False		
05/08/2019	0.46	False		
11/04/2019	0.44	False		
05/05/2020	0.49	False		
11/10/2020	0.48	False		
05/11/2021	0.49	False		
11/09/2021	0.45	False		
05/04/2022	0.46	False		
11/07/2022	0.46	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022
LT Multiplier: x 0.50
Confidence Level: 95%
Number of Outliers: One Outlier
Transform: None

Boron, total, mg/L

Location: W09D

Mean of all data: 0.40

Standard Deviation of all data: 0.022

Largest Observation Concentration of all data: Xn = 0.45

Test Statistic, high extreme of all data: Tn = 2.1

T Critical of all data: Tcr = 2.6

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	0.38	False		
02/16/2016	0.40	False		
05/11/2016	0.39	False		
08/30/2016	0.35	False		
11/14/2016	0.39	False		
02/08/2017	0.37	False		
05/15/2017	0.38	False		
08/22/2017	0.39	False		
11/14/2017	0.39	False		
05/16/2018	0.41	False		
09/07/2018	0.39	False		
11/14/2018	0.41	False		
03/05/2019	0.39	False		
05/08/2019	0.41	False		
10/02/2019	0.40	False		
11/04/2019	0.39	False		
05/05/2020	0.43	False		
08/31/2020	0.42	False		
11/09/2020	0.45	False		
05/11/2021	0.44	False		
11/08/2021	0.39	False		
05/04/2022	0.40	False		
11/07/2022	0.42	False		

Based on Grubbs one-sided outlier test

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

Boron, total, mg/L
Location: W10D

Mean of all data: 0.42
Standard Deviation of all data: 0.018
Largest Observation Concentration of all data: Xn = 0.45
Test Statistic, high extreme of all data: Tn = 1.2
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	0.40	False		
02/17/2016	0.45	False		
05/11/2016	0.43	False		
08/30/2016	0.39	False		
11/14/2016	0.42	False		
02/08/2017	0.39	False		
05/15/2017	0.41	False		
08/22/2017	0.42	False		
11/14/2017	0.42	False		
05/16/2018	0.43	False		
11/15/2018	0.44	False		
05/08/2019	0.44	False		
11/05/2019	0.41	False		
05/04/2020	0.44	False		
11/10/2020	0.44	False		
05/11/2021	0.44	False		
11/09/2021	0.43	False		
05/05/2022	0.41	False		
11/07/2022	0.44	False		

Based on Grubbs one-sided outlier test

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

Boron, total, mg/L
Location: W12D

Mean of all data: 0.51
Standard Deviation of all data: 0.018
Largest Observation Concentration of all data: Xn = 0.53
Test Statistic, high extreme of all data: Tn = 1.4
T Critical of all data: Tcr = 2.0

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	0.50	False		
02/16/2016	0.51	False		
05/11/2016	0.53	False		
08/30/2016	0.49	False		
11/14/2016	0.50	False		
02/08/2017	0.48	False		
05/15/2017	0.51	False		
08/22/2017	0.53	False		

Boron, total, mg/L
Location: W46D

Mean of all data: 0.38
Standard Deviation of all data: 0.019
Largest Observation Concentration of all data: Xn = 0.41
Test Statistic, high extreme of all data: Tn = 1.6
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	0.33	False		
02/17/2016	0.38	False		
05/11/2016	0.41	False		
08/30/2016	0.36	False		
11/14/2016	0.37	False		
02/08/2017	0.37	False		
05/16/2017	0.37	False		
08/21/2017	0.38	False		

11/14/2017	0.39	False		
05/15/2018	0.40	False		
11/14/2018	0.38	False		
05/08/2019	0.37	False		
11/04/2019	0.36	False		
05/04/2020	0.41	False		
11/09/2020	0.39	False		
05/11/2021	0.40	False		
11/08/2021	0.39	False		
05/04/2022	0.36	False		
11/07/2022	0.37	False		

Boron, total, mg/L
Location: W48

Mean of all data: 0.38
Standard Deviation of all data: 0.020
Largest Observation Concentration of all data: Xn = 0.42
Test Statistic, high extreme of all data: Tn = 2.1
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	0.35	False		
02/16/2016	0.37	False		
05/11/2016	0.39	False		
08/30/2016	0.34	False		
11/14/2016	0.36	False		
02/08/2017	0.35	False		
05/15/2017	0.36	False		
08/21/2017	0.36	False		
11/15/2017	0.37	False		
05/16/2018	0.39	False		
11/15/2018	0.39	False		
05/08/2019	0.38	False		
11/05/2019	0.37	False		
05/04/2020	0.40	False		
11/10/2020	0.40	False		

Caledonia CCR

Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

05/11/2021	0.42	False
11/09/2021	0.38	False
05/05/2022	0.37	False
11/07/2022	0.39	False

Boron, total, mg/L
Location: W49

Mean of all data: 0.44
Standard Deviation of all data: 0.017
Largest Observation Concentration of all data: Xn = 0.47
Test Statistic, high extreme of all data: Tn = 1.6
T Critical of all data: Tcr = 2.3

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
06/21/2017	0.42	False		
08/22/2017	0.41	False		
11/15/2017	0.43	False		
05/16/2018	0.44	False		
11/15/2018	0.44	False		
05/08/2019	0.45	False		
11/05/2019	0.43	False		
05/05/2020	0.46	False		
11/11/2020	0.44	False		
05/12/2021	0.47	False		
11/09/2021	0.45	False		
05/05/2022	0.44	False		
11/07/2022	0.46	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

Boron, total, mg/L
Location: W50

Mean of all data: 0.52

Standard Deviation of all data: 0.020

Largest Observation Concentration of all data: Xn = 0.54

Test Statistic, high extreme of all data: Tn = 1.3

T Critical of all data: Tcr = 2.3

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
06/02/2017	0.50	False		
08/22/2017	0.50	False		
11/15/2017	0.49	False		
05/16/2018	0.51	False		
11/15/2018	0.52	False		
05/08/2019	0.53	False		
11/05/2019	0.49	False		
05/05/2020	0.53	False		
11/11/2020	0.54	False		
05/12/2021	0.54	False		
11/09/2021	0.51	False		
05/05/2022	0.50	False		
11/07/2022	0.54	False		

Calcium, total, mg/L
Location: W08D

Mean of all data: 52.

Standard Deviation of all data: 3.0

Largest Observation Concentration of all data: Xn = 58.

Test Statistic, high extreme of all data: Tn = 2.1

T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	53.	False		
02/16/2016	55.	False		

Caledonia CCR

Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**

Confidence Level: 95% **Number of Outliers: One Outlier**

Transform: None

05/11/2016	58.	False
08/30/2016	58.	False
11/14/2016	57.	False
02/08/2017	52.	False
05/15/2017	51.	False
08/22/2017	49.	False
11/14/2017	49.	False
05/16/2018	51.	False
11/14/2018	50.	False
05/08/2019	51.	False
11/04/2019	48.	False
05/05/2020	53.	False
11/10/2020	51.	False
05/11/2021	50.	False
11/09/2021	50.	False
05/04/2022	52.	False
11/07/2022	49.	False

Calcium, total, mg/L

Location: W09D

Mean of all data: 19.

Standard Deviation of all data: 0.83

Largest Observation Concentration of all data: Xn = 21.

Test Statistic, high extreme of all data: Tn = 2.3

T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	20.	False		
02/16/2016	19.	False		
05/11/2016	19.	False		
08/30/2016	20.	False		
11/14/2016	19.	False		
02/08/2017	18.	False		
05/15/2017	18.	False		
08/22/2017	18.	False		
11/14/2017	19.	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

05/16/2018	19.	False
11/14/2018	19.	False
05/08/2019	18.	False
11/04/2019	18.	False
05/05/2020	19.	False
11/09/2020	20.	False
05/11/2021	18.	False
11/08/2021	18.	False
05/04/2022	21.	False
11/07/2022	18.	False

Calcium, total, mg/L
Location: W10D

Mean of all data: 21.
Standard Deviation of all data: 0.92
Largest Observation Concentration of all data: Xn = 23.
Test Statistic, high extreme of all data: Tn = 2.2
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	23.	False		
02/17/2016	23.	False		
05/11/2016	22.	False		
08/30/2016	22.	False		
11/14/2016	22.	False		
02/08/2017	21.	False		
05/15/2017	20.	False		
08/22/2017	21.	False		
11/14/2017	20.	False		
05/16/2018	21.	False		
11/15/2018	21.	False		
05/08/2019	21.	False		
11/05/2019	20.	False		
05/04/2020	21.	False		
11/10/2020	22.	False		
05/11/2021	21.	False		

11/09/2021	21.	False		
05/05/2022	23.	False		
11/07/2022	20.	False		

Calcium, total, mg/L
Location: W12D

Mean of all data: 25.

Standard Deviation of all data: 0.95

Largest Observation Concentration of all data: Xn = 27.

Test Statistic, high extreme of all data: Tn = 1.7

T Critical of all data: Tcr = 2.0

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	27.	False		
02/16/2016	24.	False		
05/11/2016	25.	False		
08/30/2016	26.	False		
11/14/2016	25.	False		
02/08/2017	25.	False		
05/15/2017	24.	False		
08/22/2017	24.	False		

Calcium, total, mg/L
Location: W46D

Mean of all data: 28.

Standard Deviation of all data: 3.0

Largest Observation Concentration of all data: Xn = 36.

Test Statistic, high extreme of all data: Tn = 2.7

T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	31.	False		
02/17/2016	36.	False		1
05/11/2016	33.	False		
08/30/2016	30.	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

11/14/2016	30.	False
02/08/2017	28.	False
05/16/2017	26.	False
08/21/2017	28.	False
11/14/2017	27.	False
05/15/2018	27.	False
11/14/2018	26.	False
05/08/2019	27.	False
11/04/2019	24.	False
05/04/2020	26.	False
11/09/2020	25.	False
05/11/2021	28.	False
11/08/2021	26.	False
05/04/2022	27.	False
11/07/2022	25.	False

Calcium, total, mg/L
Location: W48

Mean of all data: 27.
Standard Deviation of all data: 1.1
Largest Observation Concentration of all data: Xn = 29.
Test Statistic, high extreme of all data: Tn = 1.6
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	27.	False		
02/16/2016	25.	False		
05/11/2016	27.	False		
08/30/2016	28.	False		
11/14/2016	27.	False		
02/08/2017	26.	False		
05/15/2017	25.	False		
08/21/2017	27.	False		
11/15/2017	27.	False		
05/16/2018	27.	False		
11/15/2018	26.	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

05/08/2019	27.	False
11/05/2019	25.	False
05/04/2020	28.	False
11/10/2020	28.	False
05/11/2021	29.	False
11/09/2021	27.	False
05/05/2022	28.	False
11/07/2022	26.	False

Calcium, total, mg/L
Location: W49

Mean of all data: 20.
Standard Deviation of all data: 6.8
Largest Observation Concentration of all data: Xn = 41.
Test Statistic, high extreme of all data: Tn = 3.1
T Critical of all data: Tcr = 2.3

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
06/21/2017	41.	False		1
08/22/2017	25.	False		
11/15/2017	20.	False		
05/16/2018	18.	False		
11/15/2018	20.	False		
05/08/2019	16.	False		
11/05/2019	16.	False		
05/05/2020	18.	False		
11/11/2020	15.	False		
05/12/2021	16.	False		
11/09/2021	17.	False		
05/05/2022	18.	False		
11/07/2022	16.	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

Calcium, total, mg/L
Location: W50

Mean of all data: 29.
Standard Deviation of all data: 1.5
Largest Observation Concentration of all data: Xn = 31.
Test Statistic, high extreme of all data: Tn = 1.5
T Critical of all data: Tcr = 2.3

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
06/02/2017	31.	False		
08/22/2017	26.	False		
11/15/2017	26.	False		
05/16/2018	28.	False		
11/15/2018	27.	False		
05/08/2019	30.	False		
11/05/2019	28.	False		
05/05/2020	30.	False		
11/11/2020	30.	False		
05/12/2021	28.	False		
11/09/2021	28.	False		
05/05/2022	30.	False		
11/07/2022	29.	False		

Chloride, total, mg/L
Location: W08D

Mean of all data: 11.
Standard Deviation of all data: 1.1
Largest Observation Concentration of all data: Xn = 13.
Test Statistic, high extreme of all data: Tn = 2.1
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	13.	False		
02/16/2016	12.	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

05/11/2016	12.	False
08/30/2016	10.	False
11/14/2016	13.	False
02/08/2017	11.	False
05/15/2017	11.	False
08/22/2017	11.	False
11/14/2017	12.	False
05/16/2018	10.	False
11/14/2018	10.	False
05/08/2019	10.	False
11/04/2019	10.	False
05/05/2020	9.7	False
11/10/2020	10.	False
05/11/2021	9.8	False
11/09/2021	9.8	False
05/04/2022	12.	False
11/07/2022	9.5	False

Chloride, total, mg/L
Location: W09D

Mean of all data: 4.1

Standard Deviation of all data: 0.77

Largest Observation Concentration of all data: Xn = 6.5

Test Statistic, high extreme of all data: Tn = 3.1

T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	4.6	False		
02/16/2016	4.9	False		
05/11/2016	4.9	False		
08/30/2016	4.1	False		
11/14/2016	3.9	False		
02/08/2017	4.0	False		
05/15/2017	3.8	False		
08/22/2017	3.8	False		
11/14/2017	4.9	False		

Caledonia CCR

Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**

Confidence Level: 95% **Number of Outliers: One Outlier**

Transform: None

05/16/2018	3.4	False		
11/14/2018	3.4	False		
05/08/2019	3.7	False		
11/04/2019	3.6	False		
05/05/2020	3.7	False		
11/09/2020	3.5	False		
05/11/2021	3.7	False		
11/08/2021	3.8	False		
05/04/2022	6.5	False		1
11/07/2022	3.6	False		

Chloride, total, mg/L

Location: W10D

Mean of all data: 4.5

Standard Deviation of all data: 1.0

Largest Observation Concentration of all data: Xn = 7.1

Test Statistic, high extreme of all data: Tn = 2.6

T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	4.7	False		
02/17/2016	6.3	False		
05/11/2016	6.5	False		
08/30/2016	4.7	False		
11/14/2016	4.4	False		
02/08/2017	4.3	False		
05/15/2017	4.2	False		
08/22/2017	4.2	False		
11/14/2017	4.3	False		
05/16/2018	3.5	False		
11/15/2018	3.5	False		
05/08/2019	4.0	False		
11/05/2019	3.7	False		
05/04/2020	3.8	False		
11/10/2020	4.0	False		
05/11/2021	4.0	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/09/2021	4.0	False		
05/05/2022	7.1	False		1
11/07/2022	3.9	False		

Chloride, total, mg/L
Location: W12D

Mean of all data: 5.1
Standard Deviation of all data: 0.39
Largest Observation Concentration of all data: Xn = 5.7
Test Statistic, high extreme of all data: Tn = 1.4
T Critical of all data: Tcr = 2.0

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	5.3	False		
02/16/2016	5.6	False		
05/11/2016	5.7	False		
08/30/2016	4.9	False		
11/14/2016	5.3	False		
02/08/2017	4.9	False		
05/15/2017	4.7	False		
08/22/2017	4.7	False		

Chloride, total, mg/L
Location: W46D

Mean of all data: 7.4
Standard Deviation of all data: 2.0
Largest Observation Concentration of all data: Xn = 11.
Test Statistic, high extreme of all data: Tn = 1.6
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	6.1	False		
02/17/2016	7.4	False		
05/11/2016	10.	False		
08/30/2016	7.2	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

11/14/2016	9.6	False
02/08/2017	10.	False
05/16/2017	9.9	False
08/21/2017	11.	False
11/14/2017	6.8	False
05/15/2018	6.0	False
11/14/2018	5.8	False
05/08/2019	7.1	False
11/04/2019	5.0	False
05/04/2020	5.3	False
11/09/2020	4.8	False
05/11/2021	7.1	False
11/08/2021	5.6	False
05/04/2022	9.5	False
11/07/2022	6.8	False

Chloride, total, mg/L
Location: W48

Mean of all data: 3.8
Standard Deviation of all data: 0.79
Largest Observation Concentration of all data: Xn = 5.0
Test Statistic, high extreme of all data: Tn = 1.5
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	4.6	False		
02/16/2016	5.0	False		
05/11/2016	4.9	False		
08/30/2016	4.1	False		
11/14/2016	4.1	False		
02/08/2017	4.0	False		
05/15/2017	3.8	False		
08/21/2017	3.8	False		
11/15/2017	4.1	False		
05/16/2018	3.5	False		
11/15/2018	3.5	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

05/08/2019	3.7	False		
11/05/2019	3.5	False		
05/04/2020	3.6	False		
11/10/2020	3.7	False		
05/11/2021	3.8	False		
11/09/2021	3.8	False		
05/05/2022	<1.1	True	-1	
11/07/2022	3.8	False		

Chloride, total, mg/L
Location: W49

Mean of all data: 5.2
Standard Deviation of all data: 1.0
Largest Observation Concentration of all data: Xn = 7.3
Test Statistic, high extreme of all data: Tn = 2.1
T Critical of all data: Tcr = 2.3

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
06/21/2017	6.5	False		
08/22/2017	6.3	False		
11/15/2017	5.8	False		
05/16/2018	5.0	False		
11/15/2018	4.9	False		
05/08/2019	4.6	False		
11/05/2019	4.2	False		
05/05/2020	4.2	False		
11/11/2020	5.4	False		
05/12/2021	4.2	False		
11/09/2021	4.5	False		
05/05/2022	7.3	False		
11/07/2022	4.3	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022
LT Multiplier: x 0.50
Confidence Level: 95%
Number of Outliers: One Outlier
Transform: None

Chloride, total, mg/L
Location: W50

Mean of all data: 6.0
Standard Deviation of all data: 0.79
Largest Observation Concentration of all data: Xn = 8.3
Test Statistic, high extreme of all data: Tn = 2.9
T Critical of all data: Tcr = 2.3

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
06/02/2017	6.5	False		
08/22/2017	5.4	False		
11/15/2017	5.8	False		
05/16/2018	5.4	False		
11/15/2018	5.7	False		
05/08/2019	6.8	False		
11/05/2019	5.9	False		
05/05/2020	5.6	False		
11/11/2020	5.5	False		
05/12/2021	5.9	False		
11/09/2021	6.0	False		
05/05/2022	8.3	False		1
11/07/2022	5.8	False		

Fluoride, total, mg/L
Location: W08D

Mean of all data: 1.0
Standard Deviation of all data: 0.22
Largest Observation Concentration of all data: Xn = 1.6
Test Statistic, high extreme of all data: Tn = 2.6
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	1.0	False		
02/16/2016	0.72	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

05/11/2016	0.76	False		
08/30/2016	0.71	False		
11/14/2016	1.1	False		
02/08/2017	0.86	False		
05/15/2017	0.91	False		
08/22/2017	1.1	False		
11/14/2017	1.1	False		
05/16/2018	0.96	False		
11/14/2018	0.95	False		
05/08/2019	1.1	False		
11/04/2019	1.0	False		
05/05/2020	0.84	False		
11/10/2020	1.3	False		
05/11/2021	1.1	False		
11/09/2021	1.3	False		
05/04/2022	1.6	False		1
11/07/2022	1.2	False		

Fluoride, total, mg/L
Location: W09D

Mean of all data: 1.3
Standard Deviation of all data: 0.096
Largest Observation Concentration of all data: Xn = 1.6
Test Statistic, high extreme of all data: Tn = 2.6
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	1.3	False		
02/16/2016	1.3	False		
05/11/2016	1.4	False		
08/30/2016	1.3	False		
11/14/2016	1.4	False		
02/08/2017	1.3	False		
05/15/2017	1.4	False		
08/22/2017	1.3	False		
11/14/2017	1.4	False		

Caledonia CCR

Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

05/16/2018	1.2	False		
11/14/2018	1.2	False		
05/08/2019	1.3	False		
11/04/2019	1.3	False		
05/05/2020	1.3	False		
11/09/2020	1.5	False		
05/11/2021	1.4	False		
11/08/2021	1.4	False		
05/04/2022	1.6	False		1
11/07/2022	1.3	False		

Fluoride, total, mg/L
Location: W10D

Mean of all data: 1.3
Standard Deviation of all data: 0.11
Largest Observation Concentration of all data: Xn = 1.6
Test Statistic, high extreme of all data: Tn = 2.6
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	1.2	False		
02/17/2016	1.2	False		
05/11/2016	1.3	False		
08/30/2016	1.3	False		
11/14/2016	1.4	False		
02/08/2017	1.3	False		
05/15/2017	1.4	False		
08/22/2017	1.3	False		
11/14/2017	1.4	False		
05/16/2018	1.2	False		
11/15/2018	1.2	False		
05/08/2019	1.2	False		
11/05/2019	1.2	False		
05/04/2020	1.3	False		
11/10/2020	1.5	False		
05/11/2021	1.3	False		

11/09/2021	1.3	False		
05/05/2022	1.6	False		1
11/07/2022	1.3	False		

Fluoride, total, mg/L
Location: W12D

Mean of all data: 1.2
Standard Deviation of all data: 0.046
Largest Observation Concentration of all data: Xn = 1.3
Test Statistic, high extreme of all data: Tn = 1.6
T Critical of all data: Tcr = 2.0

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	1.2	False		
02/16/2016	1.2	False		
05/11/2016	1.3	False		
08/30/2016	1.2	False		
11/14/2016	1.3	False		
02/08/2017	1.2	False		
05/15/2017	1.2	False		
08/22/2017	1.2	False		

Fluoride, total, mg/L
Location: W46D

Mean of all data: 1.2
Standard Deviation of all data: 0.78
Largest Observation Concentration of all data: Xn = 4.0
Test Statistic, high extreme of all data: Tn = 3.6
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	0.82	False		
02/17/2016	0.74	False		
05/11/2016	4.0	False		1
08/30/2016	2.3	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**

Confidence Level: 95% **Number of Outliers: One Outlier**

Transform: None

11/14/2016	0.54	False		
02/08/2017	<0.25	True		
05/16/2017	1.1	False		
08/21/2017	1.0	False		
11/14/2017	1.2	False		
05/15/2018	1.1	False		
11/14/2018	1.0	False		
05/08/2019	1.1	False		
11/04/2019	1.1	False		
05/04/2020	1.1	False		
11/09/2020	1.3	False		
05/11/2021	1.1	False		
11/08/2021	1.2	False		
05/04/2022	1.3	False		
11/07/2022	1.1	False		

Fluoride, total, mg/L

Location: W48

Mean of all data: 0.89

Standard Deviation of all data: 0.17

Largest Observation Concentration of all data: Xn = 1.0

Test Statistic, high extreme of all data: Tn = 0.64

T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	0.90	False		
02/16/2016	0.90	False		
05/11/2016	0.98	False		
08/30/2016	0.90	False		
11/14/2016	0.99	False		
02/08/2017	0.93	False		
05/15/2017	0.95	False		
08/21/2017	0.92	False		
11/15/2017	1.0	False		
05/16/2018	0.85	False		
11/15/2018	0.82	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

05/08/2019	0.97	False		
11/05/2019	0.88	False		
05/04/2020	0.91	False		
11/10/2020	1.0	False		
05/11/2021	0.92	False		
11/09/2021	0.97	False		
05/05/2022	<0.24	True	-1	
11/07/2022	0.96	False		

Fluoride, total, mg/L
Location: W49

Mean of all data: 1.4
Standard Deviation of all data: 0.21
Largest Observation Concentration of all data: Xn = 1.9
Test Statistic, high extreme of all data: Tn = 2.5
T Critical of all data: Tcr = 2.3

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
06/21/2017	1.2	False		
08/22/2017	1.3	False		
11/15/2017	1.5	False		
05/16/2018	1.2	False		
11/15/2018	1.0	False		
05/08/2019	1.4	False		
11/05/2019	1.3	False		
05/05/2020	1.3	False		
11/11/2020	1.4	False		
05/12/2021	1.4	False		
11/09/2021	1.4	False		
05/05/2022	1.9	False		1
11/07/2022	1.5	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

Fluoride, total, mg/L
Location: W50

Mean of all data: 1.2
Standard Deviation of all data: 0.12
Largest Observation Concentration of all data: Xn = 1.4
Test Statistic, high extreme of all data: Tn = 1.9
T Critical of all data: Tcr = 2.3

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
06/02/2017	1.2	False		
08/22/2017	1.2	False		
11/15/2017	1.3	False		
05/16/2018	1.1	False		
11/15/2018	1.0	False		
05/08/2019	1.1	False		
11/05/2019	0.99	False		
05/05/2020	1.1	False		
11/11/2020	1.3	False		
05/12/2021	1.2	False		
11/09/2021	1.2	False		
05/05/2022	1.4	False		
11/07/2022	1.2	False		

pH (field), STD
Location: W08D

Mean of all data: 7.5
Standard Deviation of all data: 0.2
Largest Observation Concentration of all data: Xn = 7.9
Test Statistic, high extreme of all data: Tn = 2.3
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	7.7	False		
02/16/2016	7.4	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

05/11/2016	7.4	False		
08/30/2016	7.6	False		
11/14/2016	7.4	False		
02/08/2017	7.9	False		
05/15/2017	7.5	False		
08/22/2017	6.9	False	-1	
11/14/2017	7.4	False		
05/16/2018	7.3	False		
11/14/2018	7.5	False		
05/08/2019	7.5	False		
11/04/2019	7.4	False		
05/05/2020	7.5	False		
11/10/2020	7.7	False		
05/11/2021	7.5	False		
11/09/2021	7.5	False		
05/04/2022	7.4	False		
11/07/2022	7.7	False		

pH (field), STD
Location: W09D

Mean of all data: 8.0
Standard Deviation of all data: 0.2
Largest Observation Concentration of all data: Xn = 8.3
Test Statistic, high extreme of all data: Tn = 1.7
T Critical of all data: Tcr = 2.6

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	8.2	False		
02/16/2016	8.3	False		
05/11/2016	8.1	False		
08/30/2016	8.3	False		
11/14/2016	8.3	False		
02/08/2017	8.2	False		
05/15/2017	7.8	False		
08/22/2017	7.7	False		
11/14/2017	8.2	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

05/16/2018	7.9	False		
09/07/2018	7.9	False		
11/14/2018	8.0	False		
03/05/2019	7.8	False		
05/08/2019	8.2	False		
10/02/2019	7.9	False		
11/04/2019	7.9	False		
05/05/2020	7.9	False		
08/31/2020	7.9	False		
11/09/2020	8.0	False		
05/11/2021	8.2	False		
11/08/2021	8.1	False		
05/04/2022	7.8	False		
11/07/2022	7.9	False		

pH (field), STD
Location: W10D

Mean of all data: 8.0
Standard Deviation of all data: 0.2
Largest Observation Concentration of all data: Xn = 8.4
Test Statistic, high extreme of all data: Tn = 2.2
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	8.2	False		
02/17/2016	8.1	False		
05/11/2016	7.9	False		
08/30/2016	8.1	False		
11/14/2016	8.0	False		
02/08/2017	8.4	False		
05/15/2017	8.0	False		
08/22/2017	7.9	False		
11/14/2017	8.1	False		
05/16/2018	7.6	False		
11/15/2018	8.0	False		
05/08/2019	8.1	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

11/05/2019	8.0	False		
05/04/2020	7.8	False		
11/10/2020	7.9	False		
05/11/2021	8.1	False		
11/09/2021	8.0	False		
05/05/2022	7.9	False		
11/07/2022	7.7	False		

pH (field), STD
Location: W12D

Mean of all data: 8.2
Standard Deviation of all data: 0.3
Largest Observation Concentration of all data: Xn = 8.5
Test Statistic, high extreme of all data: Tn = 1.3
T Critical of all data: Tcr = 2.0

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	8.4	False		
02/16/2016	8.2	False		
05/11/2016	8.0	False		
08/30/2016	8.3	False		
11/14/2016	8.2	False		
02/08/2017	8.5	False		
05/15/2017	8.1	False		
08/22/2017	7.6	False		

pH (field), STD
Location: W46D

Mean of all data: 7.5
Standard Deviation of all data: 0.3
Largest Observation Concentration of all data: Xn = 8.1
Test Statistic, high extreme of all data: Tn = 2.5
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

11/11/2015	8.1	False		
02/17/2016	7.8	False		
05/11/2016	7.4	False		
08/30/2016	7.6	False		
11/14/2016	7.5	False		
02/08/2017	7.2	False		
05/16/2017	7.2	False		
08/21/2017	7.4	False		
11/14/2017	7.6	False		
05/15/2018	7.6	False		
11/14/2018	7.6	False		
05/08/2019	7.5	False		
11/04/2019	7.5	False		
05/04/2020	7.6	False		
11/09/2020	7.6	False		
05/11/2021	7.5	False		
11/08/2021	7.3	False		
05/04/2022	7.0	False		
11/07/2022	7.1	False		

pH (field), STD
Location: W48

Mean of all data: 7.9
Standard Deviation of all data: 0.2
Largest Observation Concentration of all data: Xn = 8.2
Test Statistic, high extreme of all data: Tn = 1.8
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	8.0	False		
02/16/2016	8.0	False		
05/11/2016	7.9	False		
08/30/2016	8.0	False		
11/14/2016	8.0	False		
02/08/2017	8.2	False		
05/15/2017	8.0	False		

Caledonia CCR

Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**

Confidence Level: 95% **Number of Outliers: One Outlier**

Transform: None

08/21/2017	7.5	False	-1	
11/15/2017	7.9	False		
05/16/2018	7.7	False		
11/15/2018	7.8	False		
05/08/2019	8.0	False		
11/05/2019	7.8	False		
05/04/2020	7.9	False		
11/10/2020	7.9	False		
05/11/2021	8.0	False		
11/09/2021	7.9	False		
05/05/2022	7.8	False		
11/07/2022	7.7	False		

pH (field), STD

Location: W49

Mean of all data: 7.9

Standard Deviation of all data: 0.2

Largest Observation Concentration of all data: Xn = 8.4

Test Statistic, high extreme of all data: Tn = 2.0

T Critical of all data: Tcr = 2.3

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
06/21/2017	8.0	False		
08/22/2017	7.9	False		
11/15/2017	8.1	False		
05/16/2018	7.8	False		
11/15/2018	7.9	False		
05/08/2019	8.3	False		
11/05/2019	8.0	False		
05/05/2020	7.7	False		
11/11/2020	7.8	False		
05/12/2021	8.4	False		
11/09/2021	7.6	False		
05/05/2022	7.8	False		
11/07/2022	8.1	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

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pH (field), STD

Location: W50

Mean of all data: 7.5

Standard Deviation of all data: 0.3

Largest Observation Concentration of all data: Xn = 7.8

Test Statistic, high extreme of all data: Tn = 1.1

T Critical of all data: Tcr = 2.4

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
06/02/2017	6.9	False		
08/22/2017	7.2	False		
11/15/2017	7.8	False		
05/16/2018	7.7	False		
11/15/2018	7.8	False		
05/08/2019	7.8	False		
10/03/2019	7.0	False		
11/05/2019	7.7	False		
05/05/2020	7.5	False		
11/11/2020	7.6	False		
05/12/2021	7.4	False		
11/09/2021	7.7	False		
05/05/2022	7.6	False		
11/07/2022	7.6	False		

Sulfate, total, mg/L

Location: W08D

Mean of all data: 210.

Standard Deviation of all data: 16.

Largest Observation Concentration of all data: Xn = 240.

Test Statistic, high extreme of all data: Tn = 2.2

T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	180.	False		

Caledonia CCR

Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

02/16/2016	190.	False
05/11/2016	200.	False
08/30/2016	180.	False
11/14/2016	200.	False
02/08/2017	200.	False
05/15/2017	200.	False
08/22/2017	200.	False
11/14/2017	220.	False
05/16/2018	200.	False
11/14/2018	210.	False
05/08/2019	230.	False
11/04/2019	200.	False
05/05/2020	200.	False
11/10/2020	220.	False
05/11/2021	200.	False
11/09/2021	220.	False
05/04/2022	240.	False
11/07/2022	210.	False

Sulfate, total, mg/L
Location: W09D

Mean of all data: 33.
Standard Deviation of all data: 1.6
Largest Observation Concentration of all data: Xn = 37.
Test Statistic, high extreme of all data: Tn = 2.5
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	30.	False		
02/16/2016	31.	False		
05/11/2016	32.	False		
08/30/2016	32.	False		
11/14/2016	34.	False		
02/08/2017	34.	False		
05/15/2017	33.	False		
08/22/2017	32.	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

11/14/2017	32.	False		
05/16/2018	32.	False		
11/14/2018	34.	False		
05/08/2019	37.	False		
11/04/2019	33.	False		
05/05/2020	34.	False		
11/09/2020	34.	False		
05/11/2021	36.	False		
11/08/2021	33.	False		
05/04/2022	34.	False		
11/07/2022	33.	False		

Sulfate, total, mg/L
Location: W10D

Mean of all data: 42.
Standard Deviation of all data: 2.0
Largest Observation Concentration of all data: Xn = 46.
Test Statistic, high extreme of all data: Tn = 1.8
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	39.	False		
02/17/2016	43.	False		
05/11/2016	46.	False		
08/30/2016	42.	False		
11/14/2016	44.	False		
02/08/2017	42.	False		
05/15/2017	43.	False		
08/22/2017	41.	False		
11/14/2017	45.	False		
05/16/2018	41.	False		
11/15/2018	43.	False		
05/08/2019	46.	False		
11/05/2019	40.	False		
05/04/2020	41.	False		
11/10/2020	44.	False		

05/11/2021	41.	False		
11/09/2021	41.	False		
05/05/2022	44.	False		
11/07/2022	42.	False		

Sulfate, total, mg/L
Location: W12D

Mean of all data: 110.
Standard Deviation of all data: 4.1
Largest Observation Concentration of all data: Xn = 110.
Test Statistic, high extreme of all data: Tn = 0.93
T Critical of all data: Tcr = 2.0

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	100.	False		
02/16/2016	100.	False		
05/11/2016	110.	False		
08/30/2016	99.	False		
11/14/2016	110.	False		
02/08/2017	110.	False		
05/15/2017	110.	False		
08/22/2017	110.	False		

Sulfate, total, mg/L
Location: W46D

Mean of all data: 29.
Standard Deviation of all data: 8.8
Largest Observation Concentration of all data: Xn = 37.
Test Statistic, high extreme of all data: Tn = 0.93
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	26.	False		
02/17/2016	12.	False		
05/11/2016	5.4	False	-1	

Caledonia CCR

Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**

Confidence Level: 95% **Number of Outliers: One Outlier**

Transform: None

08/30/2016	25.	False
11/14/2016	27.	False
02/08/2017	26.	False
05/16/2017	30.	False
08/21/2017	29.	False
11/14/2017	35.	False
05/15/2018	33.	False
11/14/2018	36.	False
05/08/2019	37.	False
11/04/2019	35.	False
05/04/2020	35.	False
11/09/2020	35.	False
05/11/2021	33.	False
11/08/2021	18.	False
05/04/2022	37.	False
11/07/2022	34.	False

Sulfate, total, mg/L

Location: W48

Mean of all data: 1.0

Standard Deviation of all data: 0.91

Largest Observation Concentration of all data: Xn = 3.0

Test Statistic, high extreme of all data: Tn = 2.2

T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	2.3	False		
02/16/2016	3.0	False		
05/11/2016	2.6	False		
08/30/2016	<1.0	True		
11/14/2016	<0.50	True		
02/08/2017	1.3	False		
05/15/2017	<0.50	True		
08/21/2017	<0.50	True		
11/15/2017	<0.50	True		
05/16/2018	0.62	False		

Caledonia CCR

Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

11/15/2018	0.56	False
05/08/2019	2.5	False
11/05/2019	<0.070	True
05/04/2020	0.74	False
11/10/2020	0.38	False
05/11/2021	<0.22	True
11/09/2021	<0.22	True
05/05/2022	<1.1	True
11/07/2022	0.47	False

Sulfate, total, mg/L
Location: W49

Mean of all data: 45.
Standard Deviation of all data: 8.4
Largest Observation Concentration of all data: Xn = 54.
Test Statistic, high extreme of all data: Tn = 1.1
T Critical of all data: Tcr = 2.3

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
06/21/2017	45.	False		
08/22/2017	46.	False		
11/15/2017	52.	False		
05/16/2018	47.	False		
11/15/2018	43.	False		
05/08/2019	54.	False		
11/05/2019	50.	False		
05/05/2020	22.	False	-1	
11/11/2020	46.	False		
05/12/2021	50.	False		
11/09/2021	38.	False		
05/05/2022	37.	False		
11/07/2022	50.	False		

Caledonia CCR

Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

Sulfate, total, mg/L
Location: W50

Mean of all data: 74.
Standard Deviation of all data: 9.2
Largest Observation Concentration of all data: Xn = 83.
Test Statistic, high extreme of all data: Tn = 1.0
T Critical of all data: Tcr = 2.3

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
06/02/2017	51.	False	-1	
08/22/2017	75.	False		
11/15/2017	81.	False		
05/16/2018	75.	False		
11/15/2018	76.	False		
05/08/2019	83.	False		
11/05/2019	73.	False		
05/05/2020	60.	False		
11/11/2020	75.	False		
05/12/2021	78.	False		
11/09/2021	81.	False		
05/05/2022	81.	False		
11/07/2022	67.	False		

Total Dissolved Solids, mg/L
Location: W08D

Mean of all data: 450.
Standard Deviation of all data: 25.
Largest Observation Concentration of all data: Xn = 510.
Test Statistic, high extreme of all data: Tn = 2.3
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	430.	False		
02/16/2016	460.	False		

Based on Grubbs one-sided outlier test

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

05/11/2016	450.	False
08/30/2016	480.	False
11/14/2016	510.	False
02/08/2017	450.	False
05/15/2017	450.	False
08/22/2017	440.	False
11/14/2017	420.	False
05/16/2018	440.	False
11/14/2018	430.	False
05/08/2019	440.	False
11/04/2019	430.	False
05/05/2020	450.	False
11/10/2020	410.	False
05/11/2021	450.	False
11/09/2021	470.	False
05/04/2022	480.	False
11/07/2022	480.	False

Total Dissolved Solids, mg/L
Location: W09D

Mean of all data: 190.
Standard Deviation of all data: 31.
Largest Observation Concentration of all data: Xn = 210.
Test Statistic, high extreme of all data: Tn = 0.93
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	200.	False		
02/16/2016	200.	False		
05/11/2016	190.	False		
08/30/2016	210.	False		
11/14/2016	210.	False		
02/08/2017	190.	False		
05/15/2017	200.	False		
08/22/2017	210.	False		
11/14/2017	170.	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022
LT Multiplier: x 0.50
Confidence Level: 95%
Number of Outliers: One Outlier
Transform: None

05/16/2018	180.	False		
11/14/2018	160.	False		
05/08/2019	190.	False		
11/04/2019	150.	False		
05/05/2020	160.	False		
11/09/2020	82.	False	-1	
05/11/2021	210.	False		
11/08/2021	190.	False		
05/04/2022	210.	False		
11/07/2022	210.	False		

Total Dissolved Solids, mg/L
Location: W10D

Mean of all data: 200.
Standard Deviation of all data: 21.
Largest Observation Concentration of all data: Xn = 230.
Test Statistic, high extreme of all data: Tn = 1.7
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	220.	False		
02/17/2016	190.	False		
05/11/2016	210.	False		
08/30/2016	230.	False		
11/14/2016	210.	False		
02/08/2017	190.	False		
05/15/2017	200.	False		
08/22/2017	220.	False		
11/14/2017	180.	False		
05/16/2018	180.	False		
11/15/2018	160.	False		
05/08/2019	190.	False		
11/05/2019	180.	False		
05/04/2020	190.	False		
11/10/2020	150.	False		
05/11/2021	200.	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

11/09/2021	210.	False		
05/05/2022	180.	False		
11/07/2022	220.	False		

Total Dissolved Solids, mg/L
Location: W12D

Mean of all data: 270.

Standard Deviation of all data: 17.

Largest Observation Concentration of all data: Xn = 300.

Test Statistic, high extreme of all data: Tn = 1.4

T Critical of all data: Tcr = 2.0

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	270.	False		
02/16/2016	280.	False		
05/11/2016	260.	False		
08/30/2016	300.	False		
11/14/2016	280.	False		
02/08/2017	240.	False		
05/15/2017	280.	False		
08/22/2017	270.	False		

Total Dissolved Solids, mg/L
Location: W46D

Mean of all data: 210.

Standard Deviation of all data: 38.

Largest Observation Concentration of all data: Xn = 260.

Test Statistic, high extreme of all data: Tn = 1.3

T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	230.	False		
02/17/2016	240.	False		
05/11/2016	220.	False		
08/30/2016	260.	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

11/14/2016	260.	False		
02/08/2017	110.	False	-1	
05/16/2017	230.	False		
08/21/2017	230.	False		
11/14/2017	200.	False		
05/15/2018	200.	False		
11/14/2018	140.	False		
05/08/2019	210.	False		
11/04/2019	200.	False		
05/04/2020	170.	False		
11/09/2020	200.	False		
05/11/2021	230.	False		
11/08/2021	210.	False		
05/04/2022	250.	False		
11/07/2022	220.	False		

Total Dissolved Solids, mg/L
Location: W48

Mean of all data: 230.
Standard Deviation of all data: 32.
Largest Observation Concentration of all data: Xn = 280.
Test Statistic, high extreme of all data: Tn = 1.7
T Critical of all data: Tcr = 2.5

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
11/11/2015	250.	False		
02/16/2016	220.	False		
05/11/2016	220.	False		
08/30/2016	240.	False		
11/14/2016	240.	False		
02/08/2017	220.	False		
05/15/2017	240.	False		
08/21/2017	250.	False		
11/15/2017	240.	False		
05/16/2018	200.	False		
11/15/2018	130.	False	-1	

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022 **LT Multiplier: x 0.50**
Confidence Level: 95% **Number of Outliers: One Outlier**
Transform: None

05/08/2019	220.	False
11/05/2019	190.	False
05/04/2020	210.	False
11/10/2020	220.	False
05/11/2021	240.	False
11/09/2021	260.	False
05/05/2022	200.	False
11/07/2022	280.	False

Total Dissolved Solids, mg/L
Location: W49

Mean of all data: 200.
Standard Deviation of all data: 20.
Largest Observation Concentration of all data: Xn = 240.
Test Statistic, high extreme of all data: Tn = 1.6
T Critical of all data: Tcr = 2.3

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
06/21/2017	240.	False		
08/22/2017	220.	False		
11/15/2017	210.	False		
05/16/2018	180.	False		
11/15/2018	170.	False		
05/08/2019	210.	False		
11/05/2019	180.	False		
05/05/2020	190.	False		
11/11/2020	230.	False		
05/12/2021	210.	False		
11/09/2021	200.	False		
05/05/2022	200.	False		
11/07/2022	220.	False		

Caledonia CCR
Outlier Analysis Results

User Supplied Information

Date Range: 11/11/2015 to 11/07/2022
LT Multiplier: x 0.50
Confidence Level: 95%
Number of Outliers: One Outlier
Transform: None

Total Dissolved Solids, mg/L
Location: W50

Mean of all data: 260.

Standard Deviation of all data: 20.

Largest Observation Concentration of all data: Xn = 300.

Test Statistic, high extreme of all data: Tn = 1.8

T Critical of all data: Tcr = 2.4

Sample Date	Value	LT_Value	Outlier Low Side	Outlier High Side
06/02/2017	270.	False		
08/22/2017	260.	False		
11/15/2017	260.	False		
05/16/2018	250.	False		
11/15/2018	220.	False		
05/08/2019	270.	False		
10/03/2019	260.	False		
11/05/2019	260.	False		
05/05/2020	240.	False		
11/11/2020	250.	False		
05/12/2021	280.	False		
11/09/2021	270.	False		
05/05/2022	300.	False		
11/07/2022	290.	False		

APPENDIX C-3
TREND ANALYSIS SUMMARIES

TABLE C-3. Mann-Kendall Trend Summary
ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM
CALEDONIA ASH LANDFILL
CALEDONIA, WISCONSIN

		Date Range:	**11/11/2015 to 11/07/2022**	**11/11/2017 to 11/07/2022**
Well ID	**Parameter**	**Units**	**Trend at the 95.0 % Confidence Level (two-tailed test):**	**Trend at the 95.0 % Confidence Level (two-tailed test):**
W08D	pH (field)	STD	None	None
W08D	Total Dissolved Solids	mg/L	None	Upward
W08D	Calcium, total	mg/L	Downward	None
W08D	Chloride, total	mg/L	Downward	Downward
W08D	Sulfate, total	mg/L	Upward	None
W08D	Fluoride, total	mg/L	Upward	Upward
W08D	Boron, total	mg/L	Upward	None
W09D	pH (field)	STD	Downward	None
W09D	Total Dissolved Solids	mg/L	None	None
W09D	Calcium, total	mg/L	None	None
W09D	Chloride, total	mg/L	Downward	None
W09D	Sulfate, total	mg/L	Upward	None
W09D	Fluoride, total	mg/L	None	None
W09D	Boron, total	mg/L	Upward	None
W10D	pH (field)	STD	Downward	None
W10D	Total Dissolved Solids	mg/L	None	Upward
W10D	Calcium, total	mg/L	None	None
W10D	Chloride, total	mg/L	Downward	None
W10D	Sulfate, total	mg/L	None	None
W10D	Fluoride, total	mg/L	None	None
W10D	Boron, total	mg/L	Upward	None
W46D	pH (field)	STD	Downward	Downward
W46D	Total Dissolved Solids	mg/L	None	Upward
W46D	Calcium, total	mg/L	Downward	None
W46D	Chloride, total	mg/L	Downward	None
W46D	Sulfate, total	mg/L	Upward	None
W46D	Fluoride, total	mg/L	None	None
W46D	Boron, total	mg/L	None	None
W48	pH (field)	STD	Downward	None
W48	Total Dissolved Solids	mg/L	None	None
W48	Calcium, total	mg/L	None	None
W48	Chloride, total	mg/L	Downward	None
W48	Sulfate, total	mg/L	Downward	None
W48	Fluoride, total	mg/L	None	None
W48	Boron, total	mg/L	Upward	None
W49	pH (field)	STD	None	None
W49	Total Dissolved Solids	mg/L	None	None
W49	Calcium, total	mg/L	Downward	None
W49	Chloride, total	mg/L	Downward	None
W49	Sulfate, total	mg/L	None	None
W49	Fluoride, total	mg/L	Upward	Upward
W49	Boron, total	mg/L	Upward	Upward
W50	pH (field)	STD	None	Downward
W50	Total Dissolved Solids	mg/L	None	Upward
W50	Calcium, total	mg/L	None	None
W50	Chloride, total	mg/L	None	None
W50	Sulfate, total	mg/L	None	None
W50	Fluoride, total	mg/L	None	None
W50	Boron, total	mg/L	Upward	None

APPENDIX D
SAMPLING AND ANALYSIS PLAN

Intended for
We Energies

Date
December 12, 2023

Project No.
1940104079

SAMPLING AND ANALYSIS PLAN REVISION 1

CALEDONIA POWER PLANT ASH LANDFILL

Bright ideas. Sustainable change.

SAMPLING AND ANALYSIS PLAN REVISION 1
CALEDONIA POWER PLANT ASH LANDFILL

Project name	**Caledonia Ash Landfill**
Project no.	**1940104079**
Recipient	**We Energies**
Document type	**Sampling and Analysis Plan**
Revision	**1**
Date	**December 12, 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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DOCUMENT REVISION RECORD

Issue No.	Date	Details of Revisions
Revision 0	January 30, 2023	• Original Document
Revision 1	December 12, 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
OCPP	Oak Creek 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 Oak Creek Power Plant (OCPP) Caledonia Ash Landfill (CAL) located in Caledonia, 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 Caledonia 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

ASTM International. 2004d. D5092-04e1 Standard Practice for Design and Installation of Ground Water Monitoring Wells. ASTM Book of Standards Volume 4.08.

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

Code of Federal Regulations, Title 40 Volume 25, Title 40 – Protection of Environment, Chapter I Environmental Protection Agency, Part 300 – National Oil and Hazardous Substances Pollution Contingency Plan, Subpart E – Hazardous Substance Response, Section 300.400, Procedures for Planning and Implementing Off-Site Response Actions, Revised July 1, 2003.

USDOE, 2002, Adaptive Sampling and Analysis Program (ASAP), Environmental Assessment Division (EAD), http://www.ead.anl.gov/project/dsp_topicdetail.cfm?topicid=23.

USEPA, 1987, A Compendium of Superfund Field Operation Methods, Office of Emergency and Remedial Response, EPA/540/P-87/001, December 1987.

USEPA, 1988, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Office of Solid Waste and Emergency Response, EPA/540/G-89/004, October 1988.

USEPA, 1992a, Monitoring Well Development Guidelines for Superfund Project Managers, Office of Solid Waste and Emergency Response. April 1992

USEPA, 1992b, Guide to Management of Investigative- Derived Waste (IDW). Office of Solid Waste and Emergency Response. Publication 9345.3-03FS, January 1992.

USEPA, 1992c, “Specifications and Guidance for Contaminant-Free Sample Containers”. Office of Solid Waste and Emergency Response. December 1992. Publication 9240.0-05A, EPA540/R-93/051, Washington, D.C. 28 pp.

USEPA, 1997b, Field Analytical and Site Characterization Technologies Summary of Applications, EPA 542-R-97-011, Office of Solid Waste and Emergency Response, Washington, DC, November 1997.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, USEPA Region IV, November 2001.

USEPA, 2002b, On-line field analytical technologies encyclopedia (FATE), http://fate.clu-in.org/.

USEPA, 2002c, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, OSWER, EPA 542-S-02-001.

USEPA, 2003a, Improving Decision Quality: Making the Case for Adopting Next-Generation Site Characterization Practices, Wiley Periodicals, Inc.

USEPA, 2003c, Using Dynamic Field Activities for On-Site Decision Making: A Guide for Project Managers, EPA/540/R-03/002, OSWER No. 9200.1-40, -600-R-02-013, Office of Solid Waste and Emergency Response, Washington, D.C., May 2003.

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
Caledonia Power Plant Ash Landfill, Caledonia, 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	7	1	1	NA	1	9	glass[7]	250 mL	none[8]	90 days
Metals (1)	200.7/200.8	7	1	1	NA	1	9	plastic	250 mL	HNO3 to pH<2	6 months
Inorganic Parameters											
Alkalinity	2320B	7	1	1	NA	1	9	plastic	500 mL	Cool to 4 °C	28 days
Chloride	300.0/9056	7	1	1	NA	1	9	plastic	500 mL	Cool to 4 °C	28 days
Fluoride	300.0/9056	7	1	1	NA	1	9	plastic	500 mL	Cool to 4 °C	28 days
Hardness	200.7/2340B	7	1	1	NA	1	9	plastic	500 mL	HNO3 to pH<2	28 days
Nitrate + Nitrite, N	300.0/9056	7	1	1	NA	1	9	plastic	500 mL	Cool to 4 °C	48 hours
Sulfate	300.0/9056	7	1	1	NA	1	9	plastic	500 mL	Cool to 4 °C	28 days
Total Dissolved Solids	SM 2540C	7	1	1	NA	1	9	plastic	500 mL	Cool to 4 °C	7 days
Other											
Radium 226	903.1	7	1	1	NA	1	9	plastic	1000 mL	Cool to 4 °C	NA
Radium 228	904	7	1	1	NA	1	9	plastic	1000 mL	Cool to 4 °C	NA
Field Parameters											
Dissolved Oxygen	SM 4500-O/405.1	7	NA	NA	NA	NA	6	flow-through cell	NA	none	immediately
Oxidation/Reduction Potential	SM 258/OB	7	NA	NA	NA	NA	7	flow-through cell	NA	none	immediately
pH	SM 4500-H+ B	7	NA	NA	NA	NA	7	flow-through cell	NA	none	immediately
Specific Conductance	SM 2510 B	7	NA	NA	NA	NA	7	flow-through cell	NA	none	immediately
Temperature	SM 2550	7	NA	NA	NA	NA	7	flow-through cell	NA	none	immediately
Turbidity[9]	EPA Method 180.1	7	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, zir
°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
Caledonia Power Plant Ash Landfill, Caledonia, Wisconsin

Well ID	W08D	W09D	W10D	W46D	W48	W49	W50
Well Location Latitude	42.83621	42.83892	42.83985	42.83840	42.83564	42.83987	42.83751
Well Location Longitude	-87.83965	-87.83924	-87.84015	-87.84685	-87.84441	-87.84187	-87.83865
Well Location Northing (State Plane)[4]	312,286.29	313,274.14	313,611.88	313,062.09	312,062.45	313,588.62	312,751.43
Well Location Easting (State Plane)[4]	2,579,368.75	2,579,467.21	2,579,219.14	2,577,427.29	2,578,094.55	2,578,804.50	2,579,690.72
Well Construction Material	PVC	PVC	PVC	PVC	PVC	PVC	PVC
Well Diameter (inches)	2	2	2	2	2	2	2
Top of Casing Well Elevation (ft)[3]	698.28	707.35	703.10	701.26	715.88	717.49	694.68
Well Depth (ft)[5]	185.0	185.0	180.0	202.0	191.0	195.0	175.0
Pump Intake Elevation (ft)[3]	513.8	523.0	523.4	501.2	524.2	523.0	520.7
Screen Length (ft)	5	5	5	5	5	5	5
Top of Screen Elevation (ft)[3]	515.55	524.42	525.95	501.96	527.24	525.00	522.40
Bottom of Screen Elevation (ft)[3]	510.55	519.42	520.95	496.96	522.24	520.00	517.40
Casing Length to Screen (ft)	177.73	177.93	172.15	194.30	183.64	192.49	172.28
Well Stick-up Above Ground Surface (ft)	2.73	2.93	2.15	2.30	2.64	2.46	2.26
Hydraulic Position of Well(1)	downgradient	downgradient	downgradient	background	upgradient	downgradient	downgradient

[O:KLT 9/28/15, C:SGW 10/2/15, U:GRL 9/28/17, C:JJW 9/28/17]

Notes:
ft = feet
PVC = polyvinyl chloride
1. upgradient (U) or downgradient (D)
2. Ground surface, top of protective cover pipe and top of well riser elevations for wells installed in March 2015 were surveyed by Edgerton Contractors, Inc. (ECI) on March 30, 2015. Wells W49 and W50 were surveyed by ECI on April 28, 2017.
3. Elevation datum is referenced to Mean Sea Level (MSL), NGVD 1929.
4. Horizontal datum is NAD 1927 State Plane Wisconsin South (feet).
5. Depth below ground surface (bgs).

Table 3. Summary of Groundwater Analytical Methods
Sampling and Analysis Plan Revision 1
We Energies NR 507 Groundwater Monitoring
Caledonia Power Plant Ash Landfill, Caledonia, 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

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

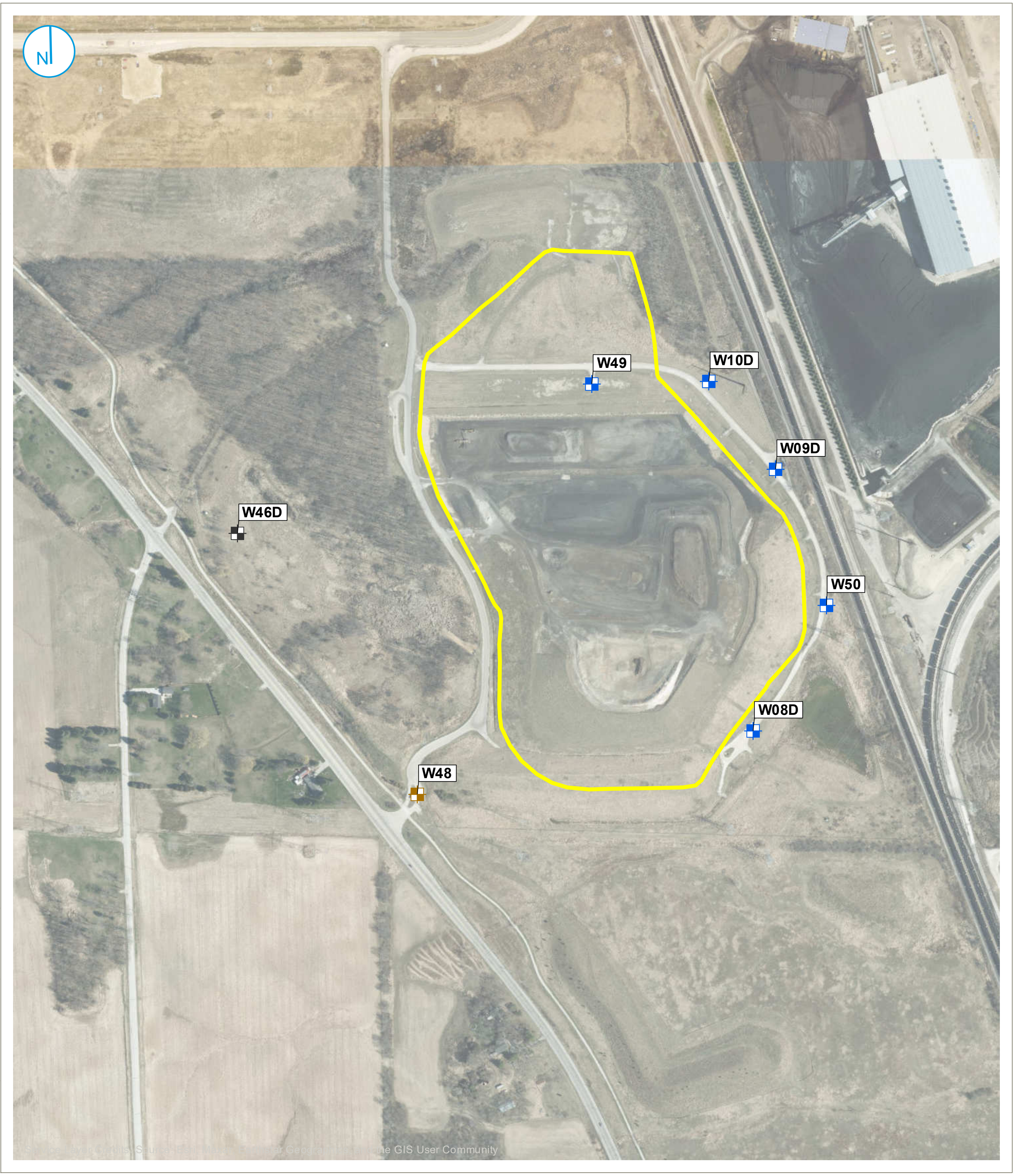
Field Parameter	Precision Goal	Accuracy Goal	Completion Goal
Water Level	± 0.01 foot	± 0.01 foot	90%
pH	± 0.1 s.u.	± 0.1 s.u.	90%
Specific Conductance	± 100 µS/cm	± 100 µS/cm	90%
Temperature	± 10%	± 10%	90%
Oxidation/Reduction Potential	± 1.0 mV	± 1.0 mV	90%
Turbidity	± 1.0 NTU	± 1.0 NTU	90%
Dissolved 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\CALEDONIA\MXD\GM_CAR_2022\Figure 1_ GW Samp Well Loc_Caledonia.mxd

PROJECT: 71202 | DATED: 1/26/2023 | DESIGNER: galarnmc



▞ NR 507 BACKGROUND MONITORING WELL LOCATION

▞ NR 507 DOWNGRADIENT MONITORING WELL LOCATION

▞ NR 507 UPGRADIENT MONITORING WELL LOCATION

▭ UNIT BOUNDARY

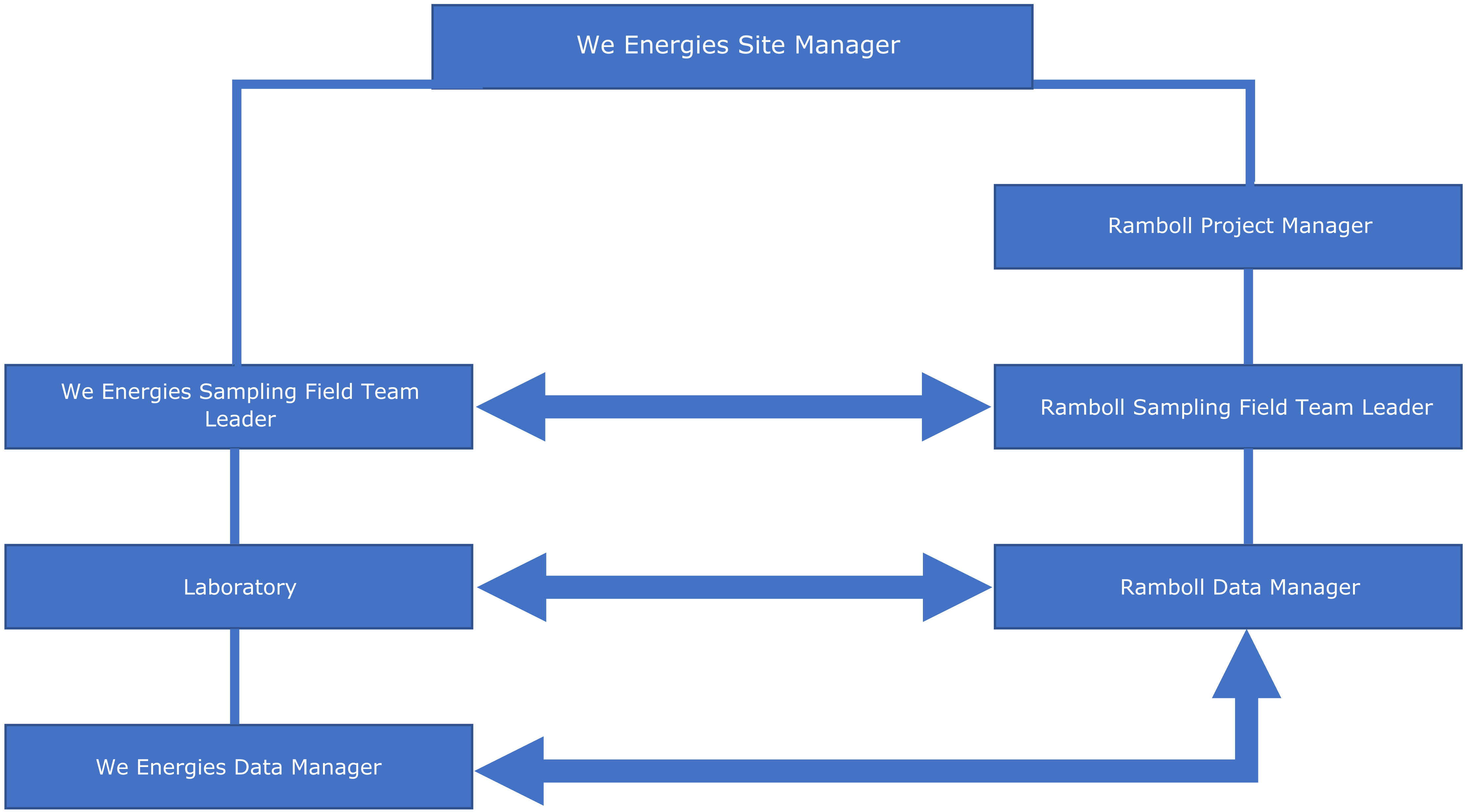
0 250 500 Feet

NR 507 GROUNDWATER SYSTEM

FIGURE 1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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



COMMUNICATION FLOW CHART

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

FIGURE 2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC

ATTACHMENTS

ATTACHMENT A
GROUNDWATER MONITORING SYSTEM CERTIFICATION

Natural Resource Technology
AN OBG COMPANY

OBG | There's a Way

September 29, 2017

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

Subject: 40 CFR Part 257, Subpart D, Section 257.91(f) Groundwater Monitoring System Certification
We Energies Caledonia Ash Landfill, Caledonia, 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.

A groundwater monitoring system that meets and exceeds the minimum requirements of Section 257.91 is designed for the We Energies Caledonia Ash Landfill, including the following monitoring wells:

- Upgradient: W48
- Background: W46D
- Downgradient: W08D, W09D, W10D, W49, W50

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 the We Energies Caledonia Ash Landfill meets the requirements of Section 257.91.

I, Glenn R. Luke, a qualified professional engineer, certify that the groundwater monitoring system at the We Energies Caledonia 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, <u>Jacob J. Walczak</u>, a qualified professional geologist, certify that the groundwater monitoring system at the We Energies Caledonia 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,
NRT | An OBG Company

Glenn R. Luke

Glenn R. Luke, PE
Senior Engineer

Jacob J. Walczak, PG
Hydrogeologist

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	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

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
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

Monitoring Well Evaluation Checklist

Site ______________________________

Inspection Date __________

Well Number __________

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

Stick-up Monitoring Wells

1. Outer protective Casing	Yes	No	NA	Comments
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☐ ☐2 HR ☐5 DAYS

REQUESTED ANALYSIS

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

Preservation Code (pick letter)

Filtered (Yor N)

Method Number and Analytes

SPECIAL REQUIREMENTS

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

APPENDIX 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^{o}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^{o}C
Turbidity	<10 NTUs or ± 10% when turbidity is greater than 10 NTUs

Notes: µS/cm = micro Siemens per centimeter
^{o}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.

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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/

Name:	Well Integrity Evaluation and Maintenance
Section:	Field Procedures
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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

	Yes	No	NA	Comments
1. Outer protective Casing				
Not corroded				
Not dented				
Not cracked				
Not loose				

	Yes	No	NA	
2. Inner casing				
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

NATURAL
RESOURCE
TECHNOLOGY

Name:	Field Instrument Calibration, Operation, and Maintenance
Section:	Field Procedures
Number:	07-11-01
Revision:	0
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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.

<u>Representative groundwater samples can be obtained for all analytes in nearly all field conditions using a bladder pump</u>. 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/

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:

- <u>Super Tracker Table</u> – Project-specific table of field and laboratory data compiled by the data group for tracking and importing data.
- <u>Project–specific sampling documents</u> – 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:

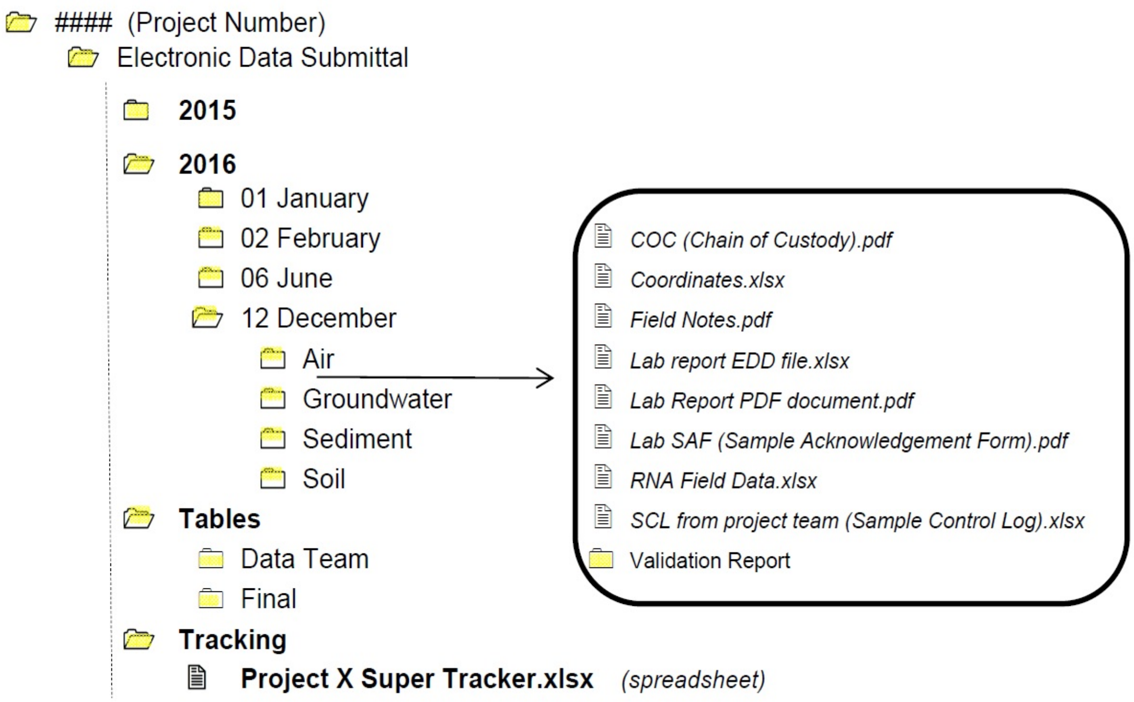
- Achieve a thorough and complete understanding of sampling and data requirements for the given project prior to mobilizing.
- Collect samples according to the sample summary provided by the PM, project-specific sampling documents, and the appropriate NRT standard field operating procedures. (NRT field 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:



- 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:

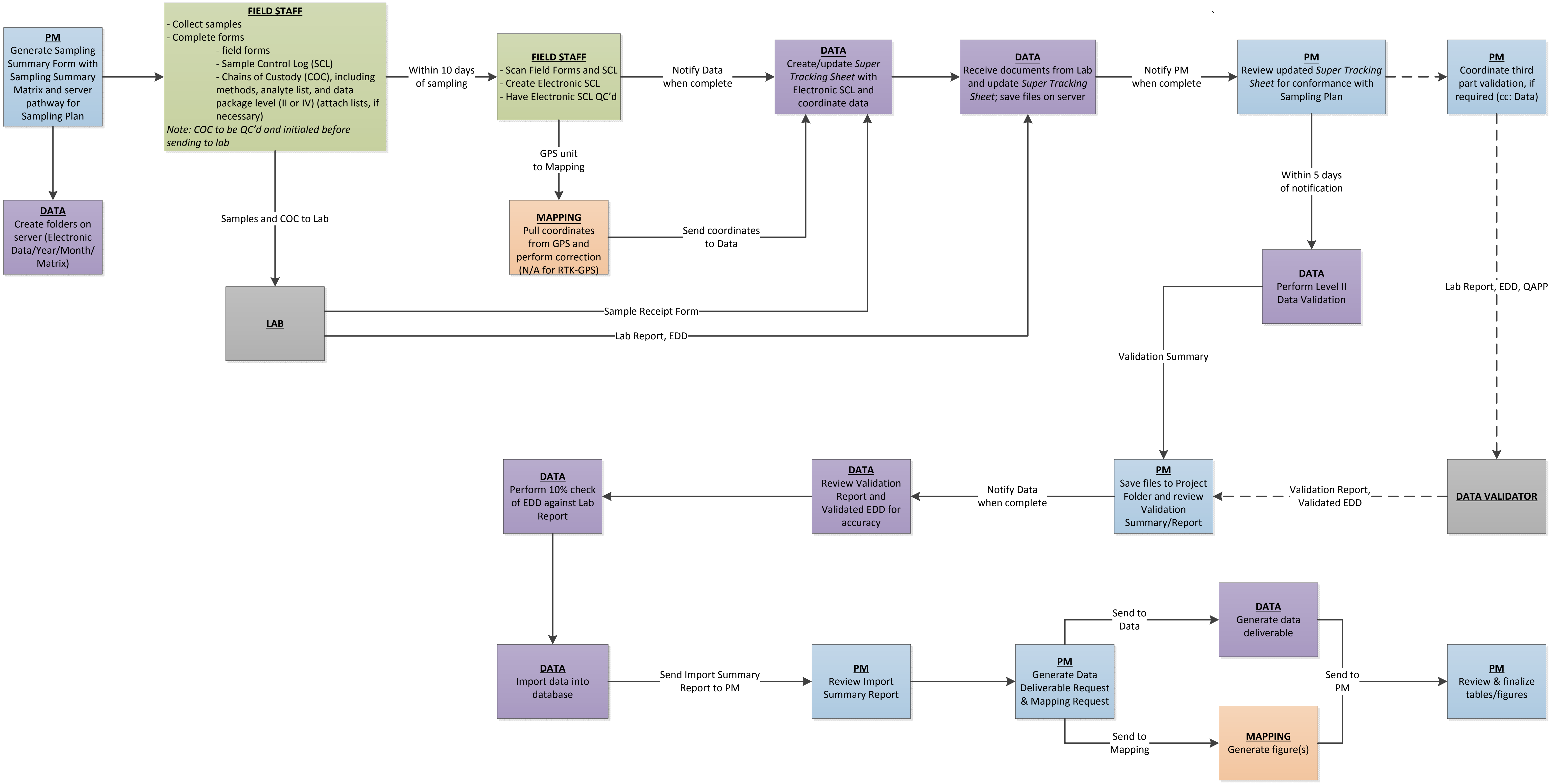
- Is not the responsibility of any one person or group
- Is required of all staff members in some form
- Begins at the planning stages of the project and continues until a final report is issued

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



Attachment A - Data Flow Process

ATTACHMENT B

SUPER TRACKER TABLE SPREADSHEET

Attachment B - Super Tracker

Please read Comments for more info →	**Job Number**	Task Number	**Site Name**	QA Plan Number	**Sample Purpose Code**	Sample Event Name	Sample Event ID (number)	**Unique Sample ID (9 digits)**	**Station Name** (MW01, QC01 SB002)	**Station Type** (well, boring)	**Sample Date** (mm/dd/yyy)	**Sample Time** (hh:mm am/pm)	**Matrix** $^{(1)}$	**Top of Soil or Sediment Interval**	**Bottom of Soil or Sediment Interval**	**Depth Units**	**Groundwater Filtered?**	**QC info** (MS/MSD, DUP)	Duplicate
Example	*2094*		*Integrys-Throop Street Station*		*ar - Assessment Routine*				*QC005*	*sb*	*5/22/2014*	*10:15 PM*	*SE*	*5*	*8*	*ft*	*F1*	*RB*	*1*

Notes:

(1) Air = AA, soil vapor = GS, sediment = SE, soil = SO, groundwater = WG, surface water = WS, waste = W (see Data team for additional abbreviations)
(2) VOCs= list compounds requested
(3) PVOCs = typically BTEX, or BTEX + naphthalene, or BTEX + styrene and TMBs
(4) PAHs 13, 16, 17 or 18 compounds
(5) Alkylated PAHs = 34 compounds
(6) SVOCs = list compounds requested (typically phenols)
(7) Filtered metals = list requested metals
(8) Total metals = non-filtered or soils = list metals requested
(9) Typical TAT for level 2 data and EDD = 10 business days
(10) Typical TAT for level 4 data and EDD = 20 business days
(11) Level II Review
(12) For additional information about the comments please see the *Geotech Data Transfer Standard Enviro Data Version 2012.*
(13) Bold headers indicate a field that is required for the data system.

Attachment B - Super Tracker

Parent Sample ID (Duplicate) *(MW004, SB526)*	**Sample Type (Grab, composite)**	Sampling Process Result	**Sampling Method**	**Geologic Unit Code**	**Lithology Code**	X coordinate	Y coordinate	Coordinate Description	Elevation GS	Elevation TOC	Datum (UOM for elevation)	Company doing Sampling	Field Sampler (initials)	CoC Witness (initials)	Chain of custody Number	**Project Team Sign off on Field Information**	Laboratory	Lab Report Number	Sample Delivery Group (Lab EDD #)
MW004	*u*	*Well Dry*	*pe*	*BED*	*LS*			*TBD 3*			*NAVD88*	*BMD*	*ANS*	*CCD*			*Lancaster Laboratories*		

Attachment B - Super Tracker

Lab Sample ID	VOCs -8260B (2)	PVOCs-8260B (3)	PAHs-8270 SIM (4)	Alkylated PAHs-8270 SIM (5)	SVOCs-8270C (6)	Dissolved metals-6010 or 6020 (7)	Total metals-6010 or 6020 (8)	DissolvedMercury-7470A	Total Mercury-7470A/7471A	PCBs-8082	TOC-Lloyd Kahn	TOC-Black carbon-Lloyd Kahn	Cyanide	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	Lab Received Date	Sample Receipt/ Condition Form from Lab
																								03/01/15	*acceptable*

Attachment B - Super Tracker

Expected Results Date (9)	Expected Date for Level 2 and EDD	Date Rcvd Level 2 data and EDD	Days Late/Days Ahead (-early / +later)	**Project Team Notified Data Set Complete DATE**	Level 2 Review(11)	Level 2 comments	Level 2 Import Date	**Project Team Notified (Level II Import) DATE**	Expected Date for Level 4 Data (10)	Date Received Level 4 Data	Days Late/Days Ahead	Data Team Notified Level IV Complete DATE	Level 4 Review	Level 4 Import Date	**Project Team Notified (Level IV Import) DATE**
03/10/15	*03/10/15*	*03/12/15*	*2*		*03/14/15*		*03/20/15*				--		*n/a*		
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Name: Equipment Decontamination
Section: Field Procedures
Number: 07-04-09
Revision: 0
Effective Date: 01/01/2014
Page: 1 of 6

Reviewed By:	JJW/SLM	Date Reviewed:	07/23/2013
Corporate Officer:	BRH	Date Approved:	07/24/2013

EQUIPMENT DECONTAMINATION

1.1 Scope and Application

This standard describes the decontamination of field equipment prior to field use. Decontamination procedures to be executed prior to field mobilization and while in the field both follow this standard operating procedure (SOP).

Sampling and field equipment decontaminated in accordance with these procedures meet the requirements for achieving standard data quality objectives. Site-specific field decontamination procedures may be substituted for the procedures described in this SOP when samples are to be analyzed for data uses with lower level data quality objectives. Refer to the project-specific documents for variances to this SOP.

1.2 Health and Safety Warnings

Follow Natural Resource Technology, Inc. (NRT) Health and Safety SOPs 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 Cleaning Materials

Specific cleaning materials to be used for your project will depend on the type and level of contaminants anticipated at a site and should be identified in site-specific documents. Typical cleaning materials used in equipment decontamination include:

- Detergent such as a standard brand of laboratory detergent (e.g., Alconox® or Liquinox®). The use of any other detergent must be justified and documented in project files. Note that some projects may require the use of phosphate-free detergent.
- Nitric acid solution (10%). This cleaning agent is prepared from reagent-grade nitric acid and deionized water.

- Pesticide-grade isopropanol cleaning solvent. Other solvents may be substituted for a particular investigation if needed (e.g., hexane). Pesticide-grade acetone or methanol is acceptable; however, if pesticide-grade acetone is used, the detection of acetone in samples collected with acetone-rinsed equipment is suspect. Pesticide-grade methanol is much more hazardous to use than either pesticide-grade isopropanol or acetone, and its use is discouraged. The use of any solvent other than pesticide-grade isopropanol for equipment decontamination purposes must be justified and documented in site documents.

- Deionized water, or tap water that has been treated by passing through a standard deionizing resin column. Deionized water should contain no detectible heavy metals or other inorganic compounds.

- Commercially available distilled tap water. Although deionized water is preferred, distilled water can be substituted for deionized water, as appropriate, on a project-specific basis. If commercially available distilled water is used, the purity of the water should be checked by submitting a sample for laboratory analysis.

- Organic-free tap water that has been treated with activated carbon and deionizing units. Organic-free water should contain no pesticides, herbicides, or extractable organic compounds, and less than 5 µg/L of purgeable organic compounds.

- Tap water from municipal water treatment systems. Untreated potable water supply is not an acceptable substitute for tap water.

During cleaning, the substitution of high-grade water (e.g., deionized, distilled, or organic-free water) for tap water is permitted and need not be noted as a variation of this SOP, provided the deionized and organic-free water meets the specific quality control procedures as outlined above. Throughout the remainder of this procedure, high-grade water refers to deionized, distilled, or organic-free water, unless otherwise specified.

1.4 Decontamination Procedure for Standard Equipment

General decontamination procedure is summarized as follows:

1. Physical removal of particles

2. Detergent wash[1]
3. Tap water rinse
4. High-grade water rinse
5. Air dry

After final decontamination and prior to storage, equipment will be wrapped in one layer of clean aluminum foil. Foil edges will be rolled into a "tab" to allow for easy removal. Then, the piece of equipment will be sealed in plastic and dated. In addition, if there was a deviation from the decontamination SOP, this will be noted on the label.

If particular contaminants are present, decontamination steps may need to be added for site specificity, including:

- Nitric acid rinse if metals are of concern at a site
- Solvent rinse if particular organics are of concern

Use of any additional decontamination steps will be identified in the site-specific documents.

1.4.1 Decontamination Procedure for Equipment Used to Collect Samples of Toxic or Hazardous Waste

Equipment that is used to collect samples of hazardous materials or toxic wastes or materials from hazardous waste sites, RCRA facilities, or in-process waste streams shall be decontaminated before it is returned from the field. At a minimum, this decontamination procedure shall consist of procedures described in Section 1.4.2. More stringent decontamination procedures may be required, depending on the waste sampled. Alternative decontamination procedures will be provided in site-specific documents.

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[1] When sampling equipment is used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the equipment several times with pesticide-grade solvent to remove residue before proceeding with Step 3. In extreme cases, it may be necessary to steam clean the field equipment before proceeding with Step 3. If the field equipment cannot be cleaned utilizing these procedures, it should be discarded.

1.4.2 Equipment-Specific Decontamination Procedures

Submersible Pumps and Non-Dedicated Hoses/Tubing Used to Purge Ground Water Wells

Submersible pumps and non-dedicated hoses/tubing used to purge ground water wells will be decontaminated using the following procedure:

1. Pump a sufficient amount of detergent water through the hose/tubing to flush residual purge water
2. Pump a sufficient amount of high grade water through the hose/tubing to flush detergent water
3. Rinse the outside of the pump housing with detergent water
4. Rinse the outside of the pump housing with tap water or higher grade water
5. Rinse the outside of the pump housing with high-grade water
6. Hoses/tubing used only for purging wells shall be cleaned prior to reuse. Hoses/tubing used for sampling shall be discarded after use, with new hose/tubing being used every sampling event
7. Equipment will be placed in a polyethylene bag or wrapped with polyethylene film to prevent contamination during storage or transit. Insure that a set of rotors, fuses, and cables are attached to each cleaned pump

1.4.2.2 Subcontractor Equipment

Subcontractor equipment that is not directly used to collect sample material (e.g. auger flights) must be decontaminated prior to arrival on site and during site work in a manner approved by NRT that mitigates the potential for cross contamination. Subcontractor equipment that is directly used to collect sample material (e.g. split spoon) must be decontaminated per Section 1.4 of this SOP or a site-specific method identified in site-specific documents. The subcontractor will collect all investigation-derived waste (IDW) generated from decontamination of their equipment in a manner that will allow it to be handled and disposed of properly.

1.4.2.3 Sample Coolers and Shipping Containers

All ice chests and reusable containers shall be washed with detergent (interior and exterior), rinsed with tap water and air dried before storage. In the event that an ice chest becomes severely contaminated with concentrated waste or other toxic material, it shall be cleaned as thoroughly as possible, rendered unusable, and properly disposed.

1.4.2.4 High-Grade Water Storage Containers

High-grade water storage containers will only be used only for transporting high-grade water. To decontaminate the container, use the following procedure:

New containers shall be rinsed thoroughly with high-grade water, filled with high-grade water and capped with one layer of Teflon® paper; and one layer of aluminum foil immediately after using.

For used containers:

- Wash the exterior of the container with detergent and rinse with deionized water.
- Rinse the interior of the container twice with solvent.
- Rinse the interior of the container thoroughly with high-grade water. The container shall be filled with high-grade water and capped with one layer of Teflon® paper, and one layer of aluminum foil. High-grade water will not be stored in the containers longer than three days.
- Cap with one layer of Teflon® paper, and one layer of aluminum foil immediately after using in the field.

1.4.2.5 Vehicles

Vehicles should be washed at the conclusion of each field trip. This routine maintenance should minimize any chance of contamination of equipment or samples due to contamination of vehicles. When vehicles are used in conjunction with hazardous waste site inspections, or on projects where pesticides, herbicides, organic compounds, or other toxic materials are known or suspected to be present, a thorough interior and exterior decontamination is mandatory at the conclusion of such investigations.

All vehicles shall be equipped with trash bags and/or trash containers to facilitate vehicle decontamination. All personnel are responsible for keeping field vehicles clean by removing all trash and other debris. All contaminated trash and equipment must be kept separate from ordinary trash and must be properly disposed on-site.

1.5 Segregating Used Field Equipment

Field equipment or reusable sample containers needing decontamination will not be stored with clean equipment or materials.

1.6 Restocking Decontaminated Equipment

All decontaminated, plastic-wrapped equipment, containers, and tubing not used in the field may be placed back in stock after the following precautions are taken:

- Soap and water rinse the outer plastic wrap on the equipment, sample tubing, or sample containers. Allow to air dry.
- If plastic wrap leaks during soap/water rinse, remove equipment and decontaminate it again.

1.7 Storage of Field Equipment and Sample Containers

All decontaminated field equipment and sample containers shall be stored in a contaminant free environment.

1.8 Disposal of Cleaning Materials

If solvents or nitric acid are used during the decontamination process for sampling equipment and containers, the solvent or acid shall be collected and disposed through an approved hazardous waste disposal contract.

1.9 References

ASTM Standard D5088, 2002 (2008), “Standard Practice for Decontamination of Field Equipment Used at Waste Sites,” ASTM International, West Conshohocken, PA, 2008, DOI: 10.1520/D5088-02R08, www.astm.org.

USEPA, Region IV, 2011, Field Equipment Cleaning and Decontamination, SESDPROC-205-R2, SESD, Athens, Georgia.

NATURAL
RESOURCE
TECHNOLOGY

Name: Sample, Labeling, Logging, and Storage
Section: Field Procedures
Number: 07-03-01
Revision: 0
Effective Date: 01/01/2014
Page: 1 of 5

Prepared By:	SGW	Date Prepared:	12-20-2012
Corporate Officer:	BRH	Date Approved:	12-23-2013

SAMPLE LABELING, LOGGING AND STORAGE

0.1. Scope and Application

This standard is applicable to labeling, logging, and storing of analytical environmental media samples including soil, groundwater, surface water, sediment, and air. Proper label procedures are essential to preserve sample identity and tracking. Storage and shipment methods must preserve sample integrity and chain of custody (COC), as well as follow applicable United States Department of Transportation (USDOT), International Air Transport Association (IATA), and carrier-specific regulations and requirements. Shipping samples and equipment is covered in standard operating procedure (SOP) 07-03-09. COC procedures are established to provide sample integrity and are covered in SOP 07-03-03. Refer to the project-specific documents for variances to this SOP.

0.2. Health and Safety Warnings

Follow Natural Resource Technology, Inc. (NRT) Health and Safety procedures when working with potentially hazardous material, preservatives, or with material of unknown origin. Project Health and Safety Plans contain additional practices, if required, to mitigate site-specific hazards.

0.3. Sample Identification

0.3.1. Unique Sample Identification

A unique 9-digit identification code will be assigned to each sample retained for analysis on all United States Environmental Protection Agency (USEPA) sites and on a site-specific basis for other projects as determined by the project manager. 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, 2012 would be identified as 122512001, as detailed below:

$$\underbrace{12}_{\textbf{Month}}\quad\underbrace{25}_{\textbf{Date}}\quad\underbrace{12}_{\textbf{Year}}\quad\underbrace{001}_{\substack{\textbf{Consecutive}\\ \textbf{Sample Number}}}$$

Consecutive sample numbers will indicate the individual sample sequence in the total set of samples collected during that phase of investigation.

0.3.2. Sample Media

Sample media will be noted on field notes and logs with 2-letter media codes as summarized below:

Air	AS	Air Sparging Point
	GP	Gas Probe
	GM	Gas Monitoring Well
	SV	Soil Vapor Probe
	SS	Sub-Slab Vapor Probe
	IA	Indoor Air Sample
	AM	Ambient Air Sample
	VE	Soil Vapor Extraction Well
Material	AC	Asbestos Containing Material
	LS	Lead Wipe Samples
Sediment	SD	Sediment Sample
Soil	SB	Soil Boring (no monitoring well installed)
	HA	Hand Auger (shallow soil sample)
	TP	Test Pit
	EB	Excavation Base Sample
	EW	Excavation Wall Sample
Water	MW	Monitoring Well
	PZ	Piezometer
	PW	Potable Well
	RW	Recovery Well
	TW	Temporary Monitoring Well
	SW	Surface Water Sampling
	SG	Surface Water Staff Gauge

0.4. Sample Labeling

Affix a non-removable, water-resistant label to the body of each container. The label will stick to a clean dry sample container much easier than a dirty wet container. Place the label on the sample container before sampling. The following information will be written on the label with indelible ink that will not smudge when wet:

- Project Number
- Sample ID
- Date of sample collection
- Time of sample collection (military time)
- Sampler initials
- Preservative (if applicable) or None
- Requested laboratory analyte(s)

0.5. Sample Logging

Thorough and accurate record keeping is achieved by completing field note and/or logbook entries during the sample process as data are collected. If possible, one person should be responsible for logging samples for consistency.

0.5.1. Sample Control Log

When using unique sample identification (Section 1.3.1), all samples will be logged daily on a sample control log (Attachment A), which will be stored in the project data files. Sample control logs will provide data entry columns and space for each sample for the following information:

- Sample ID
- Sample media (see Section 1.3.2)
- Sample location

- Sample depth or sample interval
- Analyte(s) requested
- COC number
- Analytical laboratory
- Miscellaneous notes (low sample volume, sample not submitted, etc.)

0.5.2. Sample Chain of Custody

Sample chain-of-custody will be in accordance with SOP 07-03-03. Chain of Custody records will be kept with the analytical laboratory reports in the project files.

0.6. Sample Storage

- Collect samples in the appropriate container with labels then place samples to be retained for chemical analysis into re-sealable plastic bags.
- Place bagged samples in coolers with bagged ice or other cooler devices (e.g., refrigerator) to reach and maintain required analytical preservation temperatures (typically 4 degrees Centigrade (^{o}C) +/- 2 °C).
- Complete a COC for all samples and keep with the samples in the specific cooler.
- Maintain coolers with fresh ice and periodically drain excessive melt water.
- Use signed and dated COC seals on the cooler lid when shipping the samples and when the samples are no longer in the sampler’s possession.
- Ship samples daily (if possible) or have the laboratory courier pick samples up daily. Ship samples in accordance with SOP 07-03-09.
- Maintain appropriate COC on coolers and other sample storage containers in accordance with SOP 07-03-03.

0.7. References

ASTM Standard D3694, 1996 (2004), “Standard Practices for Preparation of Sample Containers and for Preservation of Organic Constituents,” ASTM International, West Conshohocken, PA, 2004, DOI: 10.1520/D3694-96R11, www.astm.org

ASTM Standard D4220, 1995 (2007), “Standard Practices for Preserving and Transporting Soil Samples,” ASTM International, West Conshohocken, PA, 2007, DOI: 10.1520/D4220-95R07, www.astm.org

ASTM Standard D4840, 1999 (2010), “Standard Guide for Sampling Chain of Custody Procedures,” ASTM International, West Conshohocken, PA, 2010, DOI: 10.1520/D4840-99R10, www.astm.org

ATTACHMENT A

SAMPLE CONTROL LOG

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 notes

Reviewed By:	JJW/SLM	Date Reviewed:	08/20/2012
Corporate Officer:	BRH	Date Approved:	06/25/2013

SAMPLE VOLUMES, CONTAINERS, PRESERVATION, AND HOLDING TIMES

1.1 Scope and Application

This standard is applicable to the use of sampling containers and preservatives provided by a contracted analytical laboratory in quality-controlled containers. The general requirements forample containers, preservatives, and analytical holding times are discussed below. Refer to the project-specific documents 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 Sample Volumes

Sample volume requirements are determined by the laboratory based on the required analysis. Field staff should prepare for the possibility of collecting additional samples by ordering several spare sample containers for each analysis. The number of spare sample containers to bring to the site is dependent on the task and is at the discretion of the project manager. Field staff should carry a minimum of 1 extra container for every 10 samples to be collected.

In the event that there are no available laboratory-prepared sample containers on site and additional sampling is necessary, the project manager shall be contacted to determine whether it is appropriate to collect a sample. In such instances, the volume of sample obtained should be sufficient to perform all required analyses with an additional amount collected to provide for quality control needs, split samples, or repeat examinations. The laboratory receiving the sample should be consulted to determine specific volume requirements. Sample volumes collected from waste sources at hazardous waste sites or samples from sources known to be toxic should be kept to a minimum.

The sample volume required for each analysis is the volume of the standard container provided by the laboratory less empty space required for sample mixing by laboratory personnel and safe shipment of samples to the laboratory. Allow a minimum of ten percent empty space in every sample container with the exception of samples collected for purgeable organic analyses (volatile organic compounds [VOCs]) or dissolved gases such as sulfides for which sample containers must be completely filled.

1.4 Selection and Proper Preparation of Sample Containers

The type of sample container is dictated by the analyses required. Selection and preparation of sample containers will be performed by the analytical laboratory. All sample containers provided by the laboratory will be shipped with chain-of-custody records. Field personnel shall inspect all sample containers prior to commencing field activities to ensure container seals, labels, and preservatives meet COC, sample labeling, packing, and shipping requirements.

1.5 Sample Preservation

Samples for some analyses must be preserved and the preservatives will be supplied by the laboratory. In most instances, containers will be provided with preservatives already pre-measured inside the bottle. In such cases, labels will indicate preservative and likely be sealed; these containers are not rinsed prior to filling with sample.

All samples requiring preservation should be preserved immediately upon collection in the field. However, exceptions may be made when addition of a preservative may have an unknown or potentially dangerous effect, for example:

- Samples collected within a hazardous waste site that are known or thought to be highly contaminated with toxic materials. Barrel, drum, closed container, spillage, or other source samples from hazardous waste sites are not to be preserved with any chemical. These samples may be preserved by placing the sample container on ice, if necessary.

- Samples that have extremely low or high pH or samples that may generate potentially dangerous gases when preservatives are added.

All samples preserved with chemicals shall be clearly identified by indicating on the sample tag that the sample is preserved. If samples normally requiring preservation were not preserved, field records shall indicate why.

1.6 Sample Holding Times

The elapsed time between sample collection and initiation of laboratory analyses must be within the prescribed "holding time" for each analysis to be performed as defined by the analytical method, USEPA, ASTM International, and/or laboratories. Holding times for each analytical method must be confirmed with the contracted laboratory prior to sample collection.

1.7 References

ASTM Standard D3694, 1996 (2011), "Standard Practices for Preparation of Sample Containers and for Preservation of Organic Constituents," ASTM International, West Conshohocken, PA, 2011, DOI: 10.1520/D3694-96R11, www.astm.org.

ASTM Standard D4841, 1988 (2008), "Standard Practice for Estimation of Holding Time for Water Samples Containing Organic and Inorganic Constituents," ASTM International, West Conshohocken, PA, 2008, DOI: 10.1520/D4841-88R08, www.astm.org.

ASTM Standard D5903, 1996 (2006), "Standard Guide for Planning and Preparing for a Groundwater Sampling Event," ASTM International, West Conshohocken, PA, 2006, DOI: 10.1520/D5903-96R12, www.astm.org.

ASTM Standard D6517, 2000 (2012)e1, "Standard Guide for Field Preservation of Ground-Water Samples," ASTM International, West Conshohocken, PA, 2012, DOI: 10.1520/D6517-00R12E01, www.astm.org.

Reviewed By:	JJW/SLM	Date Reviewed:	08/21/2012
Corporate Officer:	BRH	Date Approved:	06/25/2013

QUALITY CONTROL SAMPLES

1.1 Scope and Application

This procedure describes the collection of quality control (QC) samples. QC samples are used to evaluate field and laboratory quality control procedures and the precision, accuracy, representativeness, and comparability of data obtained during investigative activities. Refer to the project-specific documents 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 Equipment and Materials

Equipment and materials for the collection and analysis of quality control samples shall be identical to those used for the collection and analysis of the investigative samples of the same medium and collection method.

1.4 Types of Quality Control Samples

QC samples include field duplicate samples, matrix spike (MS) and matrix spike duplicate (MSD) samples, trip blanks, field blanks, and equipment blanks.

1.4.1 Field Duplicate Samples

Field duplicate samples are collected from various media to evaluate the representativeness and comparability of data obtained during investigative activities. 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 original samples. They shall also be preserved in the same manner and submitted for the same analyses as the original samples. The minimum/required frequency of field duplicate sample collection for each sample media shall be specified in the Quality Assurance Project Plan (QAPP), Field Sampling Plan (FSP), and/or other site-specific documents.

1.4.2 Matrix Spike and Matrix Spike Duplicate Samples

Matrix Spike and Matrix Spike Duplicate (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 shall be collected at the same time, using the same procedures and equipment, and in the same types of containers as the original samples. They shall also be preserved in the same manner and submitted for the same analyses as the original samples. The minimum/required frequency of MS/MSD sample collection for each sample media shall be specified in the QAPP, FSP, and/or other site-specific documents.

1.4.3 Trip Blanks

Trip blanks are used to detect contamination that may be introduced in the field or during transit, bottle preparation, sample log-in, or sample storage within the laboratory. Trip blanks also reflect contamination that may occur during the analytical process. Trip blanks are samples of reagent-free water, properly preserved, which are prepared by the analytical laboratory in a controlled environment prior to field mobilization. Trip blanks are kept with the laboratory-provided containers through the sampling process and returned to the laboratory with the other samples being submitted for volatile organic compound (VOC) analysis. Trip blanks must be used for samples intended for VOC analysis and are preserved and analyzed for VOCs. One trip blank will accompany each cooler containing samples for VOC analysis or as specified in the QAPP, FSP, and/or other site-specific documents.

1.4.4 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 "carryover" 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 deionized (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. The minimum/required frequency of equipment blanks for each sample media shall be specified in the QAPP, FSP, and/or other site-specific documents.

1.4.5 Field Blanks

Field blanks are used to determine potential for contamination of a sample by site contaminants from a source not associated with the sample collected (e.g. air-borne dust or high concentration volatiles in air from a source not related to the samples). Field blanks shall be collected by pouring distilled or ultrapure/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, equipment blanks are handled and treated in the same manner as investigative samples, unless otherwise noted in the site-specific documents. The minimum/required frequency of equipment blanks for each sample media shall be specified in the QAPP, FSP, and/or other site-specific documents.

1.5 Evaluation of Quality Control Samples

Data generated by quality control samples and how they relate to the precision, accuracy, representativeness, and comparability of other data obtained during an investigation will be evaluated by the project team according to procedures defined in the QAPP, FSP, and/or other site-specific documents.

1.6 References

USEPA, 1990, Quality Assurance/Quality Control Guidance for Removal Activities, Sampling QA/QC Plan and Data Validation Procedures, Interim Final, EPA/540/G-90/004.

USEPA, 2002a, Quality Management Plan for the Superfund Division, Region 5, Chicago, Illinois.

USEPA, 2002b, Guidance for Quality Assurance Project Plans, EPA QA/G-5/ EPA/240/R-02/009.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

USEPA, October 2010, Field Sampling Quality Control, Region 4, Operating Procedure, SESDPROC-011-R3, SESD, Athens, Georgia, http://www.epa.gov/region4/sesd/fbqstp/Field-Sampling-Quality-Control.pdf

USEPA, August 2011, Field-based Analytical Methods, Summary of Quality Control Samples and the Information They Provide, http://www.epa.gov/superfund/programs/dfa/download/qctable.pdf

Reviewed By:	KJB	Date Reviewed:	10-29-2012
Corporate Officer:	BRH	Date Approved:	06-25-13

CHAIN-OF-CUSTODY

1.1. Scope and Application

This field procedure outlines chain-of-custody procedures to record sample data and maintain sample integrity. A chain-of-custody (COC) form is a legal document used to track sample custody from sample collection to sample delivery at the laboratory. The procedures ensure the integrity of the sample from collection to data reporting. Refer to the project-specific documents 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. Sample Custody

Samples collected must be maintained under secure conditions and documented through COC procedures. As few people as possible should be part of the COC. 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.

1.4. Chain-of-Custody Procedures

Field staff are responsible for the custody of samples until custody is transferred. Sample containers will be identified, tagged, handled, and transported in accordance with SOP 07-03-05. All samples must be accompanied by a COC form at all times and a separate COC will be generated 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 record must 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 master project file under Electronic Data Submittals (e.g., P:/1549/Electronic Data Submittals/October 2112).

1.4.1. Chain-of-Custody Errors

Erroneous information may not be erased on the COC. Errors will be lined out and initialed, and the correction written in a manner to not obscure the error.

1.5. Commercial Shipping

The COC will be maintained when using a commercial shipper (e.g., Fedex, UPS) without the carrier signing the COC. The COC will be signed for release custody, sealed in a plastic bag (e.g., one-gallon freezer Ziploc® bag), taped to the inside of the cooler lid, and seal inside. Note that nothing is written in the “received by” section of the COC at this time. The carrier’s established custody documentation procedure is used to verify custody during transportation. Shipping receipts, including tracking numbers, should be scanned and saved in the project file.

A minimum of two custody seals on the outside of the coolers are required. Custody seals shall be affixed to the top and side of the cooler and contain the following information: date, signature, and unique ID number. The unique ID numbers are recorded on the COC associated with the same container. The custody seal should be secured beneath the shipping tape so the container cannot be opened without breaking the seals. The shipping containers should be marked "THIS END UP," and arrow labels indicating the proper upward position of the container should be affixed to the container. A label containing the name and address of the shipper and receiving laboratory shall be placed on the outside of the container.

1.5.1. Multiple Cooler Shipments

If the samples are shipped in more than one container, a separate COC is required for each container. The COC must only list the samples that are within the associated container.

1.6. References

ASTM D4840-99(2010) Standard Guide for Sampling Chain-of-Custody Procedures.

ASTM D6911-03(2010) Standard Guide for Packaging and Shipping Environmental Samples for Laboratory Analysis

USEPA, Field Branches Quality System and Technical Procedures, Region 4, Science and Ecosystem Support Division, Athens, Georgia, http://www.epa.gov/region4/sesd/fbqstp/

Reviewed By:	RJG	Date Reviewed:	05-24-2012
Corporate Officer:	BRH	Date Approved:	12-23-2013

SAMPLE LOCATION IDENTIFICATION AND CONTROL

1.1. Scope and Application

This field procedure describes identification of sample locations for water levels, geological samples, and physical dimensions frequently required during field activities. Samples collected from each location will have a unique sample identifier in accordance with SOP 07-03-01. Refer to the project-specific documents for variances to this SOP.

All sampling locations shall be uniquely identified and depicted on an accurate drawing, topographic map, or other type of site illustration. Sampling locations should be referenced so their location(s) are established and reproducible. A sample location must be identified by a coordinate system or other appropriate procedures outlined in SOP-07-03-07 that would enable an independent investigator to reproduce sample collection from the same location(s).

1.2. Sample Location Identification

Sample locations are assigned alphanumeric codes, which are used to coordinate laboratory data tracking and graphic depiction of sample locations on drawings and figures. Each sample location is issued a unique numeric code that corresponds to a specific map location on a plan view of a site. An alpha-code (letter) is used to describe the type of sampling activity performed at the specific numeric location.

The following 2-letter media codes will be used:

Air	AS	Air Sparging Point
	GP	Gas Probe
	GM	Gas Monitoring Well
	SV	Soil Vapor Probe
	SS	Sub-Slab Vapor Probe
	IA	Indoor Air Sample
	AM	Ambient Air Sample
	VE	Soil Vapor Extraction Well
Material	AC	Asbestos Containing Material
	LS	Lead Wipe Samples
Sediment	SD	Sediment Sample
Soil	SB	Soil Boring (no monitoring well installed)
	HA	Hand Auger (shallow soil sample)
	TP	Test Pit
	EB	Excavation Base Sample
	EW	Excavation Wall Sample
Water	MW	Monitoring Well
	PZ	Piezometer
	PW	Potable Well
	RW	Recovery Well
	TW	Temporary Monitoring Well
	SW	Surface Water Sampling
	SG	Surface Water Staff Gauge

A typical series of alphanumeric codes for a site might include test pit locations TP01 through TP12; borings SB01, SB02, SB03; and monitoring wells MW01, MW02, MW03.

Each sample location will have only one alphanumeric code. A borehole drilled for installing a monitoring well will be identified as MW. There should not be both an SB identifier for a soil sample and an MW identifier for a groundwater sample.

Note that soil borings performed for collecting a groundwater grab sample (e.g., through screened auger, open borehole, Geoprobe®, or Hydro-Punch®) are identified as soil borings, not monitoring wells. These types of sampling locations may be further identified on site figures with a clarifying suffix (GW), such as SB01 (GW). The site map legend will explain the meaning of all symbols used to identify sampling points.

If previous work has been performed at a site, the alphanumeric code should continue with previous successive numbers. If there is any potential for conflict with existing sample number identifiers, the proposed sample number should begin with series 101, 1001, or other appropriate system. Dashes should be eliminated from sample number identifiers. For example, SB101 should be used instead of SB-101.

When applicable, sample location identifications must be identical to sample locations entered into a database of analytical results. A sample control log, if completed (SOP 07-03-01), is a good place to track sample location identification information that can be used for entering analytical results into the database and/or post-processing GPS location information.

1.3. References

USEPA, 2007, 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:	SGW	Date Prepared:	11-29-2012
Corporate Officer:	BRH	Date Approved:	11-22-2013

PACKING AND SHIPMENT OF ENVIRONMENTAL SAMPLES AND EQUIPMENT

1.1. Scope and Application

This field procedure outlines standard methods for packing (and labeling of the package) and shipping of environmental samples (e.g., soil, groundwater, surface water, sediment, and air) and field equipment. Packing and shipment methods must preserve sample integrity and chain of custody (COC), as well as follow applicable United States Department of Transportation (USDOT), International Air Transport Association (IATA) and carrier-specific regulations and requirements.

The procedures contained in this document are to be used by field personnel when packing and shipping environmental samples and dangerous goods by ground or air transport via UPS or FedEx or similar carrier. However, most packing procedures will also pertain to samples shipped by a lab courier. Samples collected during field investigations must be classified prior to shipment, as either environmental or dangerous goods samples. This standard operating procedure (SOP) cannot cover all packaging and shipping circumstances. Please refer to DOT and IATA references for comprehensive packing and shipping instructions for packing and shipping requirements not covered by 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. In addition to handling sampling media, great care should be exercised when handling sample preservatives because they are typically concentrated acids or bases and may cause harm if accidentally ingested, inhaled, or if they come in contact with the skin.

1.3. Sample Transportation

This field procedure does not address transportation of hazardous waste. Samples of hazardous waste are exempt from hazardous waste regulations, however samples may still be considered as a dangerous good and subject to appropriate regulations when transported by air. NRT staff shall avoid the shipment of samples by air transport whenever possible. To the extent feasible, arrangements should be made with laboratories for sample pick-up on site by the laboratory's courier service or a service contracted by NRT. The need for such services should be considered and budgeted for at the project proposal stage.

Environmental samples collected by NRT will not be transported on public transportation systems (e.g., buses, ferries, and passenger aircraft) or by the United States Postal Service unless authorized by the project manager and a person with up to date training. Sample media collected during field activities may meet regulatory definitions for hazardous materials and/or dangerous goods. Staff shall strictly comply with all regulations involving the shipment of hazardous and/or dangerous goods. Both USDOT and IATA regulations require that personnel receive training if they are involved in packaging, labeling, and/or shipping hazardous materials and dangerous goods. Therefore, shipment of hazardous materials and dangerous goods must be performed by individuals with up to date training. Training is required by IATA every 24 months.

The shipment of the following unpreserved samples is typically not regulated:

- Drinking water
- Groundwater
- Soil
- Sediments
- Treated effluent
- Biological samples
- Surface water

The shipment of the following preserved samples is also not regulated provided the amount of preservative used does not exceed the amounts found in 40 Code of Federal Regulation (CFR) 136.3 which 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:

- Hydrochloric acid (HCL) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater)
- Nitric acid (HNO3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater)
- Sulfuric acid (H2SO4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater)
- Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less)

Typical pre-preserved sample containers received from a laboratory do not exceed the aforementioned amounts of preservatives. As related to typical NRT work, the aforementioned preservatives pertain to but are not limited to samples collected for volatile organic compounds (VOCs) (HCL), metals (HNO_3), nitrite + nitrate nitrogen, oil and grease, total kjeldahl nitrogen (H_2SO_4), sulfide (zinc acetate/NaOH) and cyanide (NaOH).

- Drinking water
- Groundwater
- Treated effluent
- Surface water

The shipment of soil and sediment samples preserved by USEPA Method 5035 methanol or sodium bisulfate are subject to varying degrees of shipping regulations. Three levels of regulations apply depending on type and quantity of preservative used and method of sample packaging. These regulations are summarized as follows:

- Small quantity exception - (< 30 milliliters (mL) inner containers [VOC vials]), *not subject* to Hazardous Material Regulations (HMR) provided the package is in accordance with 49 CFR 173.4 (small quantity exceptions)
- Limited quantity DOT hazardous material--must meet regulatory requirements minus UN specification containers (49 CFR 172.700 training applies)
- Fully regulated DOT hazardous material—Limited Quantity exception not taken, package must be in *full* compliance with HMRs (49 CFR 172.700 training applies)

Note: DOT regulations associated with the use of preservatives in the field may be avoided by using Encore™ or Terracore samplers when collecting soil samples (these methods do not require preservation with methanol or sodium bisulfate).

1.3.1. Shipment as a Small Quantity Exception (49 CFR 173.4)

The DOT small quantity exception described in 49 CFR 173.4(a)(1)(i) states that the maximum quantity of material per inner container is limited to 30 mL for authorized liquids, other than Division 6.1,Packing Group I materials (i.e., poisons). As applied to the preservatives of Method 5035, if there is less than or equal to 30 mL of methanol or aqueous sodium bisulfate solution per inner container (VOC vials), this material is not subject to any other requirements of the hazardous materials regulations except those presented in 49 CFR 173.4. Typically, soils are preserved with 10 mLs of methanol or sodium bisulfate. However, aside from the 30 mL receptacle limit, there are additional restrictions:

- Each inner receptacle with a removable closure (cap), has its closure held securely in place (tape the cap).
- Unless equivalent cushioning and absorbent material surrounds the inside packaging, each inner receptacle is securely packed in an inside packaging with cushioning (bubble wrap) and absorbent material that will not chemically react with other material and is capable of absorbing the entire contents (if liquid) of the receptacle (sorbent pads placed in the bottom of the cooler).

- The inside packaging is securely packed in a strong outside packaging (typical plastic cooler).
- The completed package, as demonstrated by prototype testing, is capable of sustaining each of the following free drops made from a height of 1.8 meters (5.9 feet) directly onto a solid unyielding surface without breakage or leakage from any inner receptacle and without a substantial reduction in the effectiveness of the package.

The gross mass of the completed package must not exceed 29 kg (64 pounds). The package must not be opened or otherwise altered until it is no longer in commerce (chain of custody seals). The shipper must indicate on the airway bill under nature and quantity of goods: *Dangerous Goods in Excepted Quantities.* IATA also requires the application of an ***excepted quantities label****.* Refer to Attachment A of this SOP for an example of the excepted quantities label. This label should contain the certification language identified above.

Label entries include shipper signature, title, date, address, and indication of the hazard class and associated UN number. The United Nations (UN) number for methanol is 1230, Class or Division 3, sub risk 6.1 and is a flammable liquid. The UN number for sodium bisulphate is 2837, Class or Division 8, and is a corrosive.

While 49 CFR 173.4 does not have a total net quantity limitation, IATA Dangerous Goods Regulations (DGR Section 2.7.4.2) *does.* For packing group II materials (e.g., methanol and sodium bisulfate), the total net quantity limit is one (1) L. This equates to 100 inner containers (VOC vials) containing approximately 10 mL of material per outer package (i.e., sample cooler).

When discussing the shipment of DOT hazardous materials in the air mode, shippers have additional restrictions that are identified in Columns 9A/9B of the 49 CFR 172.101 hazardous materials table. Net quantity limits for methanol for passenger and cargo aircraft are one (1) liter and sixty (60) liters, respectively. The net quantity limits for aqueous sodium bisulfate solutions are one (1) liter and thirty (30) liters, respectively. Shippers should note that these quantities exceed the IATA small quantity exception. **Therefore, if preservative volume (methanol or sodium bisulfate solution) is less than 30 mL per VOC vial (inner container) and the total net quantity per cooler (outer package) is limited to one (1) L, DOT HMRs or IATA DGR's quantity limits are not an issue provided packaging conforms with 49 CFR 173.4.**

NRT samplers should strive to ship methanol or aqueous sodium bisulfate preserved samples by laboratory courier and not by air. NRT samplers should without exception package methanol and aqueous sodium bisulfate preserved samples to take advantage of the small quantity exception if shipment by air is unavoidable. NRT personnel must follow all applicable packaging, labeling, and shipping conditions as described above. Limited quantity and fully regulated DOT hazardous material shipping are not included in this SOP. For shipping quantities, samples, or materials not discussed above, or if there is any question regarding a shipment, refer to IATA, Dangerous Goods Regulations. Copies are located in the NRT office.

1.3.2. Other Dangerous Goods

Listed below are a few common dangerous goods used in environmental sampling that requiring special handling/shipping. Note this is **NOT** a complete list.

- Dry ice
- Lithium batteries
- Isobutylene compressed gas (PID calibration gas)

If any of these items are to be shipped, refer to the following:

Dry ice – Dry ice is sometimes used to freeze samples during shipment to the laboratory. Dry ice is forbidden for shipment on passenger aircraft. The following permanent markings are required on the outer packaging of all IATA dry ice shipments:

- Dry Ice or Carbon Dioxide Solid
- UN 1845
- Net weight of dry ice in kilograms
- Name and address of the shipper
- Name and address of the recipient

- Class or Division 9
  - Hazard – Miscellaneous

An IATA Class 9 Miscellaneous label must appear on all dry ice shipments. Refer to Attachment B of this SOP for an example Dry Ice label.

Lithium batteries – Lithium batteries are commonly used in devices like mobile phones, laptops, PDAs, cameras, photoionization detectors, and landfill gas meters. The two main types of lithium batteries are lithium metal (primary non-rechargeable) and lithium ion (rechargeable). They are Class or Division 9, Hazard–Miscellaneous and Packing Group II. UN numbers are as follows:

- UN 3480, Lithium ion batteries
- UN 3481, Lithium ion batteries packed with equipment
- UN 3481, Lithium ion batteries contained in equipment
- UN 3090, Lithium metal batteries
- UN 3091, Lithium metal batteries packed with equipment

To comply with Section II IATA shipping requirements, shipments containing lithium batteries and cells must comply with specific packaging guidelines.

- Ensure that lithium batteries are individually packaged in fully enclosed inner packaging such as a plastic bubble wrap or pasteboard to provide protection for each battery.
- Shield and protect lithium batteries to prevent short circuits or contact with conductive materials within the packaging that could cause short circuits.
- Ensure that packaging is proven (i.e., tested) to meet the requirements of each test in the UN Manual of Tests and Criteria, Part III, Sub-Section 38.3.
- Make sure that lithium batteries are completely enclosed (such as in equipment or surrounded by plastic with void space filled to prevent movement), except when the proper shipping names end with “contained in equipment.”

- Place contents in a sturdy outer container (hard shell pelican case, plastic cooler or heavy-duty cardboard box).
- Provide correct labeling and documentation. Refer to Attachment C for example labels.

Isobutylene compressed gas (PID calibration gas) - Isobutylene is UN number 1055, Class or Division 2.1, Hazard – Flammable gas. Isobutylene compressed gas is forbidden for transport by air. It is **not permitted** as an excepted quantity. Compressed gas needs to be transported by ground transport, only. Refer to Attachment D for an example label.

1.3.3. Packaging for Shipment

All samples shipped via commercial carrier will meet the minimum requirements listed below whether or not they are regulated by USDOT or IATA. The objectives of basic sample packaging are to ensure sample containers do not break and to prevent liquid leaking from the outer packaging from sample container breakage, condensation, or melted ice. **(If you ship a cooler and it leaks anything, it will sit where it leaked until we pick it up!)**

- Maintain COC procedures and documentation in accordance with SOP 07-03-03. Write the carrier’s name in the received column and any associated tracking number used by the carrier (e.g., FedEx or UPS air bill numbers).
- Select a sturdy cooler in good condition. Cooler size should be chosen to allow sufficient volume for packing material, samples, and ice without exceeding a weight the average person is capable of lifting and the standard weight limits for commercial carriers. Multiple coolers may be used for sample shipments.
- Close and secure the drain plug (inside and outside of cooler) with duct tape or similar material.
- Place a water absorbent pad on the bottom of the cooler and place a layer of inert cushioning material, such as bubble pack, on top of the absorbent pad.
- Line the cooler with two large heavy-duty plastic bags of sufficient size so that the full depth of the cooler may be used without exceeding the capacity of the bags.
- Place samples inside the liner bags so that at least ½ of the cooler volume is available for the placement of ice. Recommended practices for packing are summarized below:

  - Place all glass containers in separate and appropriately sized bubble bags/wrap or foam blocks. Pack samples with sufficient inner packaging to ensure containers do not bump each other or move freely during transportation.
  - To prevent labels from getting saturated during transportation, place sample container in a single sealable plastic bag (e.g., a one-gallon freezer Ziploc® bag). Multiple sealable bags may be used if all containers from a sample location will not fit in a single bag. The exception is VOA vials for VOC analysis. If more than one cooler is used for storage and/or shipping, all VOA vials must remain in a single cooler with the trip blank vials or the project must maintain separate cooler trip blanks. **(To limit the cost of analysis of multiple trip blanks always put all the VOCs as in one cooler, if possible without exceeding limitations above. Thus requiring only one trip blank analysis.)**
  - Place bottles inside the plastic bags lining the cooler with those for volatile organic analysis towards the center of the cooler. Sample containers should not exceed 50 percent of the cooler volume.
  - As a courtesy to the laboratory please ensure the sample containers have been decontaminated (if necessary) before shipment. Try not to send grossly contaminated bottles and jars to the laboratory.

- Place loose ice (do not use "blue ice") in re-sealable heavy-duty plastic bags (e.g., a one-gallon freezer Ziploc® bags). Place bagged ice in between and on top of the samples. At packing completion, cooler should be approximately 50% ice, by volume. Coolers should be completely filled so that samples do not move excessively during shipping; Twist and tie the large plastic bags used to line the coolers.

- Place COC records in a clear sealable plastic bag (e.g., one-gallon freezer Ziploc® bag) and either tape the bag to the inside of the cooler lid or lay it on top of the sealed liner bags. If the samples are shipped in more than one cooler, place a copy of the COC records in each cooler. Label the COC record copies in the coolers to reflect the total number of coolers.

- Affix at least two COC seals to the top and sides of the cooler so that the cooler cannot be opened without breaking the COC seals. Sign the custody seal with an indelible marker and cover the seal with transparent tape.

- Securely tape the top of the cooler shut with packing tape.

- Place laboratory label address on the cooler. Commercial carrier insurance for recollection of all samples will be taken on all carrier waybills.

- Wrap the cooler with strapping tape in two or more locations to secure lid.

- Place “Fragile” and “This Side Up” labels (or similar) on at least two sides of the cooler.

- **Labels used in the shipment of hazardous materials** (e.g., Cargo Only Air Craft or Flammable Solids) **are not permitted** on the outside of the container used to transport environmental samples, unless the material is classified and handled as a hazardous material for shipping.

- Retain a copy of the shipping waybill and attach the copy to the master file COC documentation.

1.4. References

ASTM International, D3694-96(2004) Standard Practices for Preparation of Sample Containers and for Preservation of Organic Constituents

ASTM International, D4220-95R00 Practices for Preserving and Transporting Soil Samples

ASTM International, D6911-03 Guide for Packaging and Shipping Environmental Samples for Laboratory Analysis

International Air Transport Association (IATA), 2012, Dangerous Goods Regulations.

USDOT, 49 CFR Parts 100 to 185

USEPA, 1981, Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples, Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273), April 13, 1981.

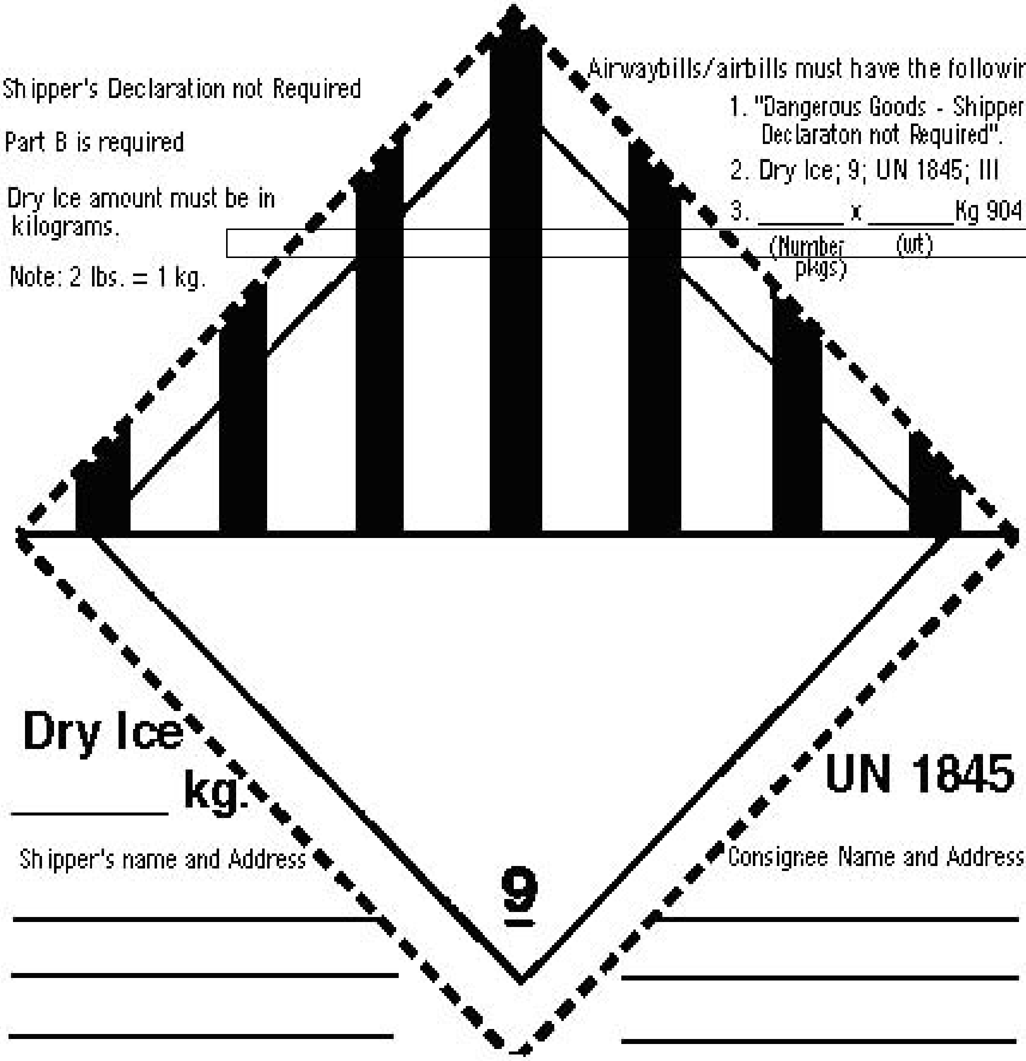
ATTACHMENT A

EXCEPTED QUANTITY LABEL

LABELMASTER ® (800) 621-5808 www.labelmaster.com

ATTACHMENT B

DRY ICE LABEL



Shipper's Declaration not Required

Part B is required

Dry Ice amount must be in kilograms.

Note: 2 lbs. = 1 kg.

Airwaybills/airbills must have the following:

1. "Dangerous Goods - Shipper's Declaraton not Required".
2. Dry Ice; 9; UN 1845; III
3. _______ x _______Kg 904
   (Number pkgs) (wt)

Dry Ice

________ kg.

UN 1845

Shipper's name and Address

Consignee Name and Address

ATTACHMENT C

LITHIUM ION SHIPPING LABELS

CAUTION !

IF DAMAGED

Lithium ion battery

DO NOT LOAD OR TRANSPORT
PACKAGE IF DAMAGED

For more information, call ____________

CAUTION!

IF DAMAGED

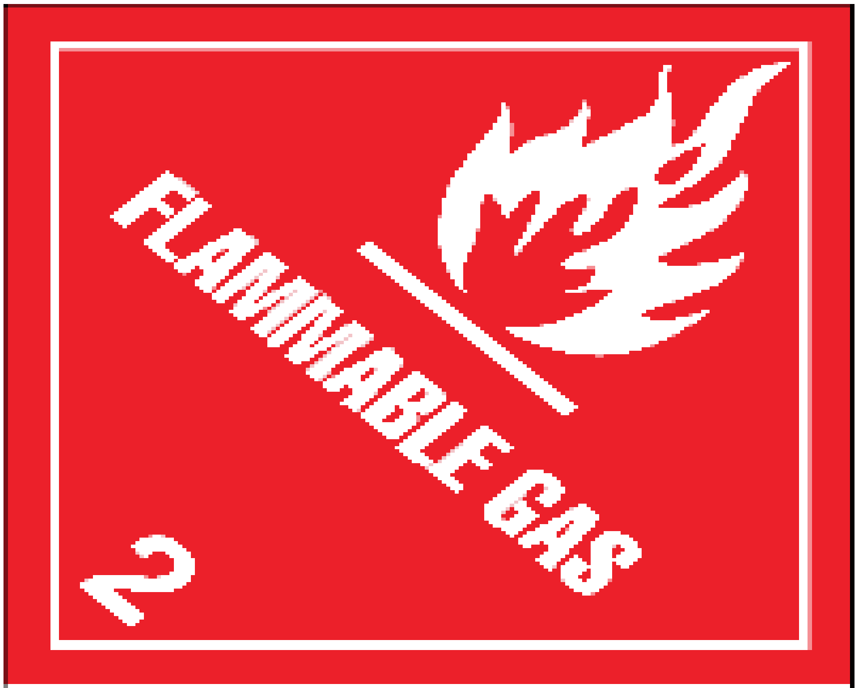
LITHIUM ____________ BATTERY

DO NOT LOAD OR TRANSPORT
PACKAGE IF DAMAGED

For more information, call ____________

ATTACHMENT D

COMPRESSED GAS LABEL



COMPRESSED GAS N.O.S.
UN 1954