Regulation Compliance Report
Closure Plan
Weston Disposal Site No. 3 Landfill
Town of Knowlton, Marathon County, Wisconsin
September 2023, Revision 1

Appendix B

Area A Preliminary Closure Schedule

Initial Closure Plan Schedule - Area A

ID	Task Name	Duration	Start	Finish
1	**Closure of Area A**	**241 days**	**Mon 3/30/26**	**Wed 11/25/26**
2	Ash Filling Ceases	1 day	Mon 3/30/26	Mon 3/30/26
3	Other Regulatory Permits - None	0 days	Mon 3/30/26	Mon 3/30/26
4	Notification of Intent to Close	0 days	Wed 4/29/26	Wed 4/29/26
5	Construction Activities	180 days	Wed 4/29/26	Sun 10/25/26
6	Notification of Closure Completion	0 days	Mon 10/26/26	Mon 10/26/26
7	Documentation	30 days	Mon 10/26/26	Tue 11/24/26
8	State Submittal - Documentation Report	0 days	Wed 11/25/26	Wed 11/25/26

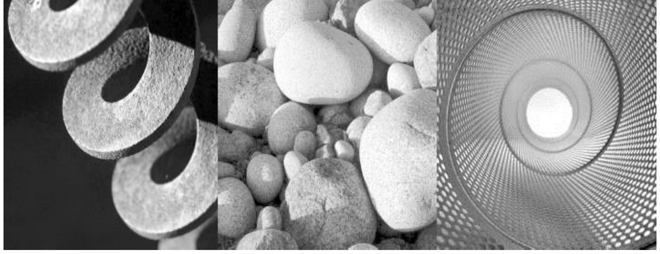
Project: Closure Plan
Date: Wed 7/5/23

Task	▬	Project Summary	┌─┐	Manual Task	▬	Finish-only	]	Progress	─
Split	┈	Inactive Task	▭	Duration-only	▬	External Tasks	▬	Manual Progress	─
Milestone	◆	Inactive Milestone	◇	Manual Summary Rollup	▬	External Milestone	◆		
Summary	┌─┐	Inactive Summary	┌─┐	Start-only	[	Deadline	⬇		

Plan of Operation Modification
Weston Disposal Site No. 3
Town of Knowlton, Wisconsin
September 29, 2023

Appendix M

Post Closure Care Plan



GEI Consultants

Consulting
Engineers and
Scientists

Regulation Compliance Report

Post-Closure Plan

Weston Disposal Site No. 3 Landfill
Town of Knowlton, Marathon County, Wisconsin

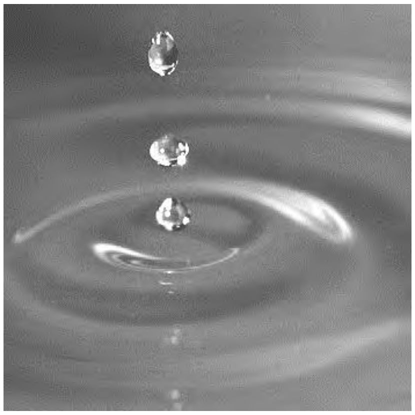
Submitted to:
WEC Energy Group
333 West Everett Street, A231
Milwaukee, Wisconsin 53203

Submitted by:
GEI Consultants, Inc.
3159 Voyager Drive
Green Bay, Wisconsin 54313
920-455-8200

September 2023, Revision 1
Project 2203724

John M. Trast

John M. Trast, P.E., D.GE
Vice President/Senior Waste
Management Leader



Andrew Schwoerer

Andrew J. Schwoerer, P.G.
Project Professional

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Tables

Revision History

Revision 0 – Original post-closure plan dated October 2016.

Revision 1 – Update of the original post-closure plan for the Plan of Operation Modification submittal to comply with the updated NR 500 of the Wisconsin Administrative Code.

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K:\WEC Energy Group\1600630_WPS WestonDisposalSite #3\In_Progress\Reports\CCR Post Closure\R1600630_WPSC WDS3 CCR Post Closure Plan_October 2016r0.docx

1. Introduction

Wisconsin Public Service Corporation (WPSC) owns and operates the Weston Disposal Site No. 3, located in the E 1/2 of the NW 1/4 and W 1/2 of the NE 1/4, Section 23, Township 26 North, Range 7 East, Town of Knowlton, Marathon County, Wisconsin. The WPSC Weston Disposal Site No. 3 Landfill is regulated as an industrial waste landfill by the Wisconsin Department of Natural Resources (WDNR) under the provisions of Chapter 289 Wisconsin State Statues, and all applicable requirements of Chapters NR 500 of the Wisconsin Administrative Code. The design, construction, operation, closure, and post-closure care requirements are specified in the WDNR conditionally approved Plan of Operations, License No. 3067, FID No. 737054120.

In addition to the state regulations, the landfill is also required to comply with 40 CFR Part 257 Subpart D – *Standards for Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments* and is defined as a CCR unit and existing CCR landfill in accordance with § 257.53. Future landfill cells are permitted by the WDNR in the conditionally approved Plan of Operation and defined as lateral expansions under § 257.53 when constructed.

This report fulfills the requirements for a written Post-Closure Plan for the Weston Disposal Site No. 3 Landfill in accordance with § 257.104 – *Post Closure Care Requirements* and NR 514.07 of the Wisconsin Administrative Code. In accordance with § 257.104(d)(1) and NR 514.07(10)(d), this report describes the monitoring and maintenance activities for the CCR unit, and the frequency at which these activities will be performed; provides the name, address, telephone number, and email address of the person or office to contact about the facility during the post-closure care period; and provides a description of the planned uses of the property during the post-closure period.

This post-closure plan includes the following sections:

Section 1 Introduction

Section 2 Post-Closure Narrative

Section 3 Conclusion and Certification

2. Post-Closure Narrative

This plan fulfills the requirements for a written Post-Closure Plan for the Weston Disposal Site No. 3 Landfill in accordance with § 257.104 – *Post Closure Care Requirements* and NR 514.07(10)(d).

Following the final closure of the Weston Disposal Site No. 3, WPSC will be responsible for the post-closure care of the facility. In accordance with NR 506.084(2)(a), the long-term care period for a CCR landfill is 40 years for purposes of record keeping and proof of owner financial responsibility and that monitoring, and maintenance of the landfill is required in perpetuity, unless an approval is granted by the department to discontinue monitoring after the 40-year long-term care period is completed. The post-closure care period is for a minimum of 40 years if the owner or operator is under detection monitoring. If the facility is in assessment monitoring, the post-closure care period is extended until the facility returns to detection monitoring.

In accordance with § 257.104(b), WPSC is responsible for providing post-closure care and maintenance including: maintaining the integrity and effectiveness of the final cover system; making repairs to the final cover as necessary to correct the effects of settlement, subsidence, erosion, or other events; maintaining the leachate collection and removal system in accordance with NR 514.07(10)(d)1.c.; maintaining the groundwater monitoring system and monitoring the groundwater in accordance with the requirements of §§ 257.90 through 257.98 and NR 514.07(10)(d)1.d.; and complying with the recordkeeping requirements specified in § 257.105(i), the notification requirements specified in § 257.106(i), and the Internet requirements specified in § 257.107(i) during the post-closure period.

§ 257.104(d)(1)(i)/NR 514.07(10)(d)1.a. A long-term care schedule that includes activities specified in NR 514.06(11) is provided in the table below:

Monitoring and Maintenance Activities	**Frequency**
Final Cover Vegetation Maintenance	Annually for first five years, every five years thereafter
Inspection of Stormwater Control Structures and Final Cover System	Annually
Final Cover Maintenance and Repairs	As needed, determined by annual inspection
Leachate Collection System Cleaning	Annually
Environmental Monitoring - Groundwater and Leachate	Semi-Annually

§ 257.104(d)(ii)/NR 514.07(10)(d)2. Post-closure period facility contact:

Mr. Eric P. Kovatch, P.G.
WEC Energy Group
333 West Everett Street
Milwaukee, Wisconsin 53203
(414) 221-2457
eric.kovatch@wecenergygroup.com

§ 257.104(d)(iii)/NR 514.07(10)(d)3. During the post-closure care period, use of the landfill final cover area will be limited to green space or other activities that do not disturb the integrity of the final cover, base liner, or any other component of the containment, leachate collection, or groundwater monitoring systems.

2.1 Final Cover System Maintenance

Inspection of the final cover system is included in the annual inspection required under§ 257.84(b). The annual inspection will note any final cover defects requiring repair.

Maintenance of the final cover will include repairs due to settlement, subsidence, erosion, or other events and regular mowing of the cover vegetation. Final cover system repairs necessitated due to settlement, subsidence, erosion, or other events will be completed as soon as practical.

Actions should be taken as soon as practical to restore and protect areas that require maintenance and reestablish vegetation for erosion protection. Final cover repair and maintenance activities will be noted in the annual inspection report required under § 257.84(b)(2) and NR 514.07(10)(d)1.b.

The final cover will be mowed at a minimum on an annual basis for the first five years to help establish a well-vegetated final cover and at a minimum once every five years thereafter, to inhibit the growth and presence of woody vegetation. Mowing on a more frequent basis may be required to accommodate more vigorous growth rate or to prevent the establishment of woody vegetation. Other techniques may also be employed to aid in the establishment of the desired vegetation and control of invasive grasses and woody vegetation, including selective herbicide applications and prescribed burning as a native prairie restoration practice.

2.2 Leachate Collection System

WPSC will be responsible for maintaining the effectiveness of the leachate collection and removal system and operating the leachate collection and removal system in accordance with the requirements of NR 504.12(3)(a). The leachate collection system will be annually jetted with a water jet cleanout device with a maximum pressure of 10,000 pounds per square inch from each access point to the toe of the opposite slope. A video camera inspection shall be conducted on all leachate collection pipes at 5-year intervals and shall extend a minimum of 300 feet onto the base grades of each leachate collection line. All blockages of the leachate collection pipe, pipe breaks, or any impedances shall be investigated. A summary report shall be submitted for each pipe cleaning and each video camera inspection event in accordance with NR 506.07(5)(g).

2.3 Groundwater Monitoring Network

WPSC will be responsible for maintaining the groundwater monitoring system and monitoring the groundwater in accordance with the requirements of §§ 257.90 through 257.98. The groundwater monitoring network will be inspected on a semi-annual basis, in conjunction with the groundwater sampling. Any noted deficiencies, damage, or required repairs will be completed as soon as practical. All groundwater monitoring will be completed in accordance with the facility's Groundwater Monitoring Plan for a minimum of the 40-year post-closure care period. Provided the site is at detection monitoring at the conclusion of the 40-year post-closure care period, monitoring will cease. However, if groundwater monitoring is at assessment monitoring, groundwater monitoring will continue until monitoring returns to detection monitoring. All sampling and analysis will be completed in accordance with the facility's sampling and analysis plan.

3. Conclusion and Certification

WPSC owns and operates the Weston Disposal Site No. 3, located in the E 1/2 of the NW 1/4 and W 1/2 of the NE 1/4, Section 23, Township 26 North, Range 7 East, Town of Knowlton, Marathon County, Wisconsin. The Weston Disposal Site No. 3 Landfill is required to comply with 40 CFR Part 257 Subpart D — *Standards for Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments* and NR 500 of the Wisconsin Administrative Code. This plan fulfills the requirements for a written Post- Closure Plan for the Weston Disposal Site No. 3 Landfill in accordance with § 257.104 - *Criteria for Conducting the Closure or Retrofit of CCR Units* and NR 514.07(10)(d), describing the monitoring and maintenance activities for the CCR unit, and the frequency at which these activities will be performed; provides the name, address, telephone number, and email address of the person or office to contact about the facility during the post-closure care period; and provides a description of the planned uses of the property during the post-closure period.

The Post-Closure Plan was completed under the direction of John M. Trast, P.E. I am a licensed professional engineer in the State of Wisconsin in accordance with the requirements of ch. A-E 4, Wisconsin Administrative Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, Wisconsin Administrative 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 40 CFR Part 257 Subpart D.

John M. Trast, P.E., D.GE
Professional Engineer License No. 31792

JOHN
MATHEW
TRAST
37192-6
GREEN BAY
WISCONSIN

09/29/2023

Table 1 - Long-Term Care Cost Estimate
Wisconsin Public Service Corporation
Weston Disposal Site No. 3
GEI Consultants, Inc.
September 29, 2023

Item	*Quantity*	*Unit*	*Unit Cost(1)*	*Total*
Land Surface Care/Cover Maintenance				
Erosion Repair, Fertilizer, Seed/Mulch	1.00	ac	2,500.00	$ 2,500.00
Final Cover Regrading Within 5% Slope Areas	1.00	LS	2,000.00	$ 2,000.00
Downslope Flumes Maintenance	1.00	LS	1,200.00	$ 1,200.00
Mowing	1.00	LS	5,000.00	$ 5,000.00
Sedimentation Basin Cleaning(2)/Road Maintenance	1.00	LS	5,000.00	$ 5,000.00
Snow Plowing	1.00	LS	5,000.00	$ 5,000.00
Monitoring System Maintenance				
Groundwater Monitoring Wells	0.68	ea	2,500.00	$ 1,700.00
Leachate Management System Maintenance				
Leachate Line Cleaning/Jetting	1	LS	10,000.00	$ 10,000.00
Leachate Pumps/Leachate Tank Electricity Costs	1	LS	24,500.00	$ 24,500.00
Leachate Pump Replacement(3)	1.00	LS	3,000.00	$ 3,000.00
Leachate Disposal/Treatment/Transportation(4)	1,569.5	1000 gal	23.00	$ 36,098.50
Leachate System Operation and Maintenance	1.0	LS	7,000.00	$ 7,000.00
Tank Replacement	1.0	LS	2,000.00	$ 2,000.00
Forcemain, Manholes, and Tank Cleaning	1.0	LS	7,000.00	$ 7,000.00
Programmable Logic Control System	1.0	LS	2,000.00	$ 2,000.00
Replace Transducers	2.0	LS	1,000.00	$ 2,000.00
Site Inspections				
Annual Site Inspection	1	LS	2,000.00	$ 2,000.00
Annual Report	1	LS	5,000.00	$ 5,000.00
Monthly Inspections - Manholes, Cover, Headwells, Tanks, Surface Water Features	12	LS	500.00	$ 6,000.00
Groundwater and Groundwater Head Monitoring (Semi-Annual)				
Semi-annual Landfill Well Monitoring (16 wells - field parameters & analytical)	32	ea	64.00	$ 2,048.00
Leachate Monitoring (Semi-Annual)				
Leachate Head Well Elevation (17 locations)	34	ea	5.00	$ 170.00
Leachate Tank Analysis	2	ea	380.00	$ 760.00
Sedimentation Basin Monitoring (Semi-Annual)				
Sedimentation Basin Analysis (7 locations)	2	ea	35.00	$ 70.00

Summary

	Number of Years	Annual Cost	Total Cost	
Land Surface Care	40	22,400.00	896,000.00	
Site Inspection	40	13,000.00	520,000.00	
Groundwater Monitoring	40	2,048.00	81,920.00	
Leachate Hauling and Treatment	40	36,098.50	1,443,940.00	
Leachate System Maintenance	40	53,500.00	2,140,000.00	
Leachate Head Monitoring	40	930.00	37,200.00	
Sedimentation Basin Monitoring	40	70.00	2,800.00	
Subtotal Long-Term Care Cost:		128,046.50	$ 5,121,860.00	**$ 5,122,000**
Contingency (10%)		12,804.65	512,186.00	
Total Annual Long-Term Care Cost:		140,851.15	5,634,046.00	**$ 5,634,000**

Notes

(1) Annual costs are in 2023 dollars.

(2) Sedimentation basins will be cleaned once per year, or as needed.

(3) Assumes the leachate pumps will be replaced once throughout the duration of LTC.

(4) Leachate treatment volume is based on an estimated rate of one inch per year per acre.

Plan of Operation Modification
Weston Disposal Site No. 3
Town of Knowlton, Wisconsin
September 29, 2023

Appendix N

Construction Quality Assurance Plan

Consulting
Engineers and
Scientists

GEI Consultants

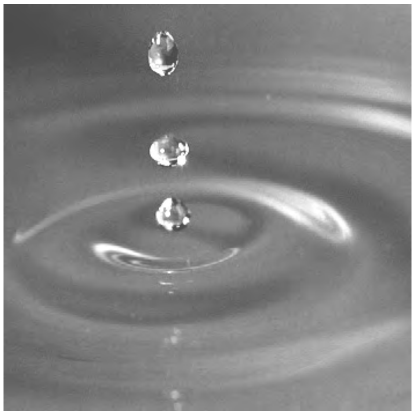
Construction Quality Assurance Plan Update for Weston Disposal Site No. 3

Knowlton, Wisconsin

Submitted to:
WEC Energy Group
333 West Everett Street
Milwaukee, Wisconsin 53203

Submitted by:
GEI Consultants, Inc.
3159 Voyager Drive
Green Bay, Wisconsin 54311
920.455.8200

September 29, 2023
Project 2203724



Andrew J. Schwoerer, P.G.
Project Professional

John M. Trast, P.E., D.GE
Vice President/Solid Waste Leader

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Appendices

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1. Introduction

1.1 Project Background

This Construction Quality Assurance (CQA) Plan has been prepared for, and is included in, the Plan of Operation Modification submittal for Weston Disposal Site No. 3 (WDS3). This CQA Plan is intended to be a "working" document, in other words, one that is updated to reflect changes in specific materials, installation practices, industry standards, or tests and testing methods as the site develops.

1.2 Purpose and Scope

The purpose of this CQA Plan is to address the quality assurance procedures and requirements for the construction at WDS3, including all earthen materials (clay, sand, aggregate, general soil, and topsoil) and synthetic materials (geomembrane, geotextile, geosynthetic clay liner (GCL), geocomposite drainage layers and piping).

This CQA Plan provides procedures that will ensure that all of the landfill components are constructed in a manner that will maximize their performance requirements and that will safeguard components from damage during construction. The CQA Plan is intended to outline procedures for constructing, testing, and documenting the landfill composite liner and cover in accordance with the design criteria and regulatory requirements.

The scope of this CQA Plan includes general CQA requirements in regard to the roles, responsibilities, and qualifications of the parties involved; the preconstruction activities; and the general inspection and documentation procedures. Specifically, this Plan establishes requirements for construction procedures and observation, field and laboratory testing frequencies and methods, and acceptance criteria for each component of the composite liner and cover. Testing and acceptance criteria are based on Chapter NR 500, Wisconsin Administrative Code (WAC), requirements where applicable. Geosynthetics testing and acceptance criteria are based on the Geosynthetic Research Institute (GRI) Standards, American Society for Testing and Materials (ASTM) and on current acceptable industry standards and practice.

The CQA Plan addresses the construction of the following systems within the landfill facility:

- Gradient control system (GCS)
- Composite liner
- Leachate collection system (LCS)
- Leachate transfer system (from landfill collection sumps to leachate collection tank)

- Composite final cover
- Storm water management system
- Access and maintenance roads

The following sources were used in the development of this Plan:

- EPA Technical Guidance Document, EPA/530-SW-86-031, titled “Construction Quality Assurance for Hazardous Waste Land Disposal Facilities”
- EPA Technical Guidance Document, EPA/530-SW-86-007, titled “Design, Construction, and Evaluation of Clay Liners for Hazardous Waste Facilities”
- Geosynthetic Research Institute, “GRI Test Method GCL 3,” revision 5 – 11/21/2019
- Geosynthetic Research Institute, “GRI Test Method GN 4,” revision 4 – 7/9/2020
- Geosynthetic Research Institute, “GRI Test Method GM 12a,” revision 2 – 3/3/16
- Geosynthetic Research Institute, “GRI Test Method GM 13,” revision 16 –3/17/2021
- Geosynthetic Research Institute, “GRI Test Method GM 17,” revision 14– 3/17/2021
- Geosynthetic Research Institute, “GRI Test Method GM 19a,” revision 10 – 3/18/2021
- American Society of Testing and Materials, *Annual Book of ASTM Standards*.
- Chapter NR 500, Wisconsin Administrative Code

1.3 Quality Assurance and Quality Control

Quality assurance and quality control are defined as follows:

- **Quality assurance** - A planned and systematic pattern of all means and actions designed to provide adequate confidence that materials or services meet contractual and regulatory requirements. This is typically performed to assure the purchaser, owner, and/or regulatory agencies that delivered materials or services are of desired quality.
- **Quality control** - Those actions that provide a means to measure and regulate the characteristics of a material or service to meet contractual and regulatory requirements. This typically is performed by, or for, the provider of materials or services as a control mechanism on the quality of the provider’s efforts.

In the context of this manual, the terms are further defined as follows:

- **Quality assurance** refers to the means and actions employed by the CQA Officer to ensure conformity of the systems′ installation with the CQA Plan and the construction plans and specifications. Quality assurance is primarily provided by an independent third party (consultant or laboratory) under the oversight of the CQA Officer.

- **Quality control** refers to those actions taken by the Manufacturer, Fabricator, or Contractor/Installer to provide materials and workmanship that meet the requirements of the CQA Plan and the construction plans and specifications. Some testing efforts required by this CQA Plan may serve as both quality control and quality assurance measures.

1.4 General Testing Requirements

This CQA Plan includes references to test procedures of the American Society for Testing and Materials (ASTM) and the Geosynthetics Research Institute (GRI). Test procedure references are always to the latest approved version up to the date of this document, unless specifically stated otherwise in this document.

Tests will be performed in strict accordance with the referenced test procedure and the description included in this Plan, unless indicated otherwise. Deviations to test procedures called out in this Plan must be approved, in writing, by the CQA Officer prior to commencement of any work.

2. CQA Roles, Responsibilities, and Qualifications

2.1 CQA Officer

The CQA Officer will supervise and be responsible for all observation, testing, and related construction documentation as described in this CQA Plan. The CQA Officer will be responsible for preparing the documentation, construction acceptance, or certification report to certify substantial compliance with appropriate sections of Chapter NR 500, WAC. The CQA Officer will be a Professional Engineer registered in the State of Wisconsin.

The CQA Officer may delegate daily observation and documentation, testing, and sampling duties to a qualified technician or engineer with experience in the assigned aspect of construction who will serve as the Construction Quality Assurance Technician (CQAT). Although these duties may be delegated, the CQA Officer will retain the responsibility for these activities.

2.2 Construction Quality Assurance Technician (CQAT)

The CQAT will carry out daily observation, testing, and sampling duties under the direct supervision of the CQA Officer. The CQAT will be a qualified technician or engineer with experience in the assigned aspect of construction. The CQAT will observe and document construction and installation procedures. The CQAT will prepare daily summary reports and will routinely transmit these to the CQA Officer. The CQAT will immediately notify the CQA Officer of problems or deviations from the CQA Plan or the construction plans and specifications.

Reporting, documentation, and resolution of problems and deficiencies will be carried out as described in Section 4. The CQAT will not have authority to approve design or specification changes without the consent of the CQA Officer.

2.3 Soil Testing Laboratory

The Soil Testing Laboratory retained will be experienced in landfill construction soil testing, the American Society of Testing and Materials Standards (ASTM), and other applicable standards. The selected laboratory will be required to be responsive to the project needs by providing test results within reasonable time frames. This will include providing verbal communication on the status of ongoing tests and immediate communication of test results as needed to facilitate ongoing construction. Such information may include hydraulic conductivity test data, maximum dry density and optimum moisture content values, and borrow source characterization data. Final laboratory reports will be checked and approved by the soil testing laboratory and submitted to the CQA Officer.

2.4 Geosynthetics Testing Laboratory/Laboratories

The Geosynthetics Testing Laboratory/Laboratories will have experience in testing geosynthetics in accordance with standards developed by ASTM and the Geosynthetics Research Institute (GRI), and other applicable test standards. The selected laboratory/laboratories will be required to be responsive to the project needs by providing test results within reasonable time frames. Final laboratory reports will be certified by the geosynthetics testing laboratory/laboratories and will be submitted to the CQA Officer.

2.5 Construction Contractor

The Construction Contractor’s role will be to furnish earthwork, construction, and piping installation, and to provide overall construction responsibility for the completion of the landfill facility. The Construction Contractor will be experienced in solid waste landfill construction, knowledgeable about clay liner construction techniques, and familiar with geosynthetic installations. The term “Contractor” is used interchangeably with “Construction Contractor” in this Plan.

2.6 Geosynthetics Installer

The Geosynthetics Installer is the company hired by the Construction Contractor or Owner to install the geosynthetic components referenced in this manual and to perform the nondestructive seam testing of the geomembranes as required by this Plan. The term ″Installer″ is used throughout this Plan when reference is made to the tasks and responsibilities of a Geosynthetics Installer.

The Installer will be trained and qualified to install the various geosynthetic components covered by this Plan. The Installer of the geomembranes will be approved and/or licensed by the Manufacturer.

Prior to confirmation of any contractual agreements, the Installer of the geosynthetics will provide the CQA Officer and/or Owner with the following written information, which must be approved by the CQA Officer and/or the Owner:

- Corporate background and information.
- Installation capabilities, including the following:
    - Information on equipment and personnel
    - Resumes of personnel
    - Daily anticipated production
    - Quality control manual for installation

- A list of at least 10 completed facilities, totaling a minimum of 2,000,000 square feet for which the Installer has completed the installation of polyethylene geomembrane. For each installation, the following information will be provided:
    - Name and purpose of facility, its location, and date of installation
    - Name of owner, project manager, designer, manufacturer, and fabricator (if any)
    - Thickness and type of polyethylene geomembrane and the surface area of the installed geomembrane

The Installer will provide a copy of the field tensiometer certification, indicating the date in which the tensiometer was calibrated prior to the start of any seaming operations. The Installer is responsible for delays caused to the project until tensiometer certification is delivered to the CQAT.

Tensiometers used in the state of Wisconsin are required to be calibrated within 3 months prior to the start of geomembrane installation. The Installer is responsible for meeting this requirement, and must supply a copy of the certification at the time of mobilization to the job site.

All personnel performing geomembrane seaming operations will be qualified by experience or by successfully passing seaming tests for the seaming methods to be used. At least one seamer will have experience in seaming a minimum of 2,000,000 square feet of polyethylene geomembrane using the same type of seaming apparatus in use at the site. The most experienced seamer, the ″master seamer,″ will provide direct supervision, as required, over less experienced seamers. No field seaming will take place without an experienced seamer (meeting the seaming criteria stated above) being present.

The Installer will provide the CQA Officer with a list of proposed seaming and testing personnel, and their professional records, prior to installation of the geosynthetics. This document will be reviewed by the CQA Officer. Any proposed seaming personnel deemed insufficiently experienced will not be accepted by the CQA Officer and/or the Owner.

The Installer will designate one representative as the Superintendent, who will represent the Installer at all site meetings and who will be responsible for acting as the Installer’s spokesperson on-site. This Superintendent will be prequalified for this role on the basis of experience, management ability, and authority.

3. Preconstruction Activities

3.1 Preconstruction Meeting

Prior to commencement of each phase of liner or final cover construction at the landfill facility, a preconstruction meeting will be held. This meeting will include the parties involved in the earth work construction, including the CQA Officer or designated representative, the CQAT, the Construction Contractor, and the Owner.

The purpose of this meeting is to begin the planning and coordination of construction tasks; to identify potential problems that might cause difficulties and delays in construction; to properly interpret the design intent by the Contractor(s); and to present the CQA Plan to all of the parties involved. It is important that the rules regarding testing, repairs, etc., be known and accepted by each party to this Plan.

Specific topics considered for this meeting include the following:

- Review critical design details of the project, including the plans and specifications.
- Review measures for storm water runoff and run-on diversion control, including sump locations, siltation control, and pumping requirements.
- Make appropriate modifications to the Construction Quality Assurance Plan, and develop project-specific addendums (if necessary).
- Review the responsibilities of each party.
- Review lines of authority and communication.
- Review methods for documenting and reporting, and for distributing documents and reports.
- Review requirements of the soil testing laboratory regarding sample sizes, methods of collection, and shipment. Also, review turn times for sample data and their implications on the construction schedule, pending receipt of acceptance data.
- Review the number and locations of the tests required for soil components.
- Review precautions to be taken to maximize bonding between lifts of compacted clay and between lifts barrier layer soil.
- Review the method for splicing segments of the compacted clay liner/cover.
- Review precautions to be taken to minimize desiccation cracking of clay surfaces and barrier layer surfaces.

- Review methods of clay layer and barrier layer surface preparation and approval prior to geosynthetics placement.
- Review the time schedule for operations.
- Observe where the site survey benchmarks are located, and review methods for maintaining vertical and horizontal control.
- Review permit documentation requirements.
- Review the survey documentation tables and plans that identify the locations where survey documentation information is required.
- Conduct a site walk-around to review material storage locations and general conditions relative to construction.
- Set up a time and place for regular construction progress meetings. The CQA Officer and/or the Owner will document this meeting.

3.2 Preinstallation Submittal

A preinstallation report will be prepared for each phase of construction of the composite liner and each phase of the composite final cover. The preinstallation report will be submitted to the WDNR no later than 15 days prior to the preinstallation meeting (refer to Subsection 3.3). The preinstallation report will include the information required under s. NR 516.04(5), including the following items:

- Any revisions and detail diagrams incorporating all changes between the owner, installer, and the quality assurance contractor.
- Identification of the manufacturer of the geosynthetics used in construction, manufacturer qualifications, technical specifications for each item, and results of the manufacturer's quality control tests for products supplied to the project.
- Results of a shear test conducted, in accordance with ASTM D5321 on the soils and geosynthetic materials selected for use in construction of the liner and the final cover.
- A Quality Control Plan which provides all information specified in s. NR 514.07(1)(i), as well as the identification of the installation contractor, contractor qualifications, and on-site supervisory staff.
- A Quality Assurance Plan which provides all information specified in s. NR 514.07(1)(j), as well as identification of the professional engineer and qualified technician who will be providing quality assurance and a summary of their qualifications and related work experience.

3.3 Preinstallation Meeting

Prior to commencement of the installation of the geomembrane component for each phase of construction of the composite liner and final cover, a preinstallation meeting will be held in accordance with s. NR 516.04(4). This meeting will include the parties involved in the construction, including the appropriate WDNR district and central staff, the CQA Officer or designated representative, the CQAT, the Construction Contractor, the Geosynthetic Installer, and the Owner.

The purpose of this meeting is to begin the planning and coordination of geosynthetic installation tasks, identify potential problems that might cause difficulties and delays in construction, to properly interpret the design intent, and to present the CQA Plan to all of the parties involved. It is important that the requirements regarding testing, seaming, repairs, etc., be known and accepted by each party to this Plan.

Specific topics considered for this meeting include the following:

- Review the proposed panel layouts and critical design details involving geosynthetic installation.
- Review measures for storm water controls and pumping requirements.
- Clarify or confirm design changes.
- Confirm acceptability of selected geosynthetic materials.
- Clarify construction concepts or practices required by the approved plans and preinstallation submittal.
- Review the responsibilities of each party.
- Review lines of authority and communication.
- Review methods for documenting and reporting, and for distributing documents and reports.
- Review requirements of geosynthetics testing laboratory regarding sample size, method of collection, and shipment. Also review turn times for sample data and their implications on the construction schedule, pending receipt of acceptance data.
- Review the number and locations of the tests required for geosynthetic components.
- Review methods of clay layer surface preparation and approval prior to geosynthetics placement.
- Establish rules for writing on the geosynthetic (i.e., who is authorized to write, what can be written, and in which color), and outline procedures for packaging and storing archive samples.

- Review geosynthetics panel and seam layout diagrams and numbering systems.
- Establish procedures for use of the geomembrane welding apparatus, if applicable.
- Finalize field cutout sample sizes.
- Review geosynthetic repair procedures.
- Establish procedures for the deployment of materials over prepared sub-grade and installed geosynthetics emphasizing protection of the geosynthetics. Specific discussion will address deployment of select granular or aggregate fill drainage materials on the sidewalls.
- Review the construction schedule.
- Review survey requirements.

The CQA Officer and/or the Owner will document this meeting, and minutes may be distributed to parties involved in the construction project.

4. General Construction Observation and Documentation

This section describes general documentation procedures to be implemented, including the use of forms, the identification and resolution of problems or deficiencies, and photographic documentation.

4.1 Progress Meetings

Progress meetings will be held regularly at the work area. At a minimum, meetings will be attended by field supervisory and CQA personnel. The purposes of the meetings are as follows:

- Review the work activity since the last progress meeting.
- Discuss the Contractor's and Installer's personnel and equipment assignments.
- Review the work schedule.
- Discuss possible issues.
- Review any new test data.
- Review data documentation requirements.
- The meetings will be documented by a person designated at the beginning of the meeting.

4.2 Daily Reports

A daily summary report will be prepared by the CQA Officer or the CQAT under direct supervision of the CQA Officer, for each day of activity and will include the following information:

- Date, project name, location, report preparer's name, and the names of representatives on- site performing CQA under the supervision of the CQA Officer
- Time work starts and ends each construction workday, along with the duration and reason for work stoppages (i.e., weather delay, equipment shortage, labor shortage, unanticipated conditions encountered, etc.)
- Data on weather conditions, including temperature, wind speed and direction, cloud cover, and precipitation
- Construction contractor's work force, equipment in use, and materials delivered to or removed from the job site

- Chronological description of work in progress, including locations and type of work performed
- A description of materials used and references or results of testing and documentation
- Discussion of problems/deficiencies identified and corrective actions taken as described in Subsection 4.4 (Problem/Deficiency Identification and Corrective Action)
- Identification/List of laboratory samples collected, marked, and delivered to laboratories, or clear reference to the document containing such information
- Subgrade acceptance reports submitted by the geosynthetic installer

Field data sheets containing the following information, as necessary, will be prepared daily by each representative:

- Test or sample location and elevation or lift number
- Type of documentation (i.e., field moisture/density test, etc.)
- Procedures used
- Test data (i.e., Proctor value, etc.)
- Results

4.3 Forms, Checklists, and Data Sheets

Additional forms may be developed during the course of the project to provide specific needs, such as GCL or geomembrane CQA documentation, or simply to improve the efficiency of data collection.

4.4 Problem/Deficiency Identification and Corrective Action

Problem and/or deficiency identification and corrective action will be documented in the daily report when a construction material or activity is observed or tested that does not meet the requirements set forth in this Plan. Problem and/or deficiency identification and corrective action documentation may include the following information:

- A description of the problem or deficiency, including reference to supplemental data or observations responsible for determining the problem or deficiency.
- The location of the problem or deficiency, including how and when the problem or deficiency was discovered, and an estimate of how long the problem or deficiency has existed.
- An opinion as to the probable cause of the problem or deficiency.

- A recommended corrective action for resolving the problem or deficiency. If the corrective action has already been implemented, then the observations and documentation to show that the problem or deficiency has been resolved should be included. If the problem or deficiency has not been resolved by the end of the day upon which it was discovered, then the report will clearly state that it is an unresolved problem or deficiency. Subsequent daily reports will indicate the status of problems or deficiencies until they are resolved.

If the problem or deficiency has not been resolved, then the CQA Officer and the CQAT will discuss the necessary corrective actions. The CQA Officer will work with the Owner and Construction Contractor to implement actions as necessary to resolve the problem or deficiency. A description of such problems or deficiencies and corrective actions implemented will be provided in the Construction Documentation Report.

The CQA Officer, working with the Owner and Construction Contractor, will determine if the problem or deficiency is an indication of a situation that might require changes to the plans and specifications and/or the CQA Plan. Revisions to the plans or specifications or the CQA Plan must be approved by the CQA Officer and the site Owner and may require consultation with the WDNR.

4.5 Photographic Documentation

Photographs will be taken to document observations, problems, deficiencies, corrective actions, and work in progress. Photographs will be in print format or digital and will be filed in chronological order in a permanent protective file or electronic file by the CQA Officer or the CQAT.

The following information may be documented in a log book for each photograph:

- Date and time
- Information regarding the orientation of the photograph itself for proper viewing (i.e., looking south)
- Description of the subject matter
- Unique identifying number for reference in reports

4.6 Surveying

Documentation surveying requirements for each composite liner or cover component are described in their respective report sections. Required surveying will be performed by personnel experienced in construction surveying. Surveys will be based on survey control points previously established at the site. Elevations will be based on mean sea level (M.S.L.) datum, and coordinates will be based on the site-specific horizontal control. The location of field tests and samples will be recorded. Generally, these locations can be determined by reference to nearby construction stakes or markings. However, if such convenient reference is not readily available, the CQA Officer or the designated CQAT will be responsible for providing or requesting survey control.

5. Compacted Select Clay Fill

5.1 General

This section includes the quality assurance requirements for placement, backfilling, and compaction of select clay fill. Compacted select clay fill will be used in the following manner:

- Constructing the landfill liner
- Constructing the final cover unless the select clay fill is replaced by a GCL overlying a minimum 2-feet-thick soil barrier layer.

Field tests and soil sample types will be recorded in the daily construction reports (refer to Subsection 4.2) including locations (by coordinates or survey point reference number) and elevation or lift number of field tests and laboratory sample points.

5.2 Procedures and Observation

The CQAT will observe compacted select clay fill construction activities and will document relevant observations to support certification of the following requirements:

- The CQAT will confirm the subbase is acceptable and ready for select clay fill placement prior to placement of select clay fill over the subbase. Procedures for determining subbase acceptance are discussed in Subsection 6.2.
- The CQAT will confirm the uniformity of the excavated soil to be used as select clay fill. Soil placement will be monitored for segregation and removal of unsuitable material and for changes in soil type, color, texture, and moisture content.
- The Construction Contractor will segregate and/or remove unsuitable materials such as granular soil, silty or sandy clay not meeting acceptance criteria, boulders, cobbles, organic material, and other deleterious material.
- The CQAT will observe clay placement and will measure field densities and moisture contents, using methods described in Subsection 5.3 (Sampling Requirements and Acceptance Criteria), to document that the compacted clay liner and cover are in substantial conformance with the placement specifications and that soil placement has been conducted in a manner to achieve a uniform, homogeneous clay mass.
- Voids created by nuclear density gauge (NDG) probes or as the result of Shelby tube samples will be backfilled with granular bentonite.
- Areas of unacceptable permeability, density, or moisture content, as defined by Subsection 5.3 (Sampling Requirements and Acceptance Criteria), will be documented by

the CQAT. Corrective action will consist of moisture-conditioning of the soil and/or additional compactive effort as necessary. Methods for moisture-conditioning soil are described below. Following corrective actions, such areas will be retested.

- If necessary, surfaces of liner or cover to receive successive lifts of clay will be moisture-conditioned either by scarification and addition of water where desiccated, or by discing and air drying where saturated to promote effective bonding of lifts. Following scarification, water will be applied with a spray bar applicator or equivalent method to achieve uniform distribution.
- The Contractor will place barrier layer material in maximum 6-inch compacted lifts.
- The CQAT will verify that compaction equipment has a minimum static weight of 30,000 pounds or has a minimum static weight 15,000 pounds that is capable of vibrating to produce a minimum dynamic compaction force of 30,000 pounds.
- The CQAT will verify that compaction equipment used to compact the clay layer has compaction feet a minimum of 6 inches long and that a sufficient number of equipment passes have been conducted to ensure complete remolding of the clay.
- Clay placement will be performed in a manner to achieve continuous and complete keying together of clay liner and cover construction areas. Stepped joints will be utilized to connect lateral segments of clay liner construction, as shown on the construction plan details.
- No frozen soil will be used for select clay fill liner or cover construction. Frozen soil in the compaction work area will be removed or allowed to melt prior to compaction.
- Stones and other penetrating objects 2 inches or larger and stones with sharp edges or points protruding from the surface of the final lift of compacted select clay fill will be removed to avoid puncturing the geomembrane. The CQAT will observe the liner or cover during this process and will document the removal of stones and other objects by the Contractor. Voids made by the removal of stones will be filled with clay soil or bentonite, and the entire liner surface will be rolled with a smooth-drum compactor.
- Preconstruction planning will be undertaken to sequence construction activities to minimize the length of time any completed clay surface will be exposed prior to receiving protective cover. Protective cover will be provided by the installation of the geomembrane.

5.3 Sampling Requirements and Acceptance Criteria

Field and laboratory sampling frequencies are based on the area or volume of material placed, as specified in s. NR 516.07. This section describes the required analyses, methods, sample frequencies, and acceptance limits. The CQAT will perform field tests and will collect soil samples for laboratory analysis.

5.3.1 Field Testing

The following field testing methods will be used by the CQAT during construction:

PARAMETER	METHOD
Soil density/Moisture content	ASTM D6938

Field density and moisture content tests will be performed on a 100-foot grid pattern for each 1-foot thickness of compacted select clay fill placed. The testing pattern will be offset on alternate lifts. In confined areas where compaction equipment is hindered or hand compaction is necessary, a minimum of two field density and moisture content tests will be performed for each 1-foot thickness of clay placed.

5.3.1.1 Field Testing Acceptance Criteria

Acceptance criteria for field density will require soil compaction to a minimum of 90 percent of the Modified Proctor (ASTM D1557) maximum dry density, or a minimum of 95 percent of the Standard Proctor (ASTM D698) maximum dry density. Moisture content requirements will be at least 2 percent wet of optimum if using the Modified Proctor, and at least wet of optimum if using the Standard Proctor, in accordance with s. NR 504.06(2)(f)(3). The acceptable range will be based on Proctor moisture-density relationships and compaction versus permeability relationships.

5.3.2 Laboratory Testing

Routine laboratory testing of the clay liner soil will be performed on samples from the clay borrow area and on the in-place clay soil samples collected by the CQAT. Samples for determining in-place properties will be collected by pushing Shelby tubes. Soil characteristics will be determined from representative samples and from Shelby tube samples.

5.3.2.1 Undisturbed Sample Analysis

One undisturbed sample will be taken for each acre or less for every 1-foot thickness of clay placed and will be submitted to the Soil Testing Laboratory.

The following analyses will be performed on all undisturbed samples obtained:

PARAMETER	TEST METHOD
Moisture content and dry density	ASTM D2216
Atterberg limits	ASTM D4318
Grain-size analysis	ASTM D6913

One of every three undisturbed samples will also be analyzed for hydraulic conductivity as follows:

PARAMETER	TEST METHOD
Hydraulic conductivity	ASTM D5084 or SW 846 EPA Method 9100

5.3.2.2 Representative Sample Analysis

Representative (grab) samples will be obtained on the basis of three criteria. First, an initial sample will be obtained from the clay borrow source (if not used in construction of a prior phase) and analyzed prior to construction. This will confirm soil characteristics and provide an initial maximum dry density and optimum moisture content for field moisture/density testing. Second, routine samples will be obtained for every 5,000 cubic yards placed. Third, in the event that changes in physical appearance or soil characteristics are observed, a sample will be obtained and analyzed. The maximum dry density and optimum moisture content values used for compaction testing may be adjusted during the course of liner and cover construction based on the results of the above sampling.

The following laboratory analyses will be performed on all representative samples obtained:

PARAMETER	TEST METHOD
Moisture-density relationship using Modified/Standard Proctor compaction	ASTM D1557 (a, b)/ ASTM D698 (a, b)
Atterberg limits	ASTM D4318
Grain-size analysis	ASTM D6913(c)

Notes:
(a)Five-point Proctor analysis required for first and second sampling criteria.
(b)A one-point Proctor analysis may be utilized for representative samples collected for the third sampling criterion (apparent changes in soil quality) to verify applicability of previously analyzed moisture-density relationships. If the result does not verify applicability, then a five-point analysis will be performed in accordance with the first sampling criterion.
(c)Distribution is to be reported through the 0.002-mm particle size.

5.3.2.3 Laboratory Testing Acceptance Criteria

The following acceptance criteria will apply to the compacted select clay fill.

- A minimum 50 percent by weight that passes the #200 sieve
- A saturated hydraulic conductivity of 1×10^{-7} cm/s or less, when compacted to required moisture contents and densities based on the modified Proctor method, standard Proctor method, or a line of optimums method approved by the WDNR.
- No clods greater than 4 inches.

- An average liquid limit of 25 or greater, with no values less than 20
- An average plasticity index of 12 or greater, with no values less than 10

5.4 Thickness Documentation

The bottom and top of the clay liner portion of the composite liner will be surveyed on a 50-foot grid pattern (same location for the top and bottom of the clay liner) and at other key location (breaks in slope, toe of slopes, top of slopes, limit of liner construction, etc.) to determine that minimum as-constructed clay liner thicknesses were achieved.

The bottom of the final cover select clay fill layer will be surveyed on a maximum 100-foot grid pattern (maximum 50-foot grid pattern if the final cover construction is less than 4 acres) and at key locations for final cover.

In the alignment for leachate collection lines, bottom and top of the clay liner elevation of the trench will be surveyed at maximum 25-foot intervals (maximum 50-foot intervals if a total station, laser equipment, or survey quality global positioning system equipment is used). The clay liner and cover thicknesses will be determined at surveyed locations or cover auger locations and reported in a tabular fashion. The minimum acceptable liner/cover thickness will be as indicated on the Plan of Operations drawings and details.

6. General Soil

6.1 General

This section includes the quality assurance requirements for placement, compaction, and grading of general soil (i.e., general fill). General soil may be any inorganic soil. General soil will be used in the construction of the following landfill components:

- Subbase preparation
- Final cover
- Access roads
- Landfill perimeter berms

All field tests, soil sample types, and survey measurements will be recorded as record construction data, including locations (by coordinates) and elevations or lifts of field tests and laboratory sample points.

6.2 Procedures and Observation

The CQAT will observe general soil placement activities and will document relevant observations to support certification of the following requirements:

- The CQAT will periodically observe loads of general fill for general conformance to material specifications and may randomly sample loads. The CQAT will perform routine conformance sampling as defined in Subsection 6.3.2.
- No frozen soil will be used for backfilling. Any frozen soil in the compaction work area will be removed.
- Loose lift thickness for general soil compaction will not exceed 18 inches.
- General soil used as structural fill (i.e., subbase preparation, perimeter landfill berms and roads) will be compacted to a minimum of 90 percent or 95 percent of the maximum dry density as determined by the Modified or Standard Proctor test, respectively.
- Unacceptable compaction density, as defined above, will be reported to the CQA Officer by the CQAT. Corrective action will consist of moisture-conditioning of the soil and/or additional compactive effort, as necessary.
- The CQAT will confirm the subbase is acceptable and ready for select clay fill placement prior to placement of select clay fill over the subbase. The CQAT will notify the Engineer

of any soft appearing areas of the subbase during subbase development and prior to select clay fill placement.

- General soil used as final cover shall be placed over the geosynthetics in the same construction season as the geosynthetic construction.

Field densities using methods described in Subsection 6.3.1 will be measured to document that the in-place soil is in substantial conformance with the required density.

6.3 Sampling Requirements and Acceptance Criteria

Testing is required for general soil used as structural fill (recompacted soil used in subgrade and berm construction). No field or laboratory testing of general soil will be required for placement in the final cover. Sampling and testing of structural fill will be conducted in accordance with NR 516.07(1m)

6.3.1 Field Testing

The following field testing method will be used by the CQAT during construction:

PARAMETER	TEST METHOD
Soil density/Moisture content	ASTM D6938

Field density and moisture content tests will be performed on a 100-foot grid pattern as much as reasonably possible for each 1-foot thickness of compacted structural fill placed or at a minimum frequency of one test per 370 cubic yards of structural fill placed. The testing pattern will be offset on alternate lifts as much as reasonably possible. In confined areas where compaction equipment is hindered or hand compaction is necessary, a minimum of two field density and moisture content tests will be performed for each 1-foot thickness of structural fill placed.

6.3.1.1 Field Testing Acceptance Criteria

Acceptance criteria for field density will require soil compaction to a minimum of 90 percent of the Modified Proctor (ASTM D1557) maximum dry density, or a minimum of 95 percent of the Standard Proctor (ASTM D698) maximum dry density.

6.3.2 Laboratory Testing

Routine laboratory testing of the structural fill will be performed on representative samples collected from the general fill borrow area and/or general fill stockpiles. Soil characteristics will be determined from representative samples.

6.3.2.1 Representative Sample Analysis

Representative (grab) samples of the structural fill will be obtained at a minimum frequency of one sample for every 5,000 cubic yards placed and a sample will be collected in the event that changes in physical appearance or soil characteristics are observed. The maximum dry density values used for compaction testing may be adjusted during the course construction based on the results of the above sampling.

The following laboratory analyses will be performed on all representative samples obtained:

PARAMETER	TEST METHOD
Moisture-density relationship using Modified or Standard Proctor compaction	ASTM D1557 (a)/ ASTM D698 (a)
Atterberg limits(b)	ASTM D4318
Grain-size analysis(c)	ASTM D6913

Notes:
(a)A one-point Proctor analysis may be utilized for representative samples collected for the third sampling criterion (apparent changes in soil quality) to verify applicability of previously analyzed moisture-density relationships. If the result does not verify applicability, then a five-point analysis will be performed in accordance with the first sampling criterion.
(b) Atterberg limits are only applicable when the sample is fine grain soil.
(c)Distribution is to be reported through the 0.002-mm particle size.

6.3.2.2 Laboratory Testing Acceptance Criteria

There are no laboratory acceptance criteria for general fill.

6.4 Thickness Documentation

Top of subbase grades will be documented on an approximate 50-foot grid, and at other key locations, such as breaks in grade, toes of slope, mid-points, and tops of slopes. In the alignment for leachate collection undercuts, the bottom of trench undercut elevations will be surveyed at maximum 25-foot intervals (maximum 50-foot intervals if total station, laser equipment, or survey grade global positioning system equipment is used). The allowable tolerance in subbase elevation will be -0.1 foot or as allowed by the CQA Officer.

The top of the grading layer elevations in the final cover will be surveyed on an approximate 100-foot grid pattern (50-foot grid pattern on final cover areas less than 4 acres), and at other key locations, such as breaks in grade and toe of slopes. The top of grading layer elevations will be at or below the approved design grades prior to final cover construction.

The rooting zone thickness of the final cover will be measured on an approximate 100-foot grid (50-foot on final cover areas less than 4 acres), and at other key locations, such as breaks in grade and toes of slopes.

In addition to survey measurements for elevation, measurements for horizontal location will also be performed using previously established horizontal control to document the boundaries and alignment of the general soil placement.

7. Granular Fill

7.1 General

Granular fill includes select granular fill, select aggregate fill, and select graded fill (if required). Select granular fill is used as gradient control system drainage layer material in the final cover drainage layer, and as leachate collection drainage layer material. Select aggregate fill is used as gradient control trench collection pipe bedding material, leachate collection pipe bedding material, backfill stone sumps, passive gas venting pipe bedding material, and as pipe bedding in the final cover drain outlets for the geosynthetic drainage layer and perimeter toe drains.

Pipe bedding material refers to the gravel to be used for structural support of the identified pipes. A select graded fill layer may be placed between select granular fill and select aggregate fill materials if required as a filtering layer to avoid piping of the select granular fill into the select aggregate fill. Limestone and dolomite stone will not be used in the leachate collection system unless no other suitable material is reasonably available. Select aggregate fill used in the leachate collection system above geomembrane should be rounded to subangular.

7.2 Procedures and Observation

The CQAT will observe granular soil placement activities and will document relevant observations to support certification of the following requirements:

- The CQAT will periodically observe loads of granular soil for general conformance to material specifications and may randomly sample loads. The CQAT will perform routine conformance sampling as defined in Subsection 7.3.
- No trucks or heavy equipment will travel directly on the liner or final cover geomembrane. Only low-ground pressure tracked equipment (< 5 psi) may operate above the geomembrane when there is a minimum 12-inch–thick layer of select granular fill or soil is in-place between the tracks of the equipment and the geomembrane. A minimum of 2 feet of material will be required to be placed over the geomembrane prior to operating other tracked and flotation tire–equipped vehicles. Rubber-tired equipment may not travel above the geomembrane unless a minimum of 3 feet of material is in-place over the geomembrane. Procedures for deployment of pipe, select aggregate fill, geocomposite drainage layers and geotextiles overlying geomembranes will be planned at the preconstruction meeting or at progress meetings. Special requirements for geomembrane protection and equipment necessary to deploy materials must be approved by the CQA Officer. Guidance will be provided to machine operators placing soil on geomembrane by the use of an observer with an unobstructed view of the advancing lift of soil.

- Care will be exercised during placement of granular soil to prevent undue damage to pipes, geomembrane, geocomposites, and geotextiles. Stone will not be dropped from a height greater than 3 feet above the pipe trench or sump. Guidance will be provided to machine operators placing soil on geomembrane by the use of an observer with an unobstructed view of the advancing lift of soil.
- A 12-ounce per square yard geotextile cushion will be placed between the geomembrane and the leachate collection pipe bedding material in the leachate collection trenches. Refer to Section 11 for geotextile requirements.
- A minimum of 4 inches of pipe bedding material will be placed under leachate collection pipes prior to pipe placement, and a minimum of 2.0 feet of bedding material will be placed over the top of the leachate collection pipes. An additional 1.0 feet of select granular material will then be placed above the pipe bedding material or graded filter over the pipe.
- If granular soil is stockpiled on-site prior to use, measures will be taken to minimize contamination by fines such as wind-blown particles and surface soil during loading operations.
- Select granular fill or soil placed above the geomembrane shall be placed during cooler temperatures, to the extent possible, to minimize the movement and folding of wrinkles in the geomembrane.
- Granular drainage layer will be placed above on the landfill base and the lower 10 feet of the sideslopes less than 30 days after completion of the geosynthetics to lessen desiccation effects.

7.3 Sampling Requirements and Acceptance Criteria

Field sampling and laboratory testing frequencies are based on proportionate sampling of construction areas or volumes of material placed as specified by s. NR 516.07. This section describes the required analyses, methods, sampling frequencies, and acceptance limits. The CQAT will collect soil samples for laboratory analysis.

7.3.1 Field Testing

No field testing will be required for select granular fill, select aggregate fill, or pipe bedding material soil. However, as stated in Subsection 7.2 above, the CQAT will perform a visual inspection of this soil for conformance to material specifications and may randomly sample deliveries.

7.3.2 Laboratory Testing

Representative (grab) samples will be obtained from the proposed select granular fill, select aggregate fill, and pipe bedding/filtering layer material sources prior to delivery of the material. On-site grab samples may also be collected from trucks delivering granular materials or stockpiles. The source sampling frequency will be dependent on the apparent uniformity of the source and must be approved by the CQA Officer.

Grab samples of granular material placed will be collected and analyzed as follows:

SOIL TYPE	FREQUENCY	PARAMETER	TEST METHOD
Select aggregate fill pipe bedding material (leachate collection pipes and groundwater collection pipes)	1/1,000 LF of pipe or a minimum of 3 samples(a)	Grain size	ASTM D6913(b)
Select aggregate fill (in sumps)	1/500 CY	Grain size	ASTM 6913(b)
Select aggregate fill (leachate collection drainage layer)	1/5,000 CY or a minimum of 2 samples(c)	Grain size	ASTM D6913 (b)
Select granular fill (gradient control drainage layer)	1/1,000 CY or a minimum of 4 samples(e)	Grain size	ASTM D6913 (b)
Select granular fill (gradient control drainage layer)	1/2,500 CY or a minimum of 2 samples(c)	Hydraulic conductivity	ASTM D2434
Select granular fill (final cover drainage layer)	1/2,500 CY or a minimum of 2 samples	Hydraulic conductivity	ASTM D2434
Select granular fill (final cover drainage layer)	1/1,000 CY or a minimum of 4 samples	Grain size	ASTM D6913 (b)
Select aggregate fill pipe bedding material (final cover toe drains)	1/1,000 CY	Grain size	ASTM D6913 (b)
Pipe bedding material (solid-wall pipe associated with the transfer of leachate and groundwater)	1/1,000 LF of pipe or a minimum of 3 samples (a)	Grain size	ASTM D6913(d)

Notes:
(a)For construction projects with a combined pipe trench of less than 3,000 linear feet, a minimum of three samples will be tested.
(b)Testing is required only to the #200 sieve.
(c)For lesser volumes, a minimum of two samples will be tested.
(d)Testing is required to the #4 sieve.
(e)For lesser volumes, a minimum of four samples will be tested.

7.3.2.1 Laboratory Testing Acceptance Criteria

Select aggregate fill utilized in the leachate collection system (leachate collection pipe bedding and leachate sump backfill material) will have a uniformity coefficient of less than 4, will contain no more than 5 percent by weight passing the #4 sieve, will have a maximum particle diameter of 1 ½ inches, and have a minimum hydraulic conductivity of 1 cm/s at the anticipated field density. Limestone and dolomite stone will not be used in the leachate collection system unless no other suitable material is reasonably available. Select aggregate fill used in the leachate collection system above geomembrane should be rounded to subangular.

Select granular fill used in the GCS drainage layer will have a remolded hydraulic conductivity of 1 x 10^{-3} cm/s or greater at the anticipated field density. Select granular fill used in the leachate collection drainage layer will have a remolded hydraulic conductivity of 1 x 10^{-2} cm/s or greater at the anticipated field density.

Select granular fill used in the final cover drainage layer will have a remolded hydraulic conductivity of 1 x 10^{-3} cm/s or greater at the anticipated field density.

Select aggregate fill pipe bedding material used in the final cover toe drains will have a remolded hydraulic conductivity of 1 x 10^{-2} cm/s or greater at the anticipated field density.

7.4 Thickness Documentation

The finished elevation of the select granular fill drainage layer portion of the leachate and gradient control systems will be surveyed on a 50-foot grid, which coincides with the grid used for the clay liner and final cover barrier layer, respectively, to verify its layer thicknesses. The minimum acceptable drainage layer thickness will be 12 inches or as shown on the Plan of Operations drawings. Pipe bedding placed along collection pipe alignments will be surveyed for elevation prior to pipe placement and following pipe backfilling at 25-foot intervals to document the thickness of gravel placed below pipe inverts and above the top of pipe. The minimum acceptable stone thickness will be 4 inches below and 24 inches above the leachate collection piping.

8. Compacted Barrier Layer

8.1 General

This section includes the quality assurance requirements for placing, backfilling, and compacting the barrier layer soil in the final cover system if the barrier layer option for the final cover is used. The 24-inch–thick soil barrier layer will consist of fine-grained soil or well graded sand with fines.

8.2 Subgrade Preparation

The Contractor will be responsible for the preparation of the subgrade of the barrier layer. Subgrade preparation will include grading the top-of-waste.

The CQA Officer or CQAT will inspect the subgrade, upon completion of the grading work and will verify, at a minimum, the following:

- A qualified surveyor has verified lines and grades as described in Subsection 6.4.
- The grading layer meets the criteria in the project specifications.

The CQAT will indicate to the Contractor any observed locations that are not adequate for the placement of the barrier layer during final cover construction. The Contractor will repair defects in the subgrade soil such that the properties of the repaired areas meet the minimum subgrade requirements.

8.3 Procedures and Observations

The CQAT will observe and document barrier layer construction activities to support certification of the following requirements:

- The CQAT will confirm the uniformity of the barrier layer soil and will monitor for segregation and removal of unsuitable material and for changes in soil type, color, texture, and moisture content. The Contractor will segregate and/or remove unsuitable materials, such as soil not meeting acceptance criteria, boulders, cobbles, and organic material.
- The CQAT will observe the barrier layer placement and will measure field densities and moisture contents (refer to Subsection 8.4), to document that the barrier layer is in substantial conformance with the specifications and that soil placement has been conducted in a manner to achieve a uniform, homogeneous mass.

- The CQAT will backfill with granular bentonite, or a bentonite-soil mixture, voids created by nuclear density gauge probes.
- The CQAT will document areas of unacceptable density or moisture content, as defined by Subsection 8.4. The Contractor will perform corrective action that will consist of the moisture-conditioning of the soil and/or additional compactive effort, as necessary. The CQAT will retest the area, following corrective actions.
- The Contractor will place barrier layer material in maximum 1-foot lifts.
- The CQAT will verify that compaction equipment has a minimum static weight of 30,000 pounds or has a minimum static weight 15,000 pounds that is capable of vibrating to produce a minimum dynamic compaction force of 30,000 pounds.
- The CQAT will verify that compaction equipment used to compact the barrier layer has compaction feet a minimum of 6 inches long.
- The Contractor will not use frozen soil in the barrier layer and will remove frozen soil from the compaction work area.
- The Contractor will remove stones and other penetrating objects 1 inch or larger protruding from the surface of the final lift of the barrier layer to avoid puncturing the overlying geosynthetics. The CQAT will document the removal of the stones and other objects. The Contractor will fill with barrier layer soil or bentonite any voids made by the removal of stones, and the entire cover surface will be rolled with a smooth-drum compactor.
- Preconstruction planning will be undertaken to sequence construction activities to minimize the length of time a completed barrier layer surface will be exposed prior to receiving protective cover. Protective cover will be provided by the installation of the GCL and subsequently the geomembrane.

8.4 Sampling Requirements and Acceptance Criteria

This section describes the required analyses, methods, sample frequencies, and acceptance limits of the barrier layer. The CQAT will collect soil samples for laboratory analysis. The CQAT will record the field sample locations in the daily construction reports or field data sheets as record construction data, including locations and lift locations of the laboratory sample points.

8.4.1 Field Testing

The CQAT will use the following field-testing methods during construction of the barrier layer:

PARAMETER	TEST METHOD
Soil density/Moisture content	ASTM D6938

Moisture content and field density tests will be performed in accordance with NR 516.07(2m)(b)(1) using a nuclear density gauge on a 100-foot grid pattern for each 1-foot thickness of barrier layer soil placed. The testing grid pattern will be offset on each subsequent layer of tests. In confined areas where compaction equipment is hindered or hand compaction is necessary, a minimum of two field density and moisture content tests will be performed for each 1-foot thickness of barrier layer soil placed.

8.4.2 Field Testing Acceptance Criteria

Acceptance criteria for field density will require soil compaction to a minimum of 90 percent of the Modified Proctor (ASTM D1557) maximum dry density or to a minimum of 95 percent of the Standard Proctor (ASTM D698) maximum dry density and at a moisture content wet of optimum moisture content.

8.4.3 Laboratory Testing

Routine laboratory testing of the barrier layer soil will be performed on samples from the borrow area or on-site stockpile (representative). Soil characteristics will be determined from the representative samples.

8.4.3.1 Representative Sample Analysis

Representative (grab) samples will be obtained on the basis of three criteria. First, an initial sample will be obtained from the borrow source (if not used in construction of a prior phase) and analyzed prior to construction. This will confirm soil characteristics and provide an initial maximum dry density and optimum moisture content for field moisture/density testing. Second, routine samples will be obtained for every 5,000 cubic yards placed. Third, in the event that changes in physical appearance or soil characteristics are observed, a sample will be obtained and analyzed. The maximum dry density and optimum moisture content values used for compaction testing may be adjusted during the course of cover construction based on the results of the above sampling.

The following laboratory analyses will be performed on the representative samples obtained:

PARAMETER	TEST METHOD
Moisture-density relationship using Modified or Standard Proctor compaction	ASTM D1557 (1, 2)/ ASTM D698 (1, 2)
Atterberg limits	ASTM D4318
Grain-size analysis	ASTM D6913(3)

Notes:
(1)Five-point Proctor analysis required, except as described in Note 2, below.
(2)One-point Proctor analysis may be utilized for representative samples collected for apparent changes in soil quality to verify applicability of previously analyzed moisture-density relationships. If the result does not verify applicability, then a five-point analysis will be performed in accordance with the first sampling criteria.
(3)Distribution is to be reported through the 0.002-mm particle size.

8.4.4 Laboratory Testing Acceptance Criteria

The following acceptance criteria will apply to the barrier layer.

- The upper 1 foot of the barrier layer will have a maximum particle diameter of 2-inches and the lower 1 foot of the barrier layer will have a maximum particle diameter of 4 inches.
- Fine grained-soil or well graded sandy soil with fines meeting the USCS soil types ML, CL, CH, SM, or SC, or dual-symbol classifications composed of those soil types, with at least 25 percent by weight passing the #200 sieve.

8.5 Thickness Documentation

The bottom of the final cover barrier layer will be surveyed on a maximum 100-foot grid pattern (maximum 50-foot grid pattern if the final cover construction is less than 4 acres) and at key locations on the final cover. Key locations include breaks in grade, top of slopes, and limits of final cover construction. The barrier layer thickness will be determined at top of grading layer surveyed locations and reported in a tabular fashion in the Construction Documentation Report. The minimum acceptable barrier layer thickness will be 2 feet.

9. Topsoil

9.1 General

This section includes the quality assurance requirements for the excavation and placement of the topsoil and for the fertilization, seeding, mulching, and watering of the topsoil layer for vegetation. Topsoil is the final layer of soil material installed on the final cover, along the outside slopes of the perimeter berms, along the ditches, and on other perimeter areas. Topsoil will be obtained from existing on-site stockpiles, from soil excavated by the clearing of the landfill footprint and associated disturbed perimeter areas, or from an off-site borrow source.

9.2 Procedures and Observation

Work covered by this section will be performed in accordance with the construction plans and specifications. The CQAT will observe topsoil placement activities and will document relevant observations to support certification of the following requirements:

- The CQAT will confirm the source and uniformity of topsoil used. Soil excavation and placement will be monitored for minimization of inorganic soil not compatible for establishment of vegetation.
- Prior to seeding, the topsoil will be worked to prepare a suitable seedbed.
- Fertilizing, seeding, and mulching will be performed in a timely manner.

9.3 Sampling Requirements and Acceptance Criteria

The topsoil will be suitable for the establishment and long-term maintenance of the selected vegetation seed mix with appropriate fertilization. At the CQA Officer’s discretion, samples may be collected for laboratory testing.

9.4 Thickness Documentation

The thickness of topsoil placement on the final cover will be documented on a 100-foot grid by surveying or by hand shoveling or auguring and measuring the observed thickness of topsoil.

10. Geomembrane

10.1 General

This section of the CQA Plan applies to the high-density polyethylene (HDPE) geomembrane used in the landfill composite liner and the linear low density polyethylene (LLDPE) geomembrane used in the composite final cover. The geomembrane used in the liner system of the landfill will be 60-mil HDPE (textured and/or smooth). The geomembrane in the final cover will be 40-mil LLDPE (textured and/or smooth).

The geomembrane will be supplied to the site in factory rolls. No factory seams will be used to prepare larger panels of geomembrane for delivery to the site.

This section is divided into five major subheadings, which cover general information, and the CQA requirements for pre-installation, installation, field seaming, and post-installation. These terms pre-installation, installation, field seaming, and post–installation are applicable only to the geomembrane installation and to not apply to the overall construction of the landfill facility.

10.2 Pre-Installation

This section describes the quality control measures that are applicable to the polyethylene (PE) resin manufacturers, geomembrane manufactures, and finished geomembrane roll delivery to the site prior to installation.

The geomembrane must be fabricated from polyethylene resin and be virgin material with no more than 10 percent rework by weight. Rework material must be of the same formulation as the parent material. No post-consumer resin allowed.

10.2.1 Manufacturing

10.2.1.1 Material Specifications

The following list specifies the required geomembrane materials for liner and final cover construction:

- Base liner sideslopes (3H:1V): 60-mil HDPE-textured
- Base liner base (less than 10 percent slopes): 60-mil HDPE-textured (smooth optional)
- Final cover (with 5 percent slopes): 40-mil HDPE-textured (smooth optional)
- Final cover (4H:1V slopes): 40-mil LLDPE-textured

10.2.1.2 Quality Control Requirements

Prior to the delivery of any geomembrane rolls to the site, the Geomembrane Manufacturer will provide the Owner and the CQA Officer with the following information:

- The resin supplier, location of supplier's production plant(s), and resin brand name and product number
- Any results of tests conducted by the Geomembrane Manufacturer and/or the Resin Manufacturer's testing laboratories to document the quality of the resin used in fabricating the geomembrane
- The Quality Control Plan that the Geomembrane Manufacturer will be using for the geomembrane being supplied

Every roll of geomembrane for delivery to the site must be manufactured and inspected in accordance with the Geomembrane Manufacturer according to the following requirements:

- First quality polyethylene resin must be used.
- The geomembrane must contain no more than a maximum of 1 percent by weight of additives, fillers, or extenders, excluding carbon black.
- Carbon black for ultraviolet protection shall be added during manufacturing of the geomembrane.
- The geomembrane must be free of holes, blisters, undispersed raw materials, or any other sign of contamination by foreign matter.

The Geomembrane Manufacturer will routinely perform specific gravity (ASTM 0792, method B or ASTM D1505) and melt index (ASTM D1238) tests on the raw resin to document the quality of the HDPE and LLDPE resin used to manufacture the geomembrane rolls assigned to this project. The maximum specific gravity allowed for the HDPE and LLDPE raw resin is 0.932 and 0.926, respectively. The maximum melt index for both the HDPE and LLDPE raw resins is 1.0 grams/10 minutes.

10.2.1.3 Manufacturer's Certification

The Geomembrane Manufacturer will test the geomembrane produced for the site according to the test method and frequencies listed in Tables 10-1, 10-2, 10-3 and 10-4 or in accordance with the most current version of GM13 and GM17.

The Geomembrane Manufacturer will provided certification, based on tests performed by either the Geomembrane Manufacturer's laboratory or another outside laboratory contracted by the Geomembrane Manufacturer, that the geomembrane supplied under this Plan will meet the specifications presented in Tables 10-1, 10-2, 10-3 and 10-4. Additionally, the Manufacturer will provide certification that the Manufacturer's Quality Control Plan was fully implemented for the geomembrane material supplied under this Plan. The Manufacturer will provide documentation to verify results of the Manufacturer's Quality Control Plan implementation if requested by the CQA Officer.

10.2.2 Delivery, Handling, and Storage of Geomembrane Rolls

The geomembrane will be protected during shipment from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The geomembrane rolls will be stored on-site in a designated area and will be protected from long-term ultraviolet exposure prior to actual installation.

- Each geomembrane roll will be marked by the Geomembrane Manufacturer with the following information (on a durable gummed label, or equivalent, on inside of core):
  - Name of Manufacturer
  - Product type and identification number (if any)
  - Roll length and width
  - Nominal product thickness
  - Roll number
  - Batch or lot number
  - Date of manufacture

Table 10-1 High Density Polyethylene (HDPE) Geomembrane – Smooth Test Frequency and Acceptance Criteria

PROPERTIES	TEST METHOD	TEST VALUE (60 mils)	TESTING FREQUENCY
Thickness (min. average) Lowest individual of 10 values	D5199	Nom. -10%	Per roll
Density mg/L (minimum)	D1505/D792	0.940 g/cc	200,000 lb
Tensile Properties (min. average)(1) Yield strength Break strength Yield elongation Break elongation	D6693 Type IV	126 lb/in. 228 lb/in. 12% 700%	20,000 lb
Tear Resistance (min. average)	D1004	42 lb	45,000 lb
Puncture Resistance (min. average)	D4833	108 lb	45,000 lb
Stress Crack Resistance(2)	D5397 (App.)	500 hr.	per GRI-GM10
Carbon Black Content (range)	D4218(3)	2.0–3.0%	20,000 lb
Carbon Black Dispersion	D5596	Note (4)	45,000 lb
Oxidative Induction Time (OIT) (min. average)(5) Standard OIT —or— High Pressure OIT	D3895 D5885	100 min. 400 min.	200,000 lb
Oven Aging at 85°C(5)(6) Standard OIT (min. average) - % retained after 90 days —or— High Pressure OIT (min. average) - % retained after 90 days	D5721 D3895 D5885	55% 80%	Per each formulation
UV Resistance(7) Standard OIT (min. average) —or— High Pressure OIT (min. average) - % retained after 1,600 hours(9)	D7238 D3895 D5885	N.R.(8) 50%	Per each formulation

Notes:

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

- Yield elongation is calculated using a gauge length of 1.3 inches.
- Break elongation is calculated using a gauge length of 2.0 inches.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D1603 (tube furnace) or D63 TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:

- Nine in Categories 1 or 2, and 1 in Category 3.

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

(7) The condition of the test should be 20-hour UV cycle at 75°C, followed by 4-hour condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value of the original HP-OIT value.

Table 10-2 High Density Polyethylene (HDPE) Geomembrane – Textured Test Frequency and Acceptance Criteria

PROPERTIES	TEST METHOD	TEST VALUE (60 mils)	TESTING FREQUENCY
Thickness (min. average) Lowest individual for 8 out of 10 values Lowest individual for any of the 10 values	D5994	Nom. (-5%) 10% 15%	Per roll
Asperity Height (min. average)(1)	D7466	16 mil.	Every second roll(2)
Density (min. average)	D1505/D 792	0.940 g/cc	200,000 lb
Tensile Properties (min. average)(3) Yield strength Break strength Yield elongation Break elongation	D6693 Type IV	126 lb/in. 90 lb/in. 12% 100%	20,000 lb
Tear Resistance (min. average)	D1004	42 lb	45,000 lb
Puncture Resistance (min. average)	D4833	90 lb	45,000 lb
Stress Crack Resistance(4)	D5397 (App.)	500 hr.	per GRI-GM10
Carbon Black Content (range)	D4218(5)	2.0–3.0%	20,000 lb
Carbon Black Dispersion	D5596	Note (6)	45,000 lb
Oxidative Induction Time (OIT) (min. average)(7) Standard OIT —or— High Pressure OIT	D3895 D5885	100 min. 400 min.	200,000 lb
Oven Aging at 85°C(7)(8) Standard OIT (min. average) - % retained after 90 days —or— High Pressure OIT (min. average) - % retained after 90 days	D5721 D3895 D5885	55% 80%	Per each formulation
UV Resistance(9) Standard OIT (min. average) —or— High Pressure OIT (min. average) - % retained after 1,600 hours(11)	D7238 D3895 D5885	N.R.(10) 50%	Per each formulation

Notes:

(1) Of 10 readings, 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils. Also refer to Note 6.

(2) Alternate the measurement side for double-sided textured sheet.

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of five test specimens each direction.

- Yield elongation is calculated using a gauge length of 1.3 inches.
- Break elongation is calculated using a gauge length of 2.0 inches.

(4) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials. The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(5) Other methods such as D1603 (tube furnace) or D63 TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:

- Nine in Categories 1 or 2, and 1 in Category 3.

(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

(9) The condition of the test should be 20-hour UV cycle at 75°C, followed by 4-hour condensation at 60°C.

(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(11) UV resistance is based on percent retained value of the original HP-OIT value.

Table 10-3 Linear Low Density Polyethylene (LLDPE) Geomembrane – Textured Test Frequency and Acceptance Criteria

PROPERTIES	TEST METHOD	TEST VALUE (40 mils)	TESTING FREQUENCY (minimum)
Thickness mils (min. average) ▪ Lowest individual for 8 out of 10 values ▪ Lowest individual for any of the 10 values	D5994	nom. (-5%) -10% -15%	Per roll
Asperity Height mils (min. average)(1)	D7466	16	Every 2nd roll(2)
Density g/ml (max.)	D1505/D792	0.939	200,000 lb
Tensile Properties (min. average)(3) ▪ Break strength - lb/in ▪ Break elongation - %	D6693 Type IV	60 250	20,000 lb
2% Modulus - lb/in (max.)	D5323	2,400	Per formulation
Tear Resistance - lb (min. average)	D1004	22	45,000 lb
Puncture Resistance - lb (min. average)	D4833	44	45,000 lb
Axi-Symmetric Break Resistance Strain - % (min.)	D5617	30	Per formulation
Carbon Black Content - %	D4218(4)	2.0-3.0	45,000 lb
Carbon Black Dispersion	D5596	Note (5)	45,000 lb
Oxidative Induction Time (OIT) (min. average)(6) ▪ Standard OIT —or— ▪ High Pressure OIT	D3895 D5885	100 400	200,000 lb
Oven Aging at 85°C(7) ▪ Standard OIT (min. average) - % retained after 90 days —or— ▪ High Pressure OIT (min. average) - % retained after 90 days	D5721 D3895 D5885	35 60	Per formulation
UV Resistance(8) ▪ Standard OIT (min. average) —or— ▪ High Pressure OIT (min. average) - % retained after 1,600 hours(10)	D3895 D5885	N.R. (9) 35	Per formulation

Notes:

(1) Of 10 readings, 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils; also refer to Note 9.

(2) Alternate the measurement side for double-sided textured sheet.

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

- Break elongation is calculated using a gauge length of 2.0 inches at 2.0 in/min.

(4) Other methods such as D1603 (tube furnace) or D63 TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:

- Nine in Categories 1 or 2, and 1 in Category 3.

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

(8) The condition of the test should be 20-hour UV cycle at 75°C, followed by 4-hour condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Table 10-4 Linear Low Density Polyethylene (LLDPE) Geomembrane – Smooth Test Frequency and Acceptance Criteria

PROPERTIES	**TEST METHOD**	**TEST VALUE (40 mils)**	**TESTING FREQUENCY (minimum)**
Thickness mils (min. average) ▪ Lowest individual for any of the 10 values	D5994	nom. -10%	Per roll
Density g/ml (max.)	D1505/D792	0.939	200,000 lb
Tensile Properties (min. average)(1) ▪ Break strength - lb/in ▪ Break elongation - %	D6693 Type IV	152 800	20,000 lb
2% Modulus - lb/in (max.)	D5323	2,400	Per formulation
Tear Resistance - lb (min. average)	D1004	22	45,000 lb
Puncture Resistance - lb (min. average)	D4833	56	45,000 lb
Axi-Symmetric Break Resistance Strain - % (min.)	D5617	30	Per formulation
Carbon Black Content - %	D4218(2)	2.0-3.0	45,000 lb
Carbon Black Dispersion	D5596	Note (3)	45,000 lb
Oxidative Induction Time (OIT) (min. average)(4) ▪ Standard OIT —or— ▪ High Pressure OIT	D3895 D5885	100 400	200,000 lb
Oven Aging at 85°C(5) ▪ Standard OIT (min. average) - % retained after 90 days —or— ▪ High Pressure OIT (min. average) - % retained after 90 days	D5721 D3895 D5885	35 60	Per formulation
UV Resistance(6) ▪ Standard OIT (min. average) —or— ▪ High Pressure OIT (min. average) - % retained after 1,600 hours(8)	D3895 D5885	N.R. (7) 35	Per formulation

Notes:

(1)Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

- Break elongation is calculated using a gauge length of 2.0 inches at 2.0 in/min.

(2)Other methods such as D1603 (tube furnace) or D63 TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

(3) Carbon black dispersion (only near spherical agglomerates) for 10 different views:

- Nine in Categories 1 or 2, and 1 in Category 3.

(4)The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(5)It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

(6)The condition of the test should be 20-hour UV cycle at 75°C, followed by 4-hour condensation at 60°C.

(7)Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(8)UV resistance is based on percent retained value regardless of the original HP-OIT value.

10.3 Installation

This section includes discussion of geomembrane roll testing requirements, earthwork required for geomembrane placement, placement of the geomembrane, defects and repairs of geomembrane, and requirements applicable to other materials in contact with the geomembrane. Subsection 10.4 describes the installation and testing requirements for geomembrane seams.

All parties involved in the installation of the geomembranes will be familiar with geomembrane and will focus on protecting the geomembrane from damage during construction activities.

10.3.1 Testing Requirements

This subsection describes the test methods, including sampling procedures and frequencies, and the role of the geosynthetics testing laboratory in testing the geomembrane roll samples. Subsection 10.2.1, under Quality Control Requirements, describes the test methods that are performed on an infrequent basis to demonstrate the uniformity of resin used to fabricate geomembrane shipped to the job site. Seam testing is described in Subsection 10.4.4 and 10.4.5.

10.3.1.1 Test Methods

A representative of the geosynthetics testing laboratory at the Geomembrane Manufacturer’s plant may collect geomembrane roll samples. Conformance samples will be collected at a rate one sample per 100,000 square feet (or per requirements of NR516.07(2)(a) of geomembrane produced for delivery to the site. At least one sample will also be obtained for each geomembrane production batch. Samples for thickness testing or measurements will be collected on every roll for delivery to the site. The Installer should not ship to, or receive at, the site geomembrane from more than two production batches in any single shipment without the prior written approval of the CQA Officer and the Owner.

Samples collected will be of a size determined by the geosynthetics testing laboratory. The laboratory technician will indicate the machine direction on the sample.

Tables 10-1, 10-2, 10-3 and 10-4 list some of the tests and the test methods that may be performed on HDPE and LLDPE geomembrane roll samples. At a minimum, the minimum number of tests required by NR516.07(2)(a) or approved by the WDNR will be conducted on the samples. The specifications and methods used in evaluating the results are discussed below under Procedures for Determining Geomembrane Roll Test Failures. Unless specified otherwise, sample specimens will be prepared in accordance with the referenced test method. The results for tear resistance and each of the tensile property tests will be reported for both the machine and cross direction if these tests are conducted.

10.3.1.2 Role of Testing Laboratory

The geosynthetics testing laboratory will be responsible for performing the tests on samples submitted to them as described above under Test Methods or as determined by the CQA Officer. The results of the tests performed will be reported to the CQA Officer, the CQAT, and the Owner.

Retesting of geomembrane rolls for quality assurance purposes because of failure to meet any or all of the acceptance specifications listed in Tables 10-1, 10-2, 10-3 and 10-4 can only be authorized by the CQA Officer.

The Geomembrane Manufacturer and/or Installer may perform their own tests according to the methods and procedures defined in Tables 10-1, 10-2, 10-3 and 10-4; however, the results will only be applicable to their own quality control needs. The results will not be substituted for the quality assurance testing describe herein.

10.3.1.3 Procedures for Determining Geomembrane Roll Test Failures

Tables 10-1, 10-2, 10-3 and 10-4 list the acceptance specifications for HDPE and LLDPE geomembranes of various thicknesses. The HDPE geomembrane values listed in the acceptance specifications of Tables 10-1 and 10-2 is from GRI Test Method GM 13. Tables 10-3 and 10-4 were developed from GRI Test Method GM 17 for LLDPE geomembranes. The most current version of GM 13 and GM 17 will supersede the acceptance specifications in the tables.

Acceptance specifications apply to both textured and smooth geomembranes. For those tests where results are reported for both machine and cross direction, each result will be compared to the listed specification to determine acceptance.

The following procedure will be used for interpreting results:

- If the test values meet the stated specification in Tables 10-1, 10-2, 10-3 and 10-4, then the roll and the lot will be accepted for use at the job site. If the sample represents all rolls from an entire shipment, then the entire shipment will also be considered accepted.
- If the result does not meet the specifications, then the roll and the batch may be retested using specimens either from the original roll sample or from another sample collected by the geosynthetics laboratory technician or the CQAT. For retesting, two additional tests will be performed for the failed test procedure. (Each additional test will consist of multiple-specimen tests if multiple specimens are called for in the test procedure). If both of the retests are acceptable, then the roll and batch will be considered to have passed this particular acceptance test; if either of the two additional tests fail, then the roll and batch will be considered unsuitable without further recourse. The CQA Officer and the Owner may obtain samples from other rolls in the batch. On the basis of testing these samples, the CQA Officer and the Owner may choose to accept a portion of the batch while rejecting the remainder.

  If retesting does not result in passing test results as defined in the preceding paragraph, or if there is any other nonconformity with the material specifications, then the Installer will withdraw the rolls from use in the project at the Installer’s sole risk, and expense. The Installer will be responsible at his/her sole risk, cost, and expense for removing this geomembrane from the site and replacing it with acceptable geomembrane.

10.3.2 Earthwork

The Construction Contractor will be responsible for preparing the supporting soil according to the plans and specifications. For each day of installation of the geomembrane, the Installer, the Contractor, and the CQAT will observe the surface and certify that the surface is acceptable for installations. The installer with prepare and sign a subgrade acceptance form for each day of geomembrane deployment.

Prior to deploying geomembrane, the geomembrane subgrade (clay liner or soil barrier layer) will be smooth drum rolled to remove irregularities, protrusions, loose, and abrupt changes in grade. The Contractor will observe the surface to certify that the subgrade is free of stone, grading stakes, construction debris, and contain no areas softened by high water content. The soil surface shall be sufficiently dry and dense such that construction equipment during panel placement will not create ruts in the subgrade surface. The soil surface will also be evaluated during geomembrane installation for any areas softened by precipitation or cracked due to desiccation. The Construction Contractor will rework areas determined to be unacceptable until acceptable.

10.3.3 Placement

10.3.3.1 Location and Panel Layout Drawing

A panel layout drawing for the geomembrane installation covered by this Plan will be prepared by the Installer prior to the installation and submitted to the CQA Officer and the Owner, showing the proposed location and orientation of geomembrane panels to be installed in relation to slope, collection trenches, anchor trench, and phase boundaries. The panel layout drawing will be submitted to the State Regulatory Agency prior to the preconstruction meeting or as soon as possible thereafter required by NR516.04(4). The Owner and the CQA Officer will review the proposed panel layout drawing and document that it is consistent with accepted practice and the construction plans and specifications.

10.3.3.2 Installation Techniques

Geomembrane panels will be installed by placing one at a time, and each panel will be seamed by the end of the day on which it was placed.

The CQAT will document that the condition of the supporting soil has not changed detrimentally during installation. The CQAT will notify the Installer and the Construction Contractor of any damage done (i.e., rutting by equipment used to deploy geomembrane) to the supporting soil prior to panel seaming.

It is the responsibility of the Installer to remove the deployed panel to allow the Construction Contractor to repair the supporting soil. The CQAT will observe and document the repair of the supporting soil. The CQAT will inform the Installer that the method of deployment will be observed during further deployment, and if damage to supporting soil continues, deployment will be stopped and an alternative means of deployment is to be developed. The CQAT will document these events and conversations in the daily report.

The Installer will take the following precautions while installing the geomembrane:

- Ensure that the equipment used does not damage the geomembrane by the way it is handled, by excessive heat, by leakage of hydrocarbons, or by other means.
- Ensure that personnel working on the geomembrane do not smoke, wear damaging clothing, or engage in other activities that could damage the geomembrane.
- Ensure that the method used to deploy the geomembrane does not cause scratches or crimps in the geomembrane.
- Ensure that the method used to deploy the rolls minimizes wrinkles.
- Ensure that the geomembrane is adequately loaded to prevent wind uplift.
- Minimize the amount of direct contact with the geomembrane, by limiting the number of personnel that are allowed on the geomembrane once QC and CQA are completed.
- Ensure that only approved equipment is allowed on the surface of the geomembrane (i.e., generators, test equipment). The use of motorized ATV vehicles is not permitted without approval from the CQA Officer.

10.3.3.3 Weather Conditions

Geomembrane will not be placed in areas of ponded water, during precipitation events, or in the presence of excess winds. The Installer must receive written approval to deploy geomembrane in temperature below 32°F.

10.3.3.4 Damages

The CQAT will examine each panel for damage after placement and will determine which panels, or panel portions, should be rejected, or accepted. Damaged panels or portions that have been rejected will be marked, removed, and recorded by the CQAT.

10.3.4 Defects and Repairs

This section applies to all defects and repairs resulting from examinations, tests, or visual observations performed on the geomembrane material itself and on the seams.

10.3.4.1 Identification

All seamed and non-seamed areas of the geomembrane will be examined and documented by the CQAT for identification of defects, holes, blisters, undispersed raw material, and any signs of contamination by any foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane will be clean at the time of examination. The CQAT will complete a final examination of the geomembrane in areas in which both the Installer and the CQAT have completed their QC and CQA, respectively. The CQAT and the Installer will perform a final examination over the entire geomembrane at the completion of the project. The Installer and/or the Construction Contractor will clean any area that is insufficiently clean to complete the final examination.

10.3.4.2 Evaluation

Each suspect area identified will be nondestructively tested using the vacuum box test method, an air test, or the spark test method. The CQAT will approve the proper test method for each suspect location.

10.3.4.3 Repair Procedures

Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test will be repaired. Several procedures exist for the repair of these areas. The procedures available include the following:

- Patching is used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
- Grinding and rewelding are used to repair small sections of extruded seams.
- Spot welding or seaming is used to repair small tears; pinholes; or other minor, localized flaws.
- Capping is used to repair large lengths of failed seams.
- Topping is used to repair areas of inadequate seams that have an exposed edge.
- Other procedures may be used at the recommendation of the Installer if agreed upon by the CQA Officer and the CQAT.

The repair procedures, materials, and techniques will be approved in advance of the specific repair by the CQA Officer, the CQAT, and the Installer. At a minimum, the following provisions will be satisfied:

- Patches or caps will extend at least 6 inches beyond the edge of the defect, and all corners of patches will be rounded with a radius of at least 3 inches.

- The type of geomembrane (i.e., smooth or textured) used for repairs will be approved by the CQAT prior to completing repairs.

10.3.4.4 Examination of Repairs

Each repair will be numbered and logged by the CQAT. Each repair will be nondestructively tested according to Subsection 10.4.4. Repairs that pass the above testing will be considered to be adequate, except that large caps may be of sufficient extent to require destructive seam sampling and testing, at the discretion of the CQAT, according to the provisions of Subsection 10.4.5.

Failed tests indicate that the repair was inadequate, and the repair will be redone and retested until a passing result is obtained. The CQAT will document that all repairs have been subjected to nondestructive testing and will record the number of each repair, the date, and the test outcome.

10.3.4.5 Large Wrinkles

When seaming of the geomembrane is completed, the CQAT will examine the geomembrane for wrinkles and determine which wrinkles (i.e., taller than wide) should be cut out and reseamed by the Installer. The wrinkle repair will be done in accordance with the equipment and procedures described in Subsection 10.4.2 and 10.4.3, respectively, and it will be nondestructively tested using the vacuum box test method described in Subsection 10.4.4.

10.3.5 Material in Contact with Geomembranes – Anchor Trench System and Backfilling

The Construction Contractor will excavate the anchor trench for the geomembrane, unless otherwise specified, to the lines and grades shown on the plans and specifications. The trench will use a “U” configuration. No more than the amount of trench required for the geomembrane to be anchored in 1 day will be excavated to minimize the desiccation potential of the anchor trench soil unless moisture content is maintained. The anchor trench will be adequately drained to prevent ponding or softening of the adjacent soil while the trench is open.

The anchor trench will be backfilled and compacted by the Contractor. Care will be taken when backfilling the trenches to prevent any damage to the geomembrane or other geosynthetics that may also be placed in the trench prior to backfilling.

The CQAT will observe the backfilling and compacting operations and will advise the Contractor of the adequacy of the soil installation. The CQAT will also advise the CQA Officer and the Owner of any problems.

Density tests will be performed at a minimum interval of one per 500 linear feet of anchor trench to observe a minimum of 85% of the maximum dry density has been obtained, as determined by ASTM D698 or D1557.

10.4 Field Seaming

This section covers the quality assurance procedures on seams used to join the rolls of geomembrane into a continuous layer. The installation of each of the geomembranes panels will include 100 percent nondestructive testing of all field seams for joining adjacent rolls of geomembranes to document that no openings or gaps exist between geomembrane sheets. In addition, destructive testing will be performed at a routine interval for determining the strength and mode of failure of field seams in both the shear and peel modes.

The allowable field seam methods, equipment, personnel qualifications, and destructive and nondestructive testing methods are described in this section.

10.4.1 Panel/Seam Layout

No horizontal seams will be allowed on slopes greater than 5 horizontal to 1 vertical. In corners and at other odd-shaped geometric intersections, the number of horizontal seams will be minimized. A seam numbering system comparable and compatible with panel numbering system will be agreed upon at the preconstruction meeting (Subsection 3.3).

10.4.2 Seaming Equipment

The approved methods for field seaming panels and repairs are the dual hot wedge (fusion-type) seam method and the extrusion fillet weld process. Dual hot wedge seaming method will be used on linear seams (production seams). Corners, butt seams, tie-ins, and long repairs will be dual hot wedge seamed. The extrusion fillet or dual hot wedge welding will be used for other repairs detail work and patches (nonproduction). No other processes can be used without prior written authorization from the CQA Officer and the Owner. Only equipment that has been specifically approved by make and model will be used.

10.4.2.1 Dual Hot Wedge Process

The Installer will meet the following requirements regarding the use, availability, and cleaning of the equipment to be used at the job site:

- An automated self-propelled type of apparatus will be used.
- The welding apparatus will be equipped to continuously monitor applicable temperatures.
- One spare operable seaming device will be maintained on-site at all times.

- Equipment used for seaming will not damage the geomembrane.
- The geomembrane will be protected in areas of heavy traffic to prevent damage discussed in Subsection 10.3.3.
- For cross seams, the intersecting dual hot wedge seam will be patched using the extrusion fillet process described below.
- The electric generator for the equipment will be placed on a smooth base in such a way that no damage occurs to the geomembrane. Similarly, a smooth insulating plate or fabric will be placed beneath the hot equipment after use.

The Installer will keep records for each seamer performing dual hot wedge seaming, including welding machine I.D. number, ambient temperature, and machine operating temperatures. These data will be recorded at intervals as agreed upon at the preconstruction meeting.

10.4.2.2 Extrusion Fillet Process

The Installer will meet the following requirements regarding the use, availability, and cleaning of the extrusion welding equipment to be used at the job site:

- The welding equipment will be equipped to continuously monitor temperature at the nozzle.
- One spare seaming device will be maintained on-site at all times.
- Equipment used for seaming will not damage the geomembrane.
- The geomembrane will be protected in areas of heavy traffic to prevent damage.
- The extruder will be cleaned and purged prior to beginning seaming, and at any time seaming operations are stopped, until all heat-degraded extrudate has been removed from the barrel.
- The electric generator for the equipment will be placed on a smooth base in such a way that no damage occurs to the geomembrane. Similarly, a smooth insulating plate or fabric will be placed beneath the hot equipment after use.
- Grinding geomembrane surfaces for welding preparation will not be performed more than 1 hour prior to seaming.
- Welding rod shall be kept clean and be of the correct type for the specific material being welded.

The Installer and, if applicable the Geomembrane Manufacturer will provide documentation to the CQA Officer regarding the quality of the extrudate used in the welding apparatus. At a minimum, the extrudate will be compatible with the base liner material and will contain the same grade and quality of polyethylene resins as used in the base material.

The Installer will keep records for each seamer performing extrusion weld seaming, including welding machine I.D. number, and ambient temperature. These data will be recorded at intervals as agreed upon at the preconstruction meeting.

10.4.3 Initial Requirements

10.4.3.1 Personnel Qualifications

All personnel performing seaming operations will be qualified by experience and by successfully passing seaming tests for the type of seaming equipment to be used. At least one seamer will have experience in seaming a minimum of 2,000,000 square feet of polyethylene geomembrane using the same type of seaming apparatus to be used at the landfill facility. The most experienced seamer, the “master seamer,” will have direct supervisory responsibility at the job site.

The Installer will provide a list of proposed seaming personnel and their experience records to the CQA Officer and the CQAT for their review and approval.

10.4.3.2 Weather Conditions

The weather conditions under which geomembrane seaming can be performed are as follows:

- Unless otherwise authorized in writing by the CQA Officer, no seaming will be attempted or performed at an ambient temperature below 32°F (0°C) or above 104°F (40°C).
- Between ambient temperatures of 32°F (0°C) and 50°F (10°C), seaming will be performed only if the geomembrane is preheated by either sun or a hot air device, provided there is no excessive ambient cooling resulting from high winds.
- Above 50°F (10°C), no preheating of the geomembrane will be required.
- Geomembrane will be dry and protected from wind.
- Seaming will not be performed during any precipitation event unless the Installer erects satisfactory shelter to protect the geomembrane areas for seaming from water and/or moisture.
- Seaming will not be performed in areas where ponded water has collected below the surface of the geomembrane.

If the Installer wishes to use methods that may allow seaming at ambient temperatures below 32°F or above 104°F, the Installer will demonstrate and certify that the methods and techniques used to perform the seaming produce seams that are entirely equivalent to seams produced at temperatures above 50°F and below 104°F, and that the overall quality of the geomembrane is not adversely affected.

The CQAT will document the following:

- Ambient temperature at which seaming is performed.
- Any precipitation events that occurred at the site, including the time of such occurrences, the intensity, and the amount of the event.

The CQAR will inform the CQA Officer and the Owner if any of the weather conditions are not being fulfilled. The CQA Officer will stop or postpone the geomembrane seaming when weather conditions are unacceptable.

10.4.3.3 Overlapping and Temporary Bond

The Installer will be responsible for ensuring that the following requirements are met:

- Panels of geomembrane will have a finished overlap of a minimum of 3 inches for extrusion welding and 4 inches for fusion welding; but, in any event, sufficient overlap will be provided to allow peel tests to be performed on the seam.
- No solvents or adhesives will be used on the geomembrane unless the CQA Officer and the Owner have approved the product in writing. Approval can only be obtained by submitting samples and data sheets to the CQA Officer and the Owner for evaluation.
- Procedures used to temporally bond adjacent geomembrane panels must not damage the geomembrane; in particular, the temperature of the hot air at the nozzle of any spot welding apparatus will be controlled such that the geomembrane is protected at all times against potential damage.

10.4.3.4 Trial Seams

Trial seams will be made on fragments of geomembrane to document that seaming conditions are adequate. Trial seams will be performed on the surface the geomembrane will be deployed on (i.e., top of compacted clay liner, top of GCL). Such trial seams will be made at the beginning of each seaming period, following work interruptions, at changes in weather, and at least once every 5 hours of seaming activities, for each seaming apparatus used that day with additional test run following work interruptions, weather changes, changes in machine settings for temperature or speed or as directed by the CQA officer or CQAT. Each seamer is required to complete a trial seam prior to seaming. Trial seams are to be run using the materials for which the seaming will be used (i.e., smooth to smooth, smooth to textured, textured to textured). At a minimum, one trial seam per welding machine will be made at the start of each day by each seaming technician performing welding that day.

The trial seams will be examined by the Installer and the CQAT for squeeze-out, foot pressure applied by the seaming equipment, and general appearance, and will be tested using a field tensiometer. If the seam fails any of these examinations, it will be repeated. If the second trial seam fails these examinations, the welding apparatus and seamer are not allowed to seam until the Installer can demonstrate the cause of the failure. Once the Installer has made the necessary corrections to the welding equipment, the seamer and the apparatus are required to pass two trial seams prior to beginning seaming. The CQAT will document the reason for the failure and all subsequent trial seams.

The trial seam samples will be at least 42 inches long by 1 foot wide after seaming, with the seam centered lengthwise. Seam overlap will be as indicated in the "Overlapping and Temporary Bond" subsection. Trial seams shall be welded under the same conditions as production seaming is to take place.

Five adjoining specimens, each 1 inch wide, will be cut from each end of the trial seam sample by the Installer. The specimens will be tested by the Installer in shear (5 field shear) and peel (5 field peel [inner and outer seams for dual hot wedge]), respectively, using a field tensiometer.

The remainder of the trial seam sample will be identified and marked by the CQAT as follows:

- The sample will be assigned a number and marked as to the welding apparatus used and the seamer's name.
- The date, time, applicable welding equipment operating temperatures, and ambient temperature at the time of seaming will be noted.
- Whether the sample passes or fails will be recorded.

The CQAT will observe trial seam procedures, and record them on the field log forms. The sample itself will be cut into three pieces, one for the Owner's record, one to be retained by the CQAT, and one to be made available to the Installer.

The CQAT may randomly select trial seam samples for destructive testing by the geosynthetics testing laboratory according to the test procedures described in Subsection 10.4.5. The frequency for trial seam laboratory testing will be at the discretion of the CQAT and the CQA Officer.

If a trial seam sample fails a destructive test performed by the geosynthetics testing laboratory, according to the acceptance criteria stated in Subsection 10.4.5, then a destructive test seam sample(s) will be taken from each of the seams completed by the seamer during the shift related to the failed trial seam test. These samples will be forwarded by the CQAT to the geosynthetics testing laboratory and, if any of them fails the tests, then the procedures described in Subsection 10.4.5 will apply. The conditions of this paragraph will be considered met if a destructive seam test sample, collected and tested according to the provisions under Location and Sampling Frequency and Sampling Procedure of Subsection 10.4.5, has already been taken and has passed.

10.4.3.5 Seam Preparation

The Installer will ensure that the following conditions for each of the geomembrane installations covered by this Plan are met:

- Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material.
- If seam overlap grinding is required, then the grinding process will be completed according to the Geomembrane Manufacturer's instructions within 1 hour of the seaming operation, and in a way that will not damage the geomembrane or cause excessive striation of the geomembrane surface.
- Seams will be aligned so as to minimize the number of wrinkles and "fishmouths."

10.4.3.6 General Seaming Procedures

Unless otherwise specified, the general seaming procedures to be used by the Installer for each of the geomembrane installations covered by this Plan, and observed by the CQAT, will be as follows:

- A firm subbase will be provided to achieve proper support for seaming.
- Fishmouths or wrinkles at the seam overlaps will be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles will be seamed, and any portion where the overlap is inadequate will then be patched with the same geomembrane (including thickness) extending a minimum of 6 inches beyond the cut in all directions.
- If seaming operations are to be conducted at night, adequate illumination will be provided.
- Seaming will be completed to the end of the panel to prevent tearing or fraying.

10.4.4 Nondestructive Testing

Each field seam will be nondestructively tested over its full length using one of the methods described in this section. The purpose of nondestructive testing is to determine the continuity of the seams. Nondestructive testing, at this stage of development, does not provide any information on the strength of seams. Seam strengths will be determined by destructive testing methods that are described in Subsection 10.4.5.

Failure of any of the nondestructive or destructive tests will require the repair of the failed section according to the procedures contained in Subsection 10.3.4.

Nondestructive testing as described in this section will be performed on seams for every geomembrane installation covered by this Plan. The recommended test methods for conducting the nondestructive seam testing are the air pressure test for dual hot wedge seams and the vacuum box test for extrusion fillet welds. These two nondestructive testing methods are described below.

The CQAT will perform the following documentation tasks:

- Observe nondestructive seam testing, and examine seams for squeeze-out, foot pressure, and general appearance. Failure of these criteria will be considered as failure of the seam, and repair or reconstruction will be required.
- Document location, date, test unit number, name of tester, and outcome of all testing.
- Inform the Installer and CQA Officer of any required repairs.
- Document that appropriate repairs are made and that the repairs are retested nondestructively with passing results.

10.4.4.1 Air Pressure Testing

The following test procedures are applicable only to dual hot wedge seams. The equipment for performing the test should meet the following minimum requirements:

- An air compressor or hand pump equipped with a pressure gauge and regulator capable of producing and sustaining a pressure of 30 psi and mounted on a cushion to protect the geomembrane surface
- Fittings, rubber hose, valves, etc., to operate the equipment, and a sharp hollow needle or other approved pressure feed device

Air pressure testing will be performed according to the following procedure:

1. Seal both ends of the seam to be tested.
2. Insert a needle or other approved pressure feed device into the airspace at one end of the dual hot wedge seam.
3. Energize the air compressor or hand pump to a pressure of 30 psi. Close the valve, and monitor the pressure in the seam airspace for approximately 7 minutes.
4. Record the pressure in the seam at the end of 2 minutes and again at the end of 7 minutes.
5. If the pressure difference between the 2-minute and 7-minute readings exceeds 3 psi for 60 mil or 4 psi for 40 mil, or if the pressure does not stabilize within the 7-minute period, one more 5-minute pressure- monitoring interval is allowed.
6. If the pressure loss over both 5-minute intervals exceeds 3 psi for 60 mil HDPE or 4 psi for 40 mil LLDPE, or if the pressure does not stabilize, then the seam fails the test.

7. If the pressure loss over either 5-minute interval does not exceed 3 psi for 60 mil HDPE or 4 psi for 40 mil LLDPE, then the seam may be deemed by the Installer to have passed the test.
8. The Installer must verify that the air channel tested was not obstructed by noting a release of air pressure at the end of the tested seam interval opposite the pressure gauge.

For any seam interval that fails the air pressure nondestructive test, additional nondestructive testing or visual inspection will be used to identify, if possible, the faulty area of the seam. The faulty area will be repaired and retested. If the faulty area cannot be identified, then the entire seam will be repaired and retested.

10.4.4.2 Vacuum Box Test

Vacuum box testing is to be used on those seams made by the extrusion fillet process, to locate the defects identified from air pressure testing, or to evaluate suspect seam and nonseam areas as discussed in Subsection 10.3.4.

Vacuum box testing equipment must meet the following minimum standards:

- A five-sided vacuum box with an open bottom, a clear viewing panel on top and a pliable gasket attached to the bottom
- A pump assembly equipped with pressure controller and pipe connections capable of achieving a vacuum of 10 inches of water.
- A vacuum gauge on the tank with an operating range from 0 to 26 inches of vacuum, and a vacuum gauge on the vacuum box with an operating range from 0 to 10 inches of water vacuum

The following procedure will be used in performing the vacuum box test:

1. Clean the seams to be tested so that they are relatively free from soil or foreign objects that might prohibit a good seal from being formed between the vacuum chamber and the geomembrane.
2. Energize the vacuum pump, and reduce the tank pressure to approximately 5 to 10 inches of water vacuum.
3. Wet a strip of geomembrane approximately twice the size of the vacuum box with the soapy solution.
4. Place and center the vacuum box with the gasket in contact with the geomembrane surface over the wetted area of the seam.
5. Applying a normal force to the top of the vacuum box, close the bleed valve, and open the vacuum valve. Check to make certain that a tight seal is created between the

geomembrane and the vacuum box. A minimum vacuum of 5 inches will be used for testing with the maximum allowable testing pressure never exceeding 10 inches of vacuum.

6. With the vacuum drawn, use the viewing panel to examine the geomembrane seam for bubbles resulting from the flow of air through the seam. Continue this examination for not less than 5 seconds.
7. Remove the vacuum box by first closing the vacuum valve and then opening the bleed valve. Proceed to Step 8 if bubbles appear in Step 6. If no bubbles appear in Step 6, then proceed directly to Step 9.
8. If bubbles appear through the geomembrane, mark the defective area for repair according to the provisions of Subsection 10.3.4. All repairs will be tested until nondestructive results are passing.
9. Move the vacuum box along the seam to be tested, overlapping the previously tested area by no less than 3 inches.

10.4.5 Destructive Seam Testing

Destructive seam testing will be performed on the geomembrane seams covered by this Plan. Destructive seam testing is performed to determine the strength of the seam in both shear and peel failure modes. Destructive seam testing will be performed within 48 hours of sampling either in an on-site laboratory by personnel under the direction of the CQA Officer or at the geosynthetics testing laboratory.

10.4.5.1 Location and Sampling Frequency

The CQAT will select locations where seam samples will be cut out for the destructive testing. The CQAT will mark the locations and record on the seam sample the assigned sample number, seam number, welder ID, machine number, and date welded. Test locations will be determined during seaming at the CQAT's discretion. Suspicion of excess crystallinity, contamination, offset welds, or any other potential causes of an imperfect seam may prompt selection of such locations. The Installer will not be informed in advance of any location where seam samples will be taken.

The minimum frequency of sample collection will be one test location for every 500 linear feet of seam length per welder per day of seaming.

10.4.5.2 Sample Procedure

Samples will be cut under the direction of the CQAT as the seaming progresses. For each sample location, the following information will be documented:

- Assigned sample number and reason for collecting the sample (e.g., as part of statistical testing program, suspicious seam, etc.)
- Seam number
- Welder ID
- Machine #
- Date Welded
- Sample location on layout drawing
- For the peel test, which geomembrane is the top and which is the bottom with respect to seams performed using dual hot wedge (fusion) weld techniques.

Specimens for qualitative field testing will be taken prior to the removal of the laboratory sample. Samples for field tensiometer testing will be 1 inch wide by 8 inches long, with the seam centered parallel to the width. A total of 10 samples will be collected for field testing. Five samples will be tested in peel (inner and outer seams for dual hot wedge samples) and five samples will be tested in shear. If all 10 samples pass the field tensiometer test described below under Field Test Methods, then the sample for laboratory testing will be taken according to the procedure described below.

The sample for laboratory testing will be located between samples used for field-testing. The destructive sample will be 12 inches wide by a minimum 42 inches long with the seam centered lengthwise. The sample will be cut by the Installer into three parts and distributed as follows:

- A sample 12 inches by 14 inches will be kept by the Installer for testing.
- A sample 12 inches by 12 inches will be given to the Owner for record storage.
- A sample 12 inches by 16 inches will be transmitted to the geosynthetics testing laboratory or on-site testing laboratory by the CQAT.

The Installer in accordance with the repair procedures described in Subsection 10.3.4 will immediately repair all holes cut into the geomembrane resulting from destructive seam sampling. The repaired area will be nondestructively tested in accordance with the requirements of Subsection 10.4.4.

10.4.5.3 End-of-Seam Sampling

In addition to the 42-inch sample cut for laboratory testing, an additional sample will be cut from at least one end of each fusion seam weld greater than 100 feet in length for field-testing as described below. The end-of seam sample, or “end bones”, will consist of a minimum of two 1 inch wide samples, often referred to as bones, can be cut from the portion of the seam that extends into/passed the anchor trench so as not to require an additional repair. A minimum of one bone will be field tested in shear mode and a minimum of one bone will be field tested in peel mode (inner and outer seam).

10.4.5.4 Field Test Methods

The 1-inch–wide samples described above under Sampling Procedure, as well as the end-of-seam samples described above under End-of-Seam Sampling, will be field-tested in both peel mode and shear mode. Testing will be performed using a field tensiometer or equivalent device. Seam testing acceptance criteria for the field testing of the destructive samples and end of seam samples is contained in Tables 10-5 or 10-6. If the samples fail the field tensiometer test, then the repair procedures of Subsection 10.3.4 for the holes left by the cutout samples, and the seam reconstruction procedures for the repair of the defective seam, discussed later in this subsection, will be implemented.

10.4.5.5 Laboratory Test Methods

Laboratory testing of the destructive seam samples will be performed by the geosynthetics testing laboratory or on-site testing laboratory under the direction of the CQA Officer. All destructive seam tests, whether performed on trial seam samples (as described above) or on samples cut out from production seams, will be performed in general accordance with the methodology of ASTM D6392, which stipulates that at least five specimens will be tested in shear and five in peel. All specimens will be cut as 1-inch–wide strips.

The following tests will be performed on each seam sample submitted for laboratory testing:

- <u>Shear and peel maximum tension</u> is the maximum load per unit width of a 1-inch–wide specimen expressed in pounds per inch of width in both the shear and peel mode, according to ASTM D6392.
- <u>Shear elongation at break</u> is the extension at break expressed as a percentage of the initial distance between the edge of the fused track and the nearer grip. This distance should be the same on both sides of the seam and is usually 2 inches.
- <u>Peel seam separation</u> estimates the length of seam bond separation expressed as a percentage of the original bond length.

Also, for both the seam shear and peel tension tests, an indication will be given for each specimen tested that defines the locus of the failure.

For shear tests, the following values will be reported for each specimen tested:

- Maximum tension in pounds per inch
- Elongation at break indicating at what percentage the specimen failed (up to a tested maximum of 50%)

- The locus of failure
-

Table 10-5 60-mil HDPE Geomembrane Seam Acceptance Criteria

PROPERTY	TEST METHOD	UNITS	TYPE OF CRITERION	ACCEPTANCE VALUES	
				SMOOTH(1)	TEXTURED (1)
Shear strength (2)	ASTM D6392	ppi	Minimum	120	120
Shear elongation (2)	--	%	Minimum	50	50
Peel strength (3),(4) Fusion	ASTM D6392	ppi	Minimum	91	91
Peel strength (3),(4) Extrusion	ASTM D6392	ppi	Minimum	78	78
Peel separation (5),(6)	--	%	Maximum	25	25

Notes:
(1)Values apply for both textured and smooth HDPE geomembranes.
(2)Five out of the five test specimens must meet these requirements. In addition, failure type must be film-tear (FTB) for all five specimens.
(3)Five of the five specimens must meet these requirements.
(4)Failure type must be film-tear bond (FTB) for five out of the five specimens.
(5)Maximum Acceptance Value for five out of the five test specimens.
(6)The following are unacceptable break codes:

- Hot wedge: AD and AD-Brk >25%
- Extrusion fillet: AD1, AD2 and AD-WLD (unless strength is achieved)

Table 10-6 40-mil LLDPE Geomembrane Seam Acceptance Criteria

PROPERTY	TEST METHOD	UNITS	TYPE OF CRITERION	ACCEPTANCE VALUES	
				NON-TEXTURED(1)	TEXTURED (1)
Shear strength (2)	ASTM D6392	ppi	Minimum	60	60
Shear elongation (2)	--	%	Minimum	50	50
Peel strength (3),(4) Fusion	ASTM D6392	ppi	Minimum	50	50
Peel strength (3),(4) Extrusion	ASTM D6392	ppi	Minimum	44	44
Peel separation (5),(6)	--	%	Maximum	25	25

Notes:
(1)If the lengthwise edges of the textured geomembrane panels are nontextured, then the nontextured specifications shall apply for testing of seams made along these edges.
(2)Five out of the five test specimens must meet these requirements. In addition, failure type must be film-tear (FTB) for all five specimens.
(3)Five of the five specimens must meet these requirements.
(4)Failure type must be film-tear bond (FTB) for five out of the five specimens.
(5)Maximum Acceptance Value for five out of the five test specimens.
(6)The following are unacceptable break codes:

- Hot wedge: AD and AD-Brk >25%
- Extrusion fillet: AD1, AD2 and AD-WLD (unless strength is achieved)

For peel tests, the following values will be reported for each specimen tested:

- Maximum tension in pounds per inch
- Seam separation expressed as percent of original seam bond length
- Locus of failure

For each set of five specimens, the mean will be calculated and reported for the shear maximum tension and the peel maximum tension.

10.4.5.6 Role of Testing Laboratory

The geosynthetics testing laboratory or on-site testing laboratory will be responsible for performing the tests on samples submitted to them as described above. The results of tests performed will be reported to the Owner, the CQA Officer, and the CQAT. Retesting of seams because of failure to meet any or all of the specifications listed below can only be authorized by the CQA Officer and the Owner.

The Geomembrane Manufacturer and/or the Installer may perform their own quality control testing in accordance with the methods and procedures defined above under Laboratory Test Methods; however, the results, if substantially different from those obtained by the geosynthetics testing laboratory or on-site laboratory, may only be used to request a retesting by the geosynthetics testing laboratory or on-site testing laboratory. All quality assurance test results from the geosynthetics testing laboratory or on-site laboratory govern over any test results from the Geomembrane Manufacturer or the Installer. Only the CQA Officer and the Owner are authorized to approve a retesting request.

10.4.5.7 Procedures for Determining Destructive Seam Test Failures

The procedures described in this section apply to the destructive testing procedures defined above under Field Test Methods and Laboratory Test Methods. Procedures for repairing failed seams are given in Subsection 10.3.4 of this Plan.

The results from the shear and peel tests for the HDPE geomembranes will be evaluated against the criteria tabulated in Table 10-5; and the LLDPE geomembrane will be evaluated against the criteria presented in Table 10-6. Tables 10-5 and 10-6 were developed from GRI-GM19a: “Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barriers”. The most current version of GM19a will supersede the acceptance specifications in these tables.

All of the tabular criteria for each respective geomembrane type must be met for a given seam to be considered acceptable.

The Installer has the following two options in determining the repair boundary whenever a seam has failed either the field tensiometer testing or the laboratory destructive testing:

1. The seam can be reconstructed between any two previously tested and passed destructive seam test locations.
2. The Installer can trace the welding path to an intermediate location (at a 10-foot minimum from the point of the failed test in each direction (e.g. a “before” and “after” sample) and request that the field tensiometer tests be performed at these intermediate locations. If the field tensiometer sample results are acceptable, then the seam sample will be sent to the geosynthetics testing laboratory. If either sample fails, then the process will be repeated until acceptable destructive seam tests have been performed in both directions away from the original failed sample location. All retesting of seams according to this procedure will use the sampling methodology described earlier in this Plan under Sampling Procedure.

The tracing of a failed seam test will continue until the seaming path boundaries are located, tracking will continue into the previous day’s work if needed and into the next day’s welding as well.

Seams reconstructed due to a failing destructive seam sample that are in excess of 100 feet long will be destructed tested, and any additional samples taken from the reconstructed zone must pass destructive seam testing.

The CQAT will be responsible for documenting all actions, including test results submitted by the geosynthetics testing laboratory, taken in conjunction with seam testing. The CQAT will also be responsible for keeping the CQA Officer informed on seam testing results and seaming progress.

The CQAT will be responsible for documenting all actions, including test results submitted by the geosynthetics test laboratory, taken in conjunction with seam testing. The CQAT will also be responsible for keeping the CQA Officer informed of the seam testing results and the seaming process.

10.5 Post-Installation

Each component covered by this Plan will be examined by the CQAT. Any defects, whether due to failed seams, pinholes, or other penetrations, will be repaired.

Placement of the geotextile cushion and select aggregate fill drainage layer will proceed as soon as practicable following the CQAT’s testing and acceptance of completed geomembrane areas.

The geotextile cushion and drainage layer will provide ultraviolet protection, thermal insulation, and protection form physical damage.

Low-ground pressure tracked equipment (<5 psi) will be used to place the drainage layer material over the geomembrane. A minimum of 1 foot of cover material is required between the geomembrane and the low-ground pressure equipment. A minimum of 2 feet of cover soil is required between the geomembrane and all other tracked or floatation wheeled equipment. A minimum of 3 feet of cover soil is required between the geomembrane and all rubber-tired vehicles.

10.6 Leak Location Testing

Leak location testing (electrical resistivity testing or other approved method) of the installed geomembrane in the liner system will be completed by or observed by the CQA Officer, CQAT, or a qualified technician. Leak location testing will be conducted after the leachate collection layer has been placed on the base grades and lower half of the sideslopes, at a minimum. Documentation of the testing method, including a description of the procedures and photographic documentation will be included in the construction documentation report. The documentation report will also include documentation of all defects and repairs including testing data for geomembrane sheet and welding and photographic documentation of the defects prior to and after repairs.

11. Geotextile

11.1 General

This section of the CQA Plan applies to nonwoven geotextile used throughout the landfill facility. Geotextile will be installed in the following locations at the landfill facility:

- Leachate collection trenches
- Leachate collection sumps

Geotextile may also be used within roadways and spillways for reinforcement. Specifications for the reinforced geotextile will be included with the project plans and specifications for each construction project.

This section is further divided into three major subheadings, which cover the quality assurance requirements for pre-installation (which includes Geotextile Manufacturers), installation, and post-installation (which includes the final examination of the geotextiles prior to placing the appropriate material above the geotextile). The terms pre-installation, installation, and post-installation are applicable only to the geotextile and do not apply to the overall construction of the landfill facility.

11.2 Pre-Installation

11.2.1 Manufacturing

The geotextile will be supplied to the site in factory rolls. Prior to the delivery of any geotextile rolls, the Geotextile Manufacturer will provide the CQA Officer and the Owner with the manufacturer's Quality Control Plan used for the production of the geotextile.

Every roll of geotextile for delivery to the site will be manufactured and inspected by the Geotextile Manufacturer, according to the following requirements:

- The geotextile must contain no needles used for punching.
- The geotextile must be free of holes and any other sign of contamination by foreign matter.

The Geotextile Manufacturer will provide certification, based on tests performed in accordance with the methods listed in Table 11-1 that the geotextile supplied under this Plan will meet the material specifications listed in Table 11-2. These tests may be performed by the Geotextile Manufacturer's laboratory or a laboratory contracted by the Manufacturer. Additionally, the

Geotextile Manufacturer will provide certification that the Manufacturer's Quality Control Plan was fully implemented for the geotextile materials supplied under this plan and that the geotextile delivered to the site does not contain needles. The Geotextile Manufacturer will provide documentation to verify the results of the Manufacturer's CQA Plan implementation required by the CQA Officer and the Owner.

The geotextile rolls will be tested and evaluated prior to acceptance. The CQA Officer may perform/require additional testing (i.e., conformance testing) as required by detailed specifications or as required in the judgment of the CQA Officer to verify that the geotextile meets the specifications.

11.2.2 Delivery, Handling, and Storage of Geotextile Rolls

Each geotextile roll to be used will be marked by the Geotextile Manufacturer with the following information and in the following manner:

When fabric is rolled on a core, each roll will be identified with a durable gummed label, or an equivalent, on the inside of the core and on the outside of the protective wrapping for the roll.

- Each roll label will contain the following information at a minimum:
  - Name of manufacturer
  - Style and type number
  - Roll length and width
  - Batch (or lot) number
  - Nominal product thickness
  - Date of manufacture
  - Roll number

Table 11-1 Geotextile Tests and Test Methods

PROPERTY	TEST METHOD
Grab tensile strength(1) (2)	ASTM D4632
Grab elongation(1) (2)	ASTM D4632
Puncture strength(1) (2)	ASTM D4833
Trapezoidal tear(1) (2)	ASTM D4533
Apparent opening size(1)	ASTM D4751
Permittivity(1)	ASTM D4491
Water flow rate(1)	ASTM D4491
UV resistance(3)	ASTM D4355

Notes:
(1)Testing is required for geotextile filter.
(2)Testing is required for geotextile cushion.
(3)Testing is required only if the geotextile is to be uncovered for more than 30 days.

Table 11-2 Geotextile Tests, Test Methods, and Acceptance Criteria

PROPERTY(1)(2)	TEST METHOD	UNITS	VALUE	10 OZ. (3)	12 OZ. (3)	16 OZ. (3)
Grab tensile strength	ASTM D4632	lb	MARV	230	300	370
Grab elongation	ASTM D4632	%	MARV	50	50	50
Puncture (CBR) strength	ASTM D6241	lb	MARV	700	800	900
Trapezoidal tear	ASTM D4533	lb	MARV	95	115	145
UV resistance	ASTM D7238	% Retained @ 500 hrs	Typical(2)	70	70	70

Notes:
1. Values are based on discussions with acceptable manufacturers and represent production values at the time this document was prepared.
2. Values reported in weaker principal direction. All values listed are Minimum Average Roll Values (MARV) except UV resistance. UV resistance is a typical value.
3. Ounce values indicate MARV's in ounce per square yard as determined in accordance with test method ASTM D5261.

The Geotextile Manufacturer will use the following guidelines in packaging, wrapping, and preparing all geotextile rolls for shipment:

- When cores are required, those that have a crushing strength sufficient to avoid collapse or other damage while in use will be used.

- Each roll will be covered with a wrapping material that will protect the geotextile from damage due to shipment, water, sunlight, or contaminants.

The following practices will be used as minimum in receiving and storing geotextile rolls in the designated storage area at the job site:

- While unloading or transferring the geotextile rolls from one location to another, care will be taken to prevent damage to the wrapping or the geotextile itself. If practicable, the Installer/Contractor may use forklift trucks fitted with poles that can be inserted into the cores of rolls. The poles will be at least two-thirds the length of the rolls, to prevent breaking the cores and possibly damaging the geotextile. Rolls will not be dragged.
- The geotextile rolls will be stored in such a manner so as to ensure that they are adequately protected from the following:
  - Precipitation
  - Ultraviolet radiation, including sunlight
  - Strong oxidizing chemicals, acids or bases
  - Flames, including welding sparks
  - Temperatures in excess of 160°Fahrenheit
  - Soiling

The CQAT will observe and document, throughout the pre-installation, installation, and post-installation periods, that the Installer provides adequate handling equipment used for moving geotextile rolls and that the equipment and handling methods used do not pose unnecessary risk of damage. The Installer/Contractor is responsible for the means and methods to implement the work.

- The Installer will responsible for ensuring that all materials installed meet specifications. The CQAT will maintain a log of the geotextile rolls delivered. The following information, at a minimum, will be recorded on the log for each shipment received at the job site:
  - Date of delivery at the job site
  - For each roll of geotextile, the roll number and the batch (lot) number

11.3 Installation

This section describes the quality assurance requirements applicable to the installation, observation, and documentation of geotextile.

11.3.1 Placement

The Installer will install all geotextile in such a manner so as to ensure that it is not damaged and that it complies with the following requirements:

- On sideslopes, the geotextile will be securely anchored and then rolled down the slope in such a manner so as to continually keep the geotextile in tension.
- In the presence of wind, all geotextile will be secured by suitable methods. The temporary securing material will be left in place until replaced with cover material, if applicable.
- In-place geotextile will be cut with special care to protect other materials from damage that could be caused by the cutting of the geotextile.
- The Installer will take the necessary precautions to prevent damage to any underlying layers during placement of the geotextile.
- During placement of the geotextile, care will be taken not to entrap in the geotextile any stones, excessive dust, or moisture that could damage the geotextile or the underlying geosynthetics, or that could clog drains or filters.
- A visual examination of the geotextile will be carried out over the entire surface after the installation by the Installer to ensure that no potentially harmful objects, such as needles, are present.
- The edges of the geomembrane between phases will be protected with a geotextile wrap and/or an overlying protective material until the edges are spliced together with the liner system of the adjacent phase.

11.3.2 Seams and Overlaps

- Geotextile placed as geotextile cushion (to protect the geomembrane liner from the drainage layer material and drainage layer material placement) will be continuously sewn, heat-bonded or seamed using another method approved by the CQA Officer. Geotextile will be overlapped 6 inches prior to seaming. The sewing method and stitch type will be per the Manufacturer’s recommendation, but must be approved by the CQA Officer and the Owner. Overlapping of geotextile without sewing may be acceptable for certain applications (i.e., seams under riprap, access roads) with approval from the CQA Officer.
- No horizontal seams will be allowed on slopes steeper than 5 horizontal to 1 vertical (i.e., seams will be along, not across, the slopes), except as part of a geotextile repair.
- Sewing will be performed with thread made from the same base material as the geotextile, or suitable equivalent.

- The Installer will pay particular attention to seams to ensure that materials are not inadvertently trapped beneath the geotextile.

The CQAT will be responsible for observing and documenting that the above provisions are performed by the Installer in an acceptable manner.

11.4 Post-Installation

11.4.1 Final Examination

The CQAT will perform a final geotextile examination after the installation of each geotextile layer has been completed. The objectives of the final examination are as follows:

- To examine for the presence of holes, tears, or other deterioration
- To examine for excessive tension due to stretching of the fabric during installation
- To examine for the presence of foreign objects (i.e., stones, soil clods) beneath the geotextile

If there will be an extended time delay between completion of the geotextile and the start of the installation of any other cover, then the Installer will make provisions by temporarily securing the geotextile using suitable methods to protect it from wind uplift. The CQAT will document in the daily report the placement of the temporary securing methods used.

11.4.2 Placement of Soil Materials

The Construction Contractor will place all soil materials located on top of a geotextile in such a manner so as to minimize the following:

- Damage to the geosynthetics
- Slippage of the geotextile on underlying layers
- Excessive tensile stresses imposed on the geotextile

12. Geosynthetic Clay Liner

12.1 Introduction

This section is divided into three major subheadings, which cover the quality assurance requirements for preinstallation (includes the geosynthetic clay liner [GCL] manufacturer), installation, and post-installation (includes the final examination of GCL prior to the placement of the geomembrane). The terms preinstallation, installation, and post-installation are applicable only to the GCL installation and do not apply to the overall construction.

12.2 Preinstallation

Preinstallation activities are designed to help ensure that a high-quality product is being manufactured and that it is properly delivered, handled, and stored to maintain its quality.

12.2.1 Manufacturer's Quality Control Plan (MQCP)

The manufacturer of each component of the GCL and the GCL itself will have a Manufacturer's Quality Control Plan (MQCP) to ensure that their product meets all of the stated minimum properties. These manufacturers include the Bentonite Supplier, the Geotextile Manufacturer, and the GCL Manufacturer.

12.2.1.1 Bentonite Supplier

The Bentonite Supplier will have a MQCP that will be adhered to in the manufacturing process. This plan will include the following information:

- Documentation that the bentonite is sodium bentonite
- Testing that demonstrates that the bentonite meets specified gradation requirements
- Testing that demonstrates that the bentonite meets specified index test requirements
- Testing that demonstrates that the bentonite has not been treated with synthetic chemicals or polymers

12.2.1.2 Geotextile Manufacturer

The Geotextile Manufacturer will have a MQCP that will be adhered to in their manufacturing process. This plan will include the following provisions:

- Testing that demonstrates that the product is made of specified polymers

- Testing that demonstrates that the product meets certain minimum average roll values (for geotextiles)

12.2.1.3 GCL Manufacturer

The GCL manufacturer will have a MQCP that describes the procedures for accomplishing quality in the final product. At a minimum, the tests shown in Table 12-1 shall be performed by the Manufacturer.

This MQCP will also dictate the following requirements:

- Overlap alignment lines are to be marked on the edges.
- Completed rolls are to be securely wrapped in plastic.
- Completed rolls are to be stored indoors, and provisions are to be in place to prevent rolls from being stacked too high, to ensure that they are kept dry, and to prevent damage during handling.
- Quality control certificates are to be provided.

12.2.2 Materials

The GCL will be needle-punched reinforced composite GCL consisting of a layer of pure sodium bentonite clay encapsulated between two geotextiles, and will comply with all of the manufacturing processes and physical/chemical criteria listed in this Section.

The bentonite clay utilized in the manufacture of the GCL, as well as any accessory bentonite clay (i.e., Volclay® granular sodium bentonite or approved equivalent) provided for seaming and detail work, will meet the manufacturer’s minimum requirements, as specified in the MQCP.

The geotextile components of the GCL, and the geosynthetic clay liner itself, will meet the minimum requirements of the respective MQCPs.

12.2.3 GCL Delivery, Handling, and Storage

The GCL panels will be supplied to the site in factory-produced rolls, which are of standard factory roll dimensions.

Table 12-1 GCL Material Tests, Test Methods, and Acceptance Criteria

	PROPERTY	TEST METHOD(1)	UNITS	VALUE
Bentonite properties	Swell Index	ASTM D5890	ml/2g	24 (min)
	Moisture Content	ASTM D4643	%	12 (max)
	Fluid loss	ASTM D5891	ml	18(max)(3)
Geotextile (as received)	Non-woven (mass per unit area)	ASTM D5261	oz/yd^2	5.9 (MARV)
	Woven (mass per unit area)	ASTM D5261	oz/yd^2	3.0 (MARV)
Physical GCL properties	Bentonite mass per unit area(1) @ 0% moisture	ASTM D5993	lb/ft^2	0.75 (MARV)
	Tensile Strength(2)	ASTM D6768	lb/in	23 (MARV)
	Peel Strength	ASTM D6496	lb/in	2.1 (MARV)
	Hydraulic Conductivity(3)	ASTM D5887	cm/sec	5 x 10^{-9} (max)
	Index Flux(4)	ASTM D5887	m^3/m^2/sec	1 x 10^{-8} (max)
	Internal Shear Strength(4)	ASTM D6243	psf	500 (typical)

Notes:
(1)At 0% moisture content
(2)Tested in machine and cross direction
(3)Deaired, deionized water @ 5 psi maximum effective confining stress and 2 psi head pressure
(4)Typical peak value for specimen hydrated for 24 hours and sheared under a 200 psf normal stress

Each roll of GCL supplied to the site will be labeled with the following information:

- Name and date of manufacturer
- Product type and identification number (if any)
- Roll number
- Lot (batch) number

The GCL Manufacturer will ensure that the crushing strength of all GCL roll cores will be sufficient to avoid collapse or other damage while in use.

The rolls of GCL will be carefully unloaded by the Contractor upon arrival at the site. At a minimum, the following practices will be followed in receiving and storing GCL rolls in the covered storage area at the job site:

- While unloading or transferring the GCL rolls from one location to another, prevent damage to the GCL.
- For standard rolls, a steel support pipe will be inserted through the cardboard roll core. The slings or lifting chains will be attached at one end to the support pipe and at the other end to the bucket of a front-end loader or lifting device. A spreader bar will be used to support and spread the slings. The bar and support pipe must be long enough to prevent damage to the edges of the GCL during hoisting.

- Alternatively, forklift trucks can be modified to lift the rolls with a steel bar, securely attached to the fork lift and inserted into the roll core. At no time will the rolls be lifted by sliding the forks under the roll.
- The rolls of GCL will be stored in their original, unopened, wrapped cover in a clean, dry area. The material will be stored off the ground on pallets or by other suitable techniques that provide continuous support over the entire length of the roll. It will be covered with a heavy, protective tarpaulin or stored beneath a roof. Care will be used to protect the GCL from the following:
  - Precipitation
  - Ultraviolet radiation, including sunlight
  - Strong oxidizing chemicals, acids or bases
  - Flames, including welding sparks
  - Temperatures in excess of 160°F

The CQAT will be responsible throughout the preinstallation, installation, and post- installation periods, for observing and documenting that the Installer provides adequate handling equipment used for moving GCL rolls and that the equipment and handling methods used do not pose any risk of damage.

The CQAT will be responsible for making certain that the name of the manufacturer, the type, and the thickness of each roll (as noted on the roll marking label described above) are correct. The CQAT will also maintain a log of GCL roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job site:

- Date of receipt of delivery at job site
- For each GCL roll, the following information will be noted:
  - Roll number
  - Batch (lot) number

12.2.4 Submittals

Submittals will be made prior to installation of the GCL concerning the GCL manufacturer/production information and the GCL installer information.

The GCL Manufacturer/Production Information will include the following:

- Corporate background and information.

- Manufacturer's Quality Control Plan (MQCP) for bentonite, geotextile, and GCL manufacturers.
- Project reference list consisting of the principal details of at least 10 projects totaling at least 8 million square feet of GCL installation, if required by the CQAT or CQA Officer.
- Results of tests conducted by the Bentonite Supplier and Geotextile Supplier to document the quality of the materials used to manufacture the GCL rolls assigned to the project.
- Copy of quality control certificates, signed by a responsible entity of the Manufacturer. Each quality control certificate will include roll identification numbers, and the results of quality control tests (refer to Subsection 12.2.1 above for minimum testing requirements).
- Manufacturer's written certification that the GCL meets the project specifications, that the GCL has been continuously inspected and found to be needle-free through magnetic and metal detection tests, that the bentonite will not shift during transportation or installation, and that the bentonite and geotextile materials meet the Manufacturer's specifications.

GCL Installer information will include the following:

- Corporate background information.
- Project reference list consisting of the principal details of at least five projects totaling at least 1 million square feet, if required by the CQAT or CQA Officer.
- List of personnel performing field operations, along with pertinent experience information, if required by the CQAT or CQA Officer.

The proposed panel layout diagram identifying placement of the GCL panels and seams, as well as any variances or additional details that deviate from the engineering drawings will also be submitted prior to installation. The layout will be drawn to scale, will include information such as dimensions and details, and will be adequate for use as a construction plan.

12.3 Installation

The following installation procedures are designed to ensure the effectiveness of the GCL in meeting its design requirements and to simplify the deployment procedures. These procedures are to be followed by the Installer, unless the Installer proposes alternative procedures in writing and the CQA Officer approves them in writing prior to installation.

12.3.1 Testing Requirements

This subsection describes the test methods, including sampling procedures and frequencies, and the role of the Geosynthetic Testing Laboratory in testing the GCL roll samples. Unless specified otherwise, all sampling procedures will be performed in accordance with the referenced test method defined in this section.

GCL roll samples will be collected by the Contractor at the discretion of, and under the direction of, the CQAT, at a rate specified by the CQAT.

Samples will be 3 feet long by the full width of the roll and will not include the first 3 feet of any roll.

Table 12-1 lists the tests and the test methods that may be performed on GCL roll samples. The specifications and methods used in evaluating the results are discussed later in this subsection. At a minimum, the testing required by NR516.07(2m)(a) will be conducted on the GCL.

12.3.1.1 Role of Testing Laboratory

The Geosynthetic Testing Laboratory will be responsible for performing the tests on samples submitted to them. The results of tests performed will be reported to the CQAT and CQA Officer.

Retesting of GCL rolls for quality assurance purposes, because of failure to meet any or all of the acceptance specifications in this section, can only be authorized by the CQA Officer.

The GCL Manufacturer and/or Installer may perform their own tests according to the methods and procedures defined in Table 12-1; however, the results will only be applicable to their own quality control needs. These results will not be substituted for the quality assurance testing described herein.

12.3.1.2 Procedure For Determining GCL Roll Test Failures

Table 12-1 lists the specifications that are applicable to the GCL. For any referenced test method that requires the testing of multiple specimens, the criteria in Table 12-1 will be met based on the average results of the multiple specimen tests.

The following procedure will be used for interpreting the results relative to acceptance or rejection of rolls, lots, and shipments of GCL to the site:

1. If the test values meet the stated specifications, then the roll and batch will be accepted for use at the job site. If the sample represents all rolls from an entire shipment, then the entire shipment will also be considered accepted.
2. If the results do not meet the specification, then the roll and the batch will be retested at the Contractor's expense using specimens either from the original roll sample or from another sample collected by the CQAT. For retesting, two additional tests will be performed for the failed test procedure. (Each additional test will consist of multiple

specimen tests if multiple specimens are called for in the failed test procedure.) If both of the retests are acceptable, then the roll and batch will be considered as having passed this particular acceptance test; if either of the two additional tests fail, then the roll and batch will be considered as being unsuitable without further recourse. The CQAT may obtain samples from other rolls in the batch. On the basis of testing these samples, the CQA Officer may choose to accept a portion of the batch while rejecting the remainder.

3. If retesting does not result in passing test results as defined in the preceding paragraph, or if there is any other nonconformity with the material specifications, then the Contractor will withdraw the rolls from use in the project at Contractor's sole risk, cost, and expense. Once withdrawn, the same rolls will not be resubmitted for use. Expenses for removing this GCL from the site and replacing it with acceptable GCL will be the sole risk and responsibility of Contractor.

12.3.2 Required Equipment

The following installation equipment is required on-site:

- Front end loader, crane, or other similar equipment. The selected piece of equipment will not cause damage to the subgrade, such as rutting. The Installer will verify in the presence of the CQAT that the selected piece of equipment does not damage the subgrade.
- A spreader bar to prevent slings from damaging the ends of the rolls.
- Several steel pipes to be inserted into the roll's core for lifting.
- Wooden pallets for aboveground storage of the GCL rolls.
- Heavy waterproof tarps for protecting all GCL rolls.
- Sandbags for securing the GCL during installation and for securing the tarps.
- Adhesive or tape for securing patches.
- Granular bentonite for seams and patches, and for securing around penetrations and structures as shown on the drawings.

12.3.3 Surface/Subgrade Preparation

GCL liner installation will not begin until a proper subbase has been prepared to accept the bentonite liner. Base material will be fine-grained soil free from angular rocks, roots, grass, and vegetation. Foreign materials and protrusions will be removed, and all cracks and voids will be filled; the surface will be made smooth and uniformly sloping. Unless otherwise required by the contract specifications and drawings, the prepared surface will be free from excessive moisture, loose earth, rocks or clay clods larger than 2 inches in diameter, rubble, and other foreign matter.

The subgrade will be uniformly compacted to a minimum of 90 percent Modified Proctor density (ASTM D1557) or 95 percent Standard Proctor density (ASTM D698), to ensure against localized settlement and rutting under wheel loads and will be smoothed with a smooth drum or vibratory roller.

The surface on which the liner is to be placed will be maintained in a firm, clean, and smooth condition, free of standing water, during liner installation.

12.3.4 Deployment

As each roll is moved from the storage area, the labels will be removed by the Installer or CQAT for storage in the project file.

The rolls of GCL will be brought to the area to be lined with a front-end loader, and support pipe will be set up such that the roll of liner is fully supported across its length. A spreader bar or similar device will be used to prevent the lifting chains or slings from damaging the edges. Dragging of the GCL liner will be minimized.

The Contractor will ensure, and the CQAT will verify, that the following criteria are being met:

- The equipment used does not damage the GCL by handling, excessive heat, leakage of hydrocarbons, or by other means.
- The prepared surface underlying the GCL has not deteriorated since previous acceptance, and it is still acceptable at the time of GCL placement.
- Personnel working on the GCL do not smoke, wear damaging clothing, or engage in other activities that could damage the GCL.
- The method used to unroll the GCL does not cause damage to the GCL, and/or the subgrade.
- The method used to place the rolls minimizes wrinkles (especially wrinkles between adjacent panels).

GCL must not be placed during precipitation events, in the presence of excessive moisture, in any area of ponded water, or during excessive winds. The GCL must be dry when installed and must be dry when covered.

The proper side of the GCL, as per the manufacturer’s recommendation, will face upward (unless otherwise dictated by project requirements). The liner will be placed over the prepared surface such that material handling will be minimized.

The GCL panels will be placed in a manner that ensures sufficient overlap as described in Subsection 12.3.5. Horizontal seams will not occur on slopes steeper than 7H:1V.

The cover material (i.e., geomembrane) will be placed over the bentonite liner during the same day as the placement of the GCL. Only those GCL rolls that can be covered that same day will be unpacked and placed in position.

When wind conditions could affect installation, the GCL liner installation will be started at the upwind side of the project and will proceed downwind. The leading edge of the liner will be secured at all times with sandbags or other means sufficient to hold it down during high winds.

The GCL will be installed in a relaxed condition and will be free of tension or stress upon completion of the installation. Stretching of the liner to fit will not be allowed. Deployed rolls (panels) will be straightened by the installation personnel to smooth out creases or irregularities.

The CQAT will visually inspect the geotextile's quality, the bentonite uniformity, and the degree of hydration, if any, of the GCL. Any areas in need of repair will be marked.

12.3.5 Seaming

Once the first panel has been deployed, adjoining panels will be laid with a 6-inch minimum overlap on longitudinal seams, and 20 inches on the panel end seams, depending on project specifications. Six-inch overlap lines will be marked on the liner to assist in obtaining the proper overlap. All dirt, gravel, or other debris will be removed from the overlap area of the GCL.

Seam overlaps, whenever possible, will be placed such that the direction of flow is from the top panel to the underlying panel to form a shingle effect.

If the GCL requires a granular bentonite seam, then the overlapping panel edge will be pulled back and granular Volclay® (or approved equivalent) sodium bentonite will be poured continuously along all seams and lap areas from the panel edge to the 6-inch lapline, at a minimum application rate of ¼ pound per linear foot or as recommended by the manufacturer.

12.3.6 Patches/Repairs

Irregular shapes, cuts, or tears in the installed GCL will be covered with sufficient liner to provide a 12-inch overlap in all directions beyond the damaged area. A layer of granular bentonite will be placed in the overlap zone in accordance with the Manufacturer's recommendations. An epoxy-based adhesive, or other approved method, will be used to secure the patch during backfill operations. Alternatively, the patch can be placed underneath the defective liner.

12.3.7 Penetration Seals

The GCL will be sealed around penetrations, pipes, and structures in accordance with the recommendations of the GCL Manufacturer.

Pipe penetrations will incorporate a collar of GCL wrapped around the pipe and securely fastened. A bentonite or mastic grout will be placed around the corners for additional protection. An additional GCL skirt placed over the bentonite grout is also recommended to provide a third level of protection and to prevent the bentonite grout from being displaced. If the seal requires granular bentonite, then a 1- to 2-inch cut will be excavated around the circumference of the pipe, into the subgrade at least 12 inches out from the pipe. Volclay® sodium bentonite (or approved equivalent) will then be packed around the pipe in the subgrade excavation and on adjacent areas so that the pipe is surrounded with granular bentonite. The GCL panel will then be placed over the pipe by penetrating the GCL with slits in a ″pie″ configuration where the pipe is to protrude in a manner that will create a snug fit between the GCL and the pipe. More sodium bentonite will then be spread around the cut edges of the GCL against the pipe and over adjacent areas. To complete the pipe penetration seal, a collar of GCL will be cut in a manner similar to that made on the main panel and will be fit around the pipe, with additional Volclay® sodium bentonite (or approved equivalent) being applied into any gaps that may remain.

12.3.8 Covering GCL

Only the amount of GCL that can be inspected, repaired, and covered with geomembrane in the same day will be installed. The GCL must be covered with geomembrane or alternative temporary cover the same day on which it is installed.

12.3.8.1 Geosynthetics

When covering the GCL, precautions will be taken to prevent damage to the GCL by restricting heavy equipment traffic. If a textured geomembrane is to be placed over the GCL, the CQAT may require a slip sheet (such as 20-mil smooth HDPE) will be placed over the GCL to allow the textured geomembrane to slide into its proper position. The slip sheet will be removed after the geomembrane is in place.

The following requirements apply to soil placement over the GCLs:

- Equipment used for placing the soil must not be driven directly on the GCL.
- A minimum thickness of 1 foot of soil is specified between a light dozer (i.e., maximum contact pressure of 5 lb/sq. inch) and the GCL.
- A minimum thickness of 3 feet of soil is specified between rubber-tired vehicles and the GCL.

Any leading edge or panels of GCL left unprotected must be covered with a heavy, waterproofing tarp that is secured and protected with sandbags or other ballast.

12.3.9 Submittals

The following will be submitted during installation:

- Daily records/logs prepared by the Installer documenting work performed, personnel involved, general working conditions, and any problems encountered or expected on the project. These records will be submitted on a weekly basis.
- Copy of daily subgrade acceptance forms by the Installer.
- Quality control documentation.

12.4 Post-Installation

12.4.1 Final Examination

The CQAT will perform a final GCL examination after portions of installation have been completed. The CQAT will examine the GCL for the following:

- Tears or defects
- Proper overlaps

If any portion of the GCL requires repairs based on the above examination, it will be repaired in accordance with the procedures in Subsection 12.3.6.

12.4.2 Submittals

The following will be submitted after installation is complete:

- Installation certification prepared by the Installer certifying that the GCL was installed in substantial accordance with the specifications and the CQA Plan.
- An as-build panel layout diagram prepared by the Installer identifying the placement of panels and seams. The numbering sequence will be as agreed upon between the CQAT and the Installer prior to commencing installation.
- A copy of the Warranty obtained from the Manufacturer/Installer.

13. Piping

13.1 General

This section includes quality assurance requirements for piping used throughout the facility. Piping will be used in the construction of the following items:

- Leachate collection system
- Leachate conveyance system
- Gradient control system
- Final cover toe drain collection and discharge piping

This section is further divided into three major subheadings, which cover the quality assurance requirements for the pre-installation (includes Piping Manufacturers and Fabricators), installation, and post-installation (includes the final observation and documentation of piping installations). The terms pre-installation, installation, and post-installation are applicable only to the piping installation and do not apply to the overall construction.

Individual pipe sizes and standard dimension ratios (SDRs) to be used for each individual pipe installation are not detailed in this section; the construction plans and specifications will be used for the determination of correct size and wall thickness.

13.2 Pre-Installation

13.2.1 Manufacturing

13.2.1.1 High-Density Polyethylene Material Specifications

High-density polyethylene (HDPE) pipe must be made from extra high molecular weight (EHMW) polyethylene (PE) resin, and the manufactured piping must be classified as Type III, Class C, Category 5, Grade P34 material according to ASTM D1248 and have a cell classification of 345464C as defined by ASTM D3350.

13.2.1.2 Polyvinyl Chloride Material Specifications

All polyvinyl chloride (PVC) pipe fittings must be PVC molded fittings. Extruded fittings may not be used unless specifically approved in writing by the CQA Officer.

13.2.1.3 Fabricator

The Piping Fabricator will be responsible for perforating the pipe delivered by the Piping Manufacturer according to the plans and specifications.

13.2.2 Delivery, Handling, and Storage of Piping

Pipe will be protected during shipment from excessive heat or cold, puncture, or other damaging or deleterious conditions. The pipe will be stored on-site in a manner suitable to protect it from long-term ultraviolet exposure prior to actual installation.

The CQAT will be responsible throughout the pre-construction, construction, and post-construction periods for observing and documenting that the Contractor provides adequate handling equipment for moving pipe and that the equipment and handling methods used do not pose any risk of damage.

The CQAT will maintain a log of pipe deliveries throughout the installation. The pipe size and type at a minimum will be recorded on the log for each shipment received at the job site.

13.3 Installation

13.3.1 Connections

13.3.1.1 HDPE Pipe

Unless approved otherwise by the CQA Officer, HDPE pipe connections will be made by the butt fusion procedure. The following procedure will be used regarding butt fusion seams:

- Seams will be made at the Manufacturer’s recommended temperature for fusing pipe and fittings.
- For pipe diameter sizes 4 inches (nominal) and larger, seams will be made using the hydraulic fusion machines. For pipe diameters of less than 4 inches, manual fusion equipment can be used.
- Care will be taken to make certain that adequate pressures are used for fusing pipes and that sufficient cooling periods are allowed prior to testing, bending, or backfilling of pipe sections.

13.3.1.2 PVC Pipe

Unless approved otherwise by the CQA Officer, all PVC pipe connections will be made according to the Standard Practice for Making Solvent-Cemented Joints with Polyvinyl chloride (PVC) Pipe and Fittings, ASTM D2855.

Particular care will be taken regarding required set and cure times for solvent- cemented joints, which vary for ambient temperature conditions. Joints will not be subjected to stresses by moving or backfilling prior to the specified set times, ASTM D2855. Only original quality solvent cement may be used since expired shelf life and deteriorated cements may cause inadequate connections.

13.3.2 Placement

Pipe placement will be done in accordance with the following procedure and requirements:

- Piping will be bedded and backfilled according to the plans and specifications.
- Piping placement will not be performed in the presence of excessive moisture.
- The prepared surface underlying the piping will not show evidence of deterioration since previous acceptance and must be acceptable prior to piping placement.
- The method used to place the piping will not cause damage to the piping and will not disturb the supporting backfill.
- The pipe bedding material will be shovel-sliced, or compacted to the spring line of the pipe to ensure proper bedding.
- Observations and measurements will be made to ensure that the pipes are of the specified size and dimension ratio, manufactured of the specified material, and that pipe perforations are sized and spaced as specified.
- All piping will be located as noted in the plans and specifications. Locations, grades, and size requirements are specified on the details of the plan set. Observations and surveying measurements will be made to ensure that the pipes are placed at the specified locations and grades and in the specified configuration. Deviations from the plans and specifications will be brought to the attention of the CQA Officer for evaluation of the necessity of corrective action.

13.3.3 Damage

The CQAT will examine each pipe after placement for damage. The CQAT will advise the CQA Officer as to which pipes will be rejected, repaired, or accepted. Damaged pipes or portions of pipes that have been rejected will be marked and removed from the installation area and documented by the CQAT.

13.4 Post-Installation

Leachate collection pipes will be cleaned with a water jet cleanout device with a maximum pressure of 10,000 pounds per square inch after collection pipe and leachate drainage layer installation is complete. The pipes will be cleaned by jetting from each cleanout access point to the toe of the opposite sideslope. Any pipes that do not appear to be free flowing will be immediately reported to the CQA Officer, and corrective action will be taken.

A video camera inspection will be conducted on all leachate collection pipes after initial pipe cleaning activities described above. The video camera inspection will extend a minimum of 300 feet onto the base grades of each leachate collection pipe.

A summary report will be submitted after the pipe cleaning and video camera inspection. The report will summarize any specialty equipment used in collection pipe cleaning, blockages or difficulties in cleaning pipes, and how blockages were removed, or pipe damage repaired. Recording tape or disk of the video camera inspection will be included with the summary report.

Solid-wall pipe (single- and double-walled) outside the limits of waste will be air pressure–tested to document that the piping system is airtight. The line will be air-pressurized to 5.0 pounds/square inch (gauge pressure). The valve on the pressurizing unit will be closed, and the system will be pressure monitored. A system pressure of 4.8 psi or greater maintained for 30 minutes after the valve closing will be considered as acceptable. The CQAT will observe and document that this operation is carried out and that the pipes are airtight.

Pipe invert elevations will be documented every 25 linear feet by survey or every 50 feet if a total station, GPS, or laser equipment is used, as well as at key points, including changes in grade, intersections, and end points.

14. Geocomposite

14.1 General

This section covers the quality assurance requirements for pre-installation, installation, and post-installation. The terms pre-installation, installation, and post-installation are applicable only to the geocomposite and to not apply to the overall construction.

14.2 Pre-Installation

14.2.1 Manufacturing

The geotextile portion of the geocomposite will be composed of a nonwoven, needle- punched, polyester or polypropylene geotextile. The Installer will ensure that the geotextile portion of the geocomposite has a minimum average roll value as listed in Table 14-1.

The geonet portion of the geocomposite must be fabricated for HDPE resin, and fabricated geonet must be classified as Type III, Class C, and Category 4 or 5, as defined by ASTM D1248. The geonet will be manufactured by extruding two sets of strands to form a three-dimensional structure to provide planar flow. The Installer will ensure that the geonet portion of the geocomposite has minimum average roll values listed in Table 14-2.

The geocomposite will be manufactured by heat-bonding the geotextile to the geonet on both sides. The bond between the geotextile and the geonet must have minimum peel strength of 1 lb/inch (ASTM D413).

The geocomposite will be supplied to the site in factory rolls. Prior to the delivery of any geocomposite rolls, the Geocomposite Manufacturer will provide the CQA Officer and the Owner with the manufacturer’s Quality Control Plan used for the production of the geocomposite.

Table 14-1 Geotextile Specifications

PROPERTY	TEST	UNITS	CRITERION	6 OZ VALUE	8 OZ VALUE
Apparent opening size	ASTM D4751	mm	Maximum	0.25	0.25
Grab strength	ASTM D4632	lb	Minimum	157	200
Grab strength elongation	ASTM D4632	Percent	Minimum	50	50
Trapezoidal tear	ASTM D4533	lb	Minimum	55	80
Puncture strength	ASTM D6241	lb	Minimum	310	430
Permittivity	ASTM D4491	Sec^{-1}	Minimum	0.2	0.2

Table 14-2 Geonet Specifications

PROPERTY	TEST	UNITS	CRITERION	VALUE	VALUE	VALUE
Thickness	ASTM D5199	Mils	Range	200	250	300
Density	ASTM D1505	g/cm^3	Minimum	0.95	0.95	0.95
Carbon black content	ASTM D1603 modified	Percent	Range	1.5 to 3.0	1.5 to 3.0	1.5 to 3.0

The Geocomposite Manufacturer will provide certification, based on tests performed in accordance with the methods listed in Table 14-1 that the geotextile supplied under this Plan will meet the material specifications listed in Table 14-1 and that the geonet supplied under this Plan will meet the material specifications in Table 14-2. These tests may be performed by the Geotextile or Geonet Manufacturer's laboratory or a laboratory contracted by the Manufacturer. Additionally, the Geocomposite Manufacturer will provide certification that the Manufacturer's Quality Control Plan was fully implemented for the geotextile materials supplied under this plan and that the geocomposite delivered to the site does not contain needles. The Geocomposite Manufacturer will provide documentation to verify the results of the Manufacturer's CQA Plan implementation required by the CQA Officer and the Owner.

The geocomposite rolls may be tested and evaluated prior to acceptance. The CQA Officer may perform/require additional testing (i.e., conformance testing) as required by detailed specifications or as required in the judgment of the CQA Officer to verify that the geocomposite meets the specifications.

14.2.2 Delivery, Handling, and Storage of Geocomposite Rolls

Each geocomposite roll will be marked by the Geocomposite Manufacturer with the following information and in the following manner:

- When fabric is rolled on a core, each roll will be identified with a durable gummed label, or an equivalent, on the inside of the core and on the outside of the protective wrapping for the roll.
- Each roll label will contain the following information, at a minimum:
    - Name of manufacturer
    - Style and type number
    - Roll length and width
    - Batch (or lot) number, if applicable
    - Date of manufacture
    - Roll number

The geocomposite Manufacturer will use the following guidelines in packing, wrapping, and preparing all geocomposite rolls for shipment:

- When cores are required, those that have a crushing strength sufficient to avoid collapse or other damage while in use will be used.
- Each roll will be covered with a wrapping material that will protect the geotextile from damage due to shipment, water, sunlight, or contaminants.

At a minimum, the following practices will be followed in receiving and storing geocomposite rolls in the covered storage area at the job site:

- While unloading or transferring the geocomposite rolls from one location to another, care will be taken to prevent damage to the geocomposite. If practicable, forklift trucks fitted with poles that can be inserted into the cores of the rolls will be used. The poles will be at least two-thirds the length of the rolls to avoid breaking the cores and possibly damaging the geocomposite. Rolls will not be dragged. For geocomposite rolls shipped with manufacturer’s straps, these straps can be used to unload or transport geocomposite rolls.
- The geocomposite rolls will be stored in a manner so as to ensure that they are adequately covered to protect the geocomposite from the following:
    - Precipitation
    - Ultraviolet radiation

  - Strong oxidizing chemicals, acids or bases
  - Flames, including welding sparks
  - Temperature in excess of 160°F

The CQAT will be responsible throughout the pre-installation, installation, and the post-installation periods for observing and documenting that the Installer provides adequate handling equipment used for moving geocomposite rolls and that the equipment used does not damage the geocomposite rolls.

The CQAT will maintain a log of geocomposite roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job site.

- Date of delivery at the job site.
- For each geocomposite roll, the following information:
  - Roll number
  - Batch (lot) number, if applicable

14.3 Installation

14.3.1 Placement

The Installer will install all geocomposite in such a manner so as to ensure that it is not damaged in any way, and in a manner that complies with the following:

- The geocomposite will be securely anchored, as shown on the design drawings and specifications, and then rolled downslope in such a manner so as to continually keep the geocomposite in tension. If needed, the geocomposite will be positioned by hand after being unrolled to minimize wrinkles. Horizontal placement of the geocomposite on sideslopes will not be allowed.
- In the presence of wind, all geocomposite will be secured by suitable means. The temporary weighted material will be left in place until replaced with cover material as shown on the design drawings and specifications.
- Cutting will be done according to manufacturer’s recommendations.
- The Installer will take the necessary precautions to prevent damage to any underlying layers during placement of the geocomposite.
- During placement of geocomposite, care will be taken not to entrap any stones, excessive dust, or moisture that could clog the drainage system, and/or stones that could damage the adjacent geomembrane.

- The geocomposite will not be welded or tack-welded to the geomembrane.

The CQAT will observe and document that the Installer performs each of the above steps. Any noncompliance with the above requirements will be recorded and reported by the CQAT.

14.3.2 Overlaps and Joining

The following requirements will be used with regard to the overlapping and joining of geocomposite rolls:

- The geotextile portion of the geocomposite will be overlapped 4 to 6 inches, and the upper geotextile will be sewn or fusion welded. The geonet portion will be overlapped a minimum of 2 inches, and will be secured with plastic ties.
- Tying will be performed with pull ties. Ties will be white or brightly colored plastic for easy identification. Ties will be placed 3 feet to 5 feet on center along the edges, and 6 inches on center on the ends of the rolls and in the anchor trenches. Metallic devices will not be used under any circumstances.
- No horizontal joints or overlaps will be allowed on slopes greater than 3 horizontal to 1 vertical, except as part of a patch.
- The Installer will pay particular attention to the overlapped areas to ensure that no earthen or foreign materials could be inadvertently trapped beneath the geocomposite.

The CQAT will observe and document that the Installer performs each of the above steps. Any noncompliance with the above requirements will be reported by the CQAT to the CQA Officer and the Owner.

14.3.3 Repairs

Any tears or other defects in the geocomposite will be repaired by placing a patch with minimum overlaps described in Subsection 14.3.2. The patch will be secured to the original geocomposite by tying every 6 inches. If the tear or other defect width is more than 50 percent of the roll width, the damaged area will be cut out and replaced with new geocomposite. Tying will be as indicated in Subsection 14.3.2.

The CQAT will examine and document that the repair of any geocomposite is performed according to the above procedure.

14.4 Post-Installation

14.4.1 Final Acceptance

The CQAT will perform a final geocomposite examination after installation has been completed. The objectives of this step are as follows:

- To examine for presence of tears or defects.
- To examine overlaps to make certain that they are in conformance with the requirements of Subsection 14.3.2.

If any portion of the geocomposite requires repairs due the above examination, they will then be performed according to the procedures in Subsection 14.3.3.

If there will be an extended delay between completion of the geocomposite and the start of the installation of any overlaying cover, the Installer will make provisions, by placing temporary securing means, to protect the geocomposite from wind uplift.

14.4.2 Placement of Soil Materials

The Contractor will place all soil materials located on top of the geocomposite in such a manner so as to minimize the following:

- Damage to the geocomposite.
- Slippage of the geocomposite on underlying layers.
- Excessive tensile stresses imposed on the geocomposite.

15. Construction Documentation Report

15.1 Summary

A Construction Certification Report shall be prepared under the direction of the CQA Officer in accordance with NR 516 of the Wisconsin Administrative Code. The report will contain, at a minimum, the following information:

Based on the review of the data and the CQA Officer's personal observations during construction, the CQA Officer shall certify that the construction has been prepared and constructed in conformance with the engineering plans and specifications.

- Daily Field Reports.
- Detailed narrative describing the construction activities in chronological order.
- Analysis and discussion of all quality assurance testing performed with summaries of all test results.
- All raw data and test reports performed during construction.
- Detailed description and documentation of all material and equipment types and specifications.
- Discussion of any construction material or equipment which deviated from the engineering plan and reasons for deviation.
- Photographs documenting all aspects of construction.
- Record drawings containing:
    - Existing site grades prior to construction.
    - Liner system subgrade grades.
    - Granular drainage layer thickness measurement locations.
    - Pipe invert grades.
    - Geomembrane panel layout diagram, including seam locations and types, repair locations, destructive sample locations, and anchor trench location.
    - Location of all field tests.
    - Final site grades.
- Correspondence and documentation with WDNR concerning rule exceptions or CQA changes.

Appendix A

Field Report

GEI Consultants

FIELD OBSERVATION REPORT

Project:		**Date:**	
Client:	.	**Weather:**	
Contractor:		**Report No:**	
Location:		Page:	
Arrival Time:		GEI Project No:	
Departure Time:		**Prep and Report Time:**	
Travel Time:		**Mileage:**	
Total Hours:			
Purpose of Site Visit:			
Observations:			
Technician:		Date:	
Reviewed by:		Date	
Final Review by:		Date:	

Photo 1:

Photo 2:

Photo 3:

Photo 4:

Appendix B

Certificate of Acceptance of Prepared Subgrade

Certificate of Acceptance Of Prepared Subgrade

GEOSYNTHETICS CONTRACTOR

NAME: ______________________________

ADDRESS: ______________________________

____

PROJECT

LOCATION: ______________________________

PROJECT: ______________________________

____

I, __________________________, a duly authorized representative of __________________________, have visually inspected the subgrade surface described above and found the surface to be acceptable for installation of the GCL. I do hereby accept the soil subgrade area as described below and shall be responsible for its integrity for suitability, installation, and future containment performance in accordance with these specifications from this date to completion and acceptance of the installation. This certification is based on observations of the surface of the subgrade only.

Area Accepted: ____

____

____

SUBGRADE RELEASED BY:

GENERAL CONTRACTOR

DATE: ______________________________

AUTHORIZED REPRESENTATIVE:

SIGNATURE: ______________________________

NAME: ______________________________

TITLE: ______________________________

SUBGRADE ACCEPTED BY:

GEOSYNTHETICS CONTRACTOR

DATE: ______________________________

AUTHORIZED REPRESENTATIVE:

SIGNATURE: ______________________________

NAME: ______________________________

TITLE: ______________________________

SUBGRADE OBSERVED BY:

CQA CONSULTANT

DATE: ______________________________

AUTHORIZED REPRESENTATIVE:

SIGNATURE: ______________________________

NAME: ______________________________

TITLE: ______________________________

Construction Quality Assurance Plan
Update for Weston Disposal Site No. 3
Knowlton, Wisconsin
September 29, 2023

Appendix C

Initial Roll Inventory

Initial Roll Inventory

Page 1 of 1

GEI Consultants

Project Name: ______________________

QA/QC Monitor: ______________________

Project Number: ______________________

Material Type: ______________________

Roll Number	Lot Number	Width/Length	Conf. Sample (Yes/No)	Certificate Sheet (Yes/No)	Date Shipped to Lab	Lab Pass/ Fail	Visual Inspection/Remarks

Appendix D

Panel Placement Summary

Panel Placement Summary

Page 1 of 1

Project Name: ______________________

Project Number: ______________________

QA/QC Monitor: ______________________

Material Type: ______________________

Panel Number	Date	Time	Roll Number	Material Type	Thickness (mils)					Final Length (Feet)	Final Width (Feet)	Final Area (Sq. Ft.)	Comments

Appendix E

Trial Weld Summary

GEI Consultants

Trial Weld Summary

Project Name: ______________________________

Project Number: ______________________________

QA/QC Monitor: ______________________

Requirements: Peel 50(F) 44(E) Shear: 60

Test No.	Date	Time	Weather (Cloudy/ Sunny)	Amb. Temp. (°F)	Welder I.D.	Machine Number	Temp. Setting/ Speed	Weld Type	(5) PEEL (ppi)										(5) SHEAR (ppi)					Test Result (P/F)	Comments
									(5) Outside Weld					(5) Inside Weld											
									1	2	3	4	5	1	2	3	4	5	1	2	3	4	5		
1																									
2																									
3																									
4																									
5																									
6																									
7																									
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17																									

Construction Quality Assurance Plan
Update for Weston Disposal Site No. 3
Knowlton, Wisconsin
September 29, 2023

Appendix F

Panel Seaming Summary

Panel Seaming Summary

Page 1 of 1

Project Name: ______________________ QA/QC Monitor: ______________________

Project Number: ______________________

Seam Number	Date Seamed	Final Seam Length (Feet)	Welder Id.	Weld Type	Machine Number	Machine Temp/ Speed/ Preheat	Time		Ambient Temp. (°F)	End of Seam Destructive Test (P/F)	Comments
							Start	Stop			

Appendix G

Non-Destructive Test Summary

Non-Destructive Test Summary

Page 1 of 1

Project Name: ____________________ QA/QC Monitor: ____________________

Project Number: ____________________ Requirements: Mil=min psi - max psi drop

Seam Number	Date Tested	Location	Air					Vacuum	Comments
			Air Pressure				Air Test Results (P/F)	Vac. Test Results (P/F)	
			Start		End				
			PSI	Time	PSI	Time			

Construction Quality Assurance Plan
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Appendix H

Repair Summary

GEI Consultants

Repair Summary

Page 1 of 1

Project Name: ______________________ QA/QC Monitor: ______________

Project Number: ______________________

Repair Number	Date	Time	Oper./Mach.	Repair Location	Description	Size of Repair	Date Vacuum Tested	Test Results (P/F)

Appendix I

Destructive Test Summary – Field

Destructive Test Summary - Field

Project Name: ______________________

QA/QC Monitor: ______________________

Project Number: ______________________

Requirements: Peel - / Shear

Sample Number	Seam Number	Date Sampled	Date Shipped	Description of Sample Location	Peel (ppi)		Shear (ppi)	Laboratory Results (P/F)	Comments
					Inside	Outside			

Construction Quality Assurance Plan
Update for Weston Disposal Site No. 3
Knowlton, Wisconsin
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Appendix J

Destructive Test Summary - Laboratory

Destructive Test Summary - Laboratory

Project Name: ________________ QA/QC Monitor: ________________

Project Number: ________________ Requirements: Peel - / Shear

Sample Number	Seam Number	Date Sampled	Date Shipped	Description of Sample Location	Peel (ppi)		Shear (ppi)	Laboratory Results (P/F)	Comments
					Inside	Outside			

Appendix K

Field Compaction Summary

Field Compaction Summary

Project Name: ____________________ Compaction Equipment: ____________________

Project Number: ____________________ Density Equipment: ____________________

Test No.	Date	North	East	Lift	Material Number	Lab. Max Dry Density	In-Place Wet Density	Moisture Content	In-Place Dry Density	Percent Compaction	Comments
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
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33											
34											
35											
36											

Plan of Operation Modification
Weston Disposal Site No. 3
Town of Knowlton, Wisconsin
September 29, 2023

Appendix O

Environmental Sampling and Analysis Plan

Intended for
Wisconsin Public Service Corporation

Date
December 19, 2023

Project No.
1940104079

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM REVISION 1

WESTON DISPOSAL SITE NO. 3

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WESTON DISPOSAL SITE NO. 3

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Prepared by	**Eric J. Tlachac, PE**
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**

Nathaniel R Keller

Nathaniel R. Keller, PG
Senior Hydrogeologist

Eric J. Tlachac

Eric J. Tlachac, PE
Senior Managing Engineer

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.

Nathaniel R Keller
____
Nathaniel R. Keller
Professional Geologist
1283-13
Wisconsin
Date: December 19, 2023

NATHANIEL R.
KELLER
PG-1283
VERONA
WI

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.

Eric J. Tlachac
____
Eric J. Tlachac
Professional Engineer
36088-6
Wisconsin
Date: December 19, 2023

ERIC J.
TLACHAC
36088
DELAFIELD,
WI

DOCUMENT REVISION RECORD

Issue No.	Date	Details of Revisions
Revision 0	January 30, 2023	• Original Document
Revision 1	December 19, 2023	• Revised Section 3.1 to remove BASIN LYS-1 and add LH-2-1 and LH-2-2 • Revised Figure 2-1 to include the leachate collection tank, leachate headwells, land storm water basins • Revised Figure 2-2 to include the entire landfill footprint • Added documentation of the design and installation, and development of LS-100, LS-101, and LS-105 to Appendix A • Added Bedrock Surface Contour Map to Appendix B and related reference in Section 2 • Revised Appendix D

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TABLES (IN TEXT)

TABLES (ATTACHED)

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
ESAP	Environmental Sampling & Analysis Plan
GCS	Gradient Control System
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
PAL	Preventive Action Limit
Ramboll	Ramboll Americas Engineering Solutions, Inc.
STS	STS Consultants, Ltd.
TDS	total dissolved solids
Wis Adm Code	Wisconsin Administrative Code
WDS3	Weston Disposal Site #3 Ash Landfill
WDNR	Wisconsin Department of Natural Resources
WPS	Wisconsin Public Service Corporation

EXECUTIVE SUMMARY

This Environmental Sampling and Analysis Plan (ESAP) Addendum was completed by Ramboll Americas Engineering Solutions, Inc. (Ramboll) for the Wisconsin Public Service Corporation (WPS) Weston Disposal Site #3 (WDS3) 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.

WDS3 is located in the Town of Knowlton, Marathon County, Wisconsin (**Figure 1-1**). The ash landfill is bordered by Legner Road to the east and vacant forested land to the west, north, and south (**Figure 2-1**). From about 1990 to 2015 a prior CCR landfill was present on site, occupying a footprint adjacent to and west of the current landfill Cells 1 and 2. In 2015, the prior landfill, including all existing CCR material, was removed and hauled to a licensed municipal solid waste facility. Closure of the former landfill and construction of current Cells 1 and 2 was completed in late 2015 and approved by the Wisconsin Department of Natural Resources (WDNR) on April 22, 2016. Placement of CCR was initiated on June 27, 2016 in Cell 2.

Two hydrostratigraphic units have been identified beneath the landfill based on stratigraphic relationships and common hydrogeologic characteristics, including:

- Silty sand: This material comprises the Uppermost Aquifer and is encountered at variable thickness ranging from about five to 20 feet thick. This unit has been interpreted as the Marathon Formation, which is composed of glacial till and bedrock residuum.
- Quartz diorite and granitic bedrock: Underlying the silty sand is the regional bedrock which generally includes a weathered zone at the bedrock surface.

Groundwater quality at WDS3 is currently monitored under federal and state programs. Both programs monitor the shallow glacial deposits and weathered bedrock, while the existing state (Ch. NR 500, Wis Adm Code) program also monitors the bedrock. Groundwater samples collected for the state program are analyzed for concentrations of dissolved parameters specified in Ch. NR 507 Table 2 and compared to Ch. NR 140, Wis Adm Code Preventive Action Limits (PALs) and Enforcement Standards (ESs). Beginning in 2015, the Uppermost Aquifer (unlithified materials) 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 five monitoring wells; 1 background (LS-101) and 4 downgradient monitoring wells (LS-100, LS-105, LS-106, and LS-107). 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.

WPS is requesting an exemption to the Ch. NR 140 PAL in Uppermost Aquifer monitoring wells-106, and PALs have been calculated for calcium and total dissolved solids at the monitoring wells in accordance with Ch. NR140.20.

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 ESAP Addendum was completed by Ramboll as part of the Plan of Operation Modification for the WPS WDS3 to present a CCR groundwater monitoring program that fulfills Wis Adm 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

WDS3 is located in Marathon County, northcentral Wisconsin, in Section 23, Township 26N, Range 7E in the Town of Knowlton (**Figure 1-1**). It is bordered by Legner Road to the east, and vacant forest land on all other boundaries.

1.3 Background

WDS3 was originally permitted by the WDNR on October 20, 1986, with the issuance of a Conditional Plan of Operation Approval. The original facility was licensed and approved to consist of 8 cells covering 35 acres and having a total design capacity of 873,000 cubic yards. Former Cell 1 was constructed and placed into operation with the construction documentation approval on December 18, 1990.

However, due to WPS's beneficial use program, Former Cell 1 was only partially filled, temporarily capped, and remained dormant. In 2011, WPS began a permitting effort to expand WDS3 from 35 acres and 873,000 cubic yards to 57.6 acres and 4,075,500 cubic yards. The expanded landfill was permitted December 11, 2014 with the issuance of a Conditional Plan of Operation Approval by WDNR.

As part of that permitting effort, the geologic and hydrogeologic investigation program defined the geologic conditions, groundwater quality, and groundwater flow for the site. This information is included in the report titled Feasibility Report, Proposed Weston Disposal Site No. 3 Expansion (AECOM, 2012).

Cells 1 and 2 of the expanded landfill (**Figure 2-1**) were constructed during 2015 and included installation of a new leachate force main, storage tank, and load-out system. Construction of Cells 1 and 2 included removal and off-site disposal of all CCR from Former Cell 1 to a licensed municipal solid waste landfill (TRC, 2016). Cells 1 and 2 have a composite liner consisting of a 60-mil high-density polyethylene (HDPE) geomembrane, geosynthetic clay layer (GCL), two (2) feet of compacted clay, and a leachate collection system. These cells also have groundwater gradient control system (GCS) placed beneath the composite liner comprised of a 12-inch thick granular fill layer extending a minimum of 25 feet beyond a series of GCS trenches containing 6-inch diameter perforated collection pipes surrounded by additional granular fill. The GCS system is designed to gravity drain groundwater during occasional occurrences of high groundwater levels.

Groundwater quality at WDS3 is currently monitored under federal and state programs. Samples collected from the state (Ch. NR 500, Wis Adm Code) groundwater monitoring well network are analyzed for concentrations of dissolved parameters specified in Ch. NR 507 Appendix I Table 2 and additional ions and metals and compared to Ch. NR 140, Wis Adm Code Preventive Action Limits (PALs) and Enforcement Standards (ESs). Monitoring under the state program has been performed at the site since approval of the Conditional Plan of Operation was received from WDNR on December 11, 2014.

In 2016, two additional monitoring wells were installed into the silty sand and bedrock representing 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 for the federal program in accordance with 40 CFR § 257.94 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 at WDS3. Previous investigations include soil borings and monitoring wells installed to characterize site geology and hydrogeology prior to initial permitting and to comply with Ch. NR 500, Wis Adm Code. The current monitoring well networks and locations are shown on **Figure 2-1**.

With the promulgation of 40 CFR § 257 in 2015, wells in the existing monitoring well network screened in the Uppermost Aquifer, as defined in 40 CFR § 257.53, were supplemented with two additional wells (LS-106 and LS-107) and monitored in accordance with 40 CFR § 257.94 detection monitoring requirements. Five monitoring wells including one background (LS-101) and four downgradient monitoring wells (LS-100, LS-105, LS-106, and LS-107) comprise the 40 CFR § 257 monitoring well network (**Table 2-1**). Wells are screened within the silty sand and weathered bedrock present onsite. The boring logs, well construction forms, and other related monitoring well forms (including a Well Information Form [WIF]) for the two additional wells are included in **Appendix A**.

2.1 Geology

Based on previous geologic investigations at the site, the geology is characterized as a thin layer of glacial till and weathered bedrock overlying a shallow, variable granitic bedrock surface that has been previously altered by glaciation (AECOM, 2012). Details of geology near WDS3 are found on the cross-sections provided in **Appendix B**.

The unconsolidated sediments are generally between 0.5 and 20 feet thick, consisting of a thin and somewhat discontinuous unit of glacial till and weathered bedrock which has been identified as the Marathon Formation (undifferentiated). The weathered bedrock layer originates from the parent bedrock material, via erosion and/or by glacial processes, which also deposited glacially transported material. The weathered bedrock is generally a silty sand (SM) with gravel- to cobble-sized pieces of the bedrock found throughout. Based on review of boring logs, it is sometimes difficult to differentiate between the till and weathered bedrock. The underlying bedrock is an igneous Precambrian granite, quartz diorite, and/or amphibole as identified during the 2012 AECOM geologic investigation.

Borings completed prior to and for the 2012 AECOM investigation indicate there is a bedrock high on the west side of the landfill site near LS-16 OW at an elevation of approximately 1,200 feet mean sea level (msl). The site is located along a regional bedrock high between Johnson Creek (0.6 mile to the east) and Peplin Creek (1.25 miles west). It is an area of groundwater recharge, with groundwater flow moving radially from the bedrock high. Another smaller bedrock high exists in the northeast corner of the site southwest of well LS-101 at approximately the same elevation; this high is located beneath the northwest corner of Cell 1. A bedrock surface contour map is provided in **Appendix B**.

2.2 Site Hydrogeology

Groundwater is encountered within the silty sand and weathered bedrock which comprise the Uppermost Aquifer. Groundwater flow generally follows the surface topography and the underlying bedrock surface, with a groundwater mound in the vicinity of the bedrock high (roughly centered near well LS-16 OW) and groundwater flowing generally to the northwest, southwest, and southeast away from this bedrock high. Groundwater mounding is also observed at the smaller bedrock high located near LS-101, with groundwater in this area flowing generally to the southeast and northwest. Measured groundwater elevations along the bedrock highs can be four or more feet higher than areas where the bedrock elevation is lower, reflecting areas of recharge proximate to the west-central part of WDS3 (future Cells 7-9) and the northern portion of Cell 1. Groundwater elevations are contoured on Figure 2-2 and illustrate the effects of the groundwater GCS that was installed to provide separation between the base of the CCR land fill and high groundwater elevations. The presence of the GCS eliminates the potential for groundwater to contact the base of the liner during high groundwater elevations and GCS details are shown in **Appendix B**.

Based on the observed groundwater divide trending southwest to northeast, with components of groundwater flow to the north and south from this divide (**Figure 2-2**), the monitoring network will be developed in phases as additional WDS3 cells are constructed. Cell 2 and the east portion of Cell 1, along with future Cell 3 and the southern portions of future Cells 4 and 5 are all predominantly east and south of the groundwater flow divide. This requires that downgradient monitoring wells be located southeast to south of Cells 1-2 and future Cells 3-5. For the west half of the property, where future Cells 6-9 will be located, the groundwater flow is south to southwest in the southern portion of this area of the site, and northwest to northeast in the northern portion of this area of the site.

Based on field testing summarized in the 2012 Feasibility Report, the unconsolidated glacial till deposit was reported to have a saturated hydraulic conductivity of $1x10^{-4}$ centimeters per second (cm/s). Observed hydraulic conductivity values for the granitic bedrock were lower, ranging from approximately $2.1x10^{-5}$ to $9.0x10^{-7}$ cm/s.

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

3.1 Existing Ch. NR 507 Monitoring Program

Semi-annual (annual where noted) groundwater monitoring is completed in accordance with Ch. NR 507, Wis Adm Code. In accordance with the December 11, 2014 Conditional Plan of Operation Environmental Monitoring Summary, the monitoring well network (**Figure 2-1**) consists of 17 monitoring wells screened in the unlithified glacial sediments and other sampling locations as follows:

- Lab analysis; LS-10 OW, LS-48P, LS-48R, LS-49R, LS-54 OW, LS-54P, LS-100P, LS-100, LS-101P, LS-101, LS-102P, LS-102, LS103P, LS-103, LS-104, LS-105P, LS-105
- Groundwater elevations: LS-09 OW, LS-9P, LS-16 OW, LS-16P, LS-22P, LS-22R, LS-24 OW, LS-24P, LS-40 OW, LS-40O, LS-50 OW, LS-51 OW, LS-52 OW, LS-52P, LS-55 OW, LS-55P, LS-56 OW, LS-56P, LS-57 OW
- the leachate tank (LCHTE TANK)
- leachate head wells: LH-1-1, LH-1-2, LH-2-1, LH-2-2

Semi-annual samples are collected in April and October 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, pH, and specific conductance.

Table A – Ch. NR 507 Groundwater Monitoring Parameters

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

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

Table B – Ch. NR 507 Leachate Monitoring Parameters

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

Table B - Ch. NR 507 Leachate Monitoring Parameters (cont.)

Inorganics		
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 Program Revisions

WPS requests to remove wells currently utilized in the Ch. NR 507 monitoring program that are proposed as Ch. NR 507.15(3) CCR wells, which will eliminate the collection of both total and dissolved parameters at the same well during each event . This includes wells LS-100, LS-101, and LS-105, which are proposed as Ch. NR 507.15(3) CCR wells (Section 4).

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 as CCR wells 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 WDS3 (**Figure 2-1**) consists of five monitoring wells installed within the Uppermost Aquifer, one background monitoring well (LS-101) and four downgradient monitoring wells (LS-100, LS-105, LS-106, and LS-107).

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 for the WDS3 Landfill (Natural Resource Technology, an OBG Company [NRT/OBG], 2017).

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

Table C – 40 CFR § 257 Groundwater Monitoring Program Parameters

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

Notes:

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

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

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

The proposed Ch. NR 507.15(3) monitoring network (CCR wells) will consist of one background monitoring well (LS-101) and four downgradient monitoring wells (LS-100, LS105, LS-106, and LS-107; **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 Cells 1 and 2 of the WDS3 ash landfill. Additional CCR wells will be installed and incorporated into the network as permitted cells are constructed in the future following WDNR approval of Plan of Operation Modifications. CCR wells will be inspected in accordance with Ch. NR 507.13 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 C**).

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 (8) rounds of baseline groundwater quality data for the parameters referenced in 40 CFR § 257 Appendices III and IV were collected beginning on February 18, 2016 and extending through June 2, 2017 (**Appendix D-1**). All laboratory analyses were performed by the We Energies laboratory or Pace Analytical, Wisconsin certified laboratories, using appropriate methods that yielded adequate sensitivity and detection limits lower than the Ch. NR 140 PAL and ES.

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

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

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

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

Beginning in the second quarter of 2023, and continuing semi-annually thereafter (April and October), groundwater will be collected from the CCR wells and sent to a Wisconsin certified laboratory for analysis of parameters summarized in **Table E,** 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 associated Ch. NR 140 standards.

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, Tables 4, Detection Leachate Monitoring Parameters

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

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

[2] Leachate volumes are compiled monthly.

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

4.6 Groundwater Standards

Groundwater analytical results will be compared to PALs and ESs listed in Ch. NR 140 Tables 1, 1A, and 2 where applicable. PALs for calcium and TDS were calculated in accordance with Ch. NR 140.20. However, an exemption may be requested, and Alternative Concentration Limits (ACLs) proposed, when the background concentration of a public health or welfare parameter exceeds the NR 140 PAL or ES (WDNR, 2007). Based on the baseline and subsequent detection monitoring sampling, only boron at LS-106 met one or more of the following criterial the criteria to request an ACL:

- 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 boron was calculated using data collected per 40 CFR § 257 beginning in 2015. If a result was below the detection limit in a well, one-half the detection limit was used in the calculation. Detailed calculation summary tables are provided in **Appendix D-2** and the applicable ACLs listed below (Table G).

Table G. Summary of Proposed Alternate Concentration Limits

Location ID	Boron (mg/L)
LS-106	0.24

The data used in ACL calculations were examined for potential outliers using a combination of box-whisker plots and trend graphs. One potential outlier was identified and removed to provide a conservative ACL value.

PALs for calcium and TDS were calculated using the mean concentration plus three times the standard deviation or the Ch. NR 140 Table 3 increment, whichever was greater. Outliers were evaluated and removed if they altered the calculated PAL by greater than ten percent. Results of the analysis are summarized in Table 4-2.

4.7 Reporting

4.7.1 GEMS Reporting

Consistent with the sampling and reporting requirements for the existing Ch. NR 507 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. 3067.

4.7.2 Deviations from Sampling Plan

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

4.7.3 Annual Groundwater Monitoring & Corrective Action Report

Annual Groundwater Monitoring and Corrective Action Reports documenting the status of the groundwater monitoring and any corrective action implemented at WDS3 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 Chs. NR 506.17(2) and (3), respectively. 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 Chs. 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 required by 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 WDS3 Ash Landfill is the cause or the exceedance is due to an error. The intent to complete this demonstration must be included in the notification referenced in Section 4.8.1. 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 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 will be submitted to WDNR demonstrating a source other than WDS3 caused the exceedance or that it resulted from error in sampling, analysis, or natural variation in background groundwater quality. 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, 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 (ASD), 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 tWDS3 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 under 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. NR 140 standards, an alternative remedy may be proposed for WDNR review and approval. The proposed alternative remedy will be evaluated as a remedial action option as described above.

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

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

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

5. REFERENCES

Natural Resource Technology, an OBG Company, 2017. Sampling and Analysis Plan. Weston Disposal Site No. 3 Landfill. October 3, 2017.

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/

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.

TABLES

TABLE 2-1
CCR GROUNDWATER MONITORING WELL INFORMATION

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM REVISION 1
WESTON DISPOSAL SITE NO. 3 LANDFILL
TOWN OF KNOWLTON, WISCONSIN

Well ID	LS-100	LS-101	LS-105	LS-106	LS107
Well Location Latitude	44.72484	44.72648	44.72295	44.72219	44.72630
Well Location Longitude	-89.63437	-89.63627	-89.63439	-89.63533	-89.63852
Well Location Northing (State Plane)^3	325,223	325,816	324,533	324,253	324,749
Well Location Easting (State Plane)^3	2,063,529	2,063,032	2,063,527	2,063,283	2,062,448
Well Construction Material	PVC	PVC	PVC	PVC	PVC
Well Diameter (inches)	2	2	2	2	2
Top of Casing Well Elevation (ft)^4	1199.04	1205.41	1190.28	1193.24	1194.40
Well Depth (ft)^5	13.9	15.0	7.8	15.0	15.0
Pump Intake Elevation (ft)^4	1188.0	1193.1	1182.6	1180.5	1181.5
Screen Length (ft)	10	10	5	10	10
Top of Screen Elevation (ft)^4	1193.0	1198.1	1185.1	1185.5	1186.5
Bottom of Screen Elevation (ft)^4	1183.0	1188.1	1180.1	1175.5	1176.5
Casing Length to Screen (ft)	6.0	7.3	5.2	7.7	7.9
Well Stick-up Above Ground Surface (ft)	2.14	2.31	2.38	2.74	2.90
Hydraulic Position of Well$^{(1)}$	D	U	D	D	D

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 obtained from well construction forms and tablulated summary provided by GEI Consultants.
3. Horizontal Datum is referenced to Wisconsin State Plane Coordinate System, Central Zone, North America Datum (NAD 83/2007), US Survey Feet.
4. Elevation datum is referenced to North American Vertical Datum 1988 (NAVD88).
5. Depth below ground surface (bgs).

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

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM REVISION 1
WESTON DISPOSAL SITE NO. 3 LANDFILL
TOWN OF KNOWLTON, 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	
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	
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	
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	
Inorganics								
Alkalinity	--	mg/L	2320B	--	--	10	5	
Fluoride	16984-48-8	mg/L	EPA 300.0/ EPA 9056	0.8	4.0	0.2	0.4	4
Chloride	16887-00-6	mg/L	EPA 300.0/ EPA 9056	125.0	250.0	2	4	250 (3)
Hardness	--	mg/L	EPA 200.7 by 2340B	--	--	54	10	
Nitrate + Nitrite, N	--	mg/L	EPA 300.0/ EPA 9056	2	10	0.15	0.04	
Sulfate	14808-79-8	mg/L	EPA 300.0/ EPA 9056	123.0	250.0	2	4	250
Total Dissolved Solids	--	mg/L	SM 2540C	--	--	8.68	20	500
Other								
Radium 226	7440-14-4	pCi/L	903.1	--	--	1	--	5
Radium 228	7440-14-4	pCi/L	904	--	--	1	--	5
Field								
pH	NA	SU	SM 4500-H+ B	--	--	NA	NA	NS
Oxidation/Reduction Potentia	NA	mV	SM 258/0B	--	--	NA	NA	NS
Dissolved Oxygen	NA	mg/L	SM 4500-O/405.1	--	--	NA	NA	NS
Temperature	NA	°C	SM 2550	--	--	NA	NA	NS
Turbidity	NA	NTU	EPA Method 180.1	--	--	NA	NA	NS
Specific Conductivity	NA	µS/cm	SM 2510 B	--	--	NA	NA	NS

Notes:

CAS = Chemical Abstract Number
°C = degrees Centigrade
MDL = Method detection limit as established by the laboratory
mg/L = milligrams per liter
mV = milliVolt
SM = Standard Methods for the Examination of Water and Wastewater
µS/cm = microSiemens per centimeter

NA = not applicable
NS = No standard
NTU = Nephelometric Turbidity Unit
RL = Reporting limit as established by the laboratory
SU = standard units
ug/L = micrograms per liter
pCi/L = picoCuries per liter

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. PROPOSED PREVENTIVE ACTION LIMITS

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM REVISION 1
WESTON DISPOSAL SITE NO. 3 LANDFILL
TOWN OF KNOWLTON, 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					
LS-101	6	2.8	14	31	31
Downgradient Monitoring Wells					
LS-100	18	11.3	52	43	52
LS-105	20	7.5	42	45	45
LS-106	11	4.8	25	36	36
LS-107	23	3.7	34	48	48

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					
LS-101	44	20	110	250	250
Downgradient Monitoring Wells					
LS-100	102	65	300	310	310
LS-105	118	44	250	320	320
LS-106	99	52	260	300	300
LS-107	111	24	190	320	320

Notes:

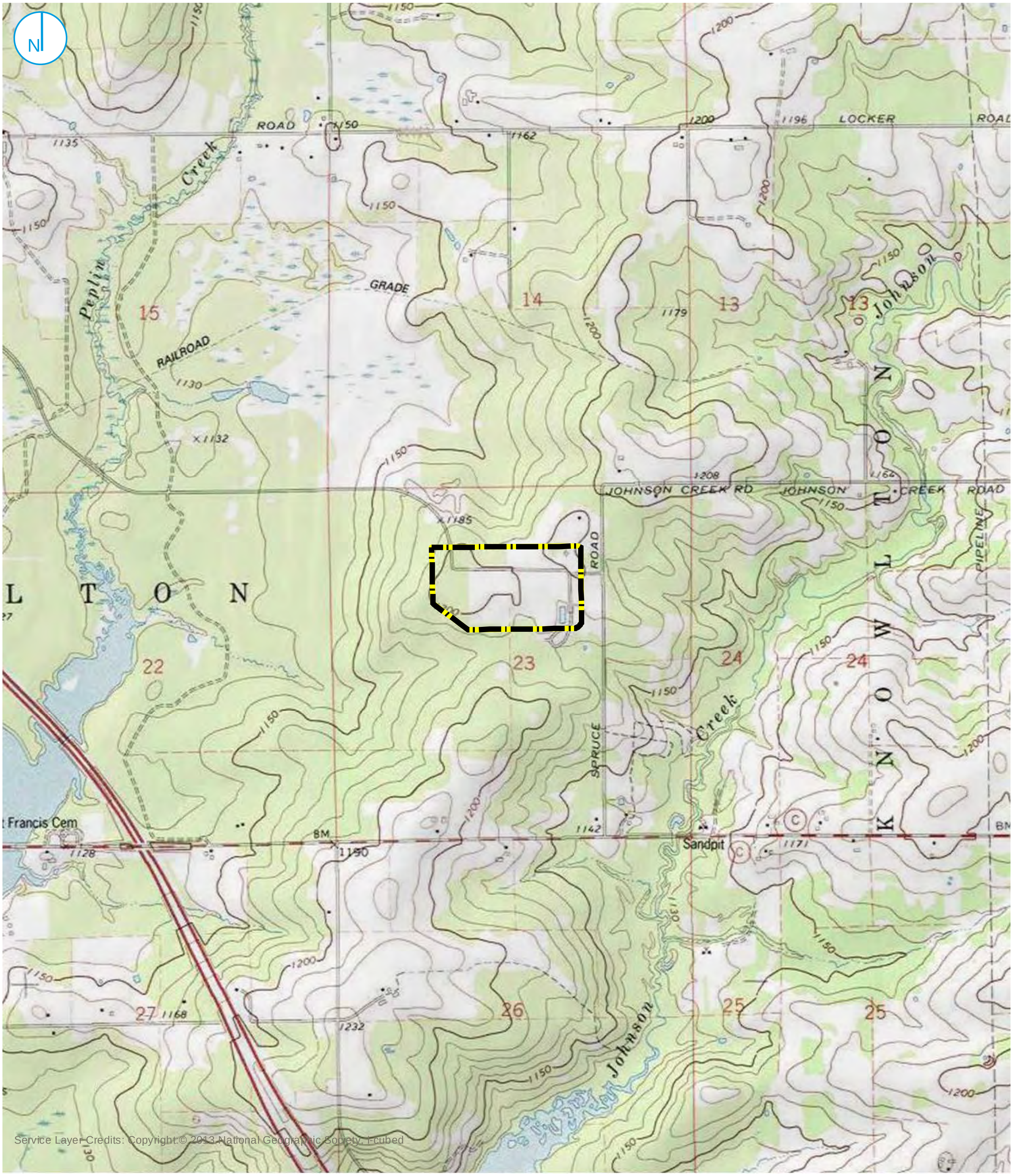
All concentrations shown in mg/L.
mg/L = milligrams per liter
PAL = Preventive Action Limit

[O: KLT 1/25/23, C:KJS 1/26/23]

FIGURES

Y:\GIS\Projects\16\1660\Weston_Power_Plant\MXD\NR507_Plan_Mods\Figure 1-1_Site Location Map.mxd

PROJECT: 169000XXXX | DATED: 1/30/2023 | DESIGNER: galarnmc



Map Scale: 1:24,000 | Map Center: 89°55'36"W 44°45'50"N

▭ WESTON DISPOSAL SITE NO. 3 LANDFILL

KEY MAP

0 1,000 2,000 Feet

SITE LOCATION MAP

FIGURE 1-1

ENVIRONMENTAL SAMPLING AND
ANALYSIS PLAN ADDENDUM
REVISION 1
WESTON DISPOSAL SITE NO. 3 LANDFILL
TOWN OF KNOWLTON, WISCONSIN

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

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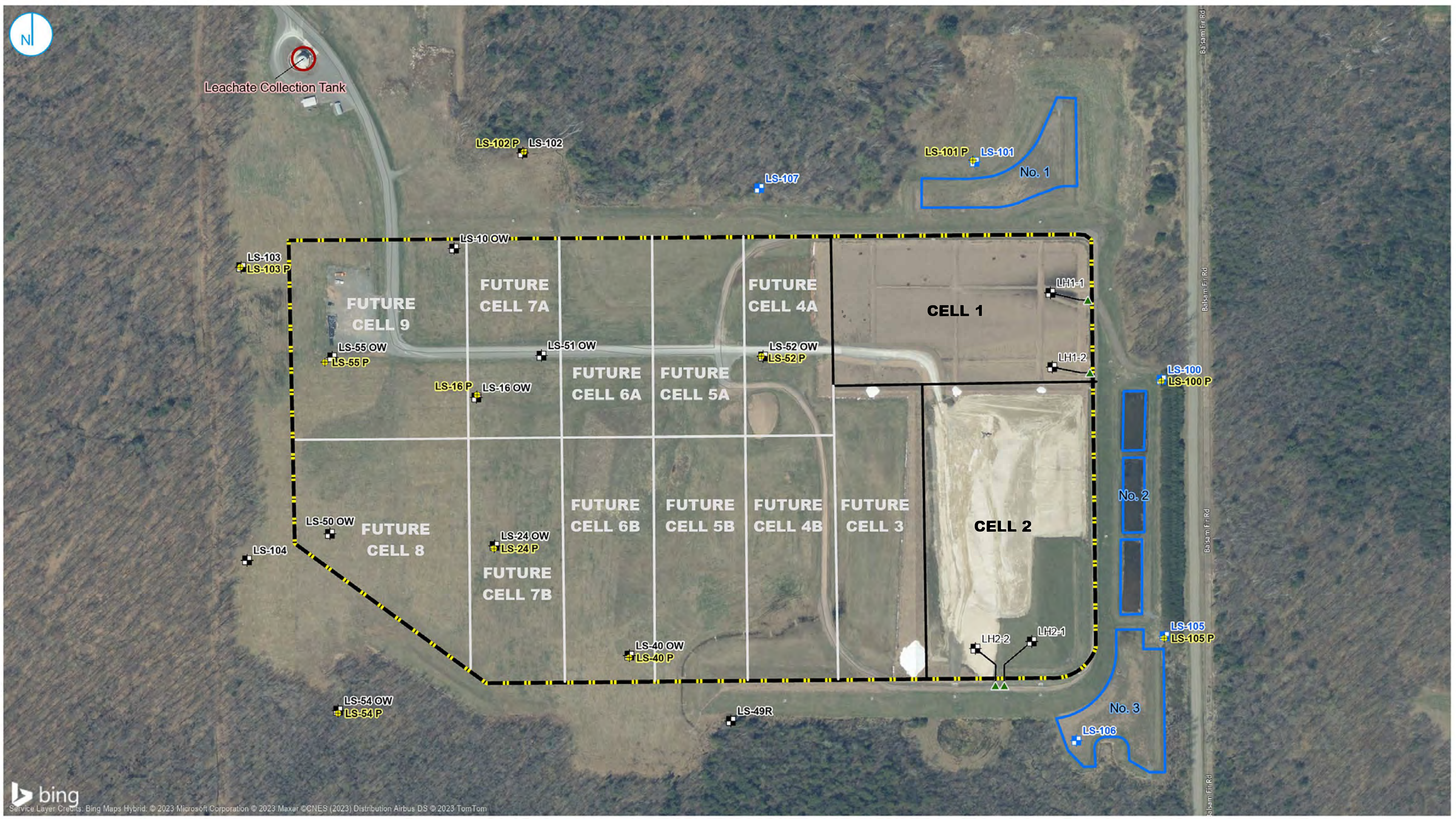


Service Layer Credits: Bing Maps Hybrid: © 2023 Microsoft Corporation © 2023 Maxar ©CNES (2023) Distribution Airbus DS © 2023 TomTom

PROJECT: 71202 | DATED: 10/27/2023 | DESIGNER: CHURCHKF

- ⊕ CCR RULE
- ⊕ MONITORING WELL
- ✛ PIEZOMETER
- — PIPE
- ▲ MEASUREMENT PORT
- ▭ STORMWATER BASINS
- ▭ LEACHATE COLLECTION TANK
- ▭ WESTON DISPOSAL SITE NO. 3 LANDFILL

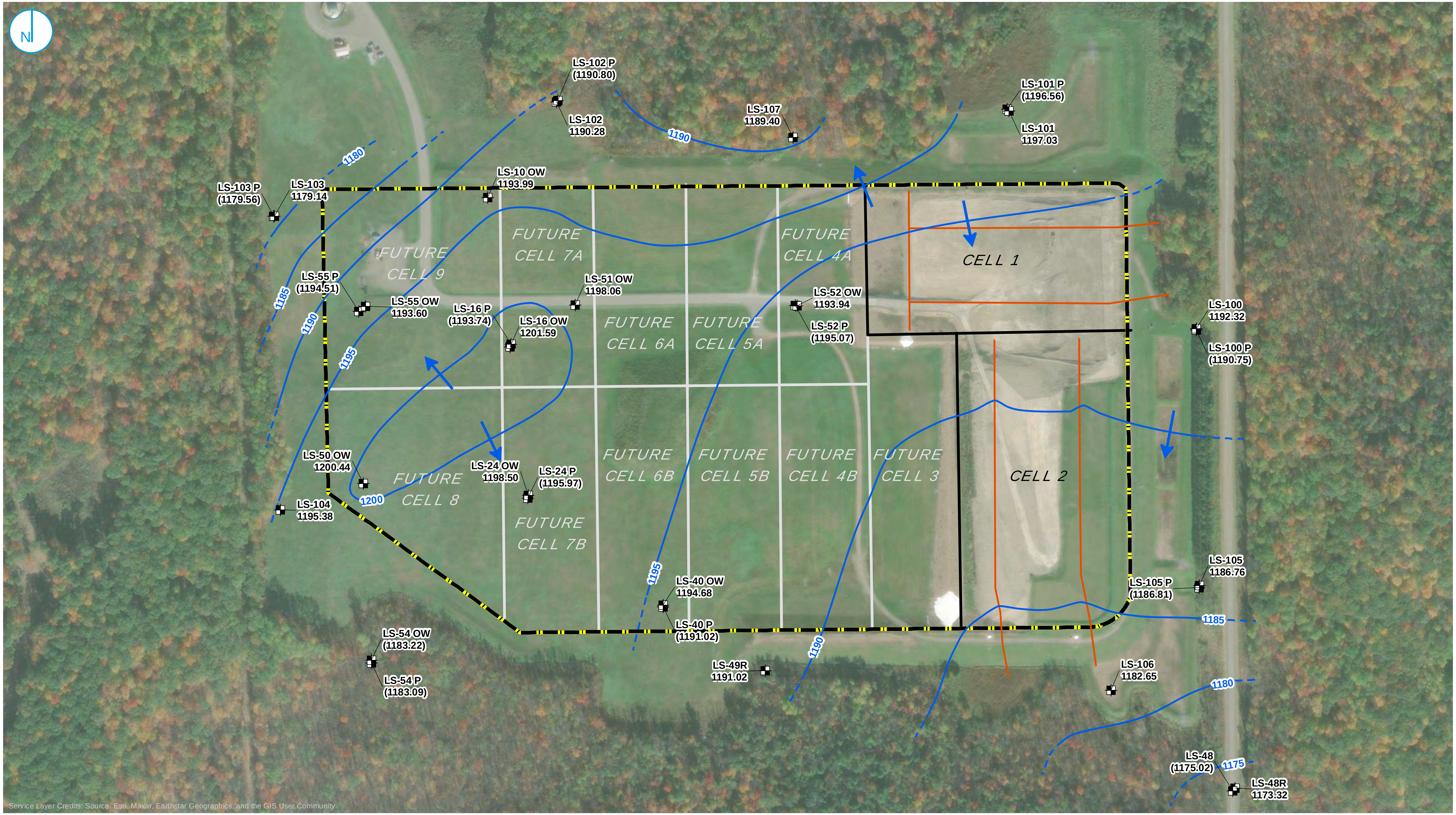
0 125 250 Feet

ACTIVE WELL NETWORKS MAP

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM
REVISION 1
WESTON DISPOSAL SITE NO. 3 LANDFILL
TOWN OF KNOWLTON, WISCONSIN

FIGURE 2-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.



✚	MONITORING WELL OR PIEZOMETER LOCATION
—	GROUNDWATER ELEVATION CONTOUR (1-FT CONTOUR INTERVAL, NAVD88)
- -	INFERRED GROUNDWATER ELEVATION CONTOUR
➔	GROUNDWATER FLOW DIRECTION
—	GROUNDWATER GRADIENT CONTROL SYSTEM
▭	WESTON DISPOSAL SITE NO. 3 LANDFILL
☐	CELL BOUNDARY

Notes
1. GROUNDWATER ELEVATIONS IN FEET NORTH AMERICAN VERTICAL DATUM OF 1988 (FT NAVD88)
2. GROUNDWATER ELEVATIONS IN PARENTHESES NOT USED FOR CONTOURING

UPPERMOST AQUIFER POTENTIOMETRIC SURFACE MAP
APRIL 27, 2023

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM
REVISION 1
WESTON DISPOSAL SITE NO. 3 LANDFILL
TOWN OF KNOWLTON, WISCONSIN

FIGURE 2-2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

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)
WESTON DISPOSAL SITE No. 3 LF	Marathon	737054120	03067	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
84	LS-106	VR450	12	A	D	Yes	02/05/2016	1190.5	1193.2	P	2	7.7	10	17.7	324,253	2,063,283
86	LS-107	VR451	12	A	D	Yes	02/05/2016	1191.5	1194.4	P	2	7.9	10	17.9	324,749	2,062,448

[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

GROUNDWATER MONITORING WELL INFORMATION FORM
Chapter 281 and 289, Wis. Stats.
Form 4400-89
Rev. 7-98

Facility Name	Facility ID Number	License, Permit or Monitoring No.	Date	Completed By (Name and Firm)	
Weston Disposal Site No. 3 Expansion			4/4/2012	Paula Leier-Engelhardt	AECOM 1035 Kepler Drive Green Bay, Wisconsin 54311

WI Unique Well No	Well Name	DNR Well ID Number	Well Location	Dir.		Date Established	Well Casing		Elevations		References		Depths			Screen Length	Well Type	Well Status	Enf. Stds.	Grad-ient	Distance to Waste
				N E	S W		Diam.	Type	Top of Well Casing	Ground Surface	MSL (X)	Site Datum (X)	Screen Top	Initial Groundwater	Well Depth			A I P N			
VU955	LS-100	064	325,223	X		8/23/2011	2.07	P	1199.04	1196.9	X		3.9	1189.1	16.0	10.0	11/mw	A	X	D	200
			2,063,529	X																	
VU956	LS-100P	062	325,229	X		8/23/2011	2.07	P	1198.91	1196.7	X		28.9	1187.9	36.1	5.0	12/pz	A	X	D	200
			2,063,529	X																	
VU952	LS-101	068	325,816	X		7/13/2011	2.07	P	1205.41	1203.1	X		5.0	1193.2	17.3	10.0	11/mw	A	X	D	90
			2,063,032	X																	
VU951	LS-101P	066	325,820	X		7/13/2011	2.07	P	1205.26	1202.7	X		30.3	1192.4	37.9	5.0	12/pz	A	X	D	90
			2,063,029	X																	
VU957	LS-102	072	325,844	X		8/30/2011	2.07	P	1192.62	1190.2	X		3.0	1188.5	10.4	5.0	11/mw	A	X	D	110
			2,061,808	X																	
VU958	LS-102P	070	325,845	X		8/30/2011	2.07	P	1192.33	1189.7	X		23.0	1188.0	30.6	5.0	12/pz	A	X	D	110
			2,061,812	X																	
VY694	LS-103	076	325,538	X		9/2/2011	2.07	P	1188.98	1186.7	X		8.8	1173.2	21.1	10.0	11/mw	A	X	D	110
			2,061,036	X																	
VY695	LS-103P	074	325,541	X		9/1/2011	2.07	P	1189.35	1186.7	X		34.0	1173.2	41.6	5.0	12/pz	A	X	D	110
			2,061,039	X																	
VU959	LS-104	078	324,748	X		9/7/2011	2.07	P	1203.76	1201.4	X		5.0	1192.0	17.4	10.0	11/mw	A	X	S	125
			2,061,042	X																	
VU953	LS-105	082	324,533	X		7/14/2011	2.07	P	1190.28	1187.9	X		2.8	1184.6	10.2	5.0	11/mw	A	X	D	180
			2,063,527	X																	
VU954	LS-105P	080	324,529	X		7/14/2011	2.07	P	1190.35	1187.9	X		23.0	1184.5	30.4	5.0	12/pz	A	X	D	180
			2,063,524	X																	

Location Coordinates Are:

☒ State Plane Coordinate
☐ Northern
☒ Central
☐ Southern

☐ Local Grid System

Sheet 1 of 1

Grid Origin Location (Check if estimated: ☐)

Lat. ____° ____' ______" Long. ____° ____' ______" or

St. Plane __________ ft. N. ___________ ft. E. S / C / N Zone

Remarks:

Completion of this form is mandatory under s. NR 507.14 and NR 110.25 Wis. Adm. Code. Failure to file this form may result in forfeiture of not less than $10 nor more than $5,000 for each day of violation. Personally identifiable information provided is intended to be used by the Department for the purposes related to the waste management program.

BORING LOGS

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

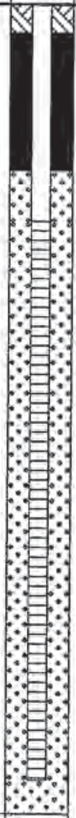
Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

Page 1 of 1

Facility/Project Name Weston Disposal Site No. 3 Expansion - 60186058		License/Permit/Monitoring Number 3067		Boring Number LS-100	
Boring Drilled By: Name of crew chief (first, last) and Firm Alex Plummer Badger State Drilling		Date Drilling Started 8/23/2011	Date Drilling Completed 8/23/2011	Drilling Method HSA/Air Rotary	
WI Unique Well No. VU955	DNR Well ID No. 064	Common Well Name LS-100	Final Static Water Level 1,189.1 Feet MSL	Surface Elevation 1,196.9 Feet MSL	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 325,223 N, 2,063,529 E S/[✓ C]/N
SW 1/4 of NE 1/4 of Section 23, T 26 N,R 7 E
Lat ° ' "
Long ° ' "
Local Grid Location
Feet ☐ N ☐ S
Feet ☐ E ☐ W

Facility ID	County Marathon	County Code 37	Civil Town/City/ or Village Knowlton

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	USCS	Graphic Log	Well Diagram	PID/FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				Blind drill from 0.0 to 14.5 feet										
			1	See Logs of Borings B-100P and B-100 for soil/rock descriptions										
			2											
			3											
			4											
			5											
			6											
			7	Auger refusal at 6.5 feet										
			8											
			9											
			10											
			11											
			12											
			13											
			14											
				End of boring at 14.5 feet (1182.4 feet, MSL) Boring advanced from 0.0 to 6.5 feet with 6-1/4-inch inner diameter hollow-stem augers. Reamed with air hammer from 0.0 to 14.5 feet. Installed Monitoring Well LS-100 at 13.9 feet.										

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

Signature Paula Leier-Engelhardt
Firm AECOM
1035 Kepler Drive Green Bay, Wisconsin 54311
Tel: 920-468-1978
Fax: 920-468-3312

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

Form 4400-122 Rev. 7-98

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

Page 1 of 2

Facility/Project Name Weston Disposal Site No. 3 Expansion - 60186058	License/Permit/Monitoring Number 3067	Boring Number LS-101	
Boring Drilled By: Name of crew chief (first, last) and Firm Alex Plummer Badger State Drilling	Date Drilling Started 7/13/2011	Date Drilling Completed 7/13/2011	Drilling Method HSA/Air Rotary
WI Unique Well No. VU952	DNR Well ID No. 068	Common Well Name LS-101	
Final Static Water Level 1,193.2 Feet MSL	Surface Elevation 1,203.1 Feet MSL	Borehole Diameter 6.0 inches	

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 325,816 N, 2,063,032 E S /[✓ C]/N
NW 1/4 of NE 1/4 of Section 23, T 26 N,R 7 E
Lat ° ' "
Long ° ' "
Local Grid Location
Feet ☐ N ☐ S
Feet ☐ E ☐ W

Facility ID	County Marathon	County Code 37	Civil Town/City/ or Village Knowlton

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/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				Blind drill from 0.0 to 16.5 feet										
				See Log of Boring B-101P for soil/rock descriptions										
			1											
			2											
			3											
			4											
			5											
			6	Auger refusal at 6.0 feet										
			7											
			8											
			9											
			10											
			11											
			12											

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

Signature Paula Freier-Engelhardt

Firm AECOM
1035 Kepler Drive Green Bay, Wisconsin 54311
Tel: 920-468-1978
Fax: 920-468-3312

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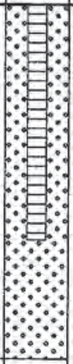
State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number LS-101 Use only as an attachment to Form 4400-122. Page 2 of 2

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	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			13 14 15 16	See Log of Boring B-101P for soil/rock descriptions										
				End of boring at 16.5 feet (1182.4 feet, MSL) Boring advanced from 0.0 to 6.0 feet with 6-1/4-inch inner diameter hollow-stem augers. Reamed with air hammer from 0.0 to 16.5 feet. Installed Monitoring Well LS-101 at 15.0 feet.										

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 1

Facility/Project Name Weston Disposal Site No. 3 Expansion - 60186058		License/Permit/Monitoring Number 3067		Boring Number LS-105	
Boring Drilled By: Name of crew chief (first, last) and Firm Alex Plummer Badger State Drilling		Date Drilling Started 7/14/2011	Date Drilling Completed 7/14/2011	Drilling Method HSA/Air Rotary	
WI Unique Well No. VU953	DNR Well ID No. 082	Common Well Name LS-105	Final Static Water Level 1,184.6 Feet MSL	Surface Elevation 1,187.9 Feet MSL	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 324,533 N, 2,063,527 E S/Ⓒ/N
SW 1/4 of NE 1/4 of Section 23, T 26 N,R 7 E
Lat ____ ° ____ ' ____ "
Long ____ ° ____ ' ____ "
Local Grid Location
Feet ☐ N ☐ S
Feet ☐ E ☐ W

Facility ID	County Marathon	County Code 37	Civil Town/City/ or Village Knowlton

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/FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				Blind drill from 0.0 to 9.3 feet										
			1	See Log of Boring LS-105P for soil/rock descriptions										
			2											
			3											
			4											
			5											
			6											
			7	Auger refusal at 7.0 feet										
			8											
			9											
				End of boring at 9.3 feet (1178.6 feet, MSL) Boring advanced from 0.0 to 7.0 feet with 6-1/4-inch inner diameter hollow-stem augers Reamed with air hammer from 0.0 to 9.3 feet Installed Monitoring Well LS-105 at 7.8 feet										

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

Signature Paula Leier-Engelhardt

Firm AECOM
1035 Kepler Drive Green Bay, Wisconsin 54311
Tel: 920-468-1978
Fax: 920-468-3312

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State of Wisconsin
Department of Natural Resources

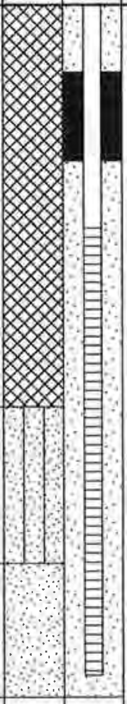
SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

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

Facility/Project Name: Weston Disposal Site #3 (Legner)
License/Permit/Monitoring Number: 3067
Boring Number: LS-106
Boring Drilled By: Name of crew chief (first, last) and Firm: Randy Ochs, Coleman Engineering Company
Date Drilling Started: 2/5/2016
Date Drilling Completed: 2/5/2016
Drilling Method: hollow stem auger
WI Unique Well No.:
DNR Well ID No.:
Common Well Name: LS-106
Final Static Water Level: 9.5 Feet MSL
Surface Elevation: 1,190.5 Feet MSL
Borehole Diameter: 6.0 inches
Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 324,253 N, 2,063,283 E S/[✓ C]/N
SW 1/4 of NW 1/4 of Section 23, T 26 N, R 7 E
Lat ___° ___' ___"
Long ___° ___' ___"
Local Grid Location: ☐ N ☐ E Feet ☐ S Feet ☐ W
Facility ID: 737054120
County: Marathon
County Code: 37
Civil Town/City/ or Village: Knowlton

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/FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			1.5 3.0 4.5 6.0 7.5 9.0	Fill: Brown medium sand (SP) - trace gravel - moist	Fill									
			10.5 12.0	Dark brown silty sand (SM) - trace roots, trace gravel - moist to wet	SM									
1 SS	24 6	5 10 15 20	13.5 15.0	Reddish brown silty sand (SP) - trace to some gravel - medium dense - wet to saturated - weathered bedrock. Sample 1 had 0.5 ft. of recovery; Sample 1A collected to recover part of lost portion of sample (0.7 ft. recovery)	SP									
				End of Boring at 15.5 feet Boring advanced to 12.5 feet with 4 1/4" ID hollow-stem auger Boring advanced from 12.5 to 15.5 feet with solid-stem auger Monitoring well installed at 15.0 feet										



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

Signature:
Firm: GEI Consultants, Inc. [Project No. 1600630]
Tel: 920-455-8200
Fax:

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

Form 4400-122 Rev. 7-98

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

Facility/Project Name: Weston Disposal Site #3 (Legner)
License/Permit/Monitoring Number: 3067
Boring Number: LS-107

Boring Drilled By: Name of crew chief (first, last) and Firm: Roger Lang, Lang Well Drilling Services
Date Drilling Started: 2/5/2016
Date Drilling Completed: 2/5/2016
Drilling Method: rotary (air)

WI Unique Well No.:
DNR Well ID No.:
Common Well Name: LS-107
Final Static Water Level: 3.2 Feet MSL
Surface Elevation: 1,191.5 Feet MSL
Borehole Diameter: 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 325,749 N, 2,062,448 E S/[✓ C]/N
SW 1/4 of NW 1/4 of Section 23, T 26 N, R 7 E
Lat ° ' "
Long ° ' "
Local Grid Location: Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID: 737054120
County: Marathon
County Code: 37
Civil Town/City/ or Village: Knowlton

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/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			1.5 3.0	Reddish brown silty sand - moist										
			4.5 6.0 7.5 9.0	Dark gray weathered bedrock - moist										
			10.5 12.0 13.5 15.0	Amphibolite - dark gray - less competent from 10.5 to 13.5 feet - very hard from 13.5 to 15.5 feet										
				End of Boring at 15.5 feet Boring advanced from 0 to 10.5 feet with 10" air rotary Boring advanced from 10.5 to 15.5 feet with 8" air rotary Monitoring well installed at 15.0 feet										

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

Signature:
Firm: GEI Consultants, Inc. [Project No. 1600630]
Tel: 920-455-8200
Fax:

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WELL CONSTRUCTION

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: Weston Disposal Site No. 3 Expansion - 60186058

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

Well Name: LS-100

Facility License, Permit or Monitoring No.: 3067

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

Lat. ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or

Wis. Unique Well No.: VU955

DNR Well Number: 064

Facility ID:

St. Plane 325,223 ft. N, 2,063,529 ft. E. S [✓ C] N

Date Well Installed: 08/23/2011

Section Location of Waste/Source

Type of Well: Well Code 11/mw

SW 1/4 of NE 1/4 of Sec. 23, T. 26 N, R. 7 ☒ E ☐ W

Well Installed By: (Person's Name and Firm) Alex Plummer, Badger State 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 1199.26 ft. MSL

B. Well casing, top elevation 1199.04 ft. MSL

C. Land surface elevation 1196.9 ft. MSL

D. Surface seal, bottom 1196.4 ft. MSL or 0.5 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
Air Rotary and Hollow Stem Auger Other ☒

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

16. Drilling additives used? ☐ Yes ☒ No

Describe ______

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

E. Bentonite seal, top 1196.4 ft. MSL or 0.5 ft.

F. Fine sand, top ______ ft. MSL or ______ ft.

G. Filter pack, top 1193.9 ft. MSL or 3.0 ft.

H. Screen joint, top 1193.0 ft. MSL or 3.9 ft.

I. Well bottom 1183.0 ft. MSL or 13.9 ft.

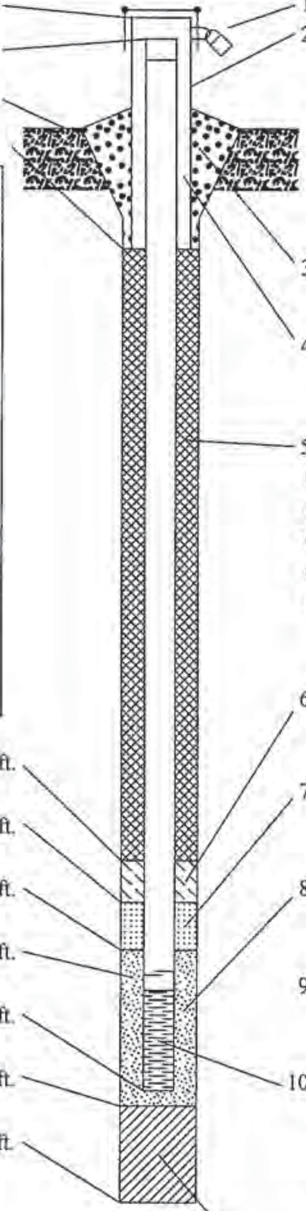
J. Filter pack, bottom 1182.4 ft. MSL or 14.5 ft.

K. Borehole, bottom 1182.4 ft. MSL or 14.5 ft.

L. Borehole, diameter 6.0 in.

M. O.D. well casing 2.38 in.

N. I.D. well casing 2.07 in.



1. Cap and lock? ☒ Yes ☐ No

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

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

4. Material between well casing and protective pipe: Bentonite ☐ 3 0; Bentonite and 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. ______ % Bentonite . . . Bentonite-cement grout ☐ 5 0
e. 1.1 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. NA
b. Volume added ______ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. R.W. Sidley, Ohio, #5
b. Volume added 3.5 ft^3

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

10. Screen material: Schedule 40 PVC
a. Screen Type: Factory cut ☒ 1 1; Continuous slot ☐ 0 1; Other ☐
b. Manufacturer: Monoflex
c. Slot size: 0.010 in.
d. Slotted length: 9.4 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.

Signature: Paula Leier-Engelhardt

Firm: AECOM
1035 Kepler Drive Green Bay, Wisconsin 54311
Tel: 920-468-1978
Fax: 920-468-3312

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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: Weston Disposal Site No. 3 Expansion - 60186058

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

Well Name: LS-101

Facility License, Permit or Monitoring No.: 3067

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

Lat. ____ ° ____ ' ____ " Long. ____ ° ____ ' ____ " or

Wis. Unique Well No.: VU952

DNR Well Number: 068

Facility ID:

St. Plane 325,816 ft. N, 2,063,032 ft. E. S [✓ C] N

Date Well Installed: 07/13/2011

Section Location of Waste/Source: NW 1/4 of NE 1/4 of Sec. 23, T. 26 N, R. 7 ☒ E ☐ W

Type of Well: Well Code 11/mw

Well Installed By: (Person's Name and Firm)
Alex Plummer
Badger State 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 1205.58 ft. MSL

B. Well casing, top elevation 1205.41 ft. MSL

C. Land surface elevation 1203.1 ft. MSL

D. Surface seal, bottom 1202.6 ft. MSL or 0.5 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
Air Rotary and Hollow Stem Auger Other ☒

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

16. Drilling additives used? ☐ Yes ☒ No

Describe ________

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

E. Bentonite seal, top 1202.6 ft. MSL or 0.5 ft.

F. Fine sand, top ________ ft. MSL or ________ ft.

G. Filter pack, top 1199.1 ft. MSL or 4.0 ft.

H. Screen joint, top 1198.1 ft. MSL or 5.0 ft.

I. Well bottom 1188.1 ft. MSL or 15.0 ft.

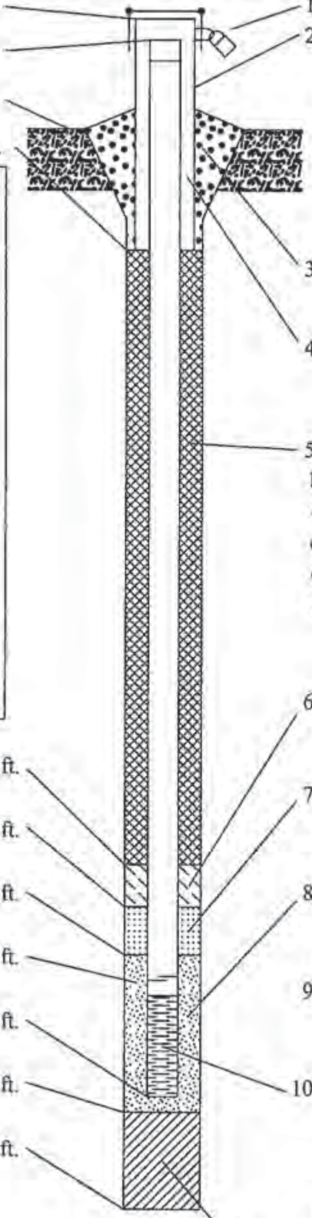
J. Filter pack, bottom 1186.6 ft. MSL or 16.5 ft.

K. Borehole, bottom 1186.6 ft. MSL or 16.5 ft.

L. Borehole, diameter 6.0 in.

M. O.D. well casing 2.38 in.

N. I.D. well casing 2.07 in.



1. Cap and lock? ☒ Yes ☐ No

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

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

4. Material between well casing and protective pipe:
Bentonite ☐ 3 0
Bentonite and 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. ____ % Bentonite . . . Bentonite-cement grout ☐ 5 0
e. 1.4 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. NA
b. Volume added ________ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. R.W. Sidley, Ohio, #5
b. Volume added 2.6 ft^3

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

10. Screen material: Schedule 40 PVC
a. Screen Type: Factory cut ☒ 1 1
Continuous slot ☐ 0 1
________ Other ☐
b. Manufacturer Monoflex
c. Slot size: 0.010 in.
d. Slotted length: 9.4 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.

Signature: Paula Loier-Englehardt

Firm: AECOM
1035 Kepler Drive Green Bay, Wisconsin 54311

Tel: 920-468-1978
Fax: 920-468-3312

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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: Weston Disposal Site No. 3 Expansion - 60186058

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

Well Name: LS-105

Facility License, Permit or Monitoring No.: 3067

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

Lat. ___° ___' ___" Long. ___° ___' ___" or

St. Plane 324,533 ft. N, 2,063,527 ft. E. S /Ⓒ/ N

Wis. Unique Well No.: VU953

DNR Well Number: 082

Facility ID:

Section Location of Waste/Source: SW 1/4 of NE 1/4 of Sec. 23, T. 26 N, R. 7 ☒E ☐W

Date Well Installed: 07/14/2011

Type of Well: Well Code 11/mw

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

Gov. Lot Number: ______

Well Installed By: (Person's Name and Firm)
Alex Plummer
Badger State Drilling

Distance from Waste/Source ______ ft.

Enf. Stds. Apply ☒

A. Protective pipe, top elevation 1190.42 ft. MSL

B. Well casing, top elevation 1190.28 ft. MSL

C. Land surface elevation 1187.9 ft. MSL

D. Surface seal, bottom 1187.9 ft. MSL or 0.0 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
Air Rotary and Hollow Stem Auger Other ☒

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

16. Drilling additives used? ☐ Yes ☒ No

Describe ______

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

E. Bentonite seal, top 1187.9 ft. MSL or 0.0 ft.

F. Fine sand, top ______ ft. MSL or ______ ft.

G. Filter pack, top 1185.9 ft. MSL or 2.0 ft.

H. Screen joint, top 1185.1 ft. MSL or 2.8 ft.

I. Well bottom 1180.1 ft. MSL or 7.8 ft.

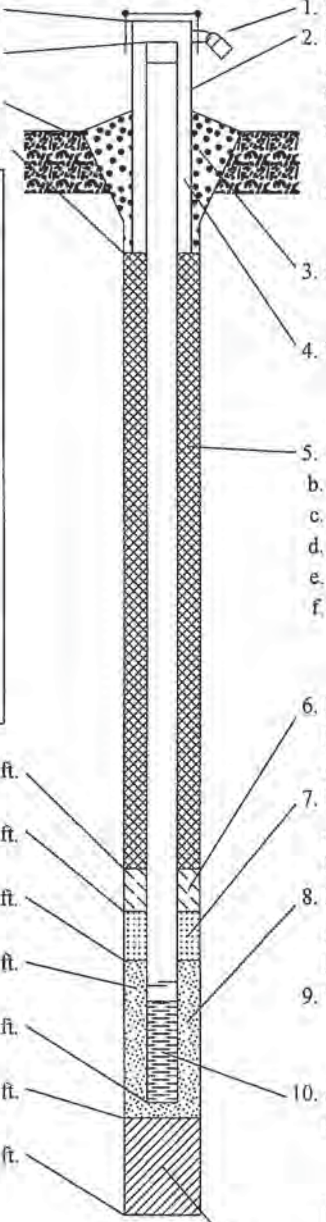
J. Filter pack, bottom 1178.6 ft. MSL or 9.3 ft.

K. Borehole, bottom 1178.6 ft. MSL or 9.3 ft.

L. Borehole, diameter 6.0 in.

M. O.D. well casing 2.38 in.

N. I.D. well casing 2.07 in.



1. Cap and lock? ☒ Yes ☐ No

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

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

4. Material between well casing and protective pipe:
Bentonite ☐ 3 0
Bentonite and 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. ______ % Bentonite . . . Bentonite-cement grout ☐ 5 0
e. 1.1 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. NA
b. Volume added ______ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. R.W. Sidley, Ohio, #5
b. Volume added 2.2 ft^3

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

10. Screen material: Schedule 40 PVC
a. Screen Type: Factory cut ☒ 1 1
Continuous slot ☐ 0 1
______ Other ☐
b. Manufacturer Monoflex
c. Slot size: 0.010 in.
d. Slotted length: 4.7 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.

Signature: Paula Leier-Engelhardt

Firm: AECOM
1035 Kepler Drive Green Bay, Wisconsin 54311

Tel: 920-468-1978
Fax: 920-468-3312

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

State of Wisconsin
Department of Natural Resources

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

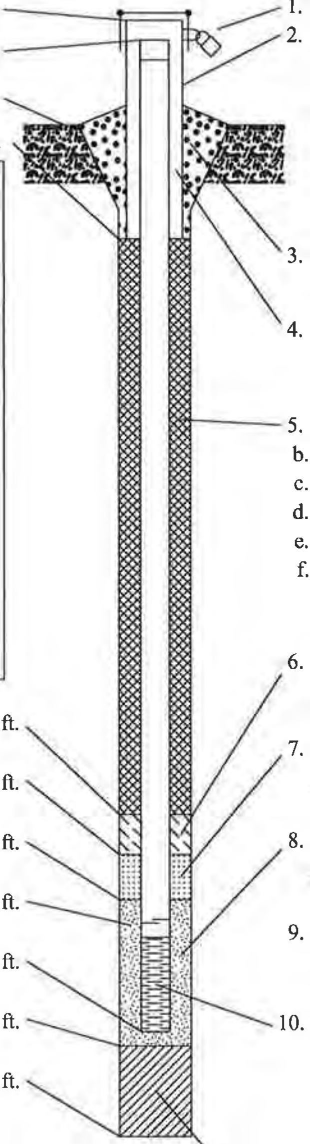
MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name Weston Disposal Site #3 (Legner)	Local Grid Location of Well ___ ft. ☐ N. ☐ S. ___ ft. ☐ E. ☐ W.	Well Name LS-106
Facility License, Permit or Monitoring No. 3067	Local Grid Origin ☐ (estimated: ☐) or Well Location ☒ Lat. ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or	Wis. Unique Well No. | DNR Well Number
Facility ID 737054120	St. Plane 324,253 ft. N, 2,063,283 ft. E. S/[✓ C]/N	Date Well Installed 02/05/2016
Type of Well 16	Section Location of Waste/Source SW 1/4 of NW 1/4 of Sec. 23, T. 26 N, R. 7 ☒ E ☐ W	Well Installed By: (Person's Name and Firm) Randy Ochs Coleman Engineering Company
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 1193.26 ft. MSL
B. Well casing, top elevation 1193.24 ft. MSL
C. Land surface elevation 1190.5 ft. MSL
D. Surface seal, bottom 1189.0 ft. MSL or 1.5 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
___ 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):
___

E. Bentonite seal, top 1189.0 ft. MSL or 1.5 ft.
F. Fine sand, top 1187.0 ft. MSL or 3.5 ft.
G. Filter pack, top 1186.5 ft. MSL or 4.0 ft.
H. Screen joint, top 1185.5 ft. MSL or 5.0 ft.
I. Well bottom 1175.5 ft. MSL or 15.0 ft.
J. Filter pack, bottom 1175.5 ft. MSL or 15.0 ft.
K. Borehole, bottom 1175.0 ft. MSL or 15.5 ft.
L. Borehole, diameter 6.0 in.
M. O.D. well casing 2.38 in.
N. I.D. well casing 2.00 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. Surface seal: Bentonite ☐ 3 0
Concrete ☐ 0 1
Sand #15 Other ☒ _ _
4. Material between well casing and protective pipe:
Bentonite ☐ 3 0
Sand #15 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. ___ % Bentonite . . . Bentonite-cement grout ☐ 5 0
e. 0.5 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. Badger Mining Co. #4060 _ _
b. Volume added 0.25 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
a. Sand #15 _ _
b. Volume added 3.5 ft^3
9. Well casing: Flush threaded PVC schedule 40 ☒ 2 3
Flush threaded PVC schedule 80 ☐ 2 4
___ Other ☐ _ _
10. Screen material: PVC Sch. 40 _ _
a. Screen Type: Factory cut ☒ 1 1
Continuous slot ☐ 0 1
___ Other ☐ _ _
b. Manufacturer Monoflex
c. Slot size: 0.010 in.
d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☐ 1 4
Sand #15 Other ☒ _ _

(GEI Consultants Project #1600630)

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

Signature	Firm GEI Consultants, Inc. 3159 Voyager Drive, Green Bay, WI 54311	Tel: 920-455-8200 Fax:

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

State of Wisconsin
Department of Natural Resources

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

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

Facility/Project Name Weston Disposal Site #3 (Legner)	Local Grid Location of Well ______ ft. ☐ N. ☐ S. ______ ft. ☐ E. ☐ W.	Well Name LS-107
Facility License, Permit or Monitoring No. 3067	Local Grid Origin ☐ (estimated: ☐) or Well Location ☒ Lat. ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or St. Plane 325,749 ft. N, 2,062,448 ft. E. S /[✓ C]/ N	Wis. Unique Well No. / DNR Well Number
Facility ID 737054120		Date Well Installed 02/05/2016
Type of Well 16	Section Location of Waste/Source SW 1/4 of NW 1/4 of Sec. 23, T. 26 N, R. 7 ☒ E ☐ W	Well Installed By: (Person's Name and Firm) Randy Ochs Coleman Engineering Company
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 1194.50 ft. MSL
B. Well casing, top elevation 1194.40 ft. MSL
C. Land surface elevation 1191.5 ft. MSL
D. Surface seal, bottom 1189.5 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
Other ☐ _ _

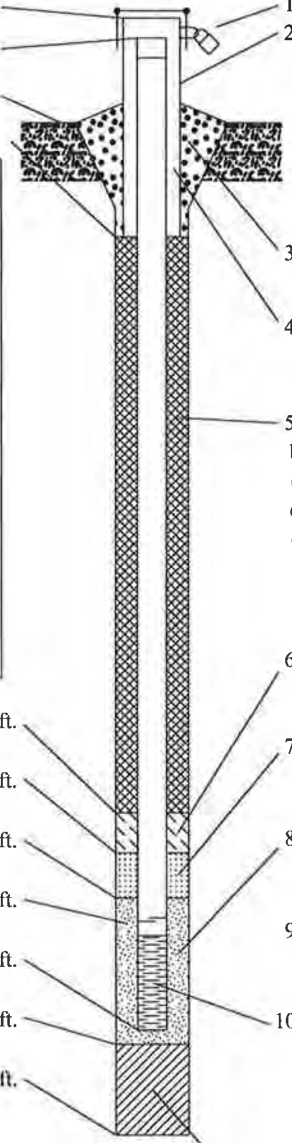
15. Drilling fluid used: Water ☐ 0 2 Air ☒ 0 1
Drilling Mud ☐ 0 3 None ☐ 9 9

16. Drilling additives used? ☐ Yes ☒ No

Describe ______

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

E. Bentonite seal, top 1189.5 ft. MSL or 2.0 ft.
F. Fine sand, top 1188.0 ft. MSL or 3.5 ft.
G. Filter pack, top 1187.5 ft. MSL or 4.0 ft.
H. Screen joint, top 1186.5 ft. MSL or 5.0 ft.
I. Well bottom 1176.5 ft. MSL or 15.0 ft.
J. Filter pack, bottom 1176.0 ft. MSL or 15.5 ft.
K. Borehole, bottom 1176.0 ft. MSL or 15.5 ft.
L. Borehole, diameter 6.0 in.
M. O.D. well casing 2.38 in.
N. I.D. well casing 2.00 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. Surface seal: Bentonite ☐ 3 0
Concrete ☐ 0 1
Sand #15 Other ☒ _ _
4. Material between well casing and protective pipe:
Bentonite ☐ 3 0
Sand #15 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. ______% Bentonite . . . Bentonite-cement grout ☐ 5 0
e. 0.5 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. Badger Mining Co. #4060
b. Volume added 2 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
a. Sand #15
b. Volume added 4 ft^3
9. Well casing: Flush threaded PVC schedule 40 ☒ 2 3
Flush threaded PVC schedule 80 ☐ 2 4
Other ☐ _ _
10. Screen material: PVC Sch. 40
a. Screen Type: Factory cut ☒ 1 1
Continuous slot ☐ 0 1
Other ☐ _ _
b. Manufacturer Monoflex
c. Slot size: 0.010 in.
d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☐ 1 4
Sand #15 Other ☒ _ _

(GEI Consultants Project #1600630)

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

Signature

Firm GEI Consultants, Inc.
3159 Voyager Drive, Green Bay, WI 54311
Tel: 920-455-8200
Fax:

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.

WELL DEVELOPMENT FORMS

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: Weston Disposal Site No. 3 Expansion - 60186058
County: Marathon
Well Name: LS-100
Facility License, Permit or Monitoring Number: 3067
County Code: 37
Wis. Unique Well Number: VU955
DNR Well Number: 064

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 ______	☐	

3. Time spent developing well 90 min.

4. Depth of well (from top of well casing) 16.0 ft.

5. Inside diameter of well 2.07 in.

6. Volume of water in filter pack and well casing 3.0 gal.

7. Volume of water removed from well 30.0 gal.

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

9. Source of water added ______

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.	11.49 ft.	11.54 ft.
Date	b.	8/25/2011	8/25/2011
Time	c.	09:00 ☒ a.m. ☐ p.m.	10:30 ☒ 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) Tan	Clear ☐ 2 0 Turbid ☒ 2 5 (Describe) Cloudy - light tan

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

	Before Development	After Development
14. Total suspended solids	27400.0 mg/l	209.0 mg/l
15. COD	55.4 mg/l	< 11.3 mg/l

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

17. Additional comments on development:

Facility Address or Owner/Responsible Party Address
Name: Stacy Brault
Firm: Wisconsin Public Service
Street: 700 North Adams Street
City/State/Zip: Green Bay Wisconsin 54311

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Paula Leier-Engelhardt
Print Name: Paula Leier-Engelhardt
Firm: AECOM

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

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 Weston Disposal Site No. 3 Expansion - 60186058	County Marathon		Well Name LS-101
Facility License, Permit or Monitoring Number 3067	County Code 37	Wis. Unique Well Number VU952	DNR Well Number 068

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 ______	☐	

3. Time spent developing well 150 min.

4. Depth of well (from top of well casing) 17.3 ft.

5. Inside diameter of well 2.07 in.

6. Volume of water in filter pack and well casing 2.2 gal.

7. Volume of water removed from well 12.0 gal.

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

9. Source of water added ______

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.	12.96 ft.	13.38 ft.
Date	b.	7/15/2011	8/30/2011
Time	c.	01:05 ☐ a.m. ☒ p.m.	01:05 ☐ 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) Reddish brown	Clear ☒ 2 0 Turbid ☐ 2 5 (Describe) Light brown to clear

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

14. Total suspended solids	2990.0 mg/l	228.0 mg/l
15. COD	25.4 mg/l	12.2 mg/l

16. Well developed by: Person's Name and Firm
Alex Plummer
Badger State Drilling

17. Additional comments on development:

Facility Address or Owner/Responsible Party Address
Name: Stacy Brault
Firm: Wisconsin Public Service
Street: 700 North Adams Street
City/State/Zip: Green Bay Wisconsin 54311

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

Signature: Paula Leier-Engelhardt
Print Name: Paula Leier-Engelhardt
Firm: AECOM

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

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 Weston Disposal Site No. 3 Expansion - 60186058	County Marathon		Well Name LS-105
Facility License, Permit or Monitoring Number 3067	County Code 37	Wis. Unique Well Number VU953	DNR Well Number 082

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 and pumped	☒	▨

3. Time spent developing well 120 min.

4. Depth of well (from top of well casing) 10.2 ft.

5. Inside diameter of well 2.07 in.

6. Volume of water in filter pack and well casing 4.3 gal.

7. Volume of water removed from well 50.0 gal.

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

9. Source of water added ____________

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.	5.96 ft.	6.00 ft.
Date	b.	7/14/2011	7/14/2011
Time	c.	02:50 ☐ a.m. ☒ p.m.	05:00 ☐ 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) Reddish brown	Clear ☒ 2 0 Turbid ☐ 2 5 (Describe) Very light brown

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

	Before Development	After Development
14. Total suspended solids	12800.0 mg/l	75.2 mg/l
15. COD	109.0 mg/l	13.9 mg/l

16. Well developed by: Person's Name and Firm
Alex Plummer
Badger State Drilling

17. Additional comments on development:

Facility Address or Owner/Responsible Party Address
Name: Stacy Brault
Firm: Wisconsin Public Service
Street: 700 North Adams Street
City/State/Zip: Green Bay Wisconsin 54311

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Paula Leier-Engelhardt
Print Name: Paula Leier-Engelhardt
Firm: AECOM

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

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 Weston Disposal Site #3 (Legner)	County Marathon	Well Name LS-106

Facility License, Permit or Monitoring Number 3067	County Code 37	Wis. Unique Well Number	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 ______________	☐	_ _

3. Time spent developing well 90 min.

4. Depth of well (from top of well casing) 17.2 ft.

5. Inside diameter of well 2.00 in.

6. Volume of water in filter pack and well casing 2.2 gal.

7. Volume of water removed from well 40.0 gal.

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

9. Source of water added ______________

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.	9.50 ft.	9.50 ft.
Date	b.	2/5/2016	2/5/2016
Time	c.	12:00 ☐ a.m. ☒ p.m.	01:30 ☐ a.m. ☒ p.m.
12. Sediment in well bottom		inches	inches
13. Water clarity		Clear ☒ 1 0 Turbid ☐ 1 5 (Describe)	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
Faith Zangl
GEI Consultants, Inc.

17. Additional comments on development:

Facility Address or Owner/Responsible Party Address

Name: Dawn DeJardin
Firm: WEC Business Service
Street: 700 N. Adams St.
City/State/Zip: Green Bay, Wisconsin 54311

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

Signature:
Print Name: Faith Zangl
Firm: GEI Consultants, Inc.

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

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 Weston Disposal Site #3 (Legner)	County Marathon		Well Name LS-107
Facility License, Permit or Monitoring Number 3067	County Code 37	Wis. Unique Well Number	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 ______	☐	– –

3. Time spent developing well 60 min.

4. Depth of well (from top of well casing) 17.9 ft.

5. Inside diameter of well 2.00 in.

6. Volume of water in filter pack and well casing 3.3 gal.

7. Volume of water removed from well 46.0 gal.

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

9. Source of water added ______

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.	3.00 ft.	3.00 ft.
Date	b.	2/5/2016	2/5/2016
Time	c.	11:00 ☒ a.m. ☐ p.m.	12:00 ☐ a.m. ☒ p.m.
12. Sediment in well bottom		inches	inches
13. Water clarity		Clear ☒ 1 0 Turbid ☐ 1 5 (Describe)	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
Faith Zangl
GEI Consultants, Inc.

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Name: Dawn DeJardin
Firm: WEC Business Service
Street: 700 N. Adams St.
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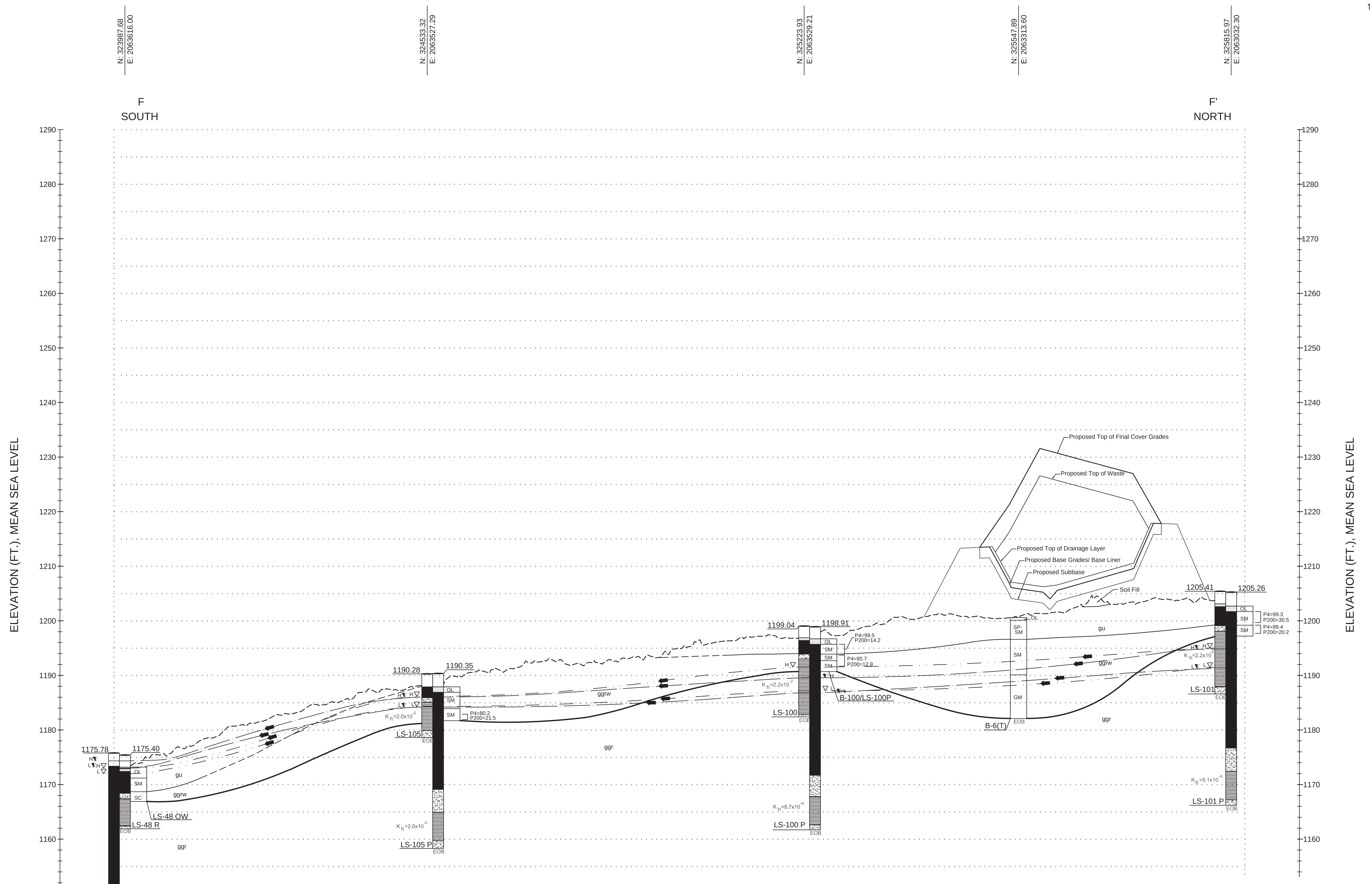
I hereby certify that the above information is true and correct to the best of my knowledge.

Signature:
Print Name: Faith Zangl
Firm: GEI Consultants, Inc.

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

APPENDIX B
SELECTED DRAWINGS AND SHEETS

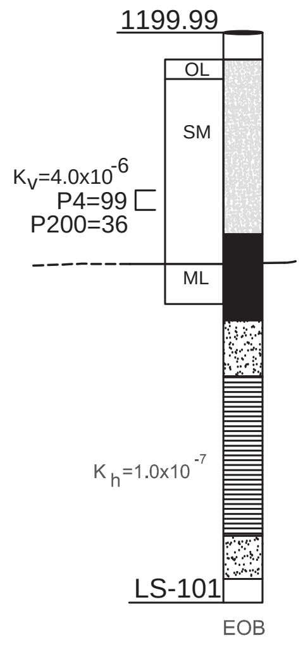


GEOLOGIC CROSS-SECTION F-F'

SCALE: 1"=100' HORIZ. & 1"=10' VERT.
10X VERTICAL EXAGGERATION

LEGEND

- – – – – – EXISTING GROUND SURFACE
- ——— LITHOSTRATIGRAPHIC UNIT (DASHED WHERE APPROXIMATE)
- ━━━ COMPETENT BEDROCK SURFACE (DASHED WHERE APPROXIMATE)
- ➡ · · — · · ▽ HIGH TABLE SURFACE - SHOWING FLOW DIRECTION
  HIGH WATER TABLE (H) 3-19-12,
  LOW WATER TABLE (L) 10-21-11
- ➡ · —— · ▼ PIEZOMETRIC SURFACE - SHOWING FLOW DIRECTION
  HIGH PIEZOMETRIC SURFACE (H) 3-19-12,
  LOW PIEZOMETRIC SURFACE (L) 10-21-11



TOP OF PVC ELEVATION
ANNULAR SPACE SEAL
SOIL CLASSIFICATION (USCS)
SAMPLE INTERVAL WITH LABORATORY (VERTICAL) HYDRAULIC CONDUCTIVITY (CENTIMETERS/SECOND) (K_V), % PASSING No. 4 SIEVE (P4), AND % PASSING No. 200 (P200)
LITHOSTRATIGRAPHIC CONTACT (DASHED WHERE APPROXIMATE)
BENTONITE SEAL
SAND FILTER PACK
WELL SCREEN
FIELD (HORIZONTAL) HYDRAULIC CONDUCTIVITY (K_h) (CENTIMETERS/SECOND)
SOIL BORING/MONITORING WELL DESIGNATION
* - ORIGINAL BORING
** - REPLACEMENT BORING
NATURAL CAVE IN OR SAND FILL
END OF BORING

STRATIGRAPHIC UNIT

PLEISTOCENE	gu - MARATHON FORMATION, UNDIFFERENTIATED (Attig and Muldoon, 1989) BROWN TO DARK BROWN SAND TO SILTY SAND DERIVED FROM TILL, RESIDUUM, OR HILLSLOPE SEDIMENT ggrw - WEATHERED BEDROCK. YELLOWISH BROWN TO DARK BROWN SILTY SAND DERIVED FROM LOWER PROTEROZOIC BEDROCK (ggr).
LOWER PROTEROZOIC	ggr - GNEISSIC GRANITE (LaBerge and Myers, 1983) LIGHT GREY TO PINK QUARTZ DIORITE AND RED TO PINK GRANITE, WITH TRACE BLACK AMPHIBOLITE

UNIFIED SOIL CLASSIFICATION

GW	WELL GRADED GRAVELS & GRAVEL WITH SAND
GP	POORLY GRADED GRAVELS & GRAVEL WITH SAND
GM	SILTY GRAVELS, SILTY GRAVELS WITH SAND
GC	CLAYEY GRAVELS, CLAYEY GRAVEL WITH SAND
SW	WELL GRADED SANDS & SAND WITH GRAVEL
SP	POORLY GRADED SANDS & SANDS WITH GRAVEL
SP-SM	POORLY GRADED SAND WITH SILT, SAND WITH SILT & GRAVEL
SM	SILTY SANDS, SILTY SAND WITH GRAVEL
SC	CLAYEY SANDS, CLAYEY SANDS WITH GRAVEL
CH	HIGH PLASTICITY CLAY
CL-ML	SILTY CLAY TO CLAYEY SILT
CL	LOW PLASTICITY CLAY, GRAVELLY-SANDY CLAYS
ML	SILT, GRAVELLY-SANDY SILT
OL	ORGANIC CLAY, SANDY-GRAVELLY ORGANIC SOIL
OH	ORGANIC, HIGH PLASTICITY, SILTY CLAY
PT	PEAT, MUCK, ORGANIC SOILS

NOTES

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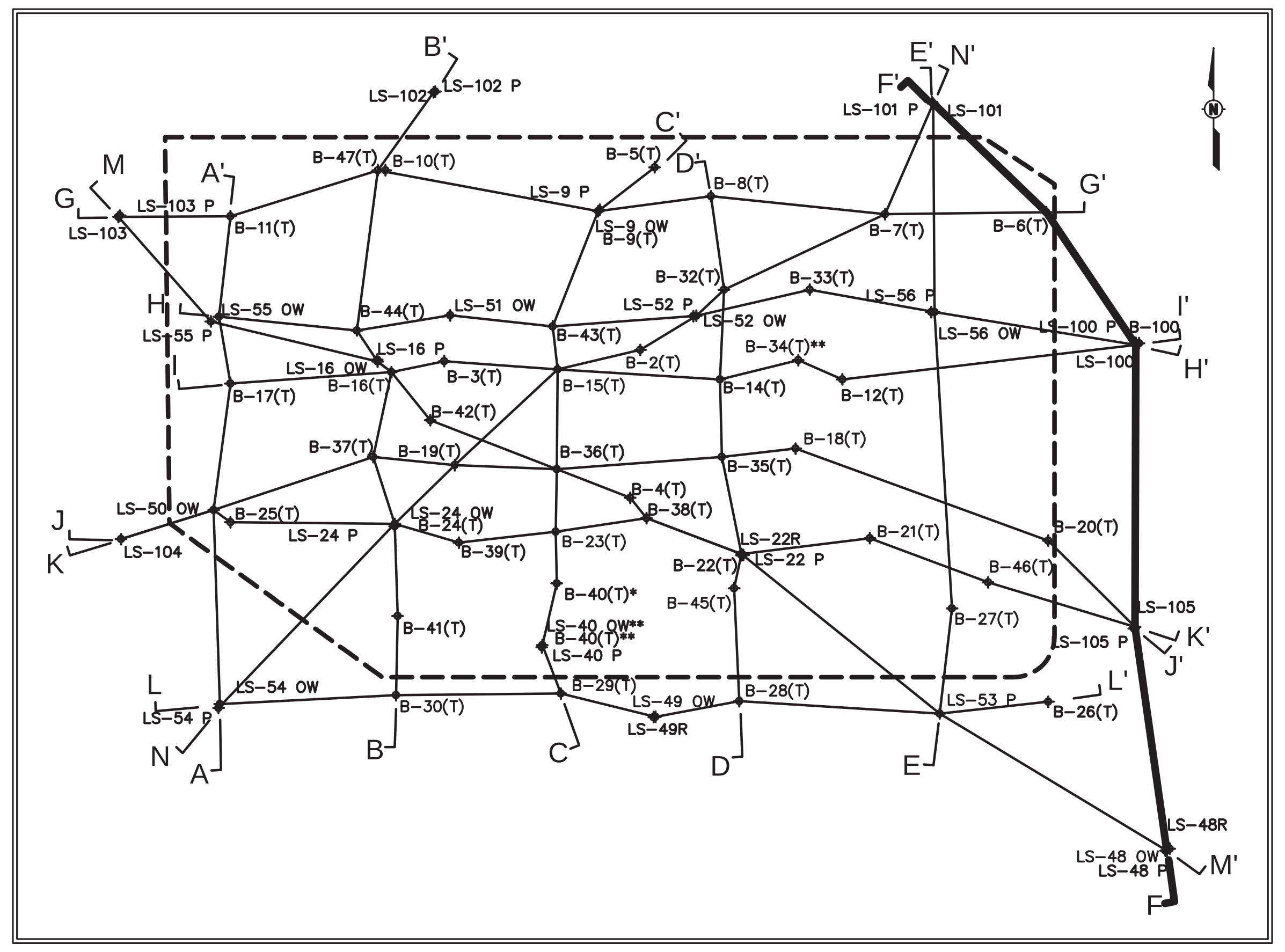
2) FILL - COAL COMBUSTION RESIDUALS
3) WATER TABLE, PIEZOMETRIC, AND COMPETENT BEDROCK SURFACE LINES WERE DRAWN BETWEEN BORINGS IN THE CROSS SECTION AND WERE NOT PRODUCED FROM THE SURFACES PRESENTED IN FR-5 THROUGH FR-8 AND FR-25



CROSS-SECTION INDEX
NOT TO SCALE

PROJECT

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www.wisconsinpublicservice.com

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www.aecom.com

REGISTRATION

ISSUE/REVISION

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I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

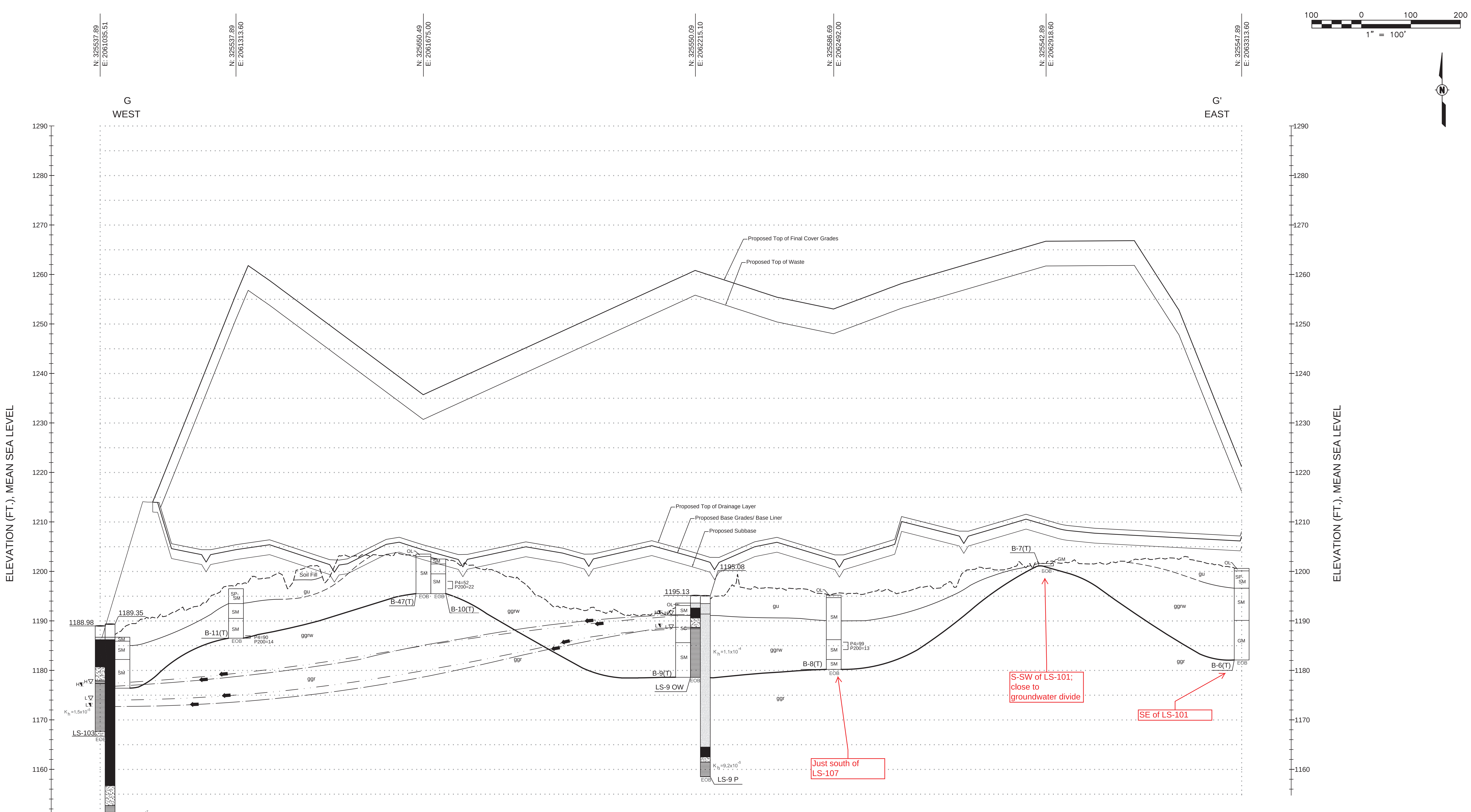
60186058

SHEET TITLE

GEOLOGIC CROSS-SECTION F-F'

SHEET NUMBER

FR-15



GEOLOGIC CROSS-SECTION G-G'

SCALE: 1"=100' HORIZ. & 1"=10' VERT.
10X VERTICAL EXAGGERATION

LEGEND

- EXISTING GROUND SURFACE
- LITHOSTRATIGRAPHIC UNIT (DASHED WHERE APPROXIMATE)
- COMPETENT BEDROCK SURFACE (DASHED WHERE APPROXIMATE)
- HIGH TABLE SURFACE - SHOWING FLOW DIRECTION
  HIGH WATER TABLE (H) 3-19-12,
  LOW WATER TABLE (L) 10-21-11
- PIEZOMETRIC SURFACE - SHOWING FLOW DIRECTION
  HIGH PIEZOMETRIC SURFACE (H) 3-19-12,
  LOW PIEZOMETRIC SURFACE (L) 10-21-11

1199.99	TOP OF PVC ELEVATION
	ANNULAR SPACE SEAL
OL / SM / ML	SOIL CLASSIFICATION (USCS)
K_V=4.0x10^{-6} P4=99 P200=36	SAMPLE INTERVAL WITH LABORATORY (VERTICAL) HYDRAULIC CONDUCTIVITY (CENTIMETERS/SECOND) (K_V), % PASSING No. 4 SIEVE (P4), AND % PASSING No. 200 (P200)
	LITHOSTRATIGRAPHIC CONTACT (DASHED WHERE APPROXIMATE)
	BENTONITE SEAL
	SAND FILTER PACK
	WELL SCREEN
K_h=1.0x10^{-7}	FIELD (HORIZONTAL) HYDRAULIC CONDUCTIVITY (K_h) (CENTIMETERS/SECOND)
LS-101	SOIL BORING/MONITORING WELL DESIGNATION — * - ORIGINAL BORING; ** - REPLACEMENT BORING
	NATURAL CAVE IN OR SAND FILL
EOB	END OF BORING

STRATIGRAPHIC UNIT

PLEISTOCENE	gu - MARATHON FORMATION, UNDIFFERENTIATED (Attig and Muldoon, 1989) BROWN TO DARK BROWN SAND TO SILTY SAND DERIVED FROM TILL, RESIDUUM, OR HILLSLOPE SEDIMENT ggrw - WEATHERED BEDROCK. YELLOWISH BROWN TO DARK BROWN SILTY SAND DERIVED FROM LOWER PROTEROZOIC BEDROCK (ggr).
LOWER PROTEROZOIC	ggr - GNEISSIC GRANITE (LaBerge and Myers, 1983) LIGHT GREY TO PINK QUARTZ DIORITE AND RED TO PINK GRANITE, WITH TRACE BLACK AMPHIBOLITE

UNIFIED SOIL CLASSIFICATION

GW	WELL GRADED GRAVELS & GRAVEL WITH SAND
GP	POORLY GRADED GRAVELS & GRAVEL WITH SAND
GM	SILTY GRAVELS, SILTY GRAVELS WITH SAND
GC	CLAYEY GRAVELS, CLAYEY GRAVEL WITH SAND
SW	WELL GRADED SANDS & SAND WITH GRAVEL
SP	POORLY GRADED SANDS & SANDS WITH GRAVEL
SP-SM	POORLY GRADED SAND WITH SILT, SAND WITH SILT & GRAVEL
SM	SILTY SANDS, SILTY SAND WITH GRAVEL
SC	CLAYEY SANDS, CLAYEY SANDS WITH GRAVEL
CH	HIGH PLASTICITY CLAY
CL-ML	SILTY CLAY TO CLAYEY SILT
CL	LOW PLASTICITY CLAY, GRAVELLY-SANDY CLAYS
ML	SILT, GRAVELLY-SANDY SILT
OL	ORGANIC CLAY, SANDY-GRAVELLY ORGANIC SOIL
OH	ORGANIC, HIGH PLASTICITY, SILTY CLAY
PT	PEAT, MUCK, ORGANIC SOILS

NOTES

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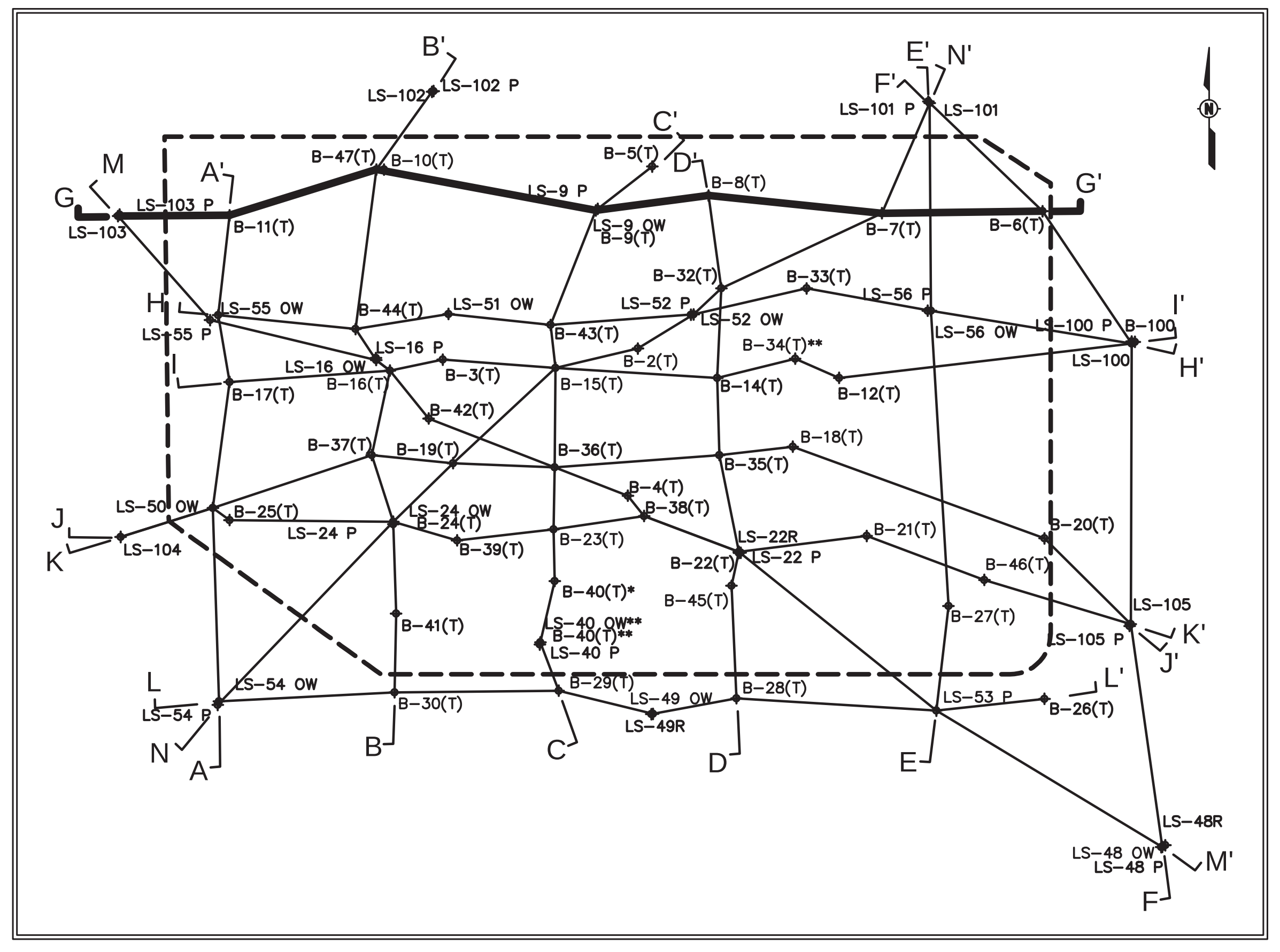
2) FILL - COAL COMBUSTION RESIDUALS

3) WATER TABLE, PIEZOMETRIC, AND COMPETENT BEDROCK SURFACE LINES WERE DRAWN BETWEEN BORINGS IN THE CROSS SECTION AND WERE NOT PRODUCED FROM THE SURFACES PRESENTED IN FR-5 THROUGH FR-8 AND FR-25



CROSS-SECTION INDEX
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AECOM

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REGISTRATION

ISSUE/REVISION

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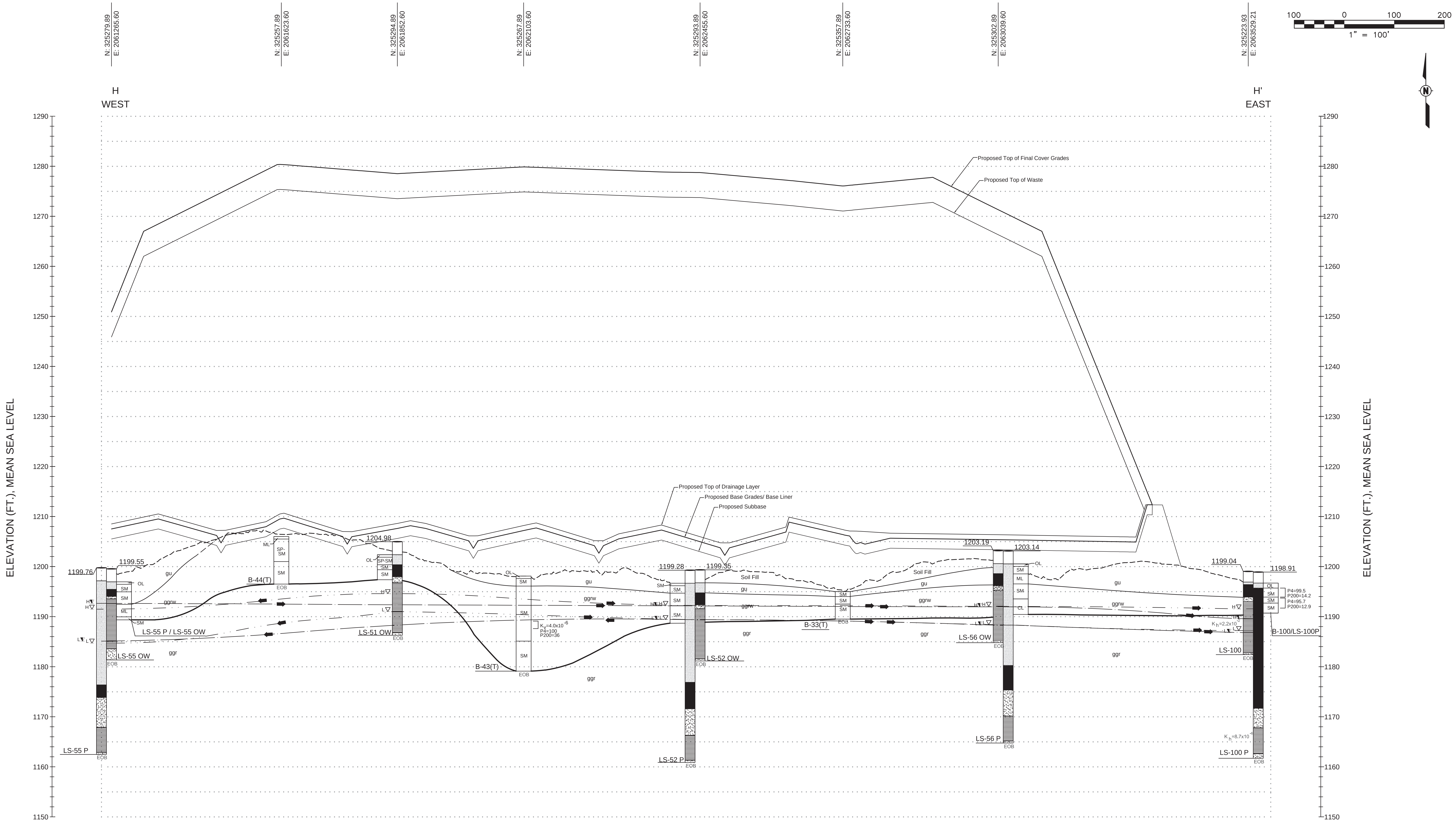
KEY PLAN

PROJECT NUMBER
60186058

SHEET TITLE
GEOLOGIC CROSS-SECTION G-G'

SHEET NUMBER
FR-16



GEOLOGIC CROSS-SECTION H-H'

SCALE: 1"=100' HORIZ. & 1"=10' VERT.
10X VERTICAL EXAGGERATION

LEGEND

- EXISTING GROUND SURFACE
- LITHOSTRATIGRAPHIC UNIT (DASHED WHERE APPROXIMATE)
- COMPETENT BEDROCK SURFACE (DASHED WHERE APPROXIMATE)
- HIGH TABLE SURFACE - SHOWING FLOW DIRECTION
  HIGH WATER TABLE (H) 3-19-12,
  LOW WATER TABLE (L) 10-21-11
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  HIGH PIEZOMETRIC SURFACE (H) 3-19-12,
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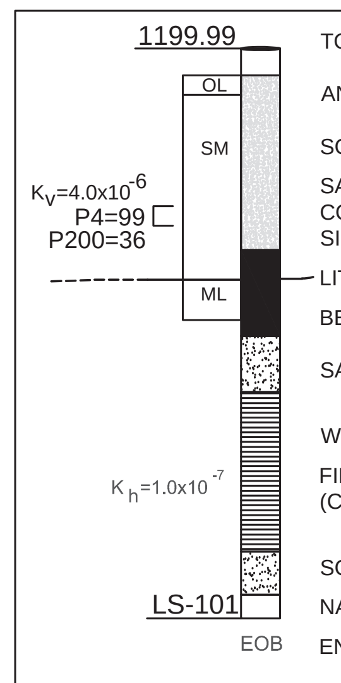

TOP OF PVC ELEVATION
ANNULAR SPACE SEAL
SOIL CLASSIFICATION (USCS)
SAMPLE INTERVAL WITH LABORATORY (VERTICAL) HYDRAULIC CONDUCTIVITY (CENTIMETERS/SECOND) (K_v), % PASSING No. 4 SIEVE (P4), AND % PASSING No. 200 (P200)
LITHOSTRATIGRAPHIC CONTACT (DASHED WHERE APPROXIMATE)
BENTONITE SEAL
SAND FILTER PACK
WELL SCREEN
FIELD (HORIZONTAL) HYDRAULIC CONDUCTIVITY (K_h) (CENTIMETERS/SECOND)
SOIL BORING/MONITORING WELL DESIGNATION
- * - ORIGINAL BORING
- ** - REPLACEMENT BORING

NATURAL CAVE IN OR SAND FILL
END OF BORING

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GP	POORLY GRADED GRAVELS & GRAVEL WITH SAND
GM	SILTY GRAVELS, SILTY GRAVELS WITH SAND
GC	CLAYEY GRAVELS, CLAYEY GRAVEL WITH SAND
SW	WELL GRADED SANDS & SAND WITH GRAVEL
SP	POORLY GRADED SANDS & SANDS WITH GRAVEL
SP-SM	POORLY GRADED SAND WITH SILT, SAND WITH SILT & GRAVEL
SM	SILTY SANDS, SILTY SAND WITH GRAVEL
SC	CLAYEY SANDS, CLAYEY SANDS WITH GRAVEL
CH	HIGH PLASTICITY CLAY
CL-ML	SILTY CLAY TO CLAYEY SILT
CL	LOW PLASTICITY CLAY, GRAVELLY-SANDY CLAYS
ML	SILT, GRAVELLY-SANDY SILT
OL	ORGANIC CLAY, SANDY-GRAVELLY ORGANIC SOIL
OH	ORGANIC, HIGH PLASTICITY, SILTY CLAY
PT	PEAT, MUCK, ORGANIC SOILS

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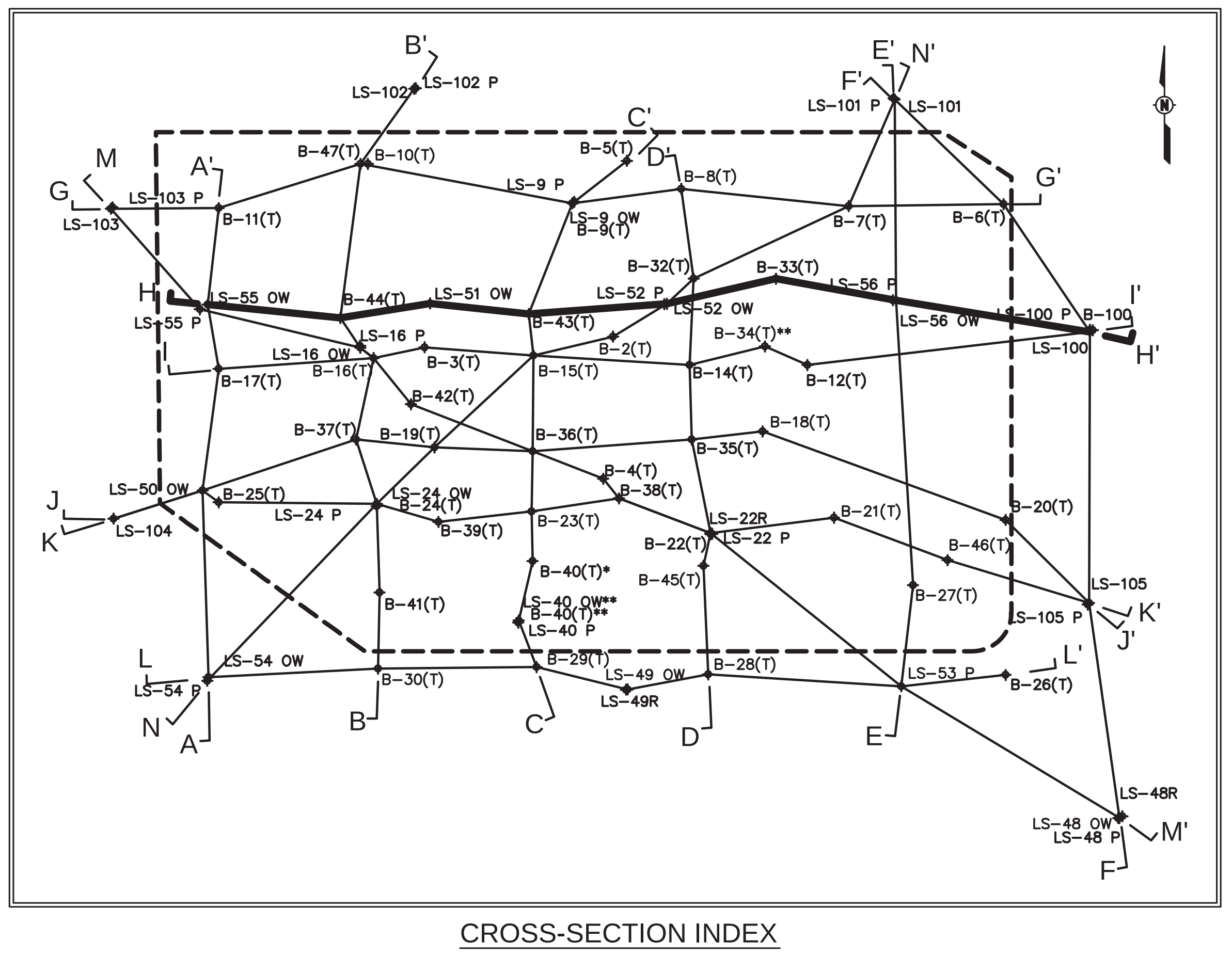

CROSS-SECTION INDEX
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REGISTRATION

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KEY PLAN

PROJECT NUMBER
60186058

SHEET TITLE
GEOLOGIC CROSS-SECTION H-H'

SHEET NUMBER
FR-17

ARCH D 24" x 36"
Approved: MJV
Checked: RW
Designer: SRK
Project Management Initials:
Last Plotted: 2012-08-01
Last saved by: CURTINK
Filename: X:\PROJECTS\WPSC_KNOWLTON\DWG\FEASIBILITY\FR-10_TO_FR-23_CROSSSECTIONS.DWG

ARCH D 24" x 36"
Approved: MJV
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Project Management Initials:
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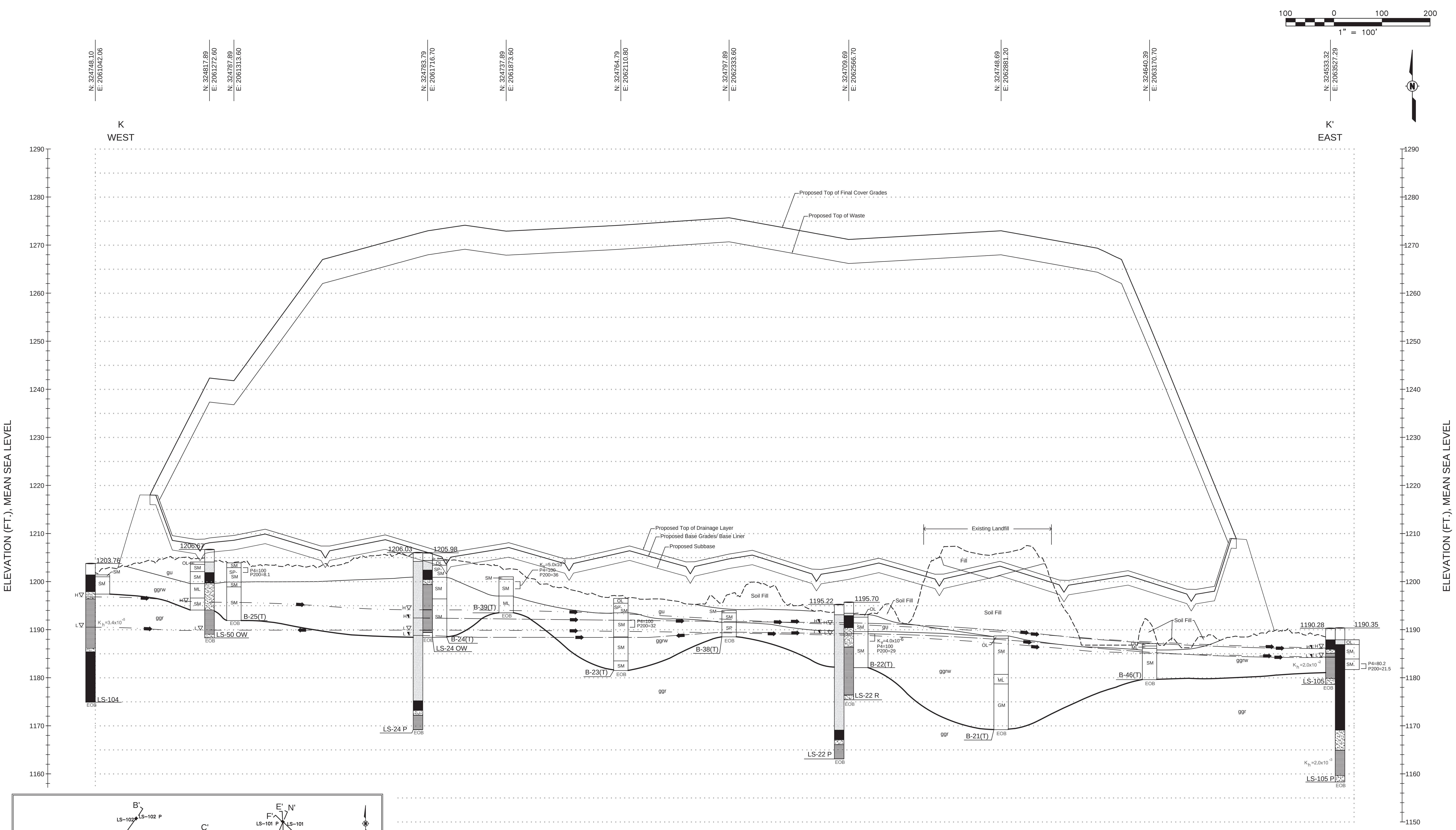
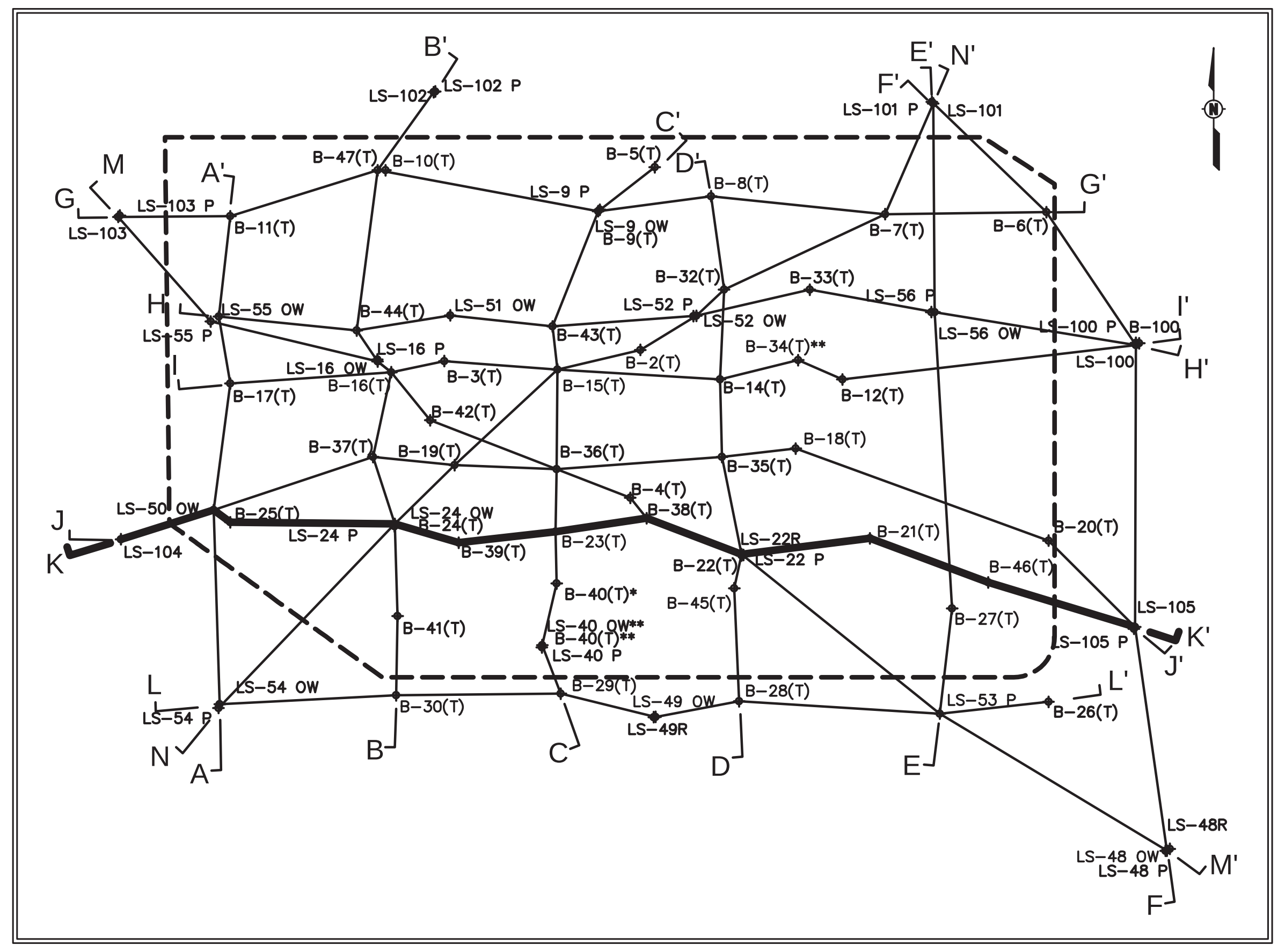


GEOLOGIC CROSS-SECTION K-K'

SCALE: 1"=100' HORIZ. & 1"=10' VERT.
10X VERTICAL EXAGGERATION



CROSS-SECTION INDEX
NOT TO SCALE

LEGEND

- – – – – – EXISTING GROUND SURFACE
- ——— LITHOSTRATIGRAPHIC UNIT (DASHED WHERE APPROXIMATE)
- ━━━ COMPETENT BEDROCK SURFACE (DASHED WHERE APPROXIMATE)
- ➡ · · — · · ▽ HIGH TABLE SURFACE - SHOWING FLOW DIRECTION
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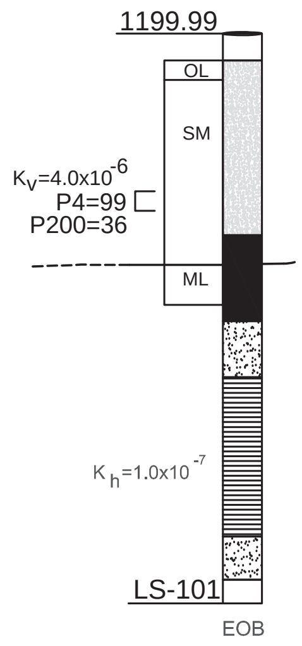

TOP OF PVC ELEVATION
ANNULAR SPACE SEAL
SOIL CLASSIFICATION (USCS)
SAMPLE INTERVAL WITH LABORATORY (VERTICAL) HYDRAULIC CONDUCTIVITY (CENTIMETERS/SECOND) (K_V), % PASSING No. 4 SIEVE (P4), AND % PASSING No. 200 (P200)
LITHOSTRATIGRAPHIC CONTACT (DASHED WHERE APPROXIMATE)
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SAND FILTER PACK
WELL SCREEN
FIELD (HORIZONTAL) HYDRAULIC CONDUCTIVITY (K_h) (CENTIMETERS/SECOND)
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END OF BORING

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UNIFIED SOIL CLASSIFICATION

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SP-SM	POORLY GRADED SAND WITH SILT, SAND WITH SILT & GRAVEL
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AECOM

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1035 Kepler Drive
Green Bay, Wisconsin 54311
920.468.1978 tel 920.468.3312 fax
www.aecom.com

REGISTRATION

ISSUE/REVISION

A	AUGUST 2012	Issued for Regulatory Review
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

60186058

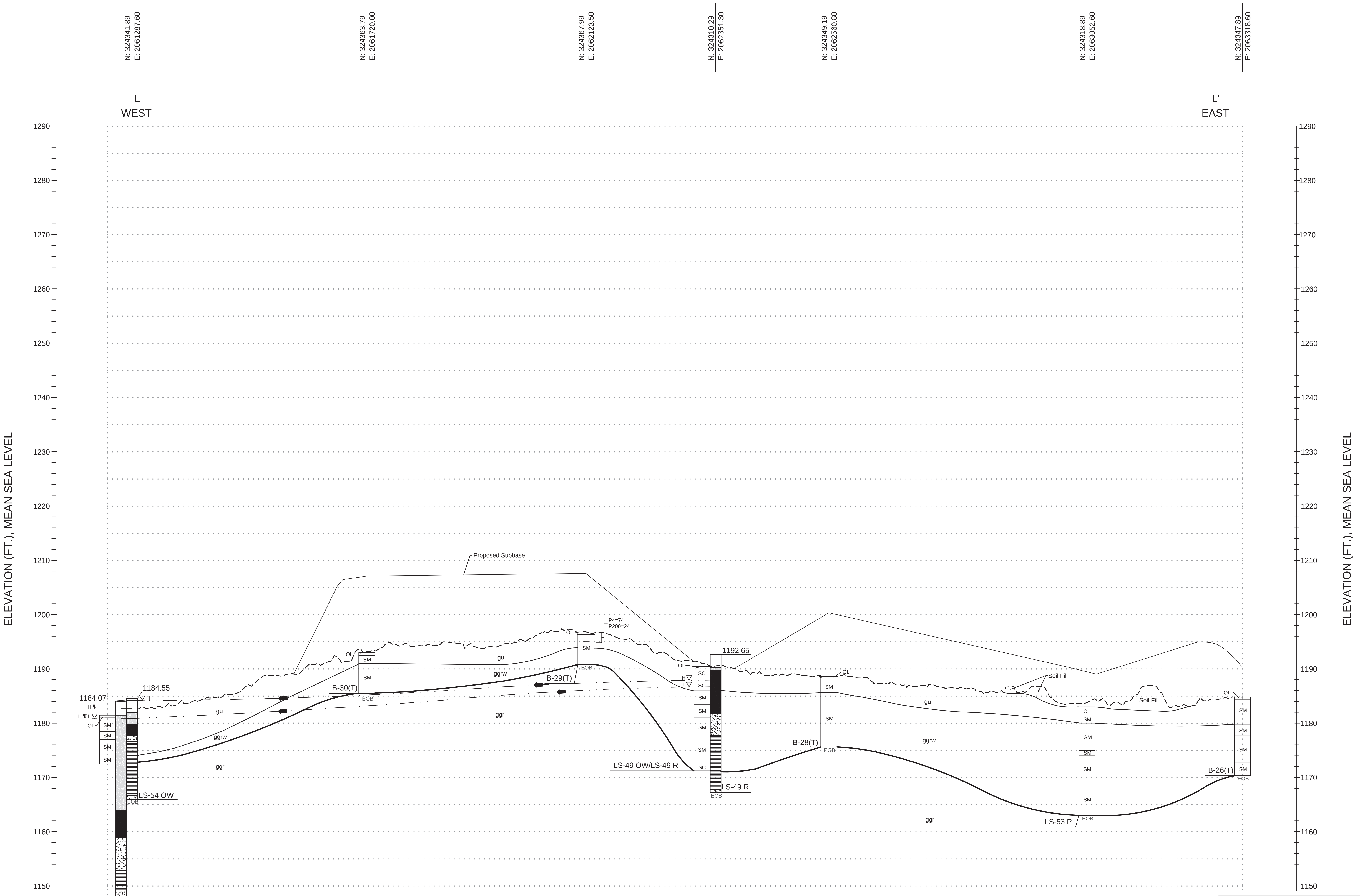
SHEET TITLE

GEOLOGIC CROSS-SECTION K-K'

SHEET NUMBER

FR-20

ARCH D 24" x 36"
Approved: MJV
Checked: RW
Designer: SRK
Project Management Initials:
Last Plotted: 2012-08-01
Last saved by: CURTINK
Filename: X:\PROJECTS\WPSC_KNOWLTON\DWG\FEASIBILITY\FR-10_TO_FR-23_CROSSSECTIONS.DWG

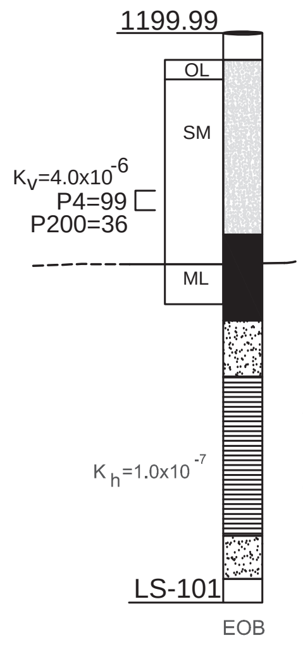


GEOLOGIC CROSS-SECTION L-L'

SCALE: 1"=100' HORIZ. & 1"=10' VERT.
10X VERTICAL EXAGGERATION

LEGEND

EXISTING GROUND SURFACE
LITHOSTRATIGRAPHIC UNIT (DASHED WHERE APPROXIMATE)
COMPETENT BEDROCK SURFACE (DASHED WHERE APPROXIMATE)
HIGH TABLE SURFACE - SHOWING FLOW DIRECTION
HIGH WATER TABLE (H) 3-19-12,
LOW WATER TABLE (L) 10-21-11
PIEZOMETRIC SURFACE - SHOWING FLOW DIRECTION
HIGH PIEZOMETRIC SURFACE (H) 3-19-12,
LOW PIEZOMETRIC SURFACE (L) 10-21-11



TOP OF PVC ELEVATION
ANNULAR SPACE SEAL
SOIL CLASSIFICATION (USCS)
SAMPLE INTERVAL WITH LABORATORY (VERTICAL) HYDRAULIC CONDUCTIVITY (CENTIMETERS/SECOND) (K_V), % PASSING No. 4 SIEVE (P4), AND % PASSING No. 200 (P200)
LITHOSTRATIGRAPHIC CONTACT (DASHED WHERE APPROXIMATE)
BENTONITE SEAL
SAND FILTER PACK
WELL SCREEN
FIELD (HORIZONTAL) HYDRAULIC CONDUCTIVITY (K_h) (CENTIMETERS/SECOND)
SOIL BORING/MONITORING WELL DESIGNATION
* - ORIGINAL BORING
** - REPLACEMENT BORING
NATURAL CAVE IN OR SAND FILL
END OF BORING

STRATIGRAPHIC UNIT

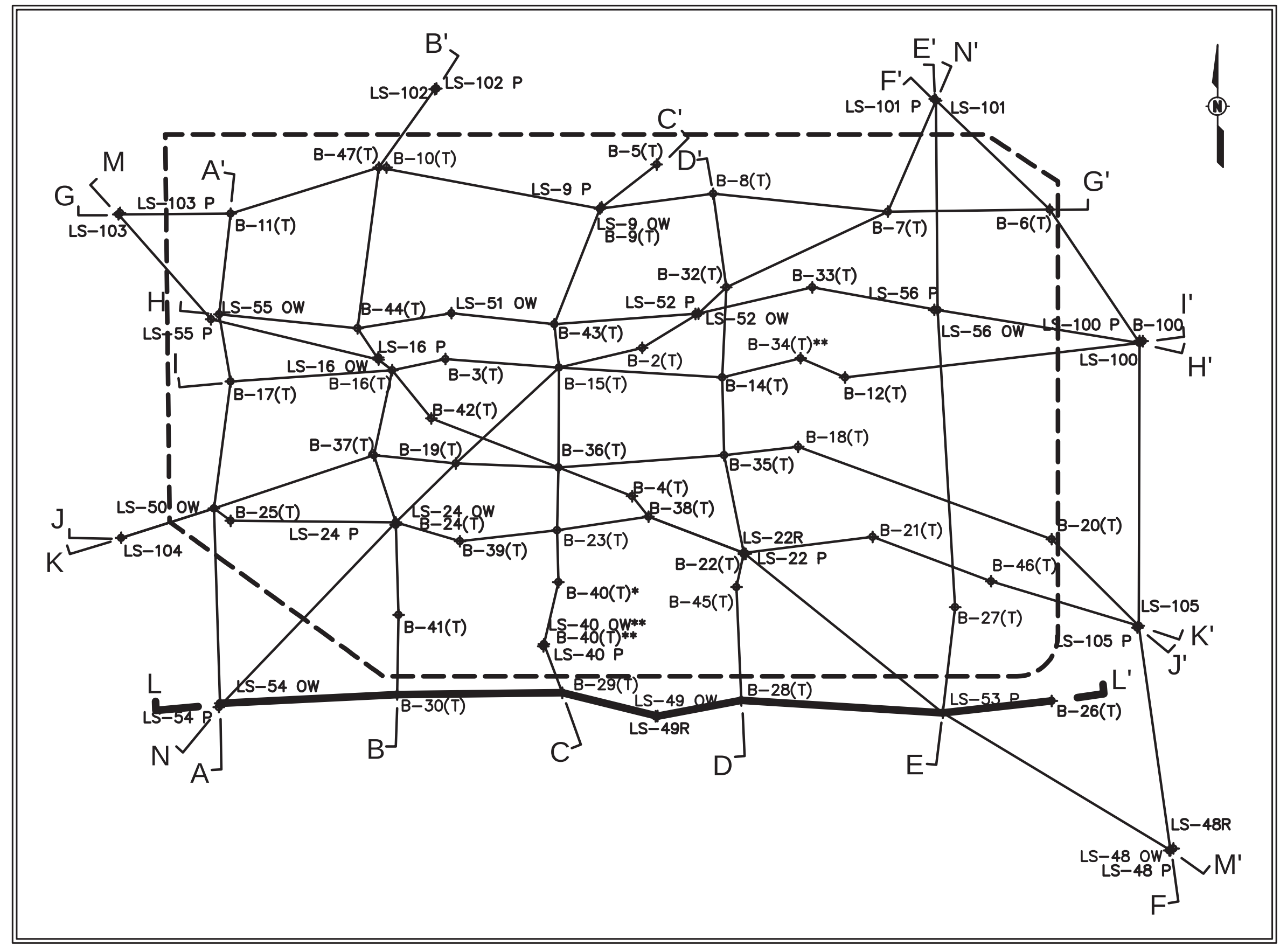
PLEISTOCENE	gu - MARATHON FORMATION, UNDIFFERENTIATED (Attig and Muldoon, 1989) BROWN TO DARK BROWN SAND TO SILTY SAND DERIVED FROM TILL, RESIDUUM, OR HILLSLOPE SEDIMENT ggrw - WEATHERED BEDROCK. YELLOWISH BROWN TO DARK BROWN SILTY SAND DERIVED FROM LOWER PROTEROZOIC BEDROCK (ggr).
LOWER PROTEROZOIC	ggr - GNEISSIC GRANITE (LaBerge and Myers, 1983) LIGHT GREY TO PINK QUARTZ DIORITE AND RED TO PINK GRANITE, WITH TRACE BLACK AMPHIBOLITE

UNIFIED SOIL CLASSIFICATION

GW	WELL GRADED GRAVELS & GRAVEL WITH SAND
GP	POORLY GRADED GRAVELS & GRAVEL WITH SAND
GM	SILTY GRAVELS, SILTY GRAVELS WITH SAND
GC	CLAYEY GRAVELS, CLAYEY GRAVEL WITH SAND
SW	WELL GRADED SANDS & SAND WITH GRAVEL
SP	POORLY GRADED SANDS & SANDS WITH GRAVEL
SP-SM	POORLY GRADED SAND WITH SILT, SAND WITH SILT & GRAVEL
SM	SILTY SANDS, SILTY SAND WITH GRAVEL
SC	CLAYEY SANDS, CLAYEY SANDS WITH GRAVEL
CH	HIGH PLASTICITY CLAY
CL-ML	SILTY CLAY TO CLAYEY SILT
CL	LOW PLASTICITY CLAY, GRAVELLY-SANDY CLAYS
ML	SILT, GRAVELLY-SANDY SILT
OL	ORGANIC CLAY, SANDY-GRAVELLY ORGANIC SOIL
OH	ORGANIC, HIGH PLASTICITY, SILTY CLAY
PT	PEAT, MUCK, ORGANIC SOILS

NOTES

1) SOIL FILL - DISTURBED SOIL OR SOIL THAT HAS BEEN PLACED FOR CONSTRUCTION OF ROADS AND BERMS ASSOCIATED WITH THE EXISTING LANDFILL
2) FILL - COAL COMBUSTION RESIDUALS
3) WATER TABLE, PIEZOMETRIC, AND COMPETENT BEDROCK SURFACE LINES WERE DRAWN BETWEEN BORINGS IN THE CROSS SECTION AND WERE NOT PRODUCED FROM THE SURFACES PRESENTED IN FR-5 THROUGH FR-8 AND FR-25



CROSS-SECTION INDEX
NOT TO SCALE

100 0 100 200
1" = 100'

AECOM

PROJECT

Feasibility Report
Weston Disposal Site
No. 3 Expansion
Legner Road
Town of Knowlton, Marathon County, WI

CLIENT

Wisconsin Public
Service Corporation
700 North Adams St., P.O. Box 19001
Green Bay, WI 54307-9001
920-433-1780 tel
www.wisconsinpublicservice.com

CONSULTANT

AECOM Technical Services, Inc.
1035 Kepler Drive
Green Bay, Wisconsin 54311
920.468.1978 tel 920.468.3312 fax
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SHEET TITLE

GEOLOGIC CROSS-SECTION L-L'

SHEET NUMBER

FR-21

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Approved: MJV

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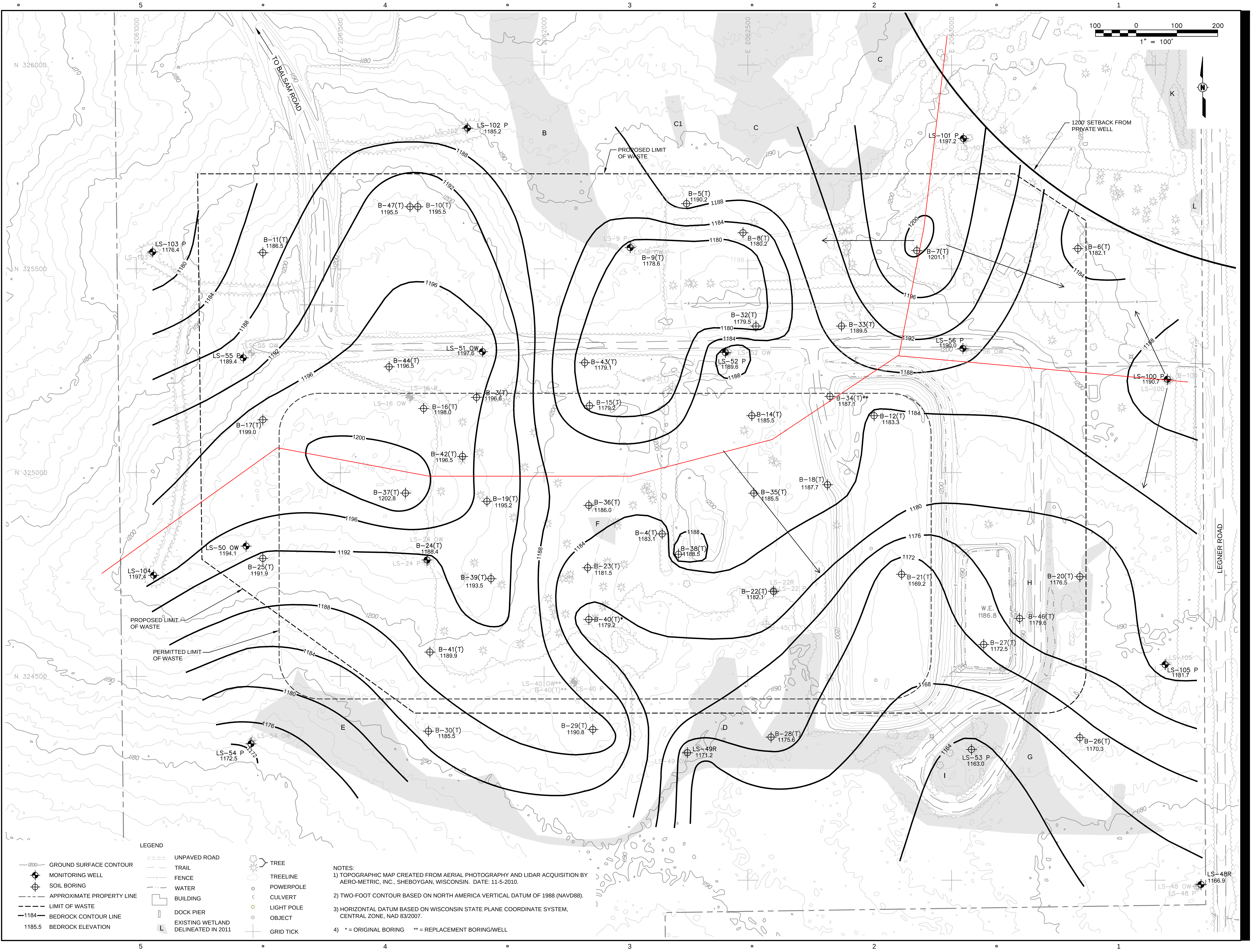

LEGEND

—1200—	GROUND SURFACE CONTOUR
⊕	MONITORING WELL
⊕	SOIL BORING
— —	APPROXIMATE PROPERTY LINE
— — —	LIMIT OF WASTE
—1184—	BEDROCK CONTOUR LINE
1185.5	BEDROCK ELEVATION
= = =	UNPAVED ROAD
— —	TRAIL
—x—	FENCE
—·· —	WATER
▭	BUILDING
▯	DOCK PIER
L	EXISTING WETLAND DELINEATED IN 2011
✳	TREE
	TREELINE
⊙	POWERPOLE
(	CULVERT
○	LIGHT POLE
⊙	OBJECT
+	GRID TICK

NOTES:

1) TOPOGRAPHIC MAP CREATED FROM AERIAL PHOTOGRAPHY AND LIDAR ACQUISITION BY AERO-METRIC, INC., SHEBOYGAN, WISCONSIN. DATE: 11-5-2010.

2) TWO-FOOT CONTOUR BASED ON NORTH AMERICA VERTICAL DATUM OF 1988 (NAVD88).

3) HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM, CENTRAL ZONE, NAD 83/2007.

4) * = ORIGINAL BORING ** = REPLACEMENT BORING/WELL

AECOM

PROJECT

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Weston Disposal Site
No. 3 Expansion
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KEY PLAN

PROJECT NUMBER

60186058

SHEET TITLE

BEDROCK SURFACE CONTOUR MAP

SHEET NUMBER

FR-25

APPENDIX C
SAMPLING AND ANALYSIS PLAN

Intended for
Wisconsin Public Service Corporation

Date
December 19, 2023

Project No.
1940104079

SAMPLING AND ANALYSIS PLAN REVISION 1

WESTON DISPOSAL SITE NUMBER 3 LANDFILL

Bright ideas. Sustainable change.

SAMPLING AND ANALYSIS PLAN REVISION 1
WESTON DISPOSAL SITE NUMBER 3 LANDFILL

Project name	**Weston Disposal Site Number 3 Landfill**
Project no.	**1940104079**
Recipient	**Wisconsin Public Service Corporation**
Document type	**Sampling and Analysis Plan**
Revision	**1**
Date	**December 19, 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**

Ramboll
234 W. Florida Street
Fifth Floor
Milwaukee, WI 53204
USA

T 414-837-3607
F 414-837-3608
https://ramboll.com

Nathaniel R Keller

Nathaniel R. Keller, PG
Technical Manager

Eric J. Tlachac

Eric J. Tlachac, PE
Senior Managing Engineer

DOCUMENT REVISION RECORD

Issue No.	Date	Details of Revisions
Revision 0	January 30, 2023	• Original Document
Revision 1	December 19, 2023	• Replaced references to We Energies with Wisconsin Public Service Corporation • 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
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
WDS3	Western Disposal Site Number 3
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 Wisconsin Public Service Corporation's Weston Disposal Site Number 3 (WDS3) Landfill located in the town of Knowlton, 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 Wisconsin Public Service Corporation's WDS3 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); Wisconsin Public Service Corporation's 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 Wisconsin Public Service Corporation's 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 Wisconsin Public Service Corporation 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 Wisconsin Public Service Corporation's database.

Laboratory EDDs and PDF reports will be sent to Ramboll and Wisconsin Public Service Corporation 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. Wisconsin Public Service Corporation 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 Wisconsin Public Service Corporation 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 Wisconsin Public Service Corporation by the Ramboll data group.

8.3 Protocol for Data Exchange

Ramboll will import and maintain the field and analytical data in the 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 Wisconsin Public Service Corporation.

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 Wisconsin Public Service Corporation.

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 Wisconsin Public Service Corporation.

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.

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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.

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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
Wisconsin Public Service Corporation NR 507 Groundwater Monitoring
Weston Disposal Site No. 3 Landfill, Knowlton, 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	5	1	1	NA	1	7	glass[7]	250 mL	none[8]	90 days
Metals (1)	200.7/200.8	5	1	1	NA	1	7	plastic	250 mL	HNO3 to pH<2	6 months
Inorganic Parameters											
Alkalinity	2320B	5	1	1	NA	1	7	plastic	500 mL	Cool to 4 °C	28 days
Chloride	300.0/9056	5	1	1	NA	1	7	plastic	500 mL	Cool to 4 °C	28 days
Fluoride	300.0/9056	5	1	1	NA	1	7	plastic	500 mL	Cool to 4 °C	28 days
Hardness	200.7/2340B	5	1	1	NA	1	7	plastic	500 mL	HNO3 to pH<2	28 days
Nitrate + Nitrite, N	300.0/9056	5	1	1	NA	1	7	plastic	500 mL	Cool to 4 °C	48 hours
Sulfate	300.0/9056	5	1	1	NA	1	7	plastic	500 mL	Cool to 4 °C	28 days
Total Dissolved Solids	SM 2540C	5	1	1	NA	1	7	plastic	500 mL	Cool to 4 °C	7 days
Other											
Radium 226	903.1	5	1	1	NA	1	7	plastic	1000 mL	Cool to 4 °C	NA
Radium 228	904	5	1	1	NA	1	7	plastic	1000 mL	Cool to 4 °C	NA
Field Parameters											
Dissolved Oxygen	SM 4500-O/405.1	5	NA	NA	NA	NA	6	flow-through cell	NA	none	immediately
Oxidation/Reduction Potential	SM 258/OB	5	NA	NA	NA	NA	5	flow-through cell	NA	none	immediately
pH	SM 4500-H+ B	5	NA	NA	NA	NA	5	flow-through cell	NA	none	immediately
Specific Conductance	SM 2510 B	5	NA	NA	NA	NA	5	flow-through cell	NA	none	immediately
Temperature	SM 2550	5	NA	NA	NA	NA	5	flow-through cell	NA	none	immediately
Turbidity[9]	EPA Method 180.1	5	NA	NA	NA	NA	6	hand-held turbidity meter[10]	NA	none	immediately

Notes:

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

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

Table 2. Sample Location Summary

Sampling and Analysis Plan Revision 1
Wisconsin Public Service Corporation NR 507 Groundwater Monitoring
Weston Disposal Site No. 3 Landfill, Knowlton, Wisconsin

Well ID	LS-100	LS-101	LS-105	LS-106	LS107
Well Location Latitude	44.72484	44.72648	44.72295	44.72219	44.72630
Well Location Longitude	-89.63437	-89.63627	-89.63439	-89.63533	-89.63852
Well Location Northing (State Plane)[3]	325,223	325,816	324,533	324,253	324,749
Well Location Easting (State Plane)[3]	2,063,529	2,063,032	2,063,527	2,063,283	2,062,448
Well Construction Material	PVC	PVC	PVC	PVC	PVC
Well Diameter (inches)	2	2	2	2	2
Top of Casing Well Elevation (ft)[4]	1199.04	1205.41	1190.28	1193.24	1194.40
Well Depth (ft)[5]	13.9	15.0	7.8	15.0	15.0
Pump Intake Elevation (ft)[4]	1188	1193.1	1182.6	1180.5	1181.5
Screen Length (ft)	10	10	5	10	10
Top of Screen Elevation (ft)[4]	1193	1198.1	1185.1	1185.5	1186.5
Bottom of Screen Elevation (ft)[4]	1183	1188.1	1180.1	1175.5	1176.5
Casing Length to Screen (ft)	6.0	7.3	5.2	7.7	7.9
Well Stick-up Above Ground Surface (ft)	2.14	2.31	2.38	2.74	2.90
Hydraulic Position of Well(1)	D	U	D	D	D

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 obtained from well construction forms and tablulated summary provided by GEI Consultants.
3. Horizontal Datum is referenced to Wisconsin State Plane Coordinate System, Central Zone, North America Datum (NAD 83/2007), US Survey Feet.
4. Elevation datum is referenced to North American Vertical Datum 1988 (NAVD88).
5. Depth below ground surface (bgs).

Table 3. Summary of Groundwater Analytical Methods

Sampling and Analysis Plan Revision 1
Wisconsin Public Service Corporation NR 507 Groundwater Monitoring
Weston Disposal Site No. 3 Landfill, Knowlton, 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
Wisconsin Public Service Corporation NR 507 Groundwater Monitoring
Weston Disposal Site No. 3 Landfill, Knowlton, 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
Wisconsin Public Service Corporation NR 507 Groundwater Monitoring
Weston Disposal Site No. 3 Landfill, Knowlton, 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
Wisconsin Public Service Corporation NR 507 Groundwater Monitoring
Weston Disposal Site No. 3 Landfill, Knowlton, 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
Wisconsin Public Service Corporation NR 507 Groundwater Monitoring
Weston Disposal Site No. 3 Landfill, Knowlton, 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
Wisconsin Public Service Corporation NR 507 Groundwater Monitoring
Weston Disposal Site No. 3 Landfill, Knowlton, Wisconsin

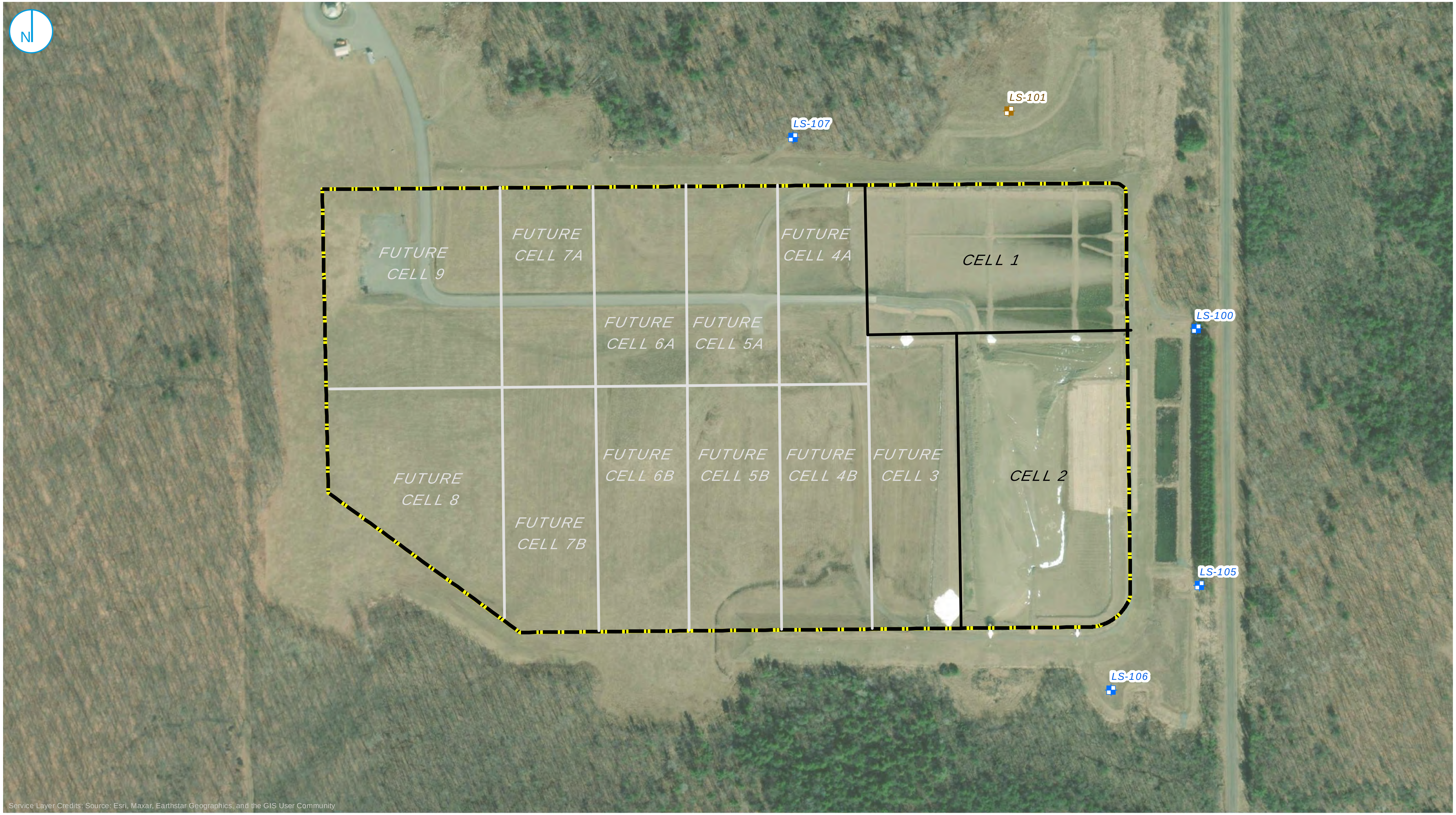
Field Parameter	Precision Goal	Accuracy Goal	Completion Goal
Water Level	± 0.01 foot	± 0.01 foot	90%
pH	± 0.1 s.u.	± 0.1 s.u.	90%
Specific Conductance	± 100 µS/cm	± 100 µS/cm	90%
Temperature	± 10%	± 10%	90%
Oxidation/Reduction Potential	± 1.0 mV	± 1.0 mV	90%
Turbidity	± 1.0 NTU	± 1.0 NTU	90%
Dissolved 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\Weston_Power_Plant\MXD\2022Annual_GWM_CAR\Figure 1_Monitoring Well Location Map.mxd

PROJECT: 71202 | DATED: 1/24/2023 | DESIGNER: galarnmc



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

- NR 507 DOWNGRADIENT MONITORING WELL LOCATION
- NR 507 UPGRADIENT MONITORING WELL LOCATION
- WESTON DISPOSAL SITE NO. 3 LANDFILL

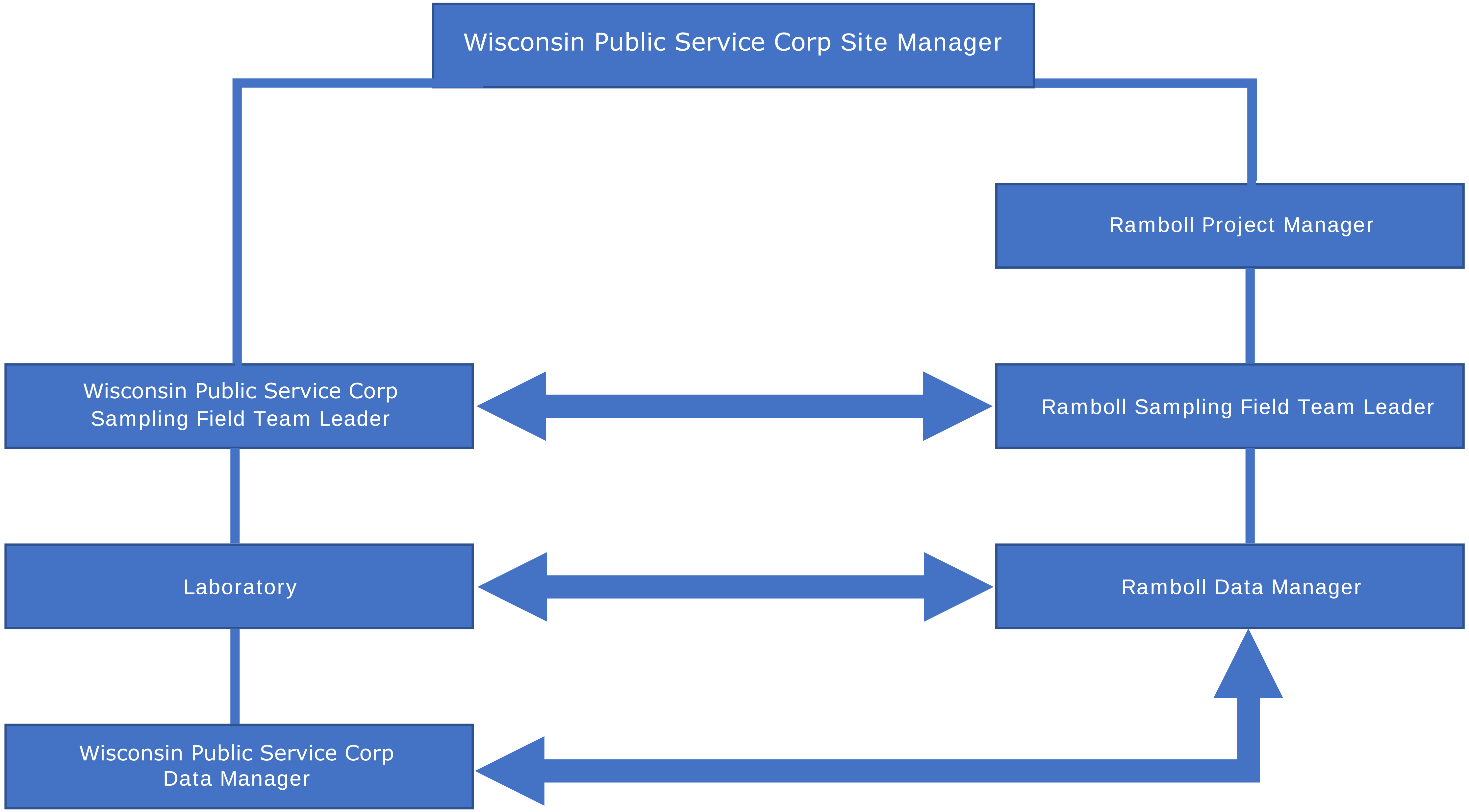
0 125 250 Feet

NR 507 GROUNDWATER MONITORING SYSTEM

FIGURE 1

SAMPLING AND ANALYSIS PLAN
REVISION 1
WESTON DISPOSAL SITE NO. 3 LANDFILL
TOWN OF KNOWLTON, WISCONSIN

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.



COMMUNICATION FLOW CHART

SAMPLING AND ANALYSIS PLAN
REVISION 1
WESTON DISPOSAL SITE NO. 3 LANDFILL
TOWN OF KNOWLTON, 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

October 3, 2017

Mr. Tim Muehlfeld
WEC Business Services, LLC
333 W. Everett Street – A231
Milwaukee, WI 53203

Subject:40 CFR Part 257, Subpart D, Section 257.91(f) Groundwater Monitoring System Certification
Wisconsin Public Service Corporation - Weston Disposal Site No. 3 Landfill, Town of Knowlton, 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 Wisconsin Public Service Corporation (WPSC) Weston Disposal Site No. 3 Landfill, including the following monitoring wells:

- Upgradient: LS-101
- Downgradient: LS-100, LS-105, LS-106, LS-107

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 WPSC Weston Disposal Site No. 3 Landfill meets the requirements of Section 257.91.

I, Glenn R. Luke, a qualified professional engineer, certify that the groundwater monitoring system at the WPSC Weston Disposal Site No. 3 Landfill has been designed and constructed to meet the requirements set forth in Section 257.91 of the United States Environmental Protection Agency's Final Rule to Regulate the Disposal of Coal Combustion Residuals from Electric Utilities as Solid Waste under Subtitle D of the Resource Conservation and Recovery Act. This certification is based on review of documentation regarding the design, installation, development, and decommissioning of monitoring wells and piezometers and ancillary measurement, sampling, and analytical devices.

Glenn R. Luke

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

I, Jacob J. Walczak, a qualified professional geologist, certify that the groundwater monitoring system at the WPSC Weston Disposal Site No. 3 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
FT BTOC - Feet Below Top of Casing
na - Not Applicable
nm - Not Measured

ORP - Oxidation-Reduction Potential
SEC - Specific Electrical Conductance
SU - Standard Units
Temp - Temperature
°C - Degrees Celcius

WELL DEVELOPMENT AND GROUNDWATER MONITORING FIELD FORM

PROJECT INFORMATION

Site: ____________________ Client: ____________________

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

Field Personnel: ____________________ Finish Date: ____________ Time: ________

WELL INFORMATION

Well ID: ____________

Casing ID: inches

EVENT TYPE

☐ Well Development ☐ Low-Flow / Low Stress Sampling

☐ Well Volume Approach Sampling ☐ Other (Specify):

WATER QUALITY INDICATOR PARAMETERS (continued)

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

NOTES (continued)

ABBREVIATIONS

Cond. - Actual Conductivity

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 __________

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

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

Comments:

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

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 Revision 1
Wisconsin Public Service Corporation 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 COUSTODY #__________

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 Revision 1
Wisconsin Public Service Corporation NR 507 Groundwater Monitoring
Site Name:____________

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

Notes:

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

ATTACHMENT C
STANDARD OPERATING PROCEDURES

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

LOW-FLOW GROUNDWATER SAMPLING

1.1 Scope and Application

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

1.2 Summary of Methods

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

1.2.1 Low-flow Method

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

1.3 SOPs for Related Tasks

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

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

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

2.1 Pre-mobilization Planning

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

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

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

2.1.1 Site-Specific Considerations

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

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

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

2.1.2 Health & Safety Plan, Personal Protective Equipment

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

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

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

2.1.3 Laboratory Coordination

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

Be sure to complete the following checklist when ordering and receiving sample containers:

- Confirm list of analytes
- Confirm methods of analysis and minimum required sample volume

- Determine whether samples are to be field-filtered and/or field-preserved
- Order extra containers as a contingency
- Count the number and type of containers received
- Discuss hold times and shipping and receiving procedures
- Determine whether special instructions are needed in writing on the chain of custody (COC)

Once the groundwater samples have been collected and shipped, make practice of calling the laboratory as a courtesy to provide anticipated arrival dates and numbers of samples. Identify samples with short hold times or that may contain exceptionally high concentrations of compounds of concern. Keep a copy of the signed COC that was shipped with the samples, and also keep any documentation of the laboratory's receipt of COCs. Include a specific list of the analytes requested on the COC as this is used by the lab to confirm the appropriate analyses have been completed and/or reported.

2.1.4 Field Equipment

Select sampling equipment necessary to achieve the data quality objectives for the project. Inspect, calibrate, and decontaminate all equipment prior to use in the field according to SOP 07-11-01 (Equipment Calibration, Operation, and Maintenance), and SOP 07-04-09 (Equipment Decontamination). The following list provides an overview of some of the items typically needed in the field:

- Health and Safety Plan (HASP)
- First Aid Kit
- PPE (minimum Level D)
- Scope of Work
- Site Maps
- Well Keys/Site Access Keys
- Mobile Phone
- Camera
- Calculator
- Field Log Book/Field Forms
- Tools
- Chain of Custody Forms

- Custody Seals
- Sample Containers
- Cooler and Ice
- Strapping Tape
- Permanent Markers/Pens
- Ziploc® Baggies
- Paper Towels
- Plastic Sheeting
- Garbage Bags
- Water Level Meter
- Weighted Steel Tape
- Oil-Water Meter
- Calibrated Buckets
- Alconox® Soap
- Brushes
- De-ionized (DI)/Potable Water
- Water Quality Meters
- Calibration Solutions
- Calibration Standards
- Meter Operation Manuals
- Flow-Through Cell
- Calibrated Beakers/Cups
- Tubing (HDPE, Tygon®, silicon)
- Disposable Filters (barrel filters)
- Bladder Pump
- Bladder Pump Control Box
- Safety Line for Bladder Pump
- Disposable Bladders
- Check Valves, Catch Plates
- Air Compressor
- Peristaltic Pump
- Submersible Pump (Whaler®, other)
- Extension Cords
- Hose Clamps
- Portable Battery (automotive/marine)
- Alligator Clips
- Electric Tape
- Generator and Gasoline

2.1.5 Field Forms

Field-records of all purging and sampling procedures are kept either in field notebooks or on site-specific field forms. Field notes for groundwater sampling may include observations and documentation of well inspection, water level, equipment calibration, purging and sampling information, sample control logs, and chain of custody. Record-keeping requirements are described Section 4.1.

2.1.6 Waste Disposal

Contaminated purge water will be discharged as directed in the site-specific sample plan. If disposal is required, it should be arranged prior to the sampling event. A waste profile and permission from regulatory authority and wastewater operator may be needed to dispose purge water to a sanitary sewer, wastewater treatment facility, landfill, or on-site disposal facility.

3.1 Groundwater Sampling Procedure

This SOP describes steps to follow when performing the low-flow method using bladder or peristaltic pumps.

Sampling generally proceeds in the following fashion:

- Establish a safe working zone
- Assess well condition
- Measure depth to groundwater
- Measure depth to well bottom (except in some cases)
- Measure thickness of any non-aqueous phase liquids (NAPLs or DNAPLs), if present
- Calculate well volumes
- Purge the well
- Collect samples

- Label and pack samples on ice for shipping
- Decontaminate equipment
- Complete all record-keeping requirements, including COC
- Ship samples

3.1.1 Well Integrity

Assess the condition of monitoring wells and protective casings prior to sampling activities. Measure depth to well bottom and compare measurement to previous measurements. The presence of obstructions and bent or broken casing (risers) must be considered before lowering pumps or other equipment into the well. Make note of, photograph, and repair, if possible, any damage to the monitoring well. Replace any missing locks or pressure caps prior to leaving the site. Include a well condition report as a part of the groundwater sampling field notes. Refer to SOP 07-07-01 (Well Integrity) for additional instructions.

3.1.2 Depth to Groundwater

Record the depth to groundwater to the nearest 0.01 ft, relative to the reference point at the top of well casing. A notch or permanent marking at the top of well casings (typically PVC) commonly marks the reference point. Measure depth to groundwater beginning at the least contaminated well and proceed to the most contaminated well. Decontaminate the water level meter (probe) with laboratory-grade soap and potable or deionized water between each well location. Refer to SOP 07-07-05 (Groundwater Elevation Measurements) and SOP 07-04-09 (Equipment Decontamination) for additional instructions.

Take time to monitor whether the measured depth to groundwater represents static groundwater elevation. Pressure caps may prevent some water columns from equilibrating with atmospheric pressure; be alert for this condition when pressure caps are very tight or produce an audible popping or hissing noise when removed. Record these observations in field notes and return to the well several times to make additional measurements to determine whether the water level has equilibrated.

Groundwater with elevated specific conductance (conductivity) may also interfere with the accuracy of water level measurement due to meter sensitivity. Adjust the sensitivity of the water level meter to make an accurate measurement, however, try to use a consistent sensitivity setting from well to well. When groundwater elevation contour maps are to be prepared, collect synoptic depth to groundwater measurements (e.g. collect measurements consecutively at every site well in the shortest period of time possible and prior to any sampling activities).

3.1.3 Depth to Bottom

Measurement of depth to well bottom is also made with a water level meter or with a measuring tape with a weighted bottom. Measure the depth to well bottom to nearest 0.01 ft relative to the reference point. Adjust measurements to account for the length of the water meter probe housing which extends below the water level sensor or for the length of weight below the bottom of the tape, if any. Decontaminate measuring tapes and water level probes and the full length of measuring tape that entered the well casing with laboratory grade soap and potable or de-ionized (DI) water according to SOP 07-04-09 (Equipment Decontamination), prior to use at other wells.

Depth to bottom measurements should be avoided in situations when performing the measurement stirs up sediment settled in the well sump. If possible, wait to take depth to well bottom measurement until after sampling is completed, and/or rely on past measurement of depth to well bottom to calculate well volumes. Note on field forms when historical depth to bottom measurements are used.

3.1.4 Thickness of NAPLs

Where immiscible liquids, such as petroleum non-aqueous phase liquid (NAPL), is present on the surface of the water column, an oil-interface probe (oil-water meter) is used to measure NAPL thickness. Differing patterns of audible alarms indicate “oil” as opposed to water. Record the depth to NAPL and depth to water relative to the reference point at the top of well casing. Decontaminate the probe and length of measuring tape that entered the well casing with laboratory grade soap and potable or DI water before use at another well. Refer to SOP 07-04-09 (Equipment Decontamination) for more instructions.

NAPL thickness can also be estimated using a bailer (glass or plastic). Slowly lower the bailer into the top of the water column. Do not allow the bailer to fill completely. Retrieve the bailer, place on a bailer stand, and measure the thickness of product in the bailer. Record the measurement as an estimate.

3.1.5 Purging and Pumping Equipment

Bladder pumps (e.g. Well Wizard®), and suction (peristaltic) pumps are preferred when performing the low-flow method. In some cases, use of a combination of equipment is appropriate, because the type of pump selected for purging may not be appropriate for sampling.

The material construction of pumps should also be considered with respect to potential interferences. For example, the use of polyvinyl chloride (PVC) and polyethylene is discouraged when the detected concentrations of organic compounds is anticipated to be at or near laboratory detection limits, because organics may leach in and out of these materials. Teflon® and Teflon®-lined sampling devices are preferred in these cases.

3.2 Purging and Sampling Using the Low-flow Method

Using the low-flow (low-stress, micro-purge) method, groundwater is purged at rates affecting minimal to no drawdown which effectively isolates stagnant water in the well casing (riser) above the pump inlet. Depth to groundwater and water quality parameters (field parameters) should be monitored throughout the purging process. Pumping rates are adjusted to ensure that flow of groundwater to the pump is from the saturated formation and not from stagnant water in the well casing. Samples are collected once drawdown and water quality parameters stabilize.

Purging for the low-flow method is performed using either a peristaltic (suction) pump, or a bladder pump. Tubing and bladders should be Teflon® or Teflon®-lined, although non-lined high-density polyethylene (HDPE) tubing is appropriate for many compounds of concern. In some situations, low-flow methods may be performed using other submersible pumps (e.g. Grundfos®, Whaler®, Proactive®) and inertia pumps (e.g. WaTerra®); see Section 3.2.3 for potential data quality implications.

3.2.1 Using a Peristaltic Pump

A peristaltic pump is used at the ground surface to apply a suction force to lift water from the well through small diameter tubing. Maximum lift for peristaltic pumps is in the range of 15 to 29 feet; and, pumping rates range from less than 50 milliliters per minute (mL/min) to several gallons per minute (gal/min). Peristaltic pumps exert reduced pressure on the pumped water which can result in degassing and volatilization of the sample. Changes in pressure can affect pH, oxidation reduction potential (ORP), and other gas-sensitive parameters (ASTM D6634-01[2006]). As a result, <u>USEPA recommends that peristaltic pumps not be used for low-flow groundwater sampling when depth to water exceeds 15 feet</u>, 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.

<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.

3.2.3 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. <u>Samples must not be collected using a pumping rate that exceeds the pumping rate at which stabilization was achieved.</u> Conceptually, once flow rate and water quality parameters have stabilized, a direct connection to the aquifer has been established, and any changes or disruptions to flow rate could break that connection and result in stagnant water being included in the samples.

The optimal pumping rate that will achieve stabilization for drawdown and water quality parameters will be specific to each well. Do not attempt to pump every well at a site at the same pumping rate. Use historical sampling information to replicate pumping rates for specific wells, as appropriate.

Monitoring Drawdown

Depth to water in the monitoring well should be monitored at 1 to 2 minute intervals until water level stabilization occurs and periodically afterwards. Drawdown during the course of pumping and sampling should not exceed 25% of the distance between the top of screen and pump inlet. Also, the volume of water pumped that is attributable to drawdown (stagnant water pumped from the well casing) should not exceed 10% of the total volume of water pumped. Some wells, especially those screened in clay, may not achieve water level stabilization (i.e., the water level continues to drop even at flow rates less than 50 ml/min). If this occurs, contact the field leader and Project Manager to discuss alternative methods for sample collection such as completely purging the well and returning to collect the sample once the well has recovered, or using a passive sampling method.

Monitoring Water Quality Parameters

Water quality parameters that provide evidence that formation-quality water is being pumped include pH, temperature, conductivity (specific conductance), dissolved oxygen, and oxidation-reduction potential (redox, or ORP, also measured as Eh). Turbidity, discussed below, may also be a useful field parameter.

Record these parameters continuously (if possible) or at regular time intervals using a closed flow through cell or similar instrumentation. Use a small volume flow through cell and monitor the cell for air bubbles (leakage).

The frequency of water quality parameter measurements should be not less than the time needed to evacuate the volume of the in-line flow through cell. Also determine the volume of water contained in the pump (i.e. bladder volume) and discharge tubing. Consider increasing time intervals to account for these volumes, especially when pumping rates are slow and/or the depth to pump inlet is significant. In instances where water quality parameter stabilization occurs quickly, be sure to also allow enough time for individual water quality instruments to stabilize (check manufacturer's recommendations). Dissolved oxygen sensors, for example, typically take longer to stabilize than pH, temperature, conductivity, and ORP sensors.

Stabilization of water quality parameters is achieved when three consecutive readings, several minutes apart, fall within the criteria listed below. These criteria are consistent with ASTM D6771-02: however, they may not apply to all sites. Site-specific parameters and criteria may be established to account for variations in aquifer properties, groundwater chemistry, well hydraulics, and contaminant distribution.

Field-Measured Parameter Stabilization Criteria for Groundwater

Parameter	**Stabilization Criteria**
Conductance, Specific Electrical	+/- 3% µS/cm @ 25°C
Dissolved Oxygen	+/- 10% of reading or +/- 0.2 mg/L, whichever is greater
Oxidation-Reduction Potential	+/- 20 mV
pH	+/- 0.2 standard units
Temperature	+/- 0.1°C
Turbidity	<10 NTUs or ± 10% when turbidity is greater than 10 NTUs

Notes: µS/cm = micro Siemens per centimeter
°C = degrees Celsius
mg/L = milligrams per liter
mV = millivolts
NTUs = nephelometric turbidity units

Turbidity

Turbidity is indicative of the stress pumping places on the screened formation. Measure turbidity with the same frequency (time intervals) as other water quality parameters or, at a minimum, at the beginning of pumping and again prior to collecting a sample. Ideally, low-flow purging should proceed until turbidity is less than 10 NTU, however, turbidity greater than 10 NTU can be natural and unavoidable. Analytical bias can occur for samples collected with turbidity greater than natural conditions.

When turbidity increases during pumping, too much stress is being placed on the well – lower the pumping rate. If the turbidity remains high, stop pumping and allow the well to rest without removing the pump. Resume pumping at a low rate and monitor turbidity for stabilization. As noted above, natural turbidity may remain higher than targeted stabilization criteria.

To minimize initial turbidity, carefully lower pumps and tubing into the monitoring well to avoid stirring sediment that has settled at the well bottom. Turbidity and other water quality parameters will typically stabilize more quickly when using dedicated pumps.

3.2.5 Sampling

When using the low-flow method, disconnect the flow cell without shutting off the pump and collect samples directly from the discharge tubing using the same pumping rate as was used to achieve stabilization. Use tubing appropriate for the compounds of concern. Collect samples for analysis of the most sensitive parameters first, and collect samples requiring field filtration last. Sampling protocol is described in detail in Section 3.3.

Be aware of potential quality control issues when collecting samples using the low-flow method:

- Samples should not be collected using a pumping rate greater than the purging/stabilization rate
- Once stabilization has been achieved do not disrupt the connection to the groundwater in the formation by shutting off the pump or changing the flow rate

- When collecting samples for analysis of VOCs, pump at a rate less than 250 mL/min, and avoid aerating groundwater in pump tubing or flow through cell
- Some chemical constituents may leach to tubing
    - Teflon® or Teflon®-lined tubing is preferred for samples that will be analyzed for VOCs, SVOCs, pesticides, and PCBs
    - HDPE or polypropylene tubing may be used for metals and other organics
    - Siliclastic (silicon) tubing should be less than 1 foot in length (when used with peristaltic pumps and when used with barrel filters)
- Shade equipment and tubing to avoid direct sunlight and warm ambient air temperatures

Field Forms

Field forms or field notes should record the following information, in addition to site and well information, to document water level and water quality parameter stabilization during low-flow pumping and sampling:

- Type, make, and model of pumping and water quality instruments
- Equipment calibration (include copies of calibration certificates as appropriate)
- Decontamination procedures
- Depth of pump or pump inlet
- Volumes of flow through cell, discharge tubing, and pump (bladder)
- Initial pumping rate and time intervals
- Drawdown, stabilized water level, and pumping rate at stabilization
- Field-measured water quality data at regular time intervals during purging
- Time and pumping rates for all measurements
- Rate of pumping at time of sample collection

Section 4.1 describes in detail the record keeping requirements to follow when groundwater sampling.

Instrument Error

Instruments suspected of producing erroneous readings should be recalibrated. If the values obtained continue to be outside normal ranges, troubleshoot or replace the instrument. If the instrument cannot be replaced and provides data critical to performing and documenting the purging procedure, notify the Project Manager. Do not discard the samples, if collected. Flag any out of range data recorded in field notes using an asterisk and a written description of the occurrence. Deviation from standard field procedure, use of alternate equipment, or re-sampling may be required to determine whether anomalous readings were the result of mechanical or human error and to ensure documentation of the collection of an epresentative sample.

3.3 Collecting Samples

Representative samples are collected when the monitoring well is purged according to the requirements of the standard procedure and when the sample is appropriately collected, preserved, handled, shipped, and analyzed. Groundwater samples must be collected in the appropriate order, field-filtered and field-preserved according to analytical methods, accompanied with quality assurance/quality control (QA/QC) samples, immediately preserved on ice, and shipped with the appropriate chain-of-custody documentation.

3.3.1 Sampling Order

Collect samples according to analyte stability, as summarized below, unless otherwise specified in a site-specific work plan or field sampling plan:

- Volatile organic compounds (VOCs)
- Semi-volatile organic compounds (SVOCs)
- Non-filtered, non-preserved samples (e.g. PCBs, pesticides, sulfate)
- Non-filtered, preserved samples (e.g. phenols, nitrogen, total metals, organic carbon)
- Available cyanide (follow lab provide cyanide kit direction for collection of sample)

- Filtered, non-preserved samples (e.g. chromium IV)
- Filtered, preserved samples (e.g. dissolved metals)
- Miscellaneous parameters

In addition, collect samples for sulfate analysis before collecting sulfuric-acid preserved samples (e.g. nitrogen), and collect samples for nitrogen compound analysis before nitric-preserve samples (e.g. dissolved metals).

3.3.2 Filling Sample Containers

Observe the procedures and cautions below when filling sample containers:

- Take precautions when handling acid preservatives or opening containers pre-filled with acid preservatives, according to the site-specific Health & Safety Plan (HASP).
- Remove sample container lids carefully. Do not touch the inside of the lid or the Teflon® lid septum, and do not place the lid on the ground.
- If containers, lids, or Teflon® septum come in contact with the ground or any other contaminated surface, carefully rinse the object with sample water; replace septum facing the sample.
- Fill sample containers with the appropriate preservative, volume, and headspace.
- Do not allow discharge tubing to come in contact with the inside of the sample container.
- Minimize sample contact with the atmosphere and collect samples away from possible sources of cross-contamination such as vehicle or equipment exhaust.
- Overfill containers used for VOC analysis (40 ml HCL-preserved glass vials) to eliminate air bubbles. Slowly fill the vial until surface tension (convex water surface) is maintained at the top of the vial. Replace the cap gently and invert the vial to check for air bubbles. Open the vial and add more water to the existing sample, if necessary, to eliminate air bubbles. Do not empty the bottle and refill.

3.3.3 Field Filtering

Use an in-line disposable 0.45 micron (µm) filter, or equivalent, to filter groundwater samples for which the analytical method requires field-filtering. When using a pump, connect the filter directly to the pump discharge tubing, and pump a small volume of sample volume through the filter before beginning to fill the sample container. Collect a field/equipment blank whenever collecting field-filtered samples.

Follow these procedures when field-filtering groundwater samples:

- Filter samples immediately in the field; if field conditions prevent field-filtering, filter samples as soon as possible or instruct the analytical laboratory to filter samples upon receipt
- Use disposable filters (i.e. Geotech® barrel filters) to eliminate cross-contamination
- Do not re-use disposable filters
- Do not re-use temporary containers/pre-filtration containers.
- Note the size and material (i.e. 500 mL polyethylene carboy) of pre-filtration containers

3.3.4 Sample Preservatives and Hold Times

Samples are to be field-preserved, if necessary, immediately after filtering or immediately after sample collection if not filtered. Pre-measured volumes of preservatives should be added to the sample bottle prior to sampling. In most cases, laboratory-supplied containers are provided with pre-measured preservatives already placed in the containers. Arrange for timely shipment of samples with short hold times.

3.3.5 QA/QC Samples

SOP 07-04-07 (Quality Control Samples) describes the intended use and collection methods for quality control samples that should be used to evaluate field and laboratory quality control procedures and the precision, accuracy, representativeness, and comparability of data obtained from groundwater samples. Deviation from the Quality Control SOP should be clearly identified in site-specific Workplan, Field Sampling Plan (FSP), or Quality Assurance Project Plan (QAPP).

The following QA/QC samples should be considered and collected, as necessary:

QA/QC Sample Type	Application
Field Duplicate	Compares differences in analytical results for identical (duplicate) samples
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	Evaluates effect of sample matrix on analytical results
Trip Blank	Identifies contribution/introduction of contaminants during shipment/transport
Temperature Blank	Verifies proper sample transport temperature
Equipment Blank	Determines effectiveness of in-field decontamination procedures (also known as Rinseate Blank)
Field Blank	Identifies possible environmental cross-contamination

4.1 Record Keeping/Field Forms

Field-records of all purging and sampling procedures are kept either in NRT notebooks or on site-specific field forms. Electronic copies of field notes and should be made and saved to the project directory on NRT's electronic server (typically these notes are stored in the same folder as the laboratory analytical results). Sample control logs and sample identification numbers are to be completed and assigned according to SOP 07-03-01 (Sample Labeling and Storage) and SOP 07-03-05 (Sample Location, Identification, and Control).

4.1.1 Field Notebook

At a minimum, the following information should be recorded in a field notebook, on groundwater sampling forms, or on a site/project-specific groundwater sampling forms:

- Weather conditions
- Well condition
- Size, diameter, and well casing material
- Water level, relative to top of well casing
- Depth to bottom, or historical depth to bottom, relative to top of well casing
- Thickness and/or presence of any NAPLs

- Calculation of well volumes
- Time when purging begins
- Purge method (e.g. bailed, pumped)
- Initial color, odor, and clarity of purge water
- Initial water quality parameter data (e.g. pH, temperature, conductivity, ORP, turbidity)
- Time intervals, water levels, water quality parameters, pumping rate, and cumulative purge volumes (if low-flow sampling)
- Sample collection time
- Water quality parameters at the time of sample collection
- Number and type of sample containers
- Method and type of field-filtration and/or field-preservation
- Sample identification number and lab identification/chain of custody number
- Name and manufacturer of any equipment used
- Calibration results
- Description of decontamination procedures
- Total purge volume
- Location where purge water is disposed (e.g. discharge to ground or contained in drum)
- If drums are used, note the location and number of drums stored on site

4.1.2 Chain of Custody

The parameters to be analyzed are to be listed for each sample on the Chain-of-Custody (COC) as is described in SOP 07-03-03 (Chain of Custody). The COC should also clearly identify the specific USEPA-approved method of analysis to be performed on each sample, provide the specific list of analytes to be reported (e.g., list specific metals or aroclors to be reported), and provide any special instructions. For example, samples that require laboratory filtering, samples that contain known interferences with the analytical method, samples expected to contain unusually elevated concentrations of compounds, and samples with short hold times, should be clearly identified.

4.1.3 Packing and Shipping

Samples are to be placed on ice immediately after sample collection, and packed and shipped according to SOP 07-03-09 (Shipping). Samples are always shipped to the laboratory or any other facility under COC-procedure and using custody seals. When using a courier, obtain driver signatures on the COC. Ship groundwater samples in compliance with all applicable requirements for shipping hazardous and/or dangerous materials.

References

ASTM International, D4448-01 Standard Guide for Sampling Groundwater Monitoring Wells

ASTM International, D5903-96(2001) Standard Guide for Planning and Preparing for a Groundwater Sampling Event

ASTM International, D6089-97(2003)e1 Standard Guide for Documenting a Ground-Water Sampling Event

ASTM International, D6301-03 Practice for the Collection of Samples of Filterable and Nonfilterable Matter in Water

ASTM International, D6452-99(2005) Standard Guide for Purging Methods for Wells Used for Ground-Water Quality Investigations

ASTM International, D6564-00(2005) Standard Guide for Field Filtration of Ground-Water Samples

ASTM International, D6634-01 Guide for the Selection of Purging and Sampling Devices for Ground-Water Monitoring Wells

ASTM International, D6771-02 Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia, www.epa.gov/region4/sesd/eisopqam/eisopqam.html.

USEPA, 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Manager, Region 5 and Region 10, EPA 542-S-02-001.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

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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
Number:	07-07-01
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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

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

Downhole Condition

	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

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

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.

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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:

- Super Tracker Table – Project-specific table of field and laboratory data compiled by the data group for tracking and importing data.
- Project–specific sampling documents – Documents compiled by the project team used to complete specific tasks. These may include but are not limited to the site-specific work plan, quality assurance project plan (QAPP), construction quality assurance project plan (CQAPP), and sampling summary.

- Import Summary – Report generated by the data group and includes a summary of the laboratory data sample designation groups that were brought into the NRT Enviro Data database.

- Quality Control – Set of procedures to ensure the quality of a service or product. It is a means of checking that samples were collected, analyzed and reported correctly.

- Quality Assurance - Maintenance of a desired level of quality in a service or product, especially by means of attention to every stage of the process of delivery or production.

- Level 2 Data Verification – Review of analytical data that includes holding times, analytical methods, surrogate recoveries, laboratory control sample recoveries, matrix spike and matrix spike duplicate recoveries and relative percent differences, method blank concentrations and reporting limits.

- Level 4 Data Validation – Comprehensive review of analytical data. This includes all of the Level 2 review items and recalculation of results, review of laboratory raw data, reconstructed ion chromatograms, initial and continuing calibration recoveries, initial and continuing blank concentrations, and other method-specific quality control data.

1.4 Roles and Responsibilities

Numerous individuals have roles and responsibilities in the collection and management of field, analytical and geotechnical data. No roles are more or less important than others and each contribute to the accurate and seamless approach to data management. Quality control is an especially important aspect of the data flow process and each staff member is responsible for some form of quality control. Staff and their responsibilities are described below.

1.4.1 Project Manager (PM)

PMs (or their designee) have responsibilities during all phases of data management which include the following:

- Generate a sampling summary form with a sampling summary matrix and server pathway for the project-specific sampling documents prior to the sampling event.

- Provide sample summary and anticipated level of QC necessary to Data Team.

- Review updated Super Tracker table (Attachment B) for conformance with the project-specific sampling documents:

    - Within 10 days of the completion of sample collection

  - Again when all analytical data is in-house
  - Bi-weekly for long-duration projects
- Coordinate third-party level 4 validation, if required, with the Data team and validation firm.
- Save level 4 validation files to project folder and review validation report. Data Team can assist with review.
- Review import summary report from the data team.
- Generate and send requests for data deliverables and mapping to the appropriate support team during any phase of the project.
- Review and finalize tables and figures.
- Define data quality objectives during kick-off meeting to explain roles/responsibilities, data schedules and sampling requirements.
- Return the GPS unit to the Mapping Team for post-processing (if required) of the sample coordinates information.
- If NRT did not collect any location information, submit a request to the company/individual who did the GPS data collection or survey and transmit it to the Mapping Team immediately upon receipt.

1.4.2 Field Staff

The field staff members for a given sampling event have the following responsibilities:

- Achieve a thorough and complete understanding of sampling and data requirements for the given project prior to mobilizing.
- Collect samples according to the sample summary provided by the PM, project-specific sampling documents, and the appropriate NRT standard field operating procedures. (NRT field operating procedures for sample collection and documentation are located at: W:\Operations\Standard Practices\Standard Operating Procedures\07 Field Procedures.)
- Complete field forms, chain of custody (COC), and sample control logs.
  - As a quality control (QC) check, the COC will be back-checked and initialed in the field by field staff who did not complete the COC, typically a team lead or other staff identified by PM in sampling event kick-off meeting.
- Send samples and completed COC to the laboratory according to NRT field SOPs.

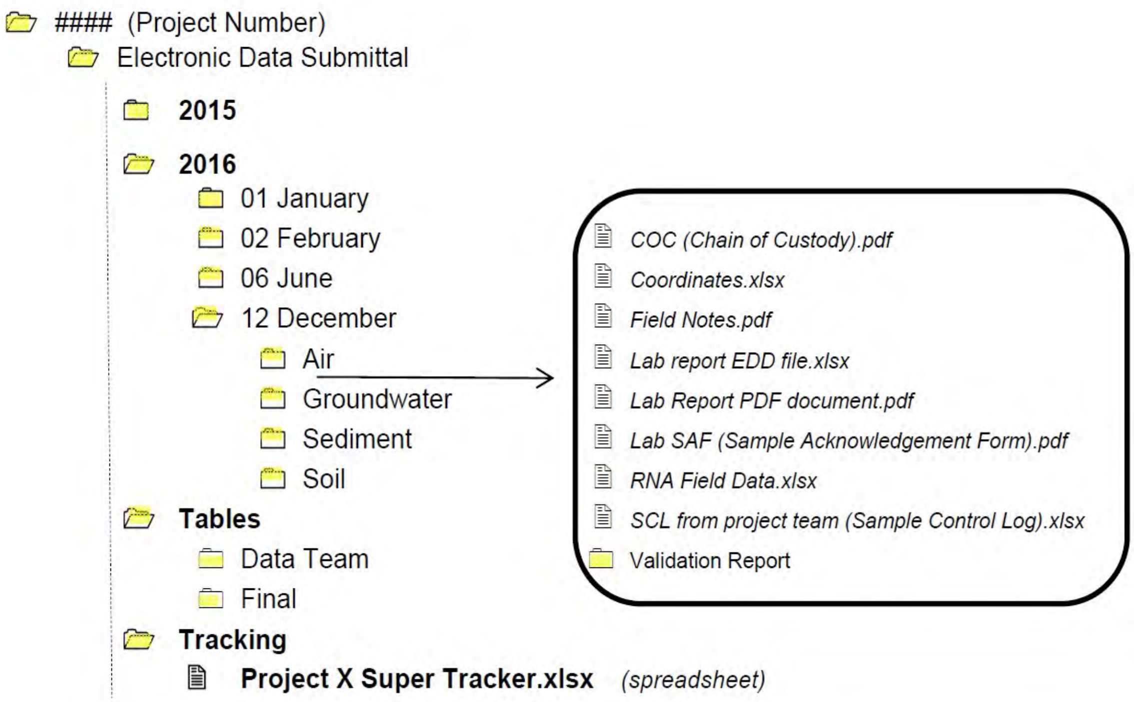
- Provide the PM with a copy of the field documentation when samples are being submitted for analysis or as soon as is possible (within 10 days of sample submission).

- Complete field documentation of the PDF formats (i.e. field forms, field notes, copy of COC) and of the electronic version of the sample control log (SCL).
    - Provide server locations (links) of completed documents to PM and Data Team:
        - Within 10 days of the end of the field sampling event
        - Bi-weekly for long-duration projects

1.4.3 Data Team

The data team members have the following responsibilities:

- Create folders on the server according to the following structure:



- 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:

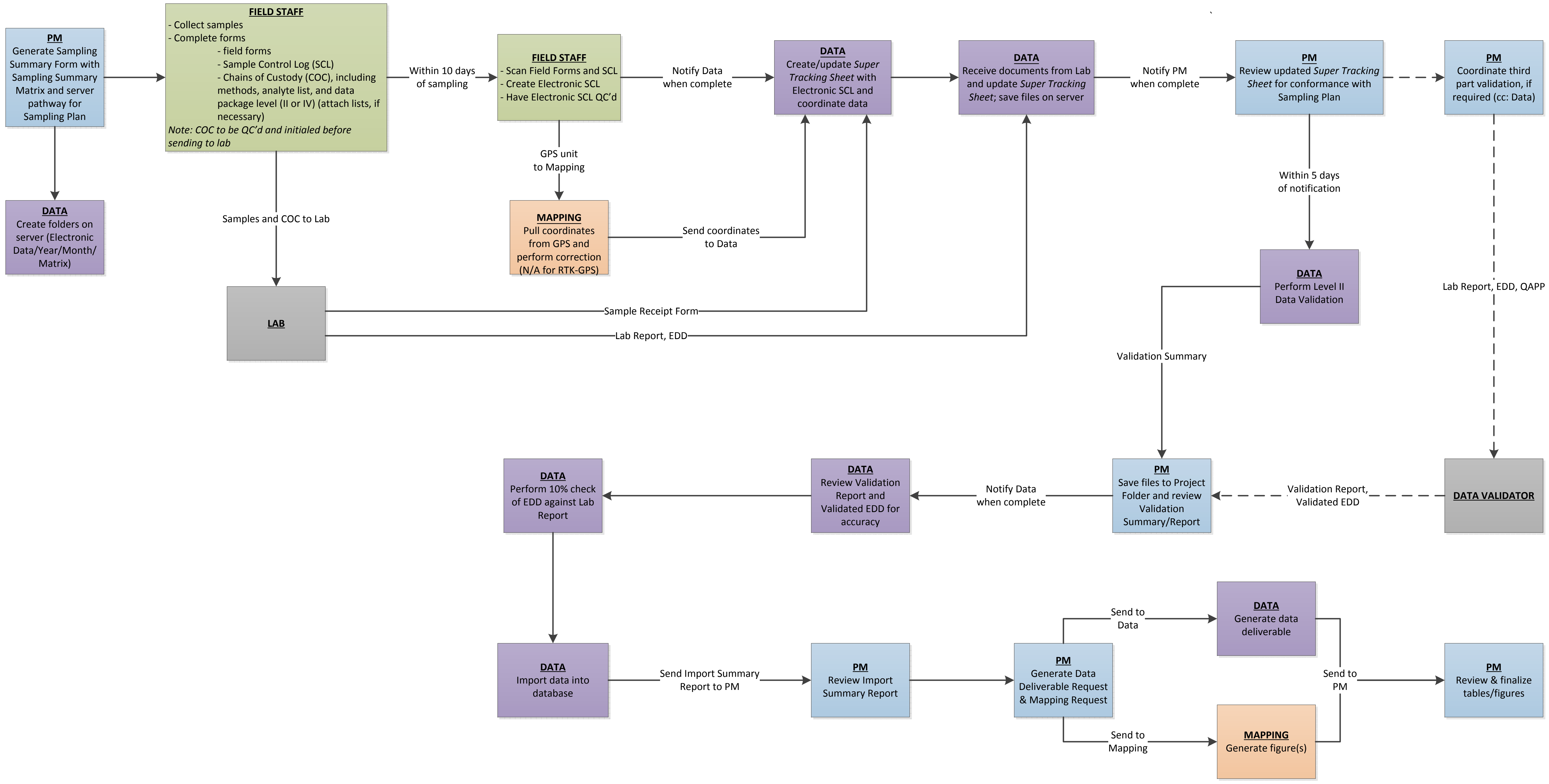
- Is not the responsibility of any one person or group
- Is required of all staff members in some form
- Begins at the planning stages of the project and continues until a final report is issued

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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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:

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

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

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Name:	Sample Volumes, Containers, Preservation, and Holding Times
Section:	Site Investigation
Number:	07-04-03
Revision:	2
Effective Date:	01/01/2013
Page:	1 of 3

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/

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Name: Packing and Shipment of Environmental Samples and Equipment
Section: Field Procedures
Number: 07- 03-09
Revision: 0
Effective Date: 01/01/2014
Page: 1 of 10

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

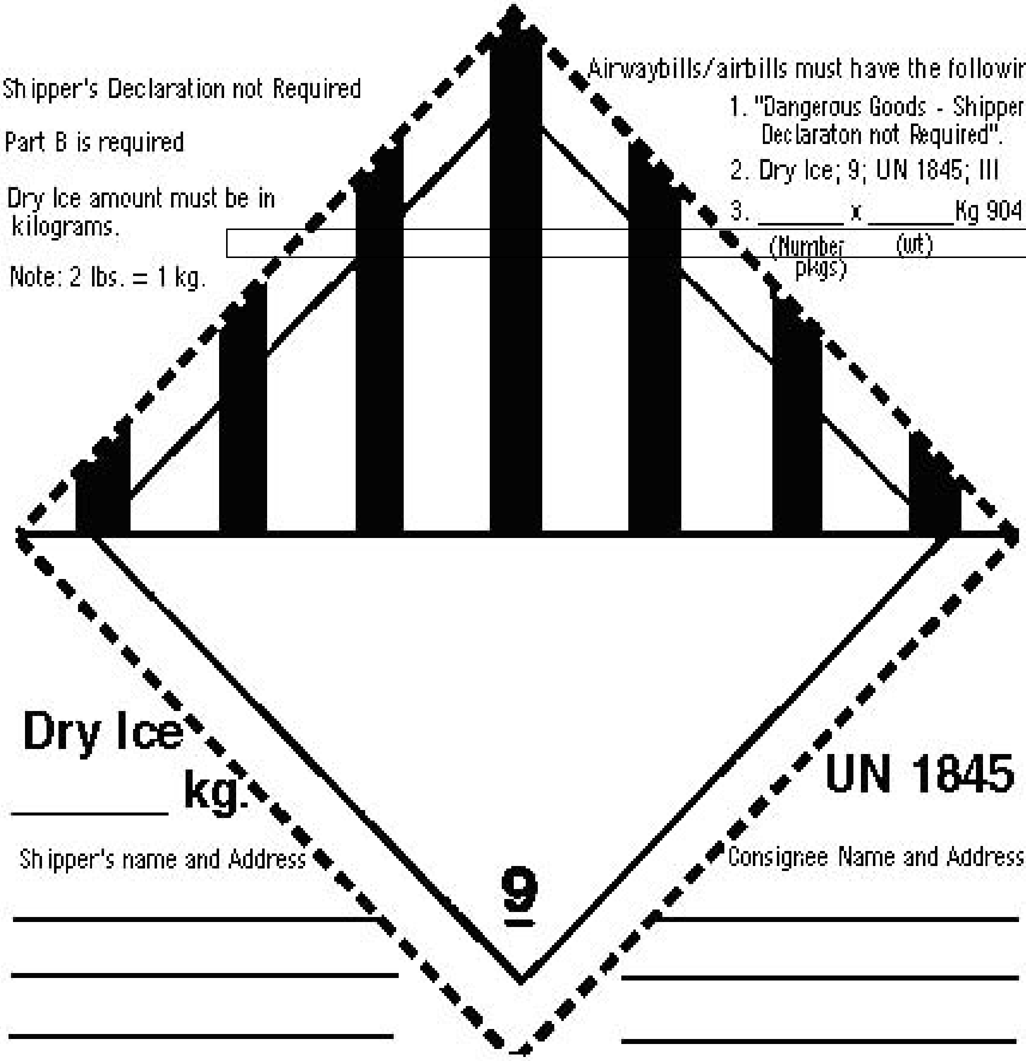
Part B is required

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

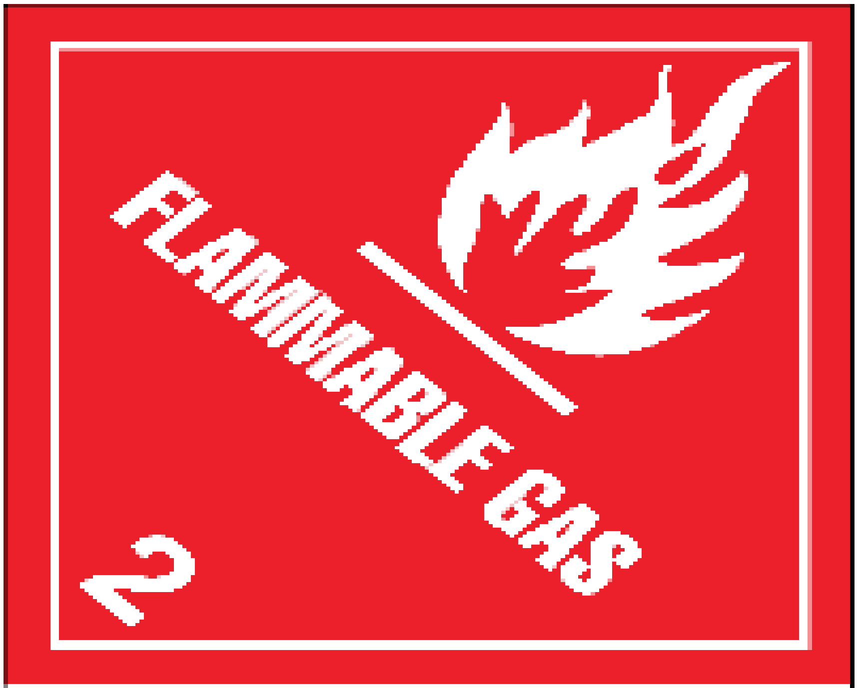
LITHIUM ________________ BATTERY

DO NOT LOAD OR TRANSPORT
PACKAGE IF DAMAGED

For more information, call ______________________________

ATTACHMENT D

COMPRESSED GAS LABEL



COMPRESSED GAS N.O.S.
UN 1954

APPENDIX D
BASELINE GROUNDWATER MONITORING DATA AND PAL CALCULATIONS

D-1

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

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

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
LS-100	2/18/2016	40128408001		0.000500	0.0480	0.028400	0.000270	13.900
	4/5/2016	40130257002		<0.000730	0.0120	0.028800	<0.000042	27.300
	6/15/2016	40133877003		0.000370	0.0350	0.032800	0.000150	22.500
	8/10/2016	40136543003		0.000520	0.0410	0.042600	0.000190	28.200
	10/5/2016	40139741002		0.000650	0.1000	0.109000	<0.000130	56.800
	12/21/2016	40143755003		0.000760	0.0980	0.128000	<0.000130	75.200
	3/10/2017	40146662002		0.000260	0.0290	0.022000	<0.000130	17.900
	6/2/2017	40151013002	23.200	0.000520	0.1100	0.025000	<0.001200	13.100
	10/11/2017	40158568002			0.0559			11.000
	4/26/2018	40168127002			0.0292			6.550
	10/25/2018	AE31422			0.0250			11.000
	4/24/2019	AE36960			0.0180			8.300
	10/24/2019	AE41530			0.0230			9.600
		AE41537	18.000					
	4/14/2020	AE45278			0.0140			11.000
	10/14/2020	AE49163	17.000		0.0373			10.200
LS-101	2/18/2016	40128408002		<0.000110	0.0086	0.018500	<0.000045	5.200
	4/5/2016	40130257003		<0.000730	0.0096	0.020700	<0.000042	3.400
	6/15/2016	40133877002		0.000180	0.0097	0.023900	<0.000130	4.700
	8/10/2016	40136543002		0.000270	0.0140	0.052500	<0.000130	11.600
	10/5/2016	40139741003		<0.000099	0.0120	0.032700	<0.000130	6.800
	12/21/2016	40143755002		0.000200	0.0120	0.027300	<0.000130	6.900
	3/10/2017	40146662003		0.000230	0.0092	0.018800	<0.000130	3.300
	6/2/2017	40151013003	10.200	<0.000280	0.0430	0.015400	<0.001200	2.500
	10/11/2017	40158568003			0.0138			11.400

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

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
LS-101	4/26/2018	40168127003			<0.0067			4.180
	10/25/2018	AE31423			0.0140			3.000
	4/24/2019	AE36961			0.0081			4.200
	10/24/2019	AE41531			0.0120			3.100
		AE41538	15.000					
	4/14/2020	AE45279			0.0080			2.400
	10/14/2020	AE49164	31.000		<0.0173			7.780
LS-105	2/18/2016	40128408003		0.001900	0.0140	0.036800	0.000150	17.300
	4/5/2016	40130257004		0.001000	0.0140	0.023900	0.000065	14.200
	6/15/2016	40133877004		0.001300	0.0130	0.025700	<0.000130	14.300
	8/10/2016	40136543004		0.002300	0.0200	0.035800	<0.000130	20.100
	10/5/2016	40139741004		0.002400	0.0300	0.056200	<0.000130	31.400
	12/21/2016	40143755005		0.002000	0.0300	0.055400	<0.000130	34.000
	3/10/2017	40146662004		0.001600	0.0260	0.049500	<0.000130	32.300
	6/2/2017	40151013004	33.800	0.001600	0.0330	0.027000	<0.001200	14.200
	10/11/2017	40158568004			0.0452			18.800
	4/26/2018	40168127004			0.0161			18.700
	10/25/2018	AE31424			0.0300			20.000
	4/24/2019	AE36962			0.0180			2.100
	10/24/2019	AE41532			0.0260			18.000
		AE41539	67.000					
	4/14/2020	AE45280			0.0170			17.000
	10/14/2020	AE49165	56.000		0.0399			17.500
LS-106	2/18/2016	40128408004		0.001500	0.0150	0.061200	0.000310	9.200
	4/5/2016	40130257005		0.002600	0.0890	0.084800	0.000740	7.700
	6/15/2016	40133877005		0.002000	0.0540	0.055400	0.000320	7.600

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

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
LS-106	8/10/2016	40136543005		0.001600	0.0630	0.054800	0.000170	10.100
	10/5/2016	40139741005		0.006400	0.3600	0.198000	0.002100	10.700
	12/21/2016	40143755006		0.002200	0.1200	0.090000	0.000740	12.300
	3/10/2017	40146662005		0.005900	0.4500	0.179000	0.002400	9.900
	6/2/2017	40151013005	31.600	0.003000	0.0910	0.063500	<0.001200	9.400
	10/11/2017	40158568005			0.1060			15.500
	4/26/2018	40168127005			0.0544			6.160
	10/25/2018	AE31425			0.0540			6.000
	4/24/2019	AE36963			0.0250			6.600
	10/24/2019	AE41533			0.2600			22.000
		AE41540	35.000					
	3/2/2020	AE44199			0.0790			14.000
	4/14/2020	AE45281			0.0690			4.800
	10/14/2020	AE49166	61.000		0.1850			15.300
LS-107	2/18/2016	40128408005		0.000200	0.0100	0.049100	<0.000045	17.000
	4/5/2016	40130257006		<0.000730	0.0097	0.036900	<0.000042	18.200
	6/15/2016	40133877001		0.000160	0.0089	0.041600	<0.000130	19.100
	8/10/2016	40136543001		0.000120	0.0120	0.045700	0.000190	21.000
	10/5/2016	40139741006		<0.000099	0.0120	0.046900	<0.000130	22.000
	12/20/2016	40143755001		0.000250	0.0140	0.054100	0.000390	25.900
	3/10/2017	40146662006		<0.000099	0.0110	0.051000	<0.000130	25.700
	6/2/2017	40151013006	60.000	<0.000280	0.0310	0.045800	<0.001200	21.900
	10/11/2017	40158568006			0.0143			26.000
	4/26/2018	40168127006			0.0097			20.100
	10/25/2018	AE31426			0.0170			21.000
	4/24/2019	AE36964			0.0091			18.000

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

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
LS-107	10/24/2019	AE41534			0.0180			19.000
		AE41541	49.000					
	4/14/2020	AE45282			0.0140			18.000
	10/14/2020	AE49167	52.000		0.0213			27.400
	3/1/2021	AE51793						28.200

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

Well Id	Date Sampled	Lab Id	Cd,tot, mg/L	Cl, tot, mg/L	Co, tot, mg/L	Copper, tot, ug/L	Cr, tot, mg/L	F, tot, mg/L
LS-100	2/18/2016	40128408001	<0.000027	4.000	0.001300		0.00520	<0.200
	4/5/2016	40130257002	<0.000025	4.300	0.000160		0.00056	<0.200
	6/15/2016	40133877003	<0.000089	3.600	0.000700		0.00290	<0.200
	8/10/2016	40136543003	<0.000089	4.900	0.000540		0.00270	<0.200
	10/5/2016	40139741002	<0.000089	0.970	0.001000		0.00100	<0.100
	12/21/2016	40143755003	0.000094	21.000	0.000300		0.00160	<0.100
	3/10/2017	40146662002	0.000090	3.600	0.000250		0.00130	<0.100
	6/2/2017	40151013002	<0.001300	1.600	<0.001400		<0.00250	<0.100
	10/11/2017	40158568002		0.860				<0.100
	4/26/2018	40168127002		0.720				<0.100
	10/25/2018	AE31422		0.290				0.066
	4/24/2019	AE36960		0.530				0.040
	10/24/2019	AE41530		0.510				<0.070
	4/14/2020	AE45278		0.540				0.013
	9/1/2020	AE48236						0.015
	10/14/2020	AE49163		0.610				0.030
LS-101	2/18/2016	40128408002	<0.000027	2.900	0.000079		0.00025	<0.200
	4/5/2016	40130257003	<0.000025	2.300	0.000150		0.00068	<0.200
	6/15/2016	40133877002	<0.000089	2.600	0.000081		<0.00039	<0.200
	8/10/2016	40136543002	<0.000089	2.400	0.000087		0.00044	<0.200
	10/5/2016	40139741003	<0.000089	2.000	0.000061		<0.00039	<0.100
	12/21/2016	40143755002	<0.000089	0.820	0.000110		0.00042	<0.100
	3/10/2017	40146662003	<0.000089	<0.500	0.000170		0.00110	<0.100
	6/2/2017	40151013003	<0.001300	0.720	<0.001400		<0.00250	<0.100
	10/11/2017	40158568003		0.760				<0.100

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

			Cd,tot, mg/L	**Cl, tot, mg/L**	**Co, tot, mg/L**	**Copper, tot, ug/L**	**Cr, tot, mg/L**	**F, tot, mg/L**
LS-101	10/11/2017							
	4/26/2018	40168127003		0.540				<0.100
	10/25/2018	AE31423		0.400				0.061
	4/24/2019	AE36961		0.620				<0.040
	10/24/2019	AE41531		0.280				<0.070
	4/14/2020	AE45279		0.170				0.022
	9/1/2020	AE48237						0.009
	10/14/2020	AE49164		0.400				0.030
LS-105	2/18/2016	40128408003	<0.000027	4.200	0.012400		0.00190	<0.200
	4/5/2016	40130257004	<0.000025	3.500	0.009400		0.00049	<0.200
	6/15/2016	40133877004	<0.000089	3.500	0.010200		0.00048	<0.200
	8/10/2016	40136543004	<0.000089	2.900	0.013600		0.00100	<0.200
	10/5/2016	40139741004	<0.000089	12.400	0.015700		0.00051	<1.000
	12/21/2016	40143755005	<0.000089	10.600	0.018500		0.00067	<0.500
	3/10/2017	40146662004	<0.000089	7.200	0.018300		0.00084	<0.100
	6/2/2017	40151013004	<0.001300	2.600	0.007600		<0.00250	<0.100
	10/11/2017	40158568004		3.600				<0.500
	4/26/2018	40168127004		2.600				<0.500
	10/25/2018	AE31424		0.740				0.085
	4/24/2019	AE36962		1.200				0.057
	10/24/2019	AE41532		0.540				0.073
	4/14/2020	AE45280		0.820				0.039
	9/1/2020	AE48238						0.055
	10/14/2020	AE49165		0.600				0.065
	3/1/2021	AE51791						0.051
LS-106	2/18/2016	40128408004	<0.000027	4.200	0.005600		0.00660	<0.200

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

			Cd,tot, mg/L	Cl, tot, mg/L	Co, tot, mg/L	Copper, tot, ug/L	Cr, tot, mg/L	F, tot, mg/L
LS-106	4/5/2016	40130257005	0.000049	3.200	0.009400		0.02340	<0.200
	6/15/2016	40133877005	<0.000089	3.200	0.008500		0.00920	<0.200
	8/10/2016	40136543005	<0.000089	<10.000	0.006000		0.00630	<1.000
	10/5/2016	40139741005	<0.000180	2.800	0.016400		0.05810	<0.500
	12/21/2016	40143755006	<0.000089	<2.500	0.009300		0.01850	<0.500
	3/10/2017	40146662005	<0.000440	<2.500	0.018400		0.06320	<0.500
	6/2/2017	40151013005	<0.001300	4.100	0.007200		0.01090	<0.500
	10/11/2017	40158568005		3.600				<0.500
	4/26/2018	40168127005		<2.500				<0.500
	10/25/2018	AE31425		0.470				0.066
	4/24/2019	AE36963		8.400				0.053
	9/13/2019	AE40532		11.000				
	10/24/2019	AE41533		8.400				<0.070
	4/14/2020	AE45281		1.300				0.049
	9/1/2020	AE48239						0.035
	10/14/2020	AE49166		1.300				0.120
	3/1/2021	AE51792						0.057
LS-107	2/18/2016	40128408005	<0.000027	9.400	0.000540		0.00050	<0.200
	4/5/2016	40130257006	<0.000025	7.400	0.000140		0.00022	<0.200
	6/15/2016	40133877001	<0.000089	7.900	0.000200		<0.00039	<0.200
	8/10/2016	40136543001	<0.000089	6.900	0.000140		0.00054	<0.200
	10/5/2016	40139741006	<0.000089	5.400	0.000092		<0.00039	<0.100
	12/20/2016	40143755001	0.000270	4.700	0.000500		0.00054	<0.100
	3/10/2017	40146662006	<0.000089	3.800	0.000240		0.00100	<0.100
	6/2/2017	40151013006	<0.001300	5.400	<0.001400		<0.00250	<0.100
	10/11/2017	40158568006		6.200				<0.100

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

			Cd,tot, mg/L	Cl, tot, mg/L	Co, tot, mg/L	Copper, tot, ug/L	Cr, tot, mg/L	F, tot, mg/L
LS-107	10/11/2017							
	4/26/2018	40168127006		3.000				<0.100
	10/25/2018	AE31426		2.700				0.065
	4/24/2019	AE36964		1.800				0.040
	10/24/2019	AE41534		1.800				<0.070
	4/14/2020	AE45282		2.100				0.029
	9/1/2020	AE48240						0.013
	10/14/2020	AE49167		9.200				0.029
	3/1/2021	AE51793		6.500				

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

Well Id	Date Sampled	Lab Id	GW Elv, ft	Li, tot, mg/L	Mo, tot, mg/L	Pb, tot, mg/L	pH (field), STD	pH (lab), STD
LS-100	2/18/2016	40128408001		0.00190	0.000310	0.000780		6.0
	2/19/2016	LS-100	1189.69					
	4/5/2016	40130257002		0.00044	0.000360	0.000130	6.5	
	4/11/2016	LS-100	1191.34					
	6/15/2016	40133877003		0.00100	0.000330	0.000230	6.5	5.9
		LS-100	1191.12					
	8/3/2016	LS-100	1189.73					
	8/10/2016	40136543003		0.00099	0.000250	0.000130	6.6	5.8
	10/5/2016	40139741002		0.00051	0.000085	0.000044	6.6	6.0
		LS-100	1191.00					
	12/20/2016	LS-100	1190.28					
	12/21/2016	40143755003		0.00066	0.000180	0.000160	7.1	5.6
	3/10/2017	40146662002		0.00045	0.000870	0.000180	8.4	
		LS-100	1191.97					
	6/2/2017	40151013002		0.00120	<0.001400	0.000440	8.0	6.2
		LS-100	1192.04					
	10/11/2017	40158568002					6.3	
	4/26/2018	40168127002	1193.74				7.0	
	10/25/2018	AE31422					6.3	
	4/24/2019	AE36960	1194.17				5.9	
	10/24/2019	AE41530	1192.26				5.5	
	4/14/2020	AE45278	1192.20				5.9	
	9/1/2020	AE48236	1189.15				5.9	
	10/14/2020	AE49163	1189.29				5.8	
LS-101	2/18/2016	40128408002		0.00031	0.000085	0.000100		5.7
	2/19/2016	LS-101	1193.12					

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

			GW Elv, ft	Li, tot, mg/L	Mo, tot, mg/L	Pb, tot, mg/L	pH (field), STD	pH (lab), STD
LS-101	2/19/2016							
	4/5/2016	40130257003		0.00040	0.000410	0.000170	6.2	
	4/11/2016	LS-101	1195.77					
	6/15/2016	40133877002		0.00020	<0.000070	0.000068	6.3	5.5
		LS-101	1195.02					
	8/3/2016	LS-101	1192.76					
	8/10/2016	40136543002		0.00054	0.000240	0.000044	6.4	5.5
	10/5/2016	40139741003		0.00029	0.000083	<0.000040	6.8	5.8
		LS-101	1194.20					
	12/20/2016	LS-101	1193.31					
	12/21/2016	40143755002		0.00043	0.000130	0.000057	7.0	5.5
	3/10/2017	40146662003		0.00024	0.000150	0.000140	7.5	
		LS-101	1196.40					
	6/2/2017	40151013003		0.00025	<0.001400	<0.000200	7.8	6.1
		LS-101	1195.26					
	10/11/2017	40158568003					5.8	
	4/26/2018	40168127003	1196.72				6.5	
	10/25/2018	AE31423					6.1	
	4/24/2019	AE36961	1198.36				5.7	
	10/24/2019	AE41531	1195.73				5.3	
	4/14/2020	AE45279	1196.01				6.0	
	9/1/2020	AE48237	1190.93				5.9	
	10/14/2020	AE49164	1187.51				5.8	
LS-105	2/18/2016	40128408003		0.00200	0.000200	0.001100		5.9
	2/19/2016	LS-105	1186.03					
	4/5/2016	40130257004		0.00054	0.000160	0.000120	6.5	
	4/11/2016	LS-105	1187.04					
	6/15/2016	40133877004		0.00043	0.000170	0.000068	6.5	5.9

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

			GW Elv, ft	Li, tot, mg/L	Mo, tot, mg/L	Pb, tot, mg/L	pH (field), STD	pH (lab), STD
LS-105	6/15/2016	LS-105	1186.75					
	8/3/2016	LS-105	1185.97					
	8/10/2016	40136543004		0.00047	0.000240	0.000140	6.7	6.0
	10/5/2016	40139741004		0.00045	0.000340	<0.000040	7.1	6.1
		LS-105	1187.78					
	12/20/2016	LS-105	1186.05					
	12/21/2016	40143755005		0.00040	0.000220	0.000089	7.5	6.0
	3/10/2017	40146662004		0.00054	0.000260	0.000250	7.8	
		LS-105	1186.93					
	6/2/2017	40151013004		0.00032	<0.001400	<0.000200	7.9	6.2
		LS-105	1187.63					
	10/11/2017	40158568004					7.2	
	4/26/2018	40168127004	1187.68				7.4	
	10/25/2018	AE31424					6.5	
	4/24/2019	AE36962	1187.78				5.9	
	10/24/2019	AE41532	1187.67				5.5	
	4/14/2020	AE45280	1187.68				6.1	
	9/1/2020	AE48238	1185.08				6.1	
	10/14/2020	AE49165	1185.23				5.7	
	3/1/2021	AE51791	1184.42				6.3	
LS-106	2/18/2016	40128408004		0.00890	0.000280	0.002100		5.8
	2/19/2016	LS-106	1181.04					
	4/5/2016	40130257005		0.01270	0.000420	0.003500	6.7	
	4/11/2016	LS-106	1182.47					
	6/15/2016	40133877005		0.00440	0.000210	0.001200	6.5	5.7
		LS-106	1182.50					
	8/3/2016	LS-106	1182.53					

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

			GW Elv, ft	Li, tot, mg/L	Mo, tot, mg/L	Pb, tot, mg/L	pH (field), STD	pH (lab), STD
LS-106	8/10/2016	40136543005		0.00250	0.000094	0.000530	6.6	5.8
	10/5/2016	40139741005		0.02170	0.000590	0.005400	7.0	6.1
		LS-106	1182.45					
	12/20/2016	LS-106	1182.14					
	12/21/2016	40143755006		0.00630	0.000170	0.001600	7.5	5.9
	3/10/2017	40146662005		0.02300	0.000420	0.005400	8.1	
		LS-106	1182.69					
	6/2/2017	40151013005		0.00380	<0.001400	0.001200	8.0	6.1
		LS-106	1182.68					
	10/11/2017	40158568005					6.6	
	4/26/2018	40168127005	1182.58				7.5	
	10/25/2018	AE31425					6.4	
	4/24/2019	AE36963	1182.16				6.1	
	9/13/2019	AE40532					6.0	
	10/24/2019	AE41533	1181.34				5.6	
	3/2/2020	AE44199	1181.06				6.4	
	4/14/2020	AE45281	1181.36				6.4	
	9/1/2020	AE48239	1181.16				6.2	
	10/14/2020	AE49166	1181.22				5.9	
	3/1/2021	AE51792	1180.90				6.5	
LS-107	2/18/2016	40128408005		0.00100	0.000220	0.000310		5.9
	2/19/2016	LS-107	1189.33					
	4/5/2016	40130257006		0.00062	0.000250	0.000055	6.2	
	4/11/2016	LS-107	1189.17					
	6/15/2016	40133877001		0.00063	0.000540	0.000110	6.5	5.9
		LS-107	1188.98					
	8/3/2016	LS-107	1188.48					

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

			GW Elv, ft	Li, tot, mg/L	Mo, tot, mg/L	Pb, tot, mg/L	pH (field), STD	pH (lab), STD
LS-107	8/10/2016	40136543001		0.00080	0.000590	0.000048	6.7	5.9
	10/5/2016	40139741006		0.00052	0.000410	<0.000040	6.8	6.1
		LS-107	1188.49					
	12/20/2016	40143755001		0.00100	0.000480	0.000350	7.2	5.6
		LS-107	1188.25					
	3/10/2017	40146662006		0.00071	0.000210	0.000100	7.4	
		LS-107	1188.94					
	6/2/2017	40151013006		0.00054	<0.001400	<0.000200	7.6	6.0
		LS-107	1188.86					
	10/11/2017	40158568006					6.1	
	4/26/2018	40168127006	1189.17				6.9	
	10/25/2018	AE31426					6.0	
	4/24/2019	AE36964	1189.37				5.7	
	10/24/2019	AE41534	1189.19				5.5	
	4/14/2020	AE45282	1189.27				5.8	
	9/1/2020	AE48240	1188.02				5.8	
	10/14/2020	AE49167	1188.05				5.6	
	3/1/2021	AE51793	1187.96				5.9	

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

Well Id	Date Sampled	Lab Id	Ra 226+228, pCi/L	Sb, tot, mg/L	Se, tot, mg/L	Silver, tot, ug/L	SO4, tot, mg/L	Spec. Cond. (field), micromhos/cm
LS-100	2/18/2016	40128408001	1.0030	<0.000066	0.00033		12.500	
	4/5/2016	40130257002	1.3900	<0.000034	0.00031		16.600	210.000
	6/15/2016	40133877003	0.7240	<0.000073	0.00045		13.100	193.000
	8/10/2016	40136543003	0.3600	<0.000073	0.00037		20.700	216.000
	10/5/2016	40139741002	1.1190	<0.000073	0.00071		4.500	480.000
	12/21/2016	40143755003	0.6950	0.000240	0.00140		202.000	550.000
	3/10/2017	40146662002	0.3260	0.000200	0.00044		30.000	160.000
	6/2/2017	40151013002	0.9960	<0.000150	0.00077		31.500	140.000
	10/11/2017	40158568002					15.700	
	4/26/2018	40168127002					13.100	0.060
	10/25/2018	AE31422					17.000	90.000
	4/24/2019	AE36960					13.000	67.000
	10/24/2019	AE41530					18.000	81.000
	4/14/2020	AE45278					14.000	89.000
	9/1/2020	AE48236						76.000
	10/14/2020	AE49163					20.000	84.000
LS-101	2/18/2016	40128408002	1.5280	<0.000066	0.00025		5.600	
	4/5/2016	40130257003	0.3310	<0.000034	0.00024		5.600	40.000
	6/15/2016	40133877002	1.5770	<0.000073	0.00034		4.800	55.000
	8/10/2016	40136543002	0.5270	<0.000073	<0.00021		4.100	102.000
	10/5/2016	40139741003	1.1990	<0.000073	<0.00021		13.300	70.000
	12/21/2016	40143755002	0.2260	0.000370	0.00025		4.300	70.000
	3/10/2017	40146662003	0.1930	<0.000073	0.00042		4.400	40.000
	6/2/2017	40151013003	0.3750	<0.000150	0.00044		4.100	35.000
	10/11/2017	40158568003					5.900	

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

			Ra 226+228, pCi/L	Sb, tot, mg/L	Se, tot, mg/L	Silver, tot, ug/L	SO4, tot, mg/L	Spec. Cond. (field), micromhos/cm
LS-101	10/11/2017							
	4/26/2018	40168127003					4.100	0.047
	10/25/2018	AE31423					3.100	39.000
	4/24/2019	AE36961					2.600	45.000
	10/24/2019	AE41531					2.600	38.000
	4/14/2020	AE45279					2.600	27.000
	9/1/2020	AE48237						51.000
	10/14/2020	AE49164					3.900	73.000
LS-105	2/18/2016	40128408003	0.3420	0.000099	0.00072		9.200	
	4/5/2016	40130257004	0.3660	<0.000034	0.00015		10.000	140.000
	6/15/2016	40133877004	1.3450	<0.000073	0.00056		9.100	157.000
	8/10/2016	40136543004	1.1369	0.000420	0.00073		4.800	198.000
	10/5/2016	40139741004	0.9710	<0.000073	0.00070		67.800	330.000
	12/21/2016	40143755005	1.0182	0.000150	0.00081		58.600	340.000
	3/10/2017	40146662004	0.1570	<0.000073	0.00051		50.400	300.000
	6/2/2017	40151013004	0.4970	<0.000150	0.00044		26.500	160.000
	10/11/2017	40158568004					31.000	
	4/26/2018	40168127004					15.900	0.180
	10/25/2018	AE31424					16.000	191.000
	4/24/2019	AE36962					19.000	201.000
	10/24/2019	AE41532					16.000	180.000
	4/14/2020	AE45280					14.000	160.000
	9/1/2020	AE48238						166.000
	10/14/2020	AE49165					17.000	166.000
	3/1/2021	AE51791						220.000
LS-106	2/18/2016	40128408004	1.5740	0.000081	0.00097		6.700	

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

			Ra 226+228, pCi/L	Sb, tot, mg/L	Se, tot, mg/L	Silver, tot, ug/L	SO4, tot, mg/L	Spec. Cond. (field), micromhos/cm
LS-106	4/5/2016	40130257005	2.1900	0.000096	0.00047		6.600	80.000
	6/15/2016	40133877005	1.0780	<0.000073	0.00140		5.500	99.000
	8/10/2016	40136543005	1.1750	<0.000073	0.00100		<10.000	116.000
	10/5/2016	40139741005	3.9750	<0.000150	0.00450		<5.000	100.000
	12/21/2016	40143755006	1.3150	0.000170	0.00190		5.700	120.000
	3/10/2017	40146662005	2.0200	<0.000360	0.00470		5.200	110.000
	6/2/2017	40151013005	0.1640	<0.000150	0.00180		11.800	136.000
	10/11/2017	40158568005					11.400	
	4/26/2018	40168127005					<5.000	0.077
	10/25/2018	AE31425					3.200	81.000
	4/24/2019	AE36963					6.300	107.000
	9/13/2019	AE40532						146.200
	10/24/2019	AE41533					6.500	131.000
	3/2/2020	AE44200						143.000
	4/14/2020	AE45281					4.300	67.000
	9/1/2020	AE48239						151.000
	10/14/2020	AE49166					3.100	151.000
	3/1/2021	AE51792						196.000
LS-107	2/18/2016	40128408005	0.4850	<0.000066	0.00031		9.000	
	4/5/2016	40130257006	0.6840	<0.000034	0.00021		9.200	160.000
	6/15/2016	40133877001	0.1750	<0.000073	0.00025		10.800	179.000
	8/10/2016	40136543001	0.3320	<0.000073	<0.00021		10.000	179.000
	10/5/2016	40139741006	0.4230	<0.000073	0.00021		10.000	190.000
	12/20/2016	40143755001	1.2450	0.000270	0.00041		12.500	200.000
	3/10/2017	40146662006	0.1840	<0.000073	<0.00021		15.200	200.000
	6/2/2017	40151013006	0.6110	<0.000150	<0.00032		19.900	197.000

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

			Ra 226+228, pCi/L	Sb, tot, mg/L	Se, tot, mg/L	Silver, tot, ug/L	SO4, tot, mg/L	Spec. Cond. (field), micromhos/cm
LS-107	6/2/2017							
	10/11/2017	40158568006					25.500	
	4/26/2018	40168127006					17.500	0.179
	10/25/2018	AE31426					26.000	186.000
	4/24/2019	AE36964					21.000	160.000
	10/24/2019	AE41534					24.000	168.000
	4/14/2020	AE45282					27.000	160.000
	9/1/2020	AE48240						181.000
	10/14/2020	AE49167					42.000	233.000
	3/1/2021	AE51793						223.000

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

Well Id	Date Sampled	Lab Id	TDS, mg/L	Temp (Celcius), degrees C	Temp (Fahrenheit), degrees F	Tl, tot, mg/L	Zinc, tot, ug/L
LS-100	2/18/2016	40128408001	122.000			0.000047	
	4/5/2016	40130257002	150.000	5.200		<0.000012	
	6/15/2016	40133877003	148.000	10.340		<0.000140	
	8/10/2016	40136543003	182.000	14.430		0.000280	
	10/5/2016	40139741002	306.000	15.800		<0.000140	
	12/21/2016	40143755003	360.000	9.720		<0.000140	
	3/10/2017	40146662002	98.000	4.940		0.000200	
	6/2/2017	40151013002	94.000		48.866	0.000290	
	10/11/2017	40158568002	80.000				
	4/26/2018	40168127002	82.000	4.550			
	10/25/2018	AE31422	50.000	14.600			
	4/24/2019	AE36960	30.000	5.600			
	10/24/2019	AE41530	50.000	14.000			
	4/14/2020	AE45278	42.000	5.400			
	9/1/2020	AE48236		18.800			
	10/14/2020	AE49163	56.000	14.400			
LS-101	2/18/2016	40128408002	50.000			<0.000018	
	4/5/2016	40130257003	52.000	5.720		<0.000012	
	6/15/2016	40133877002	44.000	9.560		<0.000140	
	8/10/2016	40136543002	84.000	12.650		0.000930	
	10/5/2016	40139741003	70.000	13.870		<0.000140	
	12/21/2016	40143755002	60.000	9.860		<0.000140	
	3/10/2017	40146662003	28.000	6.020		<0.000140	
	6/2/2017	40151013003	30.000		48.002	<0.000140	
	10/11/2017	40158568003	62.000				

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

			TDS, mg/L	Temp (Celcius), degrees C	Temp (Fahrenheit), degrees F	Tl, tot, mg/L	Zinc, tot, ug/L
LS-101	10/11/2017						
	4/26/2018	40168127003	58.000	4.890			
	10/25/2018	AE31423	44.000	12.300			
	4/24/2019	AE36961	<20.000	4.800			
	10/24/2019	AE41531	27.000	12.000			
	4/14/2020	AE45279	24.000	5.300			
	9/1/2020	AE48237		11.800			
	10/14/2020	AE49164	120.000	11.500			
LS-105	2/18/2016	40128408003	98.000			0.000024	
	4/5/2016	40130257004	94.000	6.300		0.000015	
	6/15/2016	40133877004	80.000	11.750		<0.000140	
	8/10/2016	40136543004	148.000	15.520		0.000180	
	10/5/2016	40139741004	204.000	15.250		<0.000140	
	12/21/2016	40143755005	196.000	8.220		<0.000140	
	3/10/2017	40146662004	178.000	5.950		<0.000140	
	6/2/2017	40151013004	96.000		52.736	<0.000140	
	10/11/2017	40158568004	100.000				
	4/26/2018	40168127004	118.000	4.500			
	10/25/2018	AE31424	110.000	13.000			
	4/24/2019	AE36962	110.000	6.900			
	10/24/2019	AE41532	86.000	13.000			
	4/14/2020	AE45280	62.000	6.200			
	9/1/2020	AE48238		17.800			
	10/14/2020	AE49165	110.000	14.800			
	3/1/2021	AE51791		5.500			
LS-106	2/18/2016	40128408004	70.000			0.000080	

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

			TDS, mg/L	Temp (Celcius), degrees C	Temp (Fahrenheit), degrees F	Tl, tot, mg/L	Zinc, tot, ug/L
LS-106	4/5/2016	40130257005	94.000	4.700		0.000140	
	6/15/2016	40133877005	110.000	13.190		<0.000140	
	8/10/2016	40136543005	94.000	18.230		<0.000140	
	10/5/2016	40139741005	228.000	16.560		<0.000290	
	12/21/2016	40143755006	186.000	9.520		<0.000140	
	3/10/2017	40146662005	544.000	4.480		<0.000710	
	6/2/2017	40151013005	72.000		51.980	<0.000140	
	10/11/2017	40158568005	108.000				
	4/26/2018	40168127005	88.000	5.000			
	10/25/2018	AE31425	58.000	13.800			
	4/24/2019	AE36963	52.000	5.200			
	9/13/2019	AE40532		16.200			
	10/24/2019	AE41533	130.000	14.000			
	3/2/2020	AE44199		4.600			
	4/14/2020	AE45281	20.000	5.100			
	9/1/2020	AE48242		16.500			
	10/14/2020	AE49166	160.000	14.800			
	3/1/2021	AE51792		6.100			
LS-107	2/18/2016	40128408005	88.000			0.000027	
	4/5/2016	40130257006	94.000	6.040		<0.000012	
	6/15/2016	40133877001	112.000	9.390		<0.000140	
	8/10/2016	40136543001	118.000	12.590		0.000620	
	10/5/2016	40139741006	118.000	13.780		<0.000140	
	12/20/2016	40143755001	72.000	10.110		0.000410	
	3/10/2017	40146662006	134.000	6.540		<0.000140	
	6/2/2017	40151013006	110.000		47.732	<0.000140	

Weston Disposal Site #3 CCR
D-1. CCR Monitoring Data (Baseline, Detection Monitoring Rounds 1-10, including GEMS submittal)

Date Range: 01/01/1900 to 04/01/2021

Lab Methods:

			TDS, mg/L	Temp (Celcius), degrees C	Temp (Fahrenheit), degrees F	Tl, tot, mg/L	Zinc, tot, ug/L
LS-107	6/2/2017						
	10/11/2017	40158568006	134.000				
	4/26/2018	40168127006	128.000	5.080			
	10/25/2018	AE31426	120.000	12.000			
	4/24/2019	AE36964	86.000	5.600			
	10/24/2019	AE41534	76.000	12.000			
	4/14/2020	AE45282	82.000	5.900			
	9/1/2020	AE48240		12.600			
	10/14/2020	AE49167	160.000	12.300			
	3/1/2021	AE51793		5.800			

D-2
ACL CALCULATION TABLES

TABLE D-2. ACL CALCULATION TABLES

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM REVISION 1
WESTON DISPOSAL SITE NO. 3 ASH LANDFILL
TOWN OF KNOWLTON, WISCONSIN

Location	**LS-106**							**No. of Oultiers Removed**	**Resulting Mean and Std. Dev.**	**ACL**	**Sen Slope**	**Normal /**	**% of**
Parameter	**Units**	**Count**	**Mean**	**Median**	**Maximum**	**Minimum**	**Std Dev**			**Mean + 2 Std Dev**	**Units/yr**	**Log Normal**	**Non-Detects**
B, tot	mg/L	20	0.1109	0.066	0.45	0.015	0.1171	1	0.093 / 0.086	0.260	-0.0071	No / Yes	0.00
Ca, tot	mg/L	20	10.266	9.65	22	4.24	4.729	N/A	N/A	N/A	-0.013	Yes / Yes	0.00
Cl, tot	mg/L	20	3.446	2.65	11	0.47	2.828	N/A	N/A	N/A	-0.152	No / Yes	20.00
F, tot	mg/L	21	0.148	0.1	0.5	0.035	0.121	N/A	N/A	N/A	-0.012	No / No	71.43
pH (field)	STD	22	6.5	6.4	8.1	5.6	0.7	N/A	N/A	N/A	-0.2	Yes / Yes	0.00
SO4, tot	mg/L	19	5.179	5	11.8	2.1	2.758	N/A	N/A	N/A	-0.554	No / Yes	15.79
TDS	mg/L	19	121.684	94	544	20	114.473	N/A	N/A	N/A	-5.835	No / 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 D-2. ACL CALCULATION TABLES

ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN ADDENDUM REVISION 1
WESTON DISPOSAL SITE NO. 3 ASH LANDFILL
TOWN OF KNOWLTON, WISCONSIN

Location	**LS-106**	**ES**			**PAL**		**Number Values >**	**2 Values >**
Parameter	**Units**	**(mg/L)**	**Max > ES?**	**Mean > ES?**	**(mg/L)**	**Mean > PAL?**	**PAL**	**PAL?**
B, tot	mg/L	1	No	No	0.2	No	3	**Yes**
Ca, tot	mg/L	NA	NA	NA	NA	NA	0	NA
Cl, tot	mg/L	250	No	No	125	No	0	No
F, tot	mg/L	4	No	No	0.8	No	0	**No**
pH (field)	STD	NA	NA	NA	NA	NA	0	NA
SO4, tot	mg/L	250	No	No	125	No	0	**No**
TDS	mg/L	NA	NA	NA	NA	NA	0	NA

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