Section 1. Contact and Recipient Information

Requester Information

This is the person requesting technical assistance or a post-closure modification review, that his or her liability be clarified or a specialized agreement and is identified as the requester in Section 7. DNR will address its response letter to this person.

Last Name	First	MI	Organization/ Business Name		
Waterman	Shane		3M		
Mailing Address			City	State	ZIP Code
3M Center, 225-1N-22			St. Paul	MN	55144-1000
Phone # (include area code)	Fax # (include area code)		Email		
(612) 263-5053			sawaterman@mmm.com		

The requester listed above: (select all that apply)

- ☐ Is currently the owner
- ☐ Is renting or leasing the Property
- ☐ Is a lender with a mortgagee interest in the Property
- ☒ Other. Explain the status of the Property with respect to the applicant:

  Property Owner Representative

- ☐ Is considering selling the Property
- ☐ Is considering acquiring the Property

Contact Information (to be contacted with questions about this request) ☒ Select if same as requester

Contact Last Name	First	MI	Organization/ Business Name		
Waterman	Shane		3M		
Mailing Address			City	State	ZIP Code
3M Center, 225-1N-22			St. Paul	MN	55144-1000
Phone # (include area code)	Fax # (include area code)		Email		
(612) 263-5053			sawaterman@mmm.com		

Environmental Consultant (if applicable)

Contact Last Name	First	MI	Organization/ Business Name		
Bonniwell	Chris		Tetra Tech		
Mailing Address			City	State	ZIP Code
13555 Bishops Court, Suite 201			Brookfield	WI	53005
Phone # (include area code)	Fax # (include area code)		Email		
(262) 792-1282			chris.bonniwell@tetratech.com		

Section 2. Property Information

Property Name	FID No. (if known)
3M Greystone	737078870

BRRTS No. (if known)	Parcel Identification Number
02-37-596321	14629071110998

Street Address	City	State	ZIP Code
410 Decator Dr	Wausau	WI	54401

County	Municipality where the Property is located	Property is composed of:	Property Size Acres
Marathon	◉ City ○ Town ○ Village of	○ Single tax parcel ◉ Multiple tax parcels	1,222

1. Is a response needed by a specific date? (e.g., Property closing date) Note: Most requests are completed within 60 days. Please plan accordingly.

◉ No ◯ Yes

Date requested by: _____

Reason:

_____

2. Is the "Requester" enrolled as a Voluntary Party in the Voluntary Party Liability Exemption (VPLE) program?

◉ No. **Include the fee that is required for your request in Section 3, 4 or 5.**

◯ Yes. **Do not include a separate fee.** This request will be billed separately through the VPLE Program.

Fill out the information in Section 3, 4 or 5 which corresponds with the type of request:
Section 3. Technical Assistance or Post-Closure Modifications;
Section 4. Liability Clarification; or Section 5. Specialized Agreement.

Section 3. Request for Technical Assistance or Post-Closure Modification

Select the type of technical assistance requested: **[Numbers in brackets are for WI DNR Use]**

- ☐ No Further Action Letter (NFA) (Immediate Actions) - NR 708.09, [183] - Include a fee of $350. Use for a written response to an immediate action after a discharge of a hazardous substance occurs. Generally, these are for a one-time spill event.
- ☒ Review of Site Investigation Work Plan - NR 716.09, [135] - **Include a fee of $700.**
- ☐ Review of Site Investigation Report - NR 716.15, [137] - **Include a fee of $1050.**
- ☐ Approval of a Site-Specific Soil Cleanup Standard - NR 720.10 or 12, [67] - **Include a fee of $1050.**
- ☐ Review of a Remedial Action Options Report - NR 722.13, [143] - **Include a fee of $1050.**
- ☐ Review of a Remedial Action Design Report - NR 724.09, [148] - **Include a fee of $1050.**
- ☐ Review of a Remedial Action Documentation Report - NR 724.15, [152] - **Include a fee of $350**
- ☐ Review of a Long-term Monitoring Plan - NR 724.17, [25] - **Include a fee of $425.**
- ☐ Review of an Operation and Maintenance Plan - NR 724.13, [192] - **Include a fee of $425.**

Other Technical Assistance - s. 292.55, Wis. Stats. [97] (For request to build on an abandoned landfill use Form 4400-226)

- ☐ Schedule a Technical Assistance Meeting - **Include a fee of $700.**
- ☐ Hazardous Waste Determination - **Include a fee of $700.**
- ☐ Other Technical Assistance - **Include a fee of $700.** Explain your request in an attachment.

Post-Closure Modifications - NR 727, [181]

- ☐ Post-Closure Modifications: Modification to Property boundaries and/or continuing obligations of a closed site or Property; sites may be on the GIS Registry. This also includes removal of a site or Property from the GIS Registry. **Include a fee of $1050, and:**
  - ☐ Include a fee of $300 for sites with residual soil contamination; and
  - ☐ Include a fee of $350 for sites with residual groundwater contamination, monitoring wells or for vapor intrusion continuing obligations.

Attach a description of the changes you are proposing, and documentation as to why the changes are needed (if the change to a Property, site or continuing obligation will result in revised maps, maintenance plans or photographs, those documents may be submitted later in the approval process, on a case-by-case basis).

Section 4. Request for Liability Clarification

Select the type of liability clarification requested. Use the available space given or attach information, explanations, or specific questions that you need answered in DNR's reply. Complete Sections 6 and 7 of this form. **[Numbers in brackets are for DNR Use]**

☐ "Lender" liability exemption clarification - s. 292.21, Wis. Stats. [686]

❖ **Include a fee of $700.**

Provide the following documentation:

(1) ownership status of the real Property, and/or the personal Property and fixtures;

(2) an environmental assessment, in accordance with s. 292.21, Wis. Stats.;

(3) the date the environmental assessment was conducted by the lender;

(4) the date of the Property acquisition; for foreclosure actions, include a copy of the signed and dated court order confirming the sheriff's sale.

(5) documentation showing how the Property was acquired and the steps followed under the appropriate state statutes.

(6) a copy of the Property deed with the correct legal description; and,

(7) the Lender Liability Exemption Environmental Assessment Tracking Form (Form 4400-196).

(8) If no sampling was done, please provide reasoning as to why it was **not** conducted. Include this either in the accompanying environmental assessment or as an attachment to this form, and cite language in s. 292. 21(1)(c)2.,h.-i., Wis. Stats.:

h. The collection and analysis of representative samples of soil or other materials in the ground that are suspected of being contaminated based on observations made during a visual inspection of the real Property or based on aerial photographs, or other information available to the lender, including stained or discolored soil or other materials in the ground and including soil or materials in the ground in areas with dead or distressed vegetation. The collection and analysis shall identify contaminants in the soil or other materials in the ground and shall quantify concentrations.

i. The collection and analysis of representative samples of unknown wastes or potentially hazardous substances found on the real Property and the determination of concentrations of hazardous waste and hazardous substances found in tanks, drums or other containers or in piles or lagoons on the real Property.

☐ "Representative" liability exemption clarification (e.g. trustees, receivers, etc.) - s. 292.21, Wis. Stats. [686]

❖ **Include a fee of $700.**

Provide the following documentation:

(1) ownership status of the Property;

(2) the date of Property acquisition by the representative;

(3) the means by which the Property was acquired;

(4) documentation that the representative has no beneficial interest in any entity that owns, possesses, or controls the Property;

(5) documentation that the representative has not caused any discharge of a hazardous substance on the Property; and

(6) a copy of the Property deed with the correct legal description.

☐ Clarification of local governmental unit (LGU) liability exemption at sites with: (select all that apply)

☐ hazardous substances spills - s. 292.11(9)(e), Wis. Stats. [649];

☐ Perceived environmental contamination - [649];

☐ hazardous waste - s. 292.24 (2), Wis. Stats. [649]; and/or

☐ solid waste - s. 292.23 (2), Wis. Stats. [649].

❖ **Include a fee of $700, a summary of the environmental liability clarification being requested, and the following:**

(1) clear supporting documentation showing the acquisition method used, and the steps followed under the appropriate state statute(s).

(2) current and proposed ownership status of the Property;

(3) date and means by which the Property was acquired by the LGU, where applicable;

(4) a map and the ¼, ¼ section location of the Property;

(5) summary of current uses of the Property;

(6) intended or potential use(s) of the Property;

(7) descriptions of other investigations that have taken place on the Property; and

(8) (for solid waste clarifications) a summary of the license history of the facility.

Section 4. Request for Liability Clarification (cont.)

☐ Lease liability clarification - s. 292.55, Wis. Stats. [646]

❖ **Include a fee of $700 for a single Property, or $1400 for multiple Properties and the information listed below:**

(1) a copy of the proposed lease;

(2) the name of the current owner of the Property and the person who will lease the Property;

(3) a description of the lease holder's association with any persons who have possession, control, or caused a discharge of a hazardous substance on the Property;

(4) map(s) showing the Property location and any suspected or known sources of contamination detected on the Property;

(5) a description of the intended use of the Property by the lease holder, with reference to the maps to indicate which areas will be used. Explain how the use will not interfere with any future investigation or cleanup at the Property; and

(6) all reports or investigations (e.g. Phase I and Phase II Environmental Assessments and/or Site Investigation Reports conducted under s. NR 716, Wis. Adm. Code) that identify areas of the Property where a discharge has occurred.

General or other environmental liability clarification - s. 292.55, Wis. Stats. [682] - Explain your request below.

❖ **Include a fee of $700 and an adequate summary of relevant environmental work to date.**

☐ No Action Required (NAR) - NR 716.05, [682]

❖ **Include a fee of $700.**

Use where an environmental discharge has or has not occurred, and applicant wants a DNR determination that no further assessment or clean-up work is required. Usually this is requested after a Phase I and Phase II environmental assessment has been conducted; the assessment reports should be submitted with this form. This is not a closure letter.

☐ Clarify the liability associated with a "closed" Property - s. 292.55, Wis. Stats. [682]

❖ **Include a fee of $700.**

- Include a copy of any closure documents if a state agency other than DNR approved the closure.

Use this space or attach additional sheets to provide necessary information, explanations or specific questions to be answered by the DNR.

Section 5. Request for a Specialized Agreement

Select the type of agreement needed. Include the appropriate draft agreements and supporting materials. Complete Sections 6 and 7 of this form. More information and model draft agreements are available at: dnr.wi.gov/topic/Brownfields/lgu.html#tabx4.

☐ Tax cancellation agreement - s. 75.105(2)(d), Wis. Stats. [654]

❖ **Include a fee of $700, and the information listed below:**

(1) Phase I and II Environmental Site Assessment Reports,

(2) a copy of the Property deed with the correct legal description.

☐ Agreement for assignment of tax foreclosure judgement - s.75.106, Wis. Stats. [666]

❖ **Include a fee of $700, and the information listed below:**

(1) Phase I and II Environmental Site Assessment Reports,

(2) a copy of the Property deed with the correct legal description.

☐ Negotiated agreement - Enforceable contract for non-emergency remediation - s. 292.11(7)(d) and (e), Wis. Stats. [630]

❖ **Include a fee of $1400, and the information listed below:**

(1) a draft schedule for remediation; and,

(2) the name, mailing address, phone and email for each party to the agreement.

Section 6. Other Information Submitted

Identify all materials that are included with this request.

Send both a paper copy of the signed form and all reports and supporting materials, and an electronic copy of the form and all reports, including Environmental Site Assessment Reports, and supporting materials on a compact disk.

Include one copy of any document from any state agency files that you want the Department to review as part of this request. The person submitting this request is responsible for contacting other state agencies to obtain appropriate reports or information.

☐ Phase I Environmental Site Assessment Report - Date: _____

☐ Phase II Environmental Site Assessment Report - Date: _____

☐ Legal Description of Property (required for all liability requests and specialized agreements)

☒ Map of the Property (required for all liability requests and specialized agreements)

Analytical results of the following sampled media: Select all that apply and include date of collection.

☒ Groundwater ☐ Soil ☐ Sediment ☒ Other medium - Describe: Surface basins

Date of Collection: 09/17/2024

☐ A copy of the closure letter and submittal materials

☐ Draft tax cancellation agreement

☐ Draft agreement for assignment of tax foreclosure judgment

☒ Other report(s) or information - Describe: Site Investigation Work Plan

For Property with newly identified discharges of hazardous substances only: Has a notification of a discharge of a hazardous substance been sent to the DNR as required by s. NR 706.05(1)(b), Wis. Adm. Code?

○ Yes - Date (if known): _____

○ No

Note: The Notification for Hazardous Substance Discharge Form - Non-Emergency Only (Form 4400-225) is accessible through the RR Program Submittal Portal application. Directions for using the form and the Submittal Portal application are available on the Submittal Portal web page.

Section 7. Certification by the Person who completed this form

☐ I am the person submitting this request (requester)

☒ I prepared this request for: Shane Waterman
Requester Name

I certify that I am familiar with the information submitted on this request, and that the information on and included with this request is true, accurate and complete to the best of my knowledge. I also certify I have the legal authority and the applicant's permission to make this request.

Signature: _____ Date Signed: 6/9/25

Title: Midwest Principal Account Manager

Telephone Number (include area code): (262) 792-1282

Site Investigation Work Plan
3M Company – Greystone Facility
Wausau, Wisconsin

PREPARED FOR

3M Global Environment, Health & Safety
3M Center, 225-1N-22
St. Paul, MN 55144

PRESENTED BY

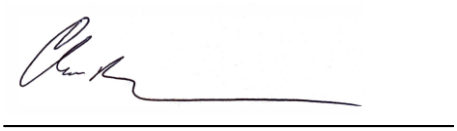
Tetra Tech, Inc.
13555 Bishops Court, Suite 201
Brookfield, WI 53005

June 9, 2025

CERTIFICATION

Hydrogeologist:

I, Chris Bonniwell, hereby certify that I am a hydrogeologist as that term is defined in s. NR 712.03 (1), Wis. Adm. Code, am registered in accordance with the requirements of ch. GHSS 2, Wis. Adm. Code, or licensed in accordance with the requirements of ch. GHSS 3, Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code.



Chris Bonniwell, Ph.D, P.G.
Midwest Principal Account Manager

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Appendix A Field Standard Operating Procedures for PFAS Sampling and Other Activities
Appendix B Field Sampling Forms and Logs

LIST OF ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
3M	3M Company
AMSL	Above Mean Sea Level
bgs	below ground surface
BRRTS	Bureau for Remediation and Redevelopment Tracking System
ft	feet
IDW	investigation derived wastes
NEtFOSAA	N-ethyl perfluorooctane sulfonamidoacetic acid
NAVD88	North American Vertical Datum of 1988
ng/L	Nanograms per liter
Pace	PACE Analytical Services, LLC
PFAS	per- and polyfluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOSA	perfluorooctane sulfonamide
PFOS	perfluorooctane sulfonic acid
QA/QC	quality assurance/quality control
SIWP	Site Investigation Work Plan
Site	3M Greystone, Wausau, Wisconsin
Tetra Tech	Tetra Tech, Inc.
WDNR	Wisconsin Department of Natural Resources

1.0 INTRODUCTION

On February 14, 2025, Tetra Tech submitted to the Wisconsin Department of Natural Resources (WDNR) notice of a hazardous discharge at the 3M Greystone Facility located at 410 Decator Drive, Wausau, Wisconsin (Site). The notice was based upon groundwater and stormwater basin sampling results that were generated by sampling that was performed in response to the detection of certain per- and polyfluoroalkyl substances (PFAS) in the Site's production well. The WDNR subsequently issued a letter on March 10, 2025, identifying 3M Company (3M) as a responsible party and directing 3M to develop a Site Investigation Work Plan (SIWP).

Tetra Tech, Inc. (Tetra Tech) has prepared this SIWP on behalf of 3M to conduct additional groundwater and surface basin investigation at the Site. The location of the Site is presented in **Figure 1.** The Site is identified in the WDNR's Bureau of Remediation and Redevelopment Tracking System (BRRTS) as site #02-37-596321.

This SIWP has been prepared in accordance with Sections NR 716.07 and NR 716.09 Wisconsin Administrative Code (Wisc. Admin. Code, Modified February 1997). The objective of the groundwater and stormwater basin investigative activities described in this SIWP is to further refine delineation and characterization of PFAS previously identified in groundwater and surface basin sampling to better understand potential on-Site and off-Site source areas and inform future selection of remedial action, if any, per NR 716.09(2)(f)(8).

1.1 SITE DESCRIPTION

The Site is located in Marathon County, in the southeast quarter (SE 1/4), Section 28 (S28) of Township 28 north (T28N) Range 7 East **(Figure 1).** The quarry mines volcanic rock, which is crushed and sorted onsite before being transported to a 3M manufacturing plant in Wausau for further processing to produce roofing granules. The quarry began operation in 1936 and has undergone several expansions throughout its history. The Site is located east of Hwy-51 and includes the mining and rock crushing operations as well as surrounding undeveloped land that is also owned by 3M. The total Site area is approximately 1,222 acres. The mine operation consists of an approximate 200-acre quarry and a 10-acre rock processing facility. The remainder of the Site consists of undeveloped and formerly agricultural property to the west of the quarry, waste fine disposal mounds to the east of the quarry that are generally vegetated, and a flood plain associated with the Wisconsin river that borders the Site to the north and east. Site details are presented in **Figure 2**. The Site is supplied by a production well located in the center of the Site (**Figure 2)** that is utilized for production processes and non-potable facility infrastructure (e.g. toilets, sinks, eyewash stations, showers, etc.).

1.2 TOPOGRAPHY AND DRAINAGE

The quarry is located in an area of bluffs and terraces along the Wisconsin River. Prior to quarry development, the quarry area was a local topographic high at an elevation of approximately 1420 feet AMSL, which drops off steeply to the north and east to about 1200 feet AMSL at the Wisconsin River (U.S. Geological Survey, 2017). The hilltop has been removed during mining activities; however, the area immediately adjacent to the quarry remains a topographic high, and the ground surface generally slopes away from the quarry toward the Wisconsin River.

The Site is comprised of 13 identified drainage areas (**Figure 2**) that utilize a complex stormwater management system that consists of twelve interconnected basins with piping and valves in place to divert stormwater and dewatering water as needed to promote settling of fines, maximize infiltration, and minimize discharge of stormwater to the Wisconsin River.

1.3 GEOLOGY & HYDROGEOLOGY

Lithology at the Site consists of limited unconsolidated surficial deposits of glacial origin except in the alluvial valley adjacent to the main channel of the Wisconsin River (Devaul and Green, 1971). Glacial till is typically less than 10 feet thick near Wausau and thought to predate the Wisconsinan glacial advance (LaBerge and Meyers, 1983). The bedrock in the quarry area is primarily classified as Precambrian felsic metavolcanic rocks, principally rhyolite (Sims, 1992; LaBerge and Meyers, 1983). Other rock types encountered within the quarry include andesite, greywacke, breccia, and unclassified volcanics. Regionally, the bedrock geology shows a complex sequence of deformation (folding and faulting), and volcanism. LaBerge and Meyers (1983) interpreted the quarry area as layers of rhyolitic ash and volcanic deposits containing older quartzite and granite boulders (conglomerate).

The water table in the upland areas surrounding the quarry is generally within the bedrock. Groundwater in bedrock occurs primarily in fractures or weathered zones, which are more common near the top of bedrock (Devaul and Green, 1971). Regionally, groundwater flow directions are expected to mimic topography, with flow generally toward the Wisconsin River (Devaul and Green, 1971).

1.4 GROUNDWATER CHARACTERIZATION

Previous sampling of groundwater and surface basins at the Site was initiated due to the presence of PFAS within the facility's production well. The analytical results from the production well sampling in September 2023 are compiled in **Table 1**. The prominent PFAS analytes detected during the September 2024 investigation activities were perfluorooctanoic acid (PFOA) [210 ng/L] and perlfuorooctane sulfonic acid (PFOS) [310 ng/L].

Several monitoring wells were historically established at the Site, which include seven wells within the alluvial valley (MW-1 through MW-4, MW-6, PZ-1, and PZ-2) that were installed for monitoring metals in groundwater within the former coloring wastewater disposal area, and two bedrock wells (OB-1 and OB-2) that were installed in the central portion of the Site as part of a 2017 hydrogeological study supporting an expansion of the quarry. Each of these wells were sampled in September 2024, with the analytical results compiled in **Table 2** and displayed on **Figure 4** and **Figure 5**. All well samples contained one or more detectable PFAS compounds. The number of compounds and concentrations in the bedrock wells were notably less than the alluvial monitoring wells. Alluvial wells contained PFOA concentrations ranging from 41 to 1,200 ng/L, with the maximum concentration in PZ-1. Alluvial wells contained PFOS concentrations ranging from 220 – 650 ng/L, with the maximum concentration in MW-1. Overall, the greatest concentrations of PFAS were associated with the northern well pair MW-1 / PZ-1 and northeastern well MW-4.

In conjunction with the sampling of existing wells, seven surface basins were sampled for PFAS (Basin02, Basin03, Basin05, Basin06, Basin10, Basin11, and Basin15), as well as the quarry sump pit. The results are compiled in **Table 2** and displayed on **Figure 4** and **Figure 5**. All surface water samples contained one or more detectable PFAS compounds. PFOA concentrations ranged from 6.4 to 250 ng/L, and PFOS concentrations ranged from 16 to 330 ng/L. Minimum concentrations were associated with Basin10 and maximum concentrations were associated with Basin02. Concentrations within Basin02 closely approximated those of the production well.

2.0 SCOPE OF WORK

The objective of the activities described in this scope of work are to further characterize the horizontal and vertical extent of PFAS groundwater impacts to better understand potential on-Site sources and identify potential off-Site sources and inform future selection of remedial action, if any, per NR 716.09(2)(f)(8)..

This scope of work includes:

- Clearing utilities prior to conducting field activities.

- Installing shallow and deep groundwater monitoring wells.
- Collecting soil samples for laboratory analysis.
- Collecting groundwater and surface basin samples for laboratory analysis.
- Collecting quality control samples.
- Handling investigation derived waste (IDW).

Details regarding the above scope of work are presented in the following sections.

2.1 SAMPLING METHODOLOGY AND RATIONALE

The proposed investigative activities were selected to:

- Further refine horizontal and vertical delineation of PFAS concentrations in groundwater,
- Assess potential on-Site and off-Site sources of impacts,
- Assess the colorant wastewater area as a potential source area,
- Assess background bedrock groundwater, and
- Assess potential surface soil accumulations of PFAS resulting from dust suppression activities.

The previously established monitoring wells, surface basins, and the proposed alluvial and bedrock monitoring wells are presented in **Figure 6** and **Figure 7**. Sample analysis will consist of PFAS analysis via EPA Method 1633 for the 33 PFAS analytes required by the State of Wisconsin. The specific activities are described in the following sections. Tetra Tech standard operating procedures (SOPs) for sample collection (including PFAS) and other field methods are presented in **Appendix A**.

2.2 UTILITY CLEARANCE

Prior to mobilization of equipment to the Site, the Wisconsin one-call (Diggers Hotline) number will be called to locate subsurface utilities at the site in public areas near proposed well locations. Tetra Tech personnel will coordinate with Diggers Hotline and 3M will locate privately held utilities in the areas of the proposed monitoring wells.

Drilling and sampling locations may be adjusted in the field depending on the results of the utility clearance and/or environmental limitations.

2.3 MONITORING WELL INSTALLATION

Monitoring well installations are proposed for the delineation of previously identified impacts, source zone characterization, and background bedrock characterization. Each of these installation activities is described below.

2.3.1 Delineation Alluvial Wells

The goal of the proposed delineation monitoring well installations is to refine the horizontal and vertical delineation of groundwater impacts identified in the previous sampling of existing groundwater monitoring wells at the Site. In addition to the horizontal and vertical delineation, the proposed wells will provide insight into potential contributions of groundwater impacts originating from other on-Site or off-Site locations. **Figure 6** and **Figure 7** depict the proposed well locations and the analytical results from the previous sampling event performed in September 2024, and **Table 1** compiles all analytical results.

Tetra Tech is proposing the installation of eight new shallow monitoring wells (MW-7 through MW-14) and two deep monitoring wells (MW-1D and MW-4D) for delineation of the impacts and assessment of potential vertical gradients with the locations shown in **Figure 6**. The specific focus of each proposed well is detailed in **Table 3** below. The

proposed delineation wells are all within the alluvial deposits predominant on the eastern portion of the site as opposed to the bedrock that is predominant in the west.

All wells will consist of 2-inch PVC permanent monitoring wells installed to the approximate depths specified in **Table 2** and will be equipped with 10-ft well screens. Borings at each location will be advanced via direct push technology (DPT) equipment to continuously collect soil cores for field screening and characterization by a Tetra Tech geologist. Up to two soil samples will be collected from above the water table from borings MW-1D, MW-4D, and MW-14 due to their proximity to the coloring wastewater disposal area that is a potential source area. Provisions for the collection of up to two soil borings per each remaining location are included to allow for soils to be collected should field observations identify the presence of historical fill material or visual indications of potentially contaminated soil. During the boring advancement of MW-4D the direct push tooling will be advanced to a maximum depth of 75 ft, until bedrock is encountered, or to limitation of drilling equipment to better refine the vertical extent of the unconsolidated material.

Samples collected for PFAS will be analyzed by Pace Analytical of Minneapolis, MN. PFAS analyses will be completed using EPA Method 1633 for the 33 PFAS analytes required by the State of Wisconsin.

Following completion of boring activities, boreholes will be converted to permanent monitoring wells via advancement of 6-inch hollow-stem augers and installation of 2-inch diameter, Schedule 40 polyvinyl chloride casing and a 10 ft, 0.010 inch slotted well screen. Shallow well screens will be positioned to intersect the observed groundwater interface with 7 ft of casing below the interface to allow for seasonal fluctuations in groundwater elevations. Per NR 141, the monitoring wells will be completed with filter pack sand (~1.1. mm diameter), topped with a fine sand (0.42 – 0.074 mm) filter pack seal, followed by a hydrated bentonite annular seal. The monitoring wells will be constructed with an above-ground, steel well vault and protected by the installation of three protective bollards. The monitoring wells will be developed in accordance with the monitoring well development procedures described in Chapter NR 141.21, Wisc. Admin. Code. Forms documenting the monitoring well construction and development (WDNR Forms 4400-113A and 44000113B) will be completed for each well; copies of the forms are included in **Appendix B**. The installed monitoring wells will be surveyed by a Wisconsin licensed professional surveyor to establish the location (North American Datum of 1983 in Wisconsin State Plane feet - NAD83-WISP), ground elevation, top of casing elevation, and top of protective casing elevation (North American Vertical Datum of 1988 - NAVD88).

2.3.2 Source Area Alluvial Well

The delineation well installations described above are intended to step out from known impacts to assess their extents and to quantify concentration gradients to understand distribution and potential migration away from source areas. To assess the coloring wastewater disposal area as a potential source for PFAS groundwater impacts, a single well is proposed at location MW-15 on **Figure 6**. The boring will be advanced via DPT with soil continuously collected and logged. A composite soil sample representing each five-foot interval over the entire length of the boring will be collected for PFAS analysis. Sampling intervals may be modified based upon observed strata. Based on available digital elevation models and the depth to water observed in MW-4, it is anticipated that MW-15 will be drilled to a depth of 70 ft bgs at the location identified. The actual location will be dependent upon conditions identified in the field that can accommodate the drilling equipment and a permanent monitoring well.

Soil logging, soil sample analysis, well installation, well construction, well development, and documentation will be similarly performed as for the alluvial wells described above.

2.3.3 Background Bedrock Well

To assess the background conditions in the bedrock aquifer to the west of the mining operations, a single bedrock well (MW-16) is proposed near the northwestern edge of the property, as shown on **Figure 7**, which is presumed as being upgradient from the alluvial wells. Based on a review of surface elevations and well logs from on-site and off-site bedrock wells, the anticipated depth of the well to intersect groundwater sufficiently for sampling is

approximately 100 ft bgs. The boring will be advanced via air rotary drilling methods to create a 6-inch diameter borehole and installation of 2-inch diameter, Schedule 40 polyvinyl chloride casing and a 10 ft, 0.010 inch slotted well screen positioned across the observed groundwater interface. Per NR 141, the monitoring wells will be completed with filter pack sand (~1.1. mm diameter), topped with a fine sand (0.42 – 0.074 mm) filter pack seal, followed by a hydrated bentonite annular seal. The well installation will include three protective bollards to protect the well riser from impacts of mowing and agricultural equipment. The actual location and depth of the proposed bedrock well is subject to change based on accessibility and drilling conditions. Well development and well construction documentation will be similarly performed as for the alluvial wells described above.

2.4 SURFACE SOIL SAMPLING

To assess the concentration of PFAS in surface soils potentially resulting from current and historical dust suppression activities that potentially utilized PFAS impacted groundwater, a limited number of surface soil samples will be collected for PFAS analysis. The location of surface soils samples will be determined following a review of typical dust suppression activities with facility representatives and surface drainage patterns. Multiple subsamples may be composited into each surface soil sample for analysis.

Samples collected for PFAS will be analyzed by a 3M selected laboratory, presumably Pace Analytical of Minneapolis, MN. It is anticipated that the PFAS analyses will be completed using EPA Method 1633 for the 33 PFAS analytes required by the State of Wisconsin.

2.5 GROUNDWATER AND SURFACE BASIN SAMPLING

Two sampling events of surface basins and groundwater are proposed to establish a baseline of concentrations. The sampling events will be approximately three months apart.

2.5.1 Groundwater Sampling

Initial groundwater sampling will allow for a minimum of a 24-hour equilibration period after monitoring well installation and development. **Table 4** below identifies the wells to be sampled and anticipated sample names. Groundwater sampling will be initiated with a synoptic groundwater level measurement event for all monitoring wells conducted prior to pre-sample purging activities for monitoring wells. Sampling will be performed using low-flow techniques in accordance with the low-flow sampling procedures included in **Appendix A**. Either a portable peristaltic or portable pneumatic bladder pump and dedicated tubing will be used to purge and sample the monitoring wells. New bladders will be used to purge and sample each monitoring well. Throughout the purging process, field parameters, including temperature, pH, specific conductivity, dissolved oxygen, oxidation-reduction (redox) potential, and turbidity will be measured. Readings will be recorded at set intervals (every 2 to 10 minutes). The groundwater samples submitted for laboratory analyses will be collected in laboratory-provided containers once the field parameters meet the appropriate stabilization criteria (three consecutive readings differing by less than 10 percent and +/-0.3 units for pH).

The portable pneumatic bladder pump will be decontaminated after the groundwater samples are collected from each monitoring well by rinsing the inside and outside of the pump with a solution of Liquinox (or equivalent) and distilled water followed by a double-rinse of distilled water. The pump will be dried with paper towels and allowed to air dry between samples. The fluid used to decontaminate the portable pneumatic bladder pump will be collected along with purge water from sampling. As noted above, dedicated tubing and new bladders will be used to purge and sample each monitoring well so these items will not require decontamination.

Due to their construction with an extensive open bedrock borehole, a grab sample via a disposable bailer will be collected from monitoring wells OB-1 and OB-2 to represent groundwater near the groundwater surface.

Samples will be submitted on ice and under proper chain-of-custody documentation to the PACE Analytical Services, LLC (Pace) laboratory in Minneapolis, Minnesota for PFAS analysis using EPA Method 1633 for the 33 PFAS analytes required by the State of Wisconsin. Tetra Tech standard groundwater sampling logs, or digital equivalent, will be completed for each monitoring well sampled; a copy of the log is presented in **Appendix B**.

2.5.2 Surface Basin Sampling

The proposed surface basins to be included in the quarterly sampling are Basins 2, 3, 5, and 6 (**Figure 5**). Each basin will be sampled via a disposable, PFAS-free dipper cup on an extended rod. Each sample will be transferred to a laboratory supplied bottle for analysis.

Samples collected for PFAS will be analyzed by Pace Analytical of Minneapolis, MN. PFAS analyses will be completed using EPA Method 1633 for the 33 PFAS analytes required by the State of Wisconsin. **Table 5** below identifies the basin to be sampled and anticipated sample names.

2.6 QUALITY CONTROL SAMPLES

The following Quality Assurance / Quality Control (QA/QC) samples will be collected:

- A Quality Assurance Project Plan (QAPP) will be developed to document data quality objectives and appropriate methods and procedures to achieve them.
- Soil QA/QC samples from well installations and surface soils will be collected at a frequency of one duplicate sample per ten samples.
- Groundwater QA/QC samples will be collected at a frequency of one duplicate sample per ten samples.
- Surface basin QA/QC samples will be collected at a frequency of one duplicate sample per ten samples.
- Field blanks will be collected by pouring laboratory-supplied PFAS-free water or distilled water directly into the laboratory supplied sample containers and equipment blanks will be collected by pouring laboratory-supplied PFAS-free water or distilled water over the non-disposable field equipment (such as flow cell or portable pneumatic bladder pump) directly into the laboratory supplied sample container. Field and equipment blanks will be collected at the rate of one per twenty samples.
- One trip blank will be analyzed for PFAS per cooler of samples. Trip blanks will use laboratory supplied containers and liquids.
- A Level IV data validation review will be performed on all laboratory analytical data.

2.7 INVESTIGATION DERIVED WASTES

IDW will be generated during well installations, consisting primarily of soil cuttings, groundwater (from monitoring well development and sample purging), used decontamination supplies (distilled water containers, paper towels, plastic sheeting), used personal protective equipment, and decontamination fluids. IDW will be segregated, containerized, and characterized by Tetra Tech based upon sample analytical results. All IDW will be containerized in new 55-gallon drums and staged in accordance with 3M facility staff's directions for subsequent disposal.

3.0 DATA ASSESSMENT AND REPORTING

A Site Investigation Report (SIR) will be prepared in accordance with NR 716.15, Wisc. Admin. Code following receipt of all validated analytical results from the initial groundwater and surface basin sampling event. The SIR will include, but will not be limited to the following:

- Facility background information
- Narrative of investigative activities performed to date
- Tables compiling field measurements (e.g., groundwater elevation) and laboratory analytical results
- Figures depicting
    - Site conditions
    - Geologic cross sections
    - Sampling locations
    - Potentiometric surface
    - Analytical results
- Appendices will include
    - Boring logs and well construction logs
    - Field sampling documentation
    - Laboratory analytical reports
    - Well receptor survey
- Narrative conclusion on the findings of the investigation and recommendations for additional investigation (if needed), as called for in NR 716.15 (6).

4.0 SCHEDULE

This SIWP is being submitted with a technical review request and associated fee. Per WDNR guidelines, a minimum period of 60 days will be allowed for WDNR review and comment on the work plan, within any activities performed in advance of this timeframe being performed at risk of request for WDNR for scope modifications. The proposed schedule is based upon approval of the SIWP by the WDNR. The following schedule of events is anticipated:

- 30 days after SIWP approval - Installation of proposed monitoring wells (~10 days to perform)
- 45 days after SIWP approval
    - Monitoring well survey
    - Initial quarterly groundwater and surface basin sampling event (~3 days)
- 135 days after SIWP approval
    - Anticipated receipt of fully validated PFAS analytical results for surface water and groundwater samples
    - Second quarterly groundwater and surface water sampling event (~3 days)
- 145 days after SIWP approval – Data submittal to WDNR within 10 days of receipt of fully validated analytical report in accordance with NR 716.14
- 180 days after SIWP approval – Submittal of SIR to WDNR

The above proposed timeline is dependent upon staffing and contractor availability, and the timeline for analytical result processing and validation is based upon previous analyses associated with the Site. Significant alterations to the schedule will be communicated to the WDNR project manager.

5.0 REFERENCES

Brown, B.A. 1988, Bedrock Geology of Wisconsin, West-Central Sheet, Wisconsin Geological and Natural History Survey.

Devaul, R. W., & Green, J. H. (1971). Water resources of Wisconsin—Central Wisconsin River basin (Hydrologic Atlas 367). U.S. Geological Survey. https://doi.org/10.3133/ha367

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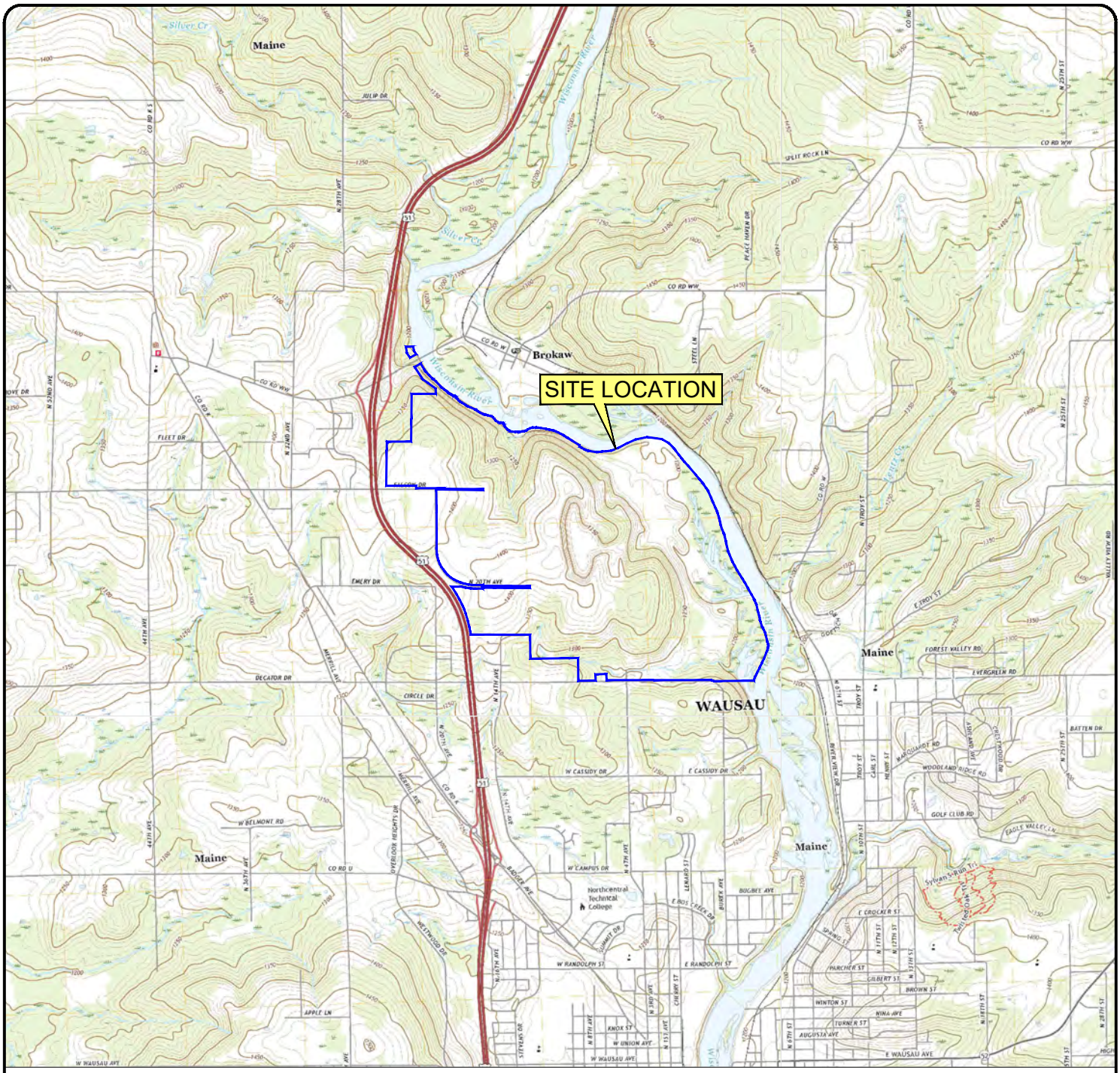
LaBerge, G. L., & Myers, P. E. (1984). Two early Proterozoic successions in central Wisconsin and their tectonic significance. GSA Bulletin, 95(2), 246–253. https://doi.org/10.1130/0016-7606(1984)95<246:TEPSIC>2.0.CO;2

Sims, P.K. (1992). Geologic map of Precambrian rocks, southern Lake Superior region, Wisconsin and northern Michigan. U.S. Geological Survey Miscellaneous Investigations Series Map I-2185. Scale 1:500,000.

Wisconsin Administrative Code, NR716.07 and NR716.09, Modified February 1997, No. 494. Wisconsin codes established to provide uniform standards related to identification and investigation of sites and facilities that are subject to regulation under Wisconsin Statutes 289 and 292,

Wisconsin Department of Natural Resources (2022a), Accessed December 2022, https://apps.dnr.wi.gov/wellconstructionpub/#!/PublicSearch/Index

Figures



SOURCE U.S.G.S. TOPOGRAPHIC UADRANGLES BROKAW, NUTTERVILLE, WAUSAU WEST, WAUSAU EAST, WI 2022

0 2000 4000 8000
Feet

N

MARATHON COUNTY WISCONSIN

P:\ACAD\001312-24010-3MWA\001312-24010-001A.DWG

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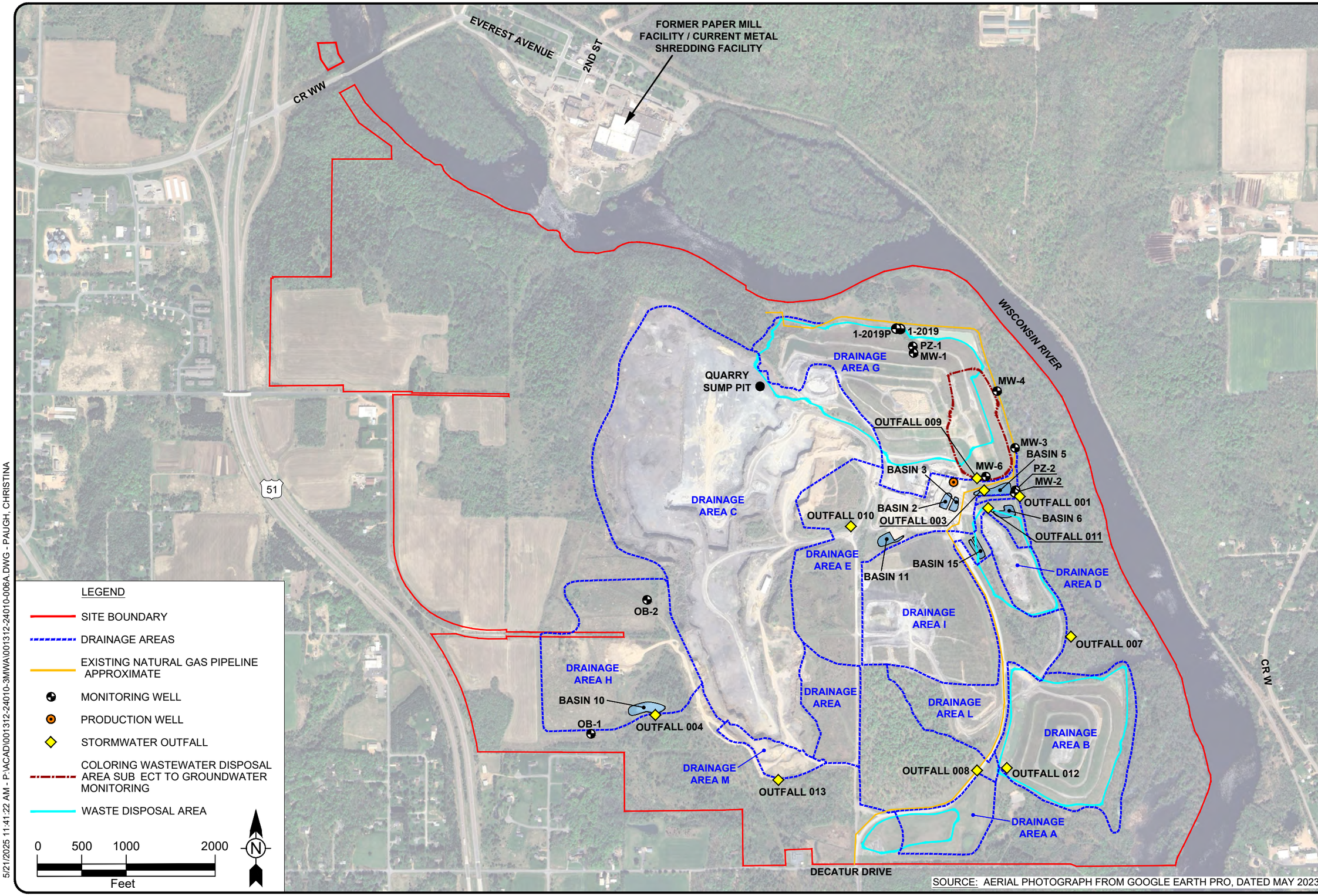
SITE LOCATION MAP

Project No:	117-001312-24010
Date:	05/19/25
Designed by:	CP
Checked by:	CB

FIGURE
1

Bar Measures 1 inch



SOURCE: AERIAL PHOTOGRAPH FROM GOOGLE EARTH PRO, DATED MAY 2023

Bar Measures 1 inch

5/21/2025 11:41:22 AM - P:\ACAD\001312-24010-3MWA\001312-24010-006A.DWG - PAUGH, CHRISTINA

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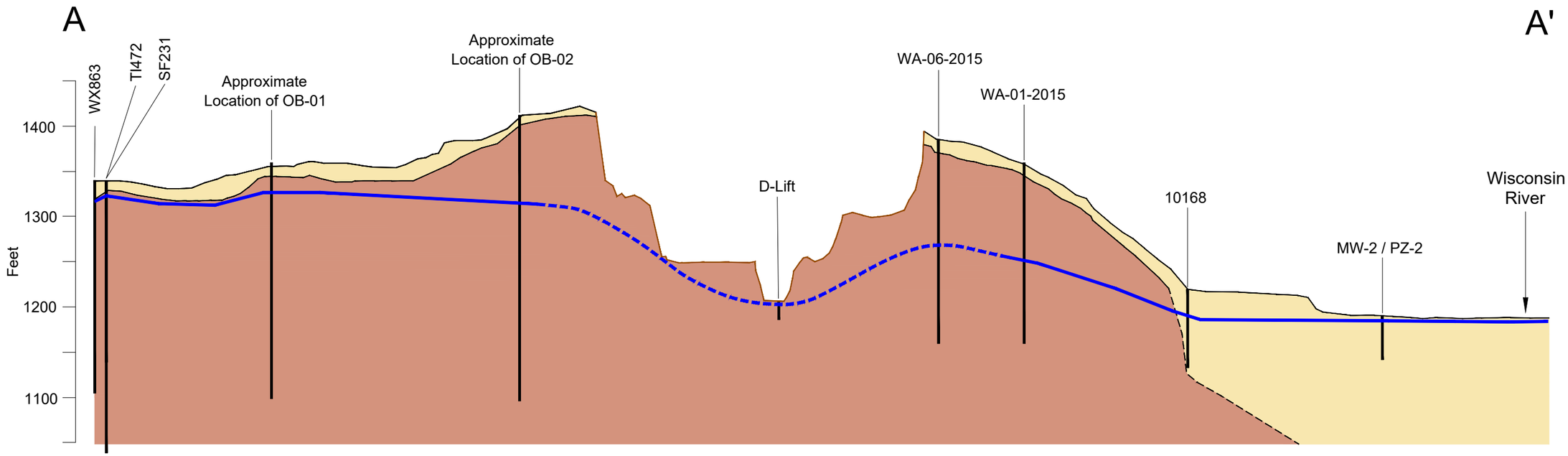
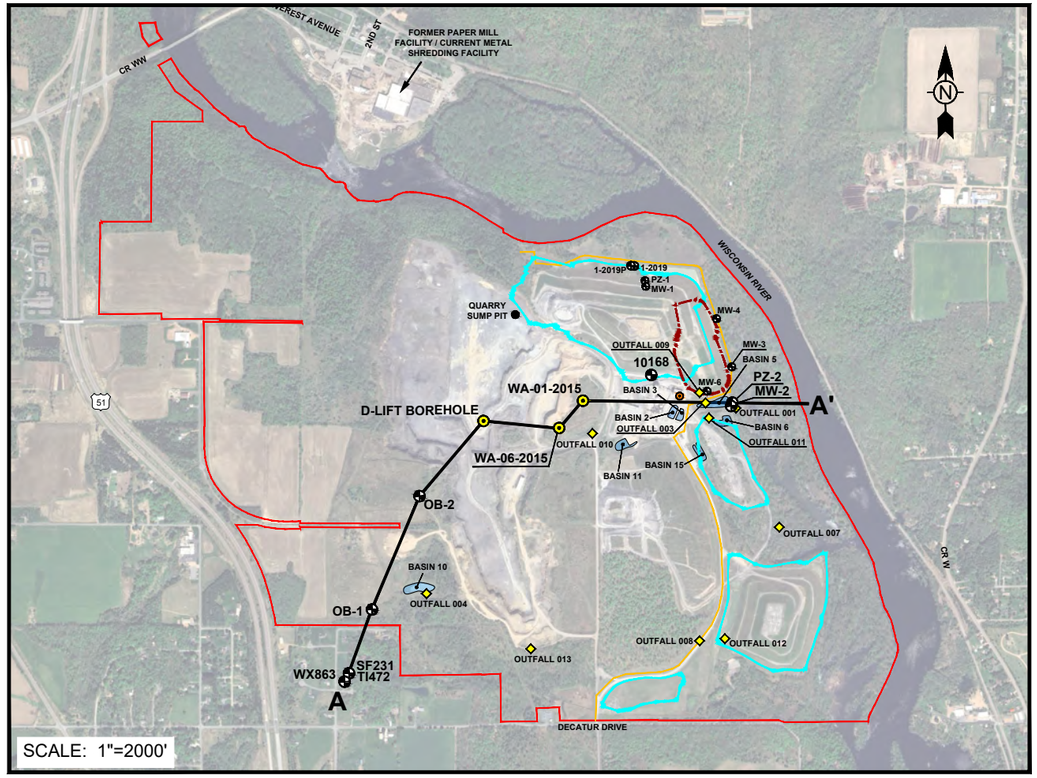
SITE DETAILS

Project No.:	117-001312-24010
Date:	05/21/25
Drawn By:	CP
Checked By:	CB

FIGURE
2





Wells

Interpolated water table

Inferred water table

Geology

Unconsolidated

Bedrock

0 300 600 1200

Horizontal Scale in Feet
5x Vertical Exaggeration

Figure derived from Hydrogeologic Investigation Report - BARR Engineering, 2017

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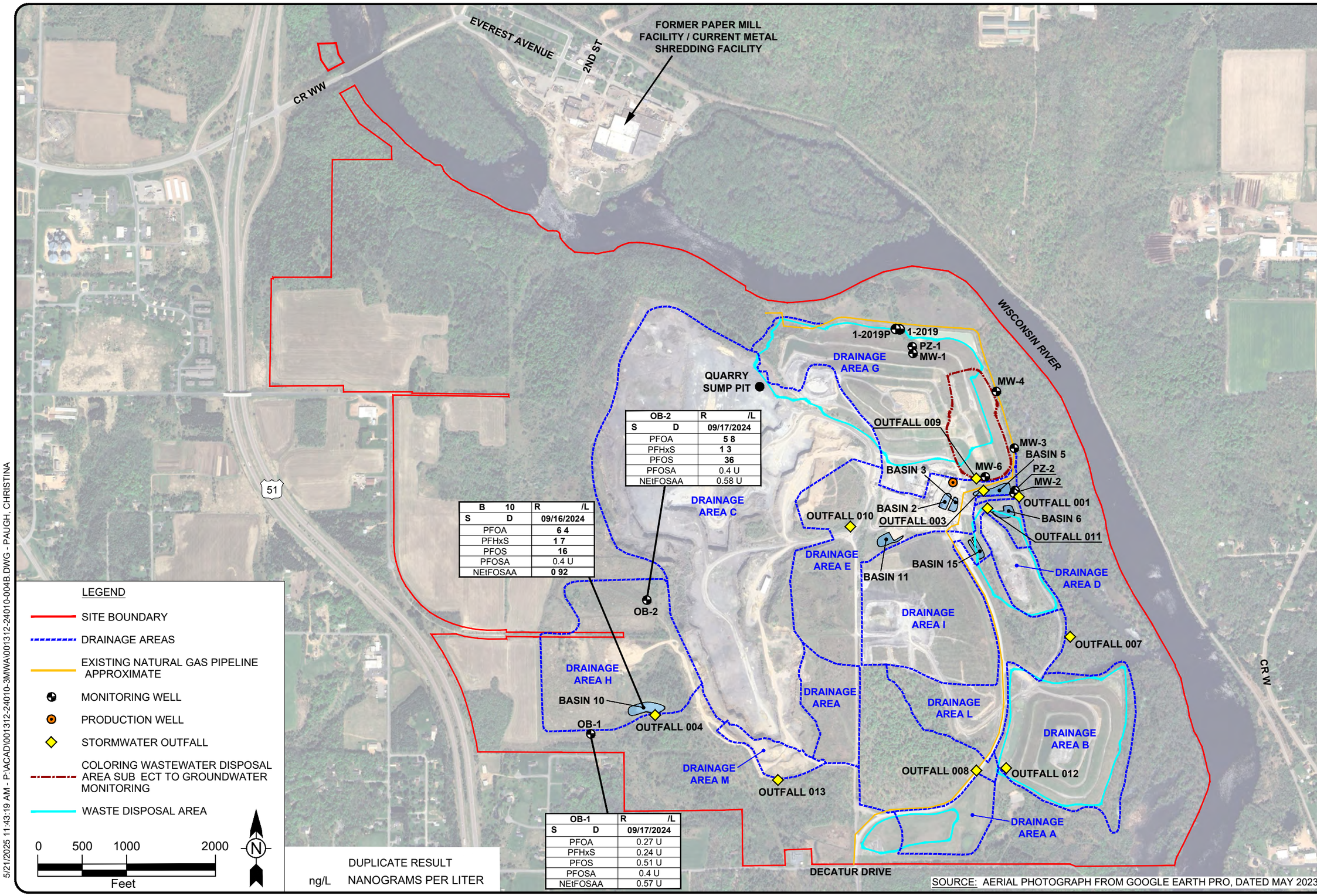
CURRENT CONDITIONS
GEOLOGIC CROSS SECTION

Project No.:	117-001312-25006
Date:	06/06/25
Drawn By:	CP
Checked By:	CB

FIGURE
1

Bar Measures 1 inch

6/6/2025 1:20:39 PM - P:\ACAD\001312-25006-3MWA\001312-25006-001A.DWG - PAUGH, CHRISTINA



OB-2	R /L
S D	09/17/2024
PFOA	5 8
PFHxS	1 3
PFOS	36
PFOSA	0.4 U
NEtFOSAA	0.58 U

B 10	R /L
S D	09/16/2024
PFOA	6 4
PFHxS	1 7
PFOS	16
PFOSA	0.4 U
NEtFOSAA	0 92

OB-1	R /L
S D	09/17/2024
PFOA	0.27 U
PFHxS	0.24 U
PFOS	0.51 U
PFOSA	0.4 U
NEtFOSAA	0.57 U

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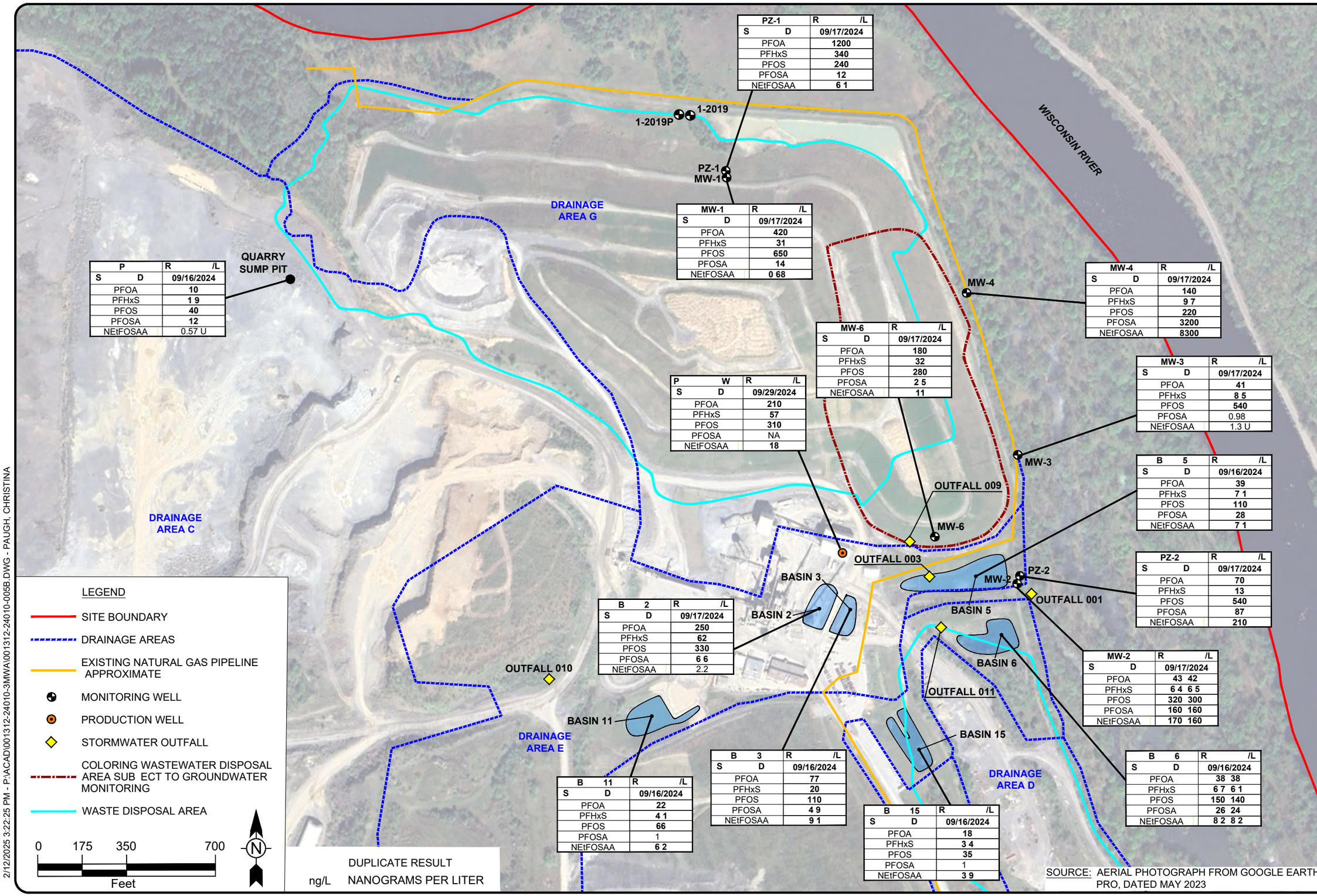
WESTERN ANALYTICAL RESULTS

Project No.:	117-001312-24010
Date:	05/21/25
Drawn By:	CP
Checked By:	CB

FIGURE
4

Bar Measures 1 inch

5/21/2025 11:43:19 AM - P:\ACAD\001312-24010-3MWA\001312-24010-004B.DWG - PAUGH, CHRISTINA



PZ-1	R /L
S D	09/17/2024
PFOA	1200
PFHxS	340
PFOS	240
PFOSA	12
NEtFOSAA	6 1

MW-1	R /L
S D	09/17/2024
PFOA	420
PFHxS	31
PFOS	650
PFOSA	14
NEtFOSAA	0 68

P	R /L
S D	09/16/2024
PFOA	10
PFHxS	1 9
PFOS	40
PFOSA	12
NEtFOSAA	0.57 U

MW-4	R /L
S D	09/17/2024
PFOA	140
PFHxS	9 7
PFOS	220
PFOSA	3200
NEtFOSAA	8300

MW-6	R /L
S D	09/17/2024
PFOA	180
PFHxS	32
PFOS	280
PFOSA	2 5
NEtFOSAA	11

P W	R /L
S D	09/29/2024
PFOA	210
PFHxS	57
PFOS	310
PFOSA	NA
NEtFOSAA	18

MW-3	R /L
S D	09/17/2024
PFOA	41
PFHxS	8 5
PFOS	540
PFOSA	0.98
NEtFOSAA	1.3 U

B 5	R /L
S D	09/16/2024
PFOA	39
PFHxS	7 1
PFOS	110
PFOSA	28
NEtFOSAA	7 1

PZ-2	R /L
S D	09/17/2024
PFOA	70
PFHxS	13
PFOS	540
PFOSA	87
NEtFOSAA	210

MW-2	R /L
S D	09/17/2024
PFOA	43 42
PFHxS	6 4 6 5
PFOS	320 300
PFOSA	160 160
NEtFOSAA	170 160

B 6	R /L
S D	09/16/2024
PFOA	38 38
PFHxS	6 7 6 1
PFOS	150 140
PFOSA	26 24
NEtFOSAA	8 2 8 2

B 2	R /L
S D	09/17/2024
PFOA	250
PFHxS	62
PFOS	330
PFOSA	6 6
NEtFOSAA	2.2

B 3	R /L
S D	09/16/2024
PFOA	77
PFHxS	20
PFOS	110
PFOSA	4 9
NEtFOSAA	9 1

B 11	R /L
S D	09/16/2024
PFOA	22
PFHxS	4 1
PFOS	66
PFOSA	1
NEtFOSAA	6 2

B 15	R /L
S D	09/16/2024
PFOA	18
PFHxS	3 4
PFOS	35
PFOSA	1
NEtFOSAA	3 9

LEGEND

- SITE BOUNDARY
- DRAINAGE AREAS
- EXISTING NATURAL GAS PIPELINE APPROXIMATE
- MONITORING WELL
- PRODUCTION WELL
- STORMWATER OUTFALL
- COLORING WASTEWATER DISPOSAL AREA SUB ECT TO GROUNDWATER MONITORING
- WASTE DISPOSAL AREA

0 175 350 700
Feet

N

DUPLICATE RESULT

ng/L NANOGRAMS PER LITER

SOURCE: AERIAL PHOTOGRAPH FROM GOOGLE EARTH PRO, DATED MAY 2023

Bar Measures 1 inch

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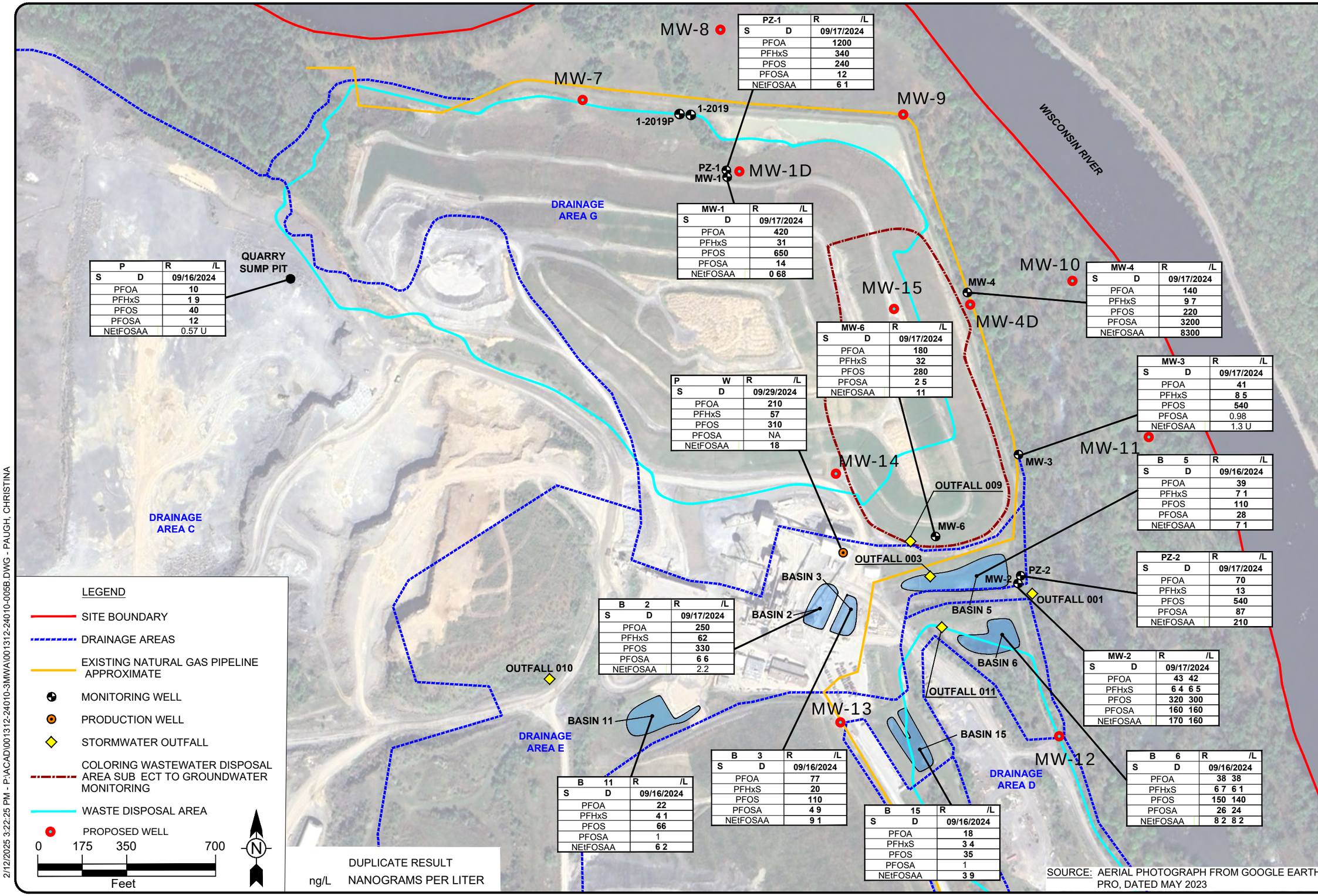
ANALYTICAL RESULTS - EAST

Project No.:	117-001312-24010
Date:	02/12/25
Drawn By:	CP
Checked By:	CB

FIGURE
5

2/12/2025 3:22:25 PM - P:\ACAD\001312-24010-3MWA\001312-24010-005B.DWG - PAUGH, CHRISTINA



PZ-1	R /L
S D	09/17/2024
PFOA	1200
PFHxS	340
PFOS	240
PFOSA	12
NEtFOSAA	6 1

MW-1	R /L
S D	09/17/2024
PFOA	420
PFHxS	31
PFOS	650
PFOSA	14
NEtFOSAA	0 68

P	R /L
S D	09/16/2024
PFOA	10
PFHxS	1 9
PFOS	40
PFOSA	12
NEtFOSAA	0.57 U

MW-4	R /L
S D	09/17/2024
PFOA	140
PFHxS	9 7
PFOS	220
PFOSA	3200
NEtFOSAA	8300

MW-6	R /L
S D	09/17/2024
PFOA	180
PFHxS	32
PFOS	280
PFOSA	2 5
NEtFOSAA	11

P W	R /L
S D	09/29/2024
PFOA	210
PFHxS	57
PFOS	310
PFOSA	NA
NEtFOSAA	18

MW-3	R /L
S D	09/17/2024
PFOA	41
PFHxS	8 5
PFOS	540
PFOSA	0.98
NEtFOSAA	1.3 U

B 5	R /L
S D	09/16/2024
PFOA	39
PFHxS	7 1
PFOS	110
PFOSA	28
NEtFOSAA	7 1

PZ-2	R /L
S D	09/17/2024
PFOA	70
PFHxS	13
PFOS	540
PFOSA	87
NEtFOSAA	210

B 2	R /L
S D	09/17/2024
PFOA	250
PFHxS	62
PFOS	330
PFOSA	6 6
NEtFOSAA	2.2

MW-2	R /L
S D	09/17/2024
PFOA	43 42
PFHxS	6 4 6 5
PFOS	320 300
PFOSA	160 160
NEtFOSAA	170 160

B 11	R /L
S D	09/16/2024
PFOA	22
PFHxS	4 1
PFOS	66
PFOSA	1
NEtFOSAA	6 2

B 3	R /L
S D	09/16/2024
PFOA	77
PFHxS	20
PFOS	110
PFOSA	4 9
NEtFOSAA	9 1

B 15	R /L
S D	09/16/2024
PFOA	18
PFHxS	3 4
PFOS	35
PFOSA	1
NEtFOSAA	3 9

B 6	R /L
S D	09/16/2024
PFOA	38 38
PFHxS	6 7 6 1
PFOS	150 140
PFOSA	26 24
NEtFOSAA	8 2 8 2

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PROPOSED ALLUVIAL WELLS

Project No.:	117-001312-24010
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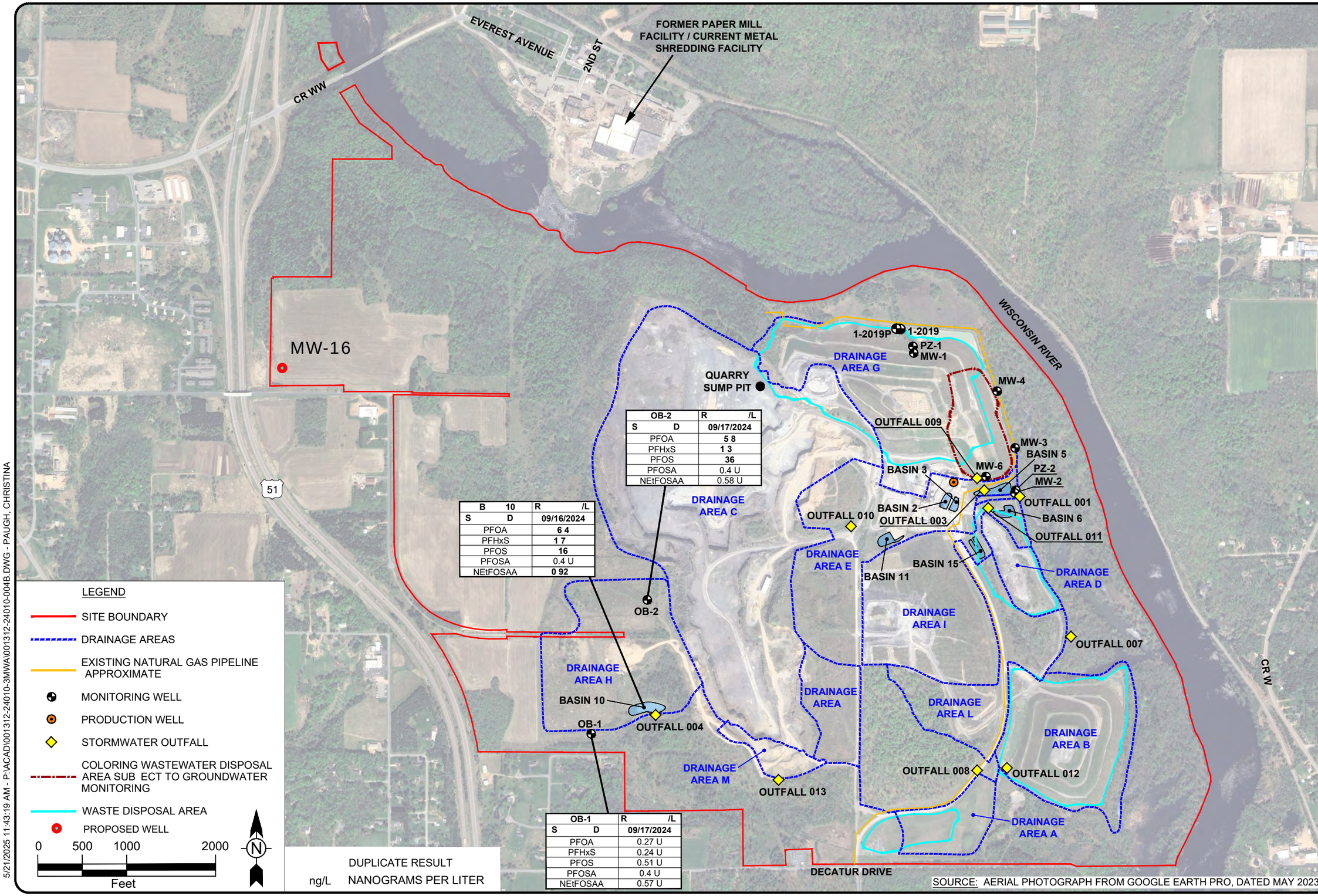
Checked By:	CB

FIGURE
6

2/12/2025 3:22:25 PM - P:\ACAD\001312-24010-3MWA\001312-24010-005B.DWG - PAUGH, CHRISTINA



OB-2	R /L
S D	09/17/2024
PFOA	5 8
PFHxS	1 3
PFOS	36
PFOSA	0.4 U
NEtFOSAA	0.58 U

B 10	R /L
S D	09/16/2024
PFOA	6 4
PFHxS	1 7
PFOS	16
PFOSA	0.4 U
NEtFOSAA	0 92

OB-1	R /L
S D	09/17/2024
PFOA	0.27 U
PFHxS	0.24 U
PFOS	0.51 U
PFOSA	0.4 U
NEtFOSAA	0.57 U

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PROPOSED BEDROCK WELL

Project No.:	117-001312-24010
Date:	05/21/25
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FIGURE
7

Bar Measures 1 inch

5/21/2025 11:43:19 AM - P:\ACAD\001312-24010-3MWA\001312-24010-004B.DWG - PAUGH, CHRISTINA

Tables

Table 1 - Groundwater and Stormwater Basin Sampling Details

3M Greystone - Site Investigation Work Plan

Wausau, Wisconsin

Sample Location	Latitude	Longitude	Sampling Date	Temp (°C)	Specific Conductance	DO (mg/L)	pH (S.U.)	ORP (mV)	Turb (NTU)	Approx Pump Rate (mL/min)	Depth to Water (ft. below TOC) 9/17/2024	Reference Elevation TOC[14] (ft AMSL)	Total Well Depth (ft. below TOC) 9/17/2024	Groundwater Elevation (ft. AMSL)	Sampling Method
				Low-Flow Parameter Stabilization Criteria											
				3%	3%	10%	0.1	10 mV	10%						
MW-1	-89.63709	45.018269	9/17/2024	11.6	0.264	8.04	6.50	165.1	5.71	220	20.52	1207.35	27.70	1,186.83	Low-Flow
MW-2	-89.63485	45.014166	9/17/2024	15.5	0.307	-0.40	7.27	-79.5	30.00	230	22.78	1211.44	32.00	1,188.66	Low-Flow
MW-3	-89.635049	45.015806	9/17/2024	12.4	0.915	6.65	7.33	137.4	8.61	NA	33.20	1221.26	43.40	1,188.06	Bailer
MW-4	-89.635737	45.017439	9/17/2024	11.8	0.745	0.27	7.03	-39.7	2.08	170	20.62	1206.81	29.40	1,186.19	Low-Flow
MW-6	-89.636168	45.014693	9/17/2024	16.6	0.337	9.61	7.76	114.9	135.69	NA	41.19	1229.71	49.11	1,188.52	Bailer
PZ-1	-89.637118	45.018395	9/17/2024	11.0	0.925	0.55	6.47	150.9	17.68	300	20.50	NM	43.70	NM	Low-Flow
PZ-2	-89.634847	45.014177	9/17/2024	12.7	0.439	0.47	7.13	-98.3	2.38	290	23.48	NM	48.40	NM	Low-Flow
OB-1	-89.653568	45.006743	9/17/2024	14.1	0.213	0.78	7.91	-30.7	1.04	NA	35.73	NM	NM	NM	Bailer
OB-2	-89.651501	45.01089	9/17/2024	NM	NM	NM	NM	NM	NM	NA	NM	NM	NM	NM	Bailer
Basin02	-89.637829	45.013761	9/16/2024	*Not Measured*							NA	NA	NA	NA	Grab
Basin03	-89.637373	45.01373	9/16/2024	*Not Measured*							NA	NA	NA	NA	Grab
Basin05	-89.636207	45.014164	9/16/2024	*Not Measured*							NA	NA	NA	NA	Grab
Basin06	-89.634812	45.013688	9/16/2024	*Not Measured*							NA	NA	NA	NA	Grab
Basin10	-89.650256	45.007742	9/16/2024	*Not Measured*							NA	NA	NA	NA	Grab
Basin11	-89.640728	45.012851	9/16/2024	*Not Measured*							NA	NA	NA	NA	Grab
Basin15	-89.636545	45.012425	9/16/2024	*Not Measured*							NA	NA	NA	NA	Grab
Pit	-89.642443	45.0156	9/16/2024	*Not Measured*							NA	NA	NA	NA	Grab

Notes:

1. Temp (°C) = Temperature in degrees Celsius
2. pH (S.U.) = pH represented in pH units
3. Specific Conductance (mS/cm) = Conductivity represented in microsiemens per centimeter
4. ORP (mV) = Oxidation reduction potential represented in millivolts
5. DO (mg/L) = Dissolved oxygen represented in milligrams per liter
6. Turb (NTU) = Turbidity represented in nepholometeric turbidity units
7. mL/min = milliliters per minute
8. NA = not applicable
9. NM = not measured
10. ft. AMSL = feet above mean sea level
11. ft. below TOC = feet below the top of well casing
12. ft. BGS = feet below ground surface
13. NS = Not Sampled
14. Reference elevations calculated from January 2000 Waste Disposal Operations and Reclamation Plan Vol. II

Table 2 - Groundwater and Stormwater Basin Analytical Results

3M Greystone - Site Investigation Work Plan

Wausau, WI

			Carboxylates/Carboxylic Acids (PFCA)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA/PFUdA/PFDA)	Perfluorododecanoic acid (PFDoA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluoroalkyl Sulfonates/Sulfonic Acids (PFSA)	Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorononane sulfonic acid (PFNS)	Perfluorodecane sulfonic acid (PFDS)	Perfluorododecanesulfonic acid (PFDoS)	Perfluoroalkane Sulfonamides / Sufonamidoacetic Acids, Sulfonamidoethanols (FASA)	Perfluorooctane sulfonamide (PFOSA)	N-methyl perfluorooctane sulfonamide (NMeFOSA)	N-ethyl perfluorooctane sulfonamide (NEtFOSA)	N-methyl perfluorooctane sulfonamidoacetic acid (NMeFOSAA)	N-ethyl perfluorooctane sulfonamidoacetic acid (NEtFOSAA)	N-methyl perfluorooctane sulfonamidoethanol (NMeFOSE)	N-ethyl perfluorooctane sulfonamidoethanol (NEtFOSE)	Fluorotelomer Substances (FTS)	4:2 Fluorotelomer sulfonic acid (4:2FTS)	6:2 Fluorotelomer sulfonic acid (6:2FTS)	8:2 Fluorotelomer sulfonic acid (8:2FTS)	Replacement Chemicals	Hexafluoropropylene oxide dimer acid (HFPO-DA)	4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
		Units		ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L		ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L		ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L		ng/L	ng/L	ng/L		ng/L	ng/L	ng/L	ng/L
Prod Well	**9/29/2023**			NA	NA	**22**	**33**	**210**	**1**	0.33 U	0.30 U	0.23 U	0.43 U	0.34 U		**8.0**	NA	**57**	NA	**310**	NA	NA	NA		*NA*	0.40 U	*NA*	*NA*	**18**	*NA*	*NA*		*NA*	*NA*	*NA*		0.41 U	0.37 U	0.34 U	0.31 U
MW-1	**9/17/2024**	10:15		**4**	**2.6**	**8.7**	**23**	**420**	**2**	0.25 U	0.64 U	0.43 U	0.28 U	0.36 U		**5.8**	**8.9**	**31**	**89**	**650**	0.47 U	0.57 U	0.53 U		**14**	0.62 U	0.45 U	0.78 U	**0.68** J	0.48 U	0.6 U		0.36 U	**1.5** J	0.79 U		0.25 U	0.32 U	0.35 U	0.4 U
MW-2	**9/17/2024**	13:35		**6.2**	**2** J	**4.3**	**6.1**	**43**	**0.73** J	0.5 U	1.3 U	0.86 U	0.56 U	0.71 U		**1.4** J	**1.6** J	**6.4**	**2.4** J	**320**	**1.7** J	1.1 U	1.1 U		**160**	1.2 U	0.9 U	1.5 U	**170**	0.95 U	1.2 U		0.72 U	**2.2** J	1.6 U		0.5 U	0.63 U	0.7 U	0.8 U
	9/17/2024*	13:45		**6.5**	**2.1** J	**4.4**	**6.1**	**42**	**0.67** J	0.48 U	1.2 U	0.84 U	0.55 U	0.7 U		**1.4** J	**1.5** J	**6.5**	**2.4** J	**300**	**1.9** J	1.1 U	1 U		**160**	1.2 U	0.88 U	1.5 U	**160**	0.93 U	1.2 U		0.7 U	**1.2** J	1.5 U		0.49 U	0.62 U	0.68 U	0.79 U
MW-3	**9/17/2024**	12:40		**9.5**	**8.9**	**17**	**13**	**41**	**1.3** J	0.48 U	1.2 U	0.83 U	**0.58** J	0.69 U		**7.6**	**4.8**	**8.5**	**1.9** J	**540**	0.91 U	1.1 U	1 U		**0.98** J	1.2 U	0.87 U	1.5 U	1.3 U	0.92 U	1.2 U		0.7 U	1.1 U	1.5 U		0.48 U	0.62 U	0.68 U	0.78 U
MW-4	**9/17/2024**	11:50		**7.7**	**3.8**	**12**	**49**	**140**	**1.1** J	**0.27** J	0.66 U	**0.61** J	0.29 U	0.37 U		**2.3**	**2.4**	**9.7**	**2**	**220**	**1.7** J	**1.5** J	0.55 U		**3200**	0.64 U	9.4 U	**49**	**8300**	0.5 U	0.62 U		0.37 U	0.59 U	0.81 U		0.26 U	0.33 U	0.36 U	0.42 U
MW-6	**9/17/2024**	17:00		**11**	**7.2**	**9.6**	**14**	**180**	**0.68** J	0.49 U	1.3 U	0.85 U	0.56 U	0.71 U		**3.3** J	**4.6**	**32**	**5.7**	**280**	0.93 U	1.1 U	1 U		**2.5** J	1.2 U	0.9 U	1.5 U	**11**	0.95 U	1.2 U		0.72 U	**2.7** J	1.6 U		0.5 U	0.63 U	0.7 U	0.8 U
PZ-1	**9/17/2024**	10:44		**34**	**49**	**180**	**340**	**1200**	**1.4** J	0.27 U	0.69 U	0.47 U	0.31 U	0.39 U		**78**	**170**	**340**	**16**	**240**	0.51 U	0.62 U	0.58 U		**12**	0.68 U	0.49 U	0.85 U	**6.1**	0.52 U	0.65 U		0.39 U	**1.1** J	0.86 U		0.27 U	0.35 U	0.38 U	0.44 U
PZ-2	**9/17/2024**	14:05		**9.6**	**4.7**	**5.3**	**8.7**	**70**	**0.89** J	0.48 U	1.2 U	0.82 U	0.54 U	0.69 U		**3** J	**3.4** J	**13**	**4.3**	**540**	1 J	1.1 U	1 U		**87**	1.2 U	**6**	1.5 U	**210**	0.92 U	1.1 U		0.69 U	1.1 U	1.5 U		0.48 U	0.61 U	0.67 U	0.78 U
OB-1	**9/17/2024**	16:00		**4.9**	**19**	**22**	**0.52** J	0.27 U	0.21 U	0.25 U	0.64 U	0.44 U	0.28 U	0.36 U		0.2 U	0.26 U	0.24 U	0.64 U	0.51 U	0.48 U	0.57 U	0.54 U		0.4 U	0.63 U	0.46 U	0.79 U	0.57 U	0.49 U	0.61 U		0.37 U	0.58 U	0.8 U		0.25 U	0.32 U	0.36 U	0.41 U
OB-2	**9/17/2024**	14:55		**1.6** J	**0.43** J	**0.61** J	**0.82** J	**5.8**	0.21 U	0.25 U	0.65 U	0.44 U	0.29 U	0.37 U		**0.41** J	0.26 U	**1.3** J	0.64 U	**36**	0.48 U	0.58 U	0.54 U		0.4 U	0.64 U	0.46 U	0.79 U	0.58 U	0.49 U	0.61 U		0.37 U	0.58 U	0.8 U		0.26 U	0.33 U	0.36 U	0.41 U
Basin02	**9/17/2024**	13:45		**33**	**27**	**25**	**34**	**250**	**1.7** J	**0.26** J	0.64 U	0.43 U	0.28 U	0.36 U		**25**	**11**	**62**	**9.8**	**330**	0.47 U	0.57 U	0.53 U		**6.6**	0.63 U	0.46 U	0.78 U	2.2	**0.49** J	0.6 U		0.36 U	**3.6**	0.79 U		0.25 U	0.32 U	0.35 U	0.41 U
Basin03	**9/16/2024**	13:36		**8.5**	**9.7**	**7.2**	**8.7**	**77**	**0.71** J	0.25 U	0.65 U	0.44 U	0.29 U	0.36 U		**4**	**3.4**	**20**	**3.8**	**110**	0.48 U	0.57 U	0.54 U		**4.9**	0.63 U	0.46 U	0.79 U	**9.1**	0.49 U	0.61 U		0.37 U	**0.62** J	0.8 U		0.25 U	0.32 U	0.36 U	0.41 U
Basin05	**9/16/2024**	14:40		**6.1**	**1.7** J	**2.9**	**5.5**	**39**	**0.51** J	0.25 U	0.63 U	0.43 U	0.28 U	0.36 U		**1.9**	**1.7** J	**7.1**	**1.9**	**110**	0.47 U	0.56 U	0.53 U		**28**	0.62 U	0.45 U	0.77 U	**7.1**	0.48 U	0.59 U		0.36 U	**2.3**	0.78 U		0.25 U	0.32 U	0.35 U	0.4 U
Basin06	**9/16/2024**	13:58		**10**	**1.8** J	**2.8**	**5**	**38**	**0.62** J	0.25 U	0.63 U	0.43 U	0.28 U	0.36 U		**1.8** J	**1.5** J	**6.7**	**1.6** J	**150**	0.47 U	0.56 U	0.53 U		**26**	0.62 U	0.45 U	0.77 U	**8.2**	0.48 U	0.59 U		0.36 U	0.57 U	0.78 U		0.25 U	0.32 U	0.35 U	0.4 U
	9/16/2024*	14:00		**11**	**1.7** J	**3**	**4.4**	**38**	**0.62** J	0.25 U	0.64 U	0.44 U	0.28 U	0.36 U		**1.8**	**1.4** J	**6.1**	**1.7** J	**140**	0.48 U	0.57 U	0.54 U		**24**	0.63 U	0.46 U	0.79 U	**8.2**	**0.61** J	0.6 U		0.37 U	0.58 U	0.8 U		0.25 U	0.32 U	0.36 U	0.41 U
Basin10	**9/16/2024**	15:15		**5.6**	**2.4**	**0.56** J	**0.76** J	**6.4**	**0.24** J	0.25 U	0.65 U	0.44 U	0.29 U	0.37 U		**0.72** J	**0.42** J	**1.7** J	0.64 U	**16**	0.48 U	0.57 U	0.54 U		0.4 U	0.63 U	0.46 U	0.79 U	**0.92** J	0.49 U	0.61 U		0.37 U	0.58 U	0.8 U		0.25 U	0.32 U	0.36 U	0.41 U
Basin11	**9/16/2024**	13:08		**12**	**1.5** J	**1.9** J	**2.7**	**22**	**0.63** J	0.26 U	0.66 U	0.44 U	0.29 U	0.37 U		**1.5** J	**1.1** J	**4.1**	**1.2** J	**66**	0.49 U	0.58 U	0.55 U		**1** J	0.64 U	0.47 U	0.8 U	**6.2**	0.49 U	0.62 U		0.37 U	0.59 U	0.81 U		0.26 U	0.33 U	0.36 U	0.42 U
Basin15	**9/16/2024**	13:20		**19**	**4.9**	**2.8**	**3.1**	**18**	**0.6** J	0.25 U	0.63 U	0.43 U	0.28 U	0.36 U		**1.7** J	**0.84** J	**3.4**	**0.73** J	**35**	0.47 U	0.56 U	0.53 U		**1** J	0.62 U	0.45 U	0.77 U	**3.9**	0.48 U	0.6 U		0.36 U	0.57 U	0.78 U		0.25 U	0.32 U	0.35 U	0.4 U
Pit	**9/16/2024**	15:45		**5.1**	**0.5** J	**0.85** J	**1.5** J	**10**	0.34 U	0.25 U	0.64 U	0.43 U	0.28 U	0.36 U		**0.75** J	**0.51** J	**1.9**	0.63 U	**40**	0.48 U	0.57 U	0.54 U		**12**	0.63 U	0.46 U	0.78 U	0.57 U	0.48 U	0.6 U		0.36 U	0.57 U	0.79 U		0.26 U	0.32 U	0.35 U	0.41 U

Notes:

1. PFAS laboratory analysis was completed utilizing EPA Method 537.1 Modified
2. ng/L = nanogram per liter
3. -- = Criteria Not Established
4. **Bold** values signify a detection
5. U = Not detected above laboratory reporting limit
6. J = The reported result is an estimated value
7. * = Duplicate sample

Table 3 – Proposed Well Depths and Purpose

Well Name	Depth*	Purpose
MW-7	30 ft	Delineation west of MW-1, refinement of potentiometric surface, evaluation of potential off-site contributor
MW-8	30 ft	Delineation north of MW-1, refinement of potentiometric surface, evaluation of potential off-site contributor
MW-9	30 ft	Delineation west of MW-1 & north of MW-4, refinement of potentiometric surface, evaluation of potential off-site contributor
MW-10	30 ft	Delineation east of MW-4, refinement of potentiometric surface, evaluation of potential off-site contributor
MW-11	30 ft	Delineation east of MW-2 & MW-3, refinement of potentiometric surface, evaluation of potential off-site contributor
MW-12	30 ft	Delineation south of MW-2, refinement of potentiometric surface, evaluation of potential on-site source area
MW-13	35 ft	Delineation southwest of MW-2 and MW-6, refinement of potentiometric surface, evaluation of potential on-site source area
MW-14	35 ft	Delineation west of MW-3 & southwest of MW-4, refinement of potentiometric surface, evaluation of potential on-site source area
Deep Delineation Wells		
MW-4D	45 ft	Vertical delineation of MW-4, refinement of potentiometric surface, evaluation of potential off-site source area
MW-1D	60 ft	Vertical Delineation of MW-1/PZ-1, evaluation of potential off-site source area

** Well depths indicated assume bedrock is not encountered prior to target depth*

Table 4 – Groundwater Sample Collection Names

Well ID	Depth	Status	Sample Name
MW-1	Shallow (20.52 ft bgs)	Existing	MEWI-GW-MW1-0-YYMMDD
MW-1D	Deep (60 ft bgs)	New	MEWI-GW-MW1D-0-YYMMDD
MW-2	Shallow (32 ft bgs)	Existing	MEWI-GW-MW2-0-YYMMDD
MW-3	Shallow (43.4 ft bgs)	Existing	MEWI-GW-MW3-0-YYMMDD
MW-4*	Shallow (29.4 ft bgs)	Existing	MEWI-GW-MW4-0-YYMMDD
MW-4D	Deep (45 ft bgs)	New	MEWI-GW-MW4D-0-YYMMDD
MW-6	Deep (49.11 ft bgs)	Existing	MEWI-GW-MW6-0-YYMMDD
MW-7	Shallow (30 ft bgs)	New	MEWI-GW-MW7-0-YYMMDD
MW-8	Shallow (30 ft bgs)	New	MEWI-GW-MW8-0-YYMMDD
MW-9	Shallow (30 ft bgs)	New	MEWI-GW-MW8-0-YYMMDD
MW-10	Shallow (30 ft bgs)	New	MEWI-GW-MW10-0-YYMMDD
MW-11	Shallow (30 ft bgs)	New	MEWI-GW-MW11-0-YYMMDD
MW-12	Shallow (30 ft bgs)	New	MEWI-GW-MW12-0-YYMMDD
MW-13	Shallow (35 ft bgs)	New	MEWI-GW-MW13-0-YYMMDD
MW-14*	Deep (35 ft bgs)	New	MEWI-GW-MW14-0-YYMMDD
MW-15	Shallow (70 ft bgs)	New	MEWI-GW-MW15-0-YYMMDD
MW-16	Bedrock (100 ft bgs)	New	MEWI-GW-MW16-0-YYMMDD
OB-1	Deep Bedrock (261 ft bgs)	Existing	MEWI-GW-OB1-0-YYMMDD
OB-2	Deep Bedrock (316 ft bgs)	Existing	MEWI-GW-OB2-0-YYMMDD
PZ-1	Shallow (43.7 ft bgs)	Existing	MEWI-GW-PZ1-0-YYMMDD
PZ-2	Shallow (48.4 ft bgs)	Existing	MEWI-GW-PZ2-0-YYMMDD

** Duplicate sample location*

Note: YYMMDD will be replaced with the year, month, and day of sampling (e.g., 250516 for May 16, 2025)

Table 5 – Surface Water Sample Collection Names

Basin ID	Sample Name
Basin02*	MEWI-GW-Basin02-0-YYMMDD
Basin03	MEWI-GW-Basin03-0-YYMMDD
Basin05	MEWI-GW-Basin05-0-YYMMDD
Basin06	MEWI-GW-Basin06-0-YYMMDD

** Duplicate sample location*

Note: YYMMDD will be replaced with the year, month, and day of sampling (e.g., 250516 for May 16, 2025)

Appendix A
Field Standard Operating Procedures for PFAS and Other Activities

SOP 1

Sample Acquisition for Per- and Polyfluoroalkyl Substances (PFAS)

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the methods and protocols to be used for collecting and handling samples to be analyzed for Per- and Polyfluoroalkyl substances (PFAS). PFAS are present in many consumer products including some typical sampling equipment and are ubiquitous in the environment. Because regulatory screening criteria are very low, measurements of very low PFAS concentrations are required. These two conditions make the collection of samples for accurate quantitation of PFAS concentrations difficult unless special precautions are taken to avoid introducing contaminants into the samples. Instructions are provided herein for collection of environmental samples without contaminating them. This SOP is designed to supplement but not replace existing sampling SOPs. In addition, some clients and/or projects may have specific PFAS-related sampling requirements that extend beyond the procedures described in this SOP.

2.0 SCOPE AND APPLICABILITY

This document provides information on proper sampling equipment and techniques for groundwater, surface water, sediment, and soil sampling for PFAS analysis. Sampling of air or biota is not addressed in this SOP, but the same principles would apply for those media.

3.0 BACKGROUND

PFAS have been used since the 1940s as manufacturer-applied oil and water repellants on products such as clothing, upholstery, paper, and carpets; and in making fluoropolymers for non- stick cookware. They are found in textiles and leather products, mist suppressants for metal plating, the photography industry, photolithography, semi-conductors, paper and packaging coatings, cleaning products, pesticides, and cosmetics. They have been used in well-known consumer products including Teflon®, StainMaster®, Scotchgard®, and GoreTex®. In the 1960s, aqueous film-forming foam (AFFF) containing PFAS was developed for fighting flammable liquid fires, particularly petroleum-fueled (Class B) fires (ATSDR, 2009). The two most researched and most prevalent PFAS in the environment are perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) (ATSDR, 2009).

PFAS are persistent in the environment, tend to bioaccumulate, and demonstrate toxicity in laboratory animals, enough to raise concerns about their presence in the environment. Some areas where PFAS may have been released to the environment include the following:

- Firefighting training areas
- Areas where firefighting products/materials are stored
- Aircraft crash sites

- Metal coating and plating facilities
- Water treatment systems and receiving water bodies
- Airport hangars and other facilities storing fire-fighting foams
- Fluorochemical manufacturing, use, and disposal facilities

PFAS are ubiquitous in consumer products and some materials used in environmental sampling (Teflon® tubing, waterproof logbooks, or GoreTex® field clothing). There are many potential sources of PFAS that are independent of media being sampled; therefore, it is essential to take special precautions to minimize the potential for contaminating environmental samples with PFAS during collection and handling. Laboratory detection limits are low for these compounds and contact of sample material or sampling equipment with any one of the multitude of PFAS sources could result in detectable contamination. In addition, PFAS tend to adsorb to glass so glass sample collection containers are inappropriate. Adsorption to glass sample containers may result in a low bias for measured PFAS concentrations.

Collection and analysis of Quality Control blanks is an important aspect of verifying that samples have not been contaminated during sample collection and handling. Use of additional blanks or blanks of a different type than usual may be required. Consult Section 7.7 of this SOP for instructions regarding collection of field reagent blanks (FRBs).

4.0 DEFINITIONS AND ABBREVIATIONS

AFFF – Aqueous film-forming foam.

FRB – Field Reagent Blank. A blank sample prepared in the field by transferring laboratory- supplied, chemically-preserved deionized water to an empty, laboratory-supplied collection bottle. FRBs are typically analyzed only for PFAS and are treated as a site sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all PFAS analytical procedures. The purpose of FRBs is to indicate whether PFAS measured in corresponding site samples may have been introduced during sample collection and handling.

PFAS – Per- and polyfluoroalkyl Substances. A reference term currently in use, replacing “PFCs” in recent scientific and other technical literature. The term is inclusive of both perfluorinated chemicals like PFOA and PFOS and polyfluoroalkyl substances like fluorinated telomers.

PFOA – Perfluorooctanoic Acid. PFOA is used as an aqueous dispersion agent and in the manufacture of fluoropolymers (including Teflon®) that are used in industrial components such as electrical wire casings, fire- and chemical-resistant tubing, and plumbing seal tape. PFOA is used in surface treatment products to impart oil, stain, grease, and water resistance. PFOA can also be produced by the breakdown

of some fluorinated telomers.

PFOS – Perfluorooctane Sulfonate. PFOS was a key ingredient in Scotchgard® and used in the manufacture of Class B AFFF used per DoD military specifications.

5.0 SAFETY PRECAUTIONS

Sample acquisition activities shall be conducted in accordance health and safety requirements identified in the project-specific Health and Safety Plan (HASP), corporate health and safety policies, and individual sampling SOPs, as applicable.

6.0 PERSONNEL RESPONSIBILITIES, QUALIFICATIONS, AND TRAINING

Project Manager (PM) – The PM is responsible for determining sampling objectives, initial sampling locations, and field procedures used in the collection of samples of environmental media. Additionally, in consultation with other project personnel (geologist, hydrogeologist, etc.), the PM is responsible for selecting and detailing the specific sampling techniques, equipment to be used, and providing detailed input in this regard to the project planning documents. The PM has the overall responsibility for ensuring that sampling activities are properly conducted by appropriately trained staff.

Site Safety Officer (SSO) – The SSO (or a qualified designee) is responsible for providing the technical support necessary to implement the project HASP, AP or equivalent. The SSO or SSO designee may also be required to advise the Field Operations Leader (FOL) on safety-related matters regarding sampling, such as measures to mitigate potential hazards from hazardous objects or conditions. The SSO may be referred to as the Site Safety and Health Officer (SSHO).

Project Geologist/Sampler – The project geologist/sampler is responsible for the proper acquisition of samples in accordance with this SOP or other project-specific documents. In addition, this individual is responsible for the completion of all required paperwork (e.g., sample log sheets, field notebook, boring logs, container labels, custody seals, and chain-of-custody forms) associated with the collection of those samples.

Field Operations Leader (FOL) – This individual is primarily responsible for the execution of the field sampling program in accordance with the project planning documents. This is accomplished through management of a field sampling team for the proper acquisition of samples.

General personnel qualifications for environmental media sample collection include the following:

- Occupational Safety and Health Administration (OSHA) 40-hour HAZWOPER and applicable refresher training.

- Ability to perform field work under the expected physical and environmental (i.e., weather) conditions
- Familiarity with appropriate procedures for sample documentation, handling, packaging, and shipping
- Familiarity with chemical-specific requirements for collection and handling of samples for PFAS analysis as described in this procedure.
- Personnel implementing this SOP must read and understand this SOP prior to collection of samples designated for PFAS analysis.

7.0 PROCEDURES

All personnel involved in sample acquisition must strive to prevent contact of sample media with potential sources of PFAS contamination. Given the widespread use of PFAS in products including those typically preferred for environmental sampling, all samples for PFAS analysis are to be collected using precautions to avoid inadvertent contamination of the sample media. These precautions are identified below for selection of sampling equipment and general field equipment, field personnel clothing and protective gear, sample containers and sample handling activities.

7.1 Selection Of Equipment

It is important to research available equipment and materials at the planning stage to avoid last minute problems in the field; for example, ensuring compatibility of high-density polyethylene (HDPE) tubing with fittings for use in a peristaltic or other pump; or ensuring that equipment does not contain Teflon®.

Sampling Equipment:

- Avoid using any sampling equipment constructed of or containing polytetrafluoroethylene (PTFE) or Teflon® (DuPont brand name) or fluorinated ethylene propylene (FEP) during sample handling or mobilization/demobilization.
- Avoid using low-density polyethylene products (LDPE) if contamination from those products can be transferred to environmental samples or QC samples.
- Use sampling equipment made of stainless steel, acetate, silicone, high-density polyethylene (HDPE), or polypropylene. This applies to tubing, pumps and pump components, tape for plumbing fittings, trowels, mixing bowls or other equipment that could contact the sample media. Gasket and O-ring components of sampling equipment may contain fluoropolymers.

Non-Sampling Field Equipment:

- Avoid using waterproof field books or paper during sampling activities. Non-waterproof loose-leaf paper or notebooks are acceptable. Do not use plastic clipboards, binders, or spiral hard cover notebooks that may be coated; use Masonite or aluminum clipboards instead.
- Avoid using Post-it® notes or similar removable notes during sample handling or mobilization/demobilization activities.
- Avoid using Sharpies® or similar indelible markers; do use ball-point pens or pencils for note taking and sample bottle labeling.

Field Personnel Clothing and Protective Gear:

- Avoid wearing new clothing due to the possible treating of fabric with PFAS for stain resistance. Wear clothing made from natural fibers (e.g., cotton) to the extent possible. Clothing should have been washed at least several times between time of purchase and time of first use during sampling activities. Avoid using fabric softener when laundering clothing to be worn during sample collection.
- During wet weather, use rain gear made from polyurethane or wax-coated materials.
- Avoid wearing water-resistant (e.g., Gore-Tex® or similar material) clothing or footwear (i.e., boots) immediately prior to or during sample collection and management.
- Avoid wearing cosmetics, shampoos, moisturizers, or other similar personal hygiene products on the day of sampling.
- Use sunscreens and insect repellants with 100% natural ingredients. The following items are acceptable for use, but the suitability of these items has not been independently verified:
    - Sunscreens - Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss my face, Baby sunscreens that are “free” or “natural.”
    - Insect Repellents - Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect repellant, Herbal Armor, California Baby Natural Bug Spray, BabyGanics
    - Sunscreen and insect repellant - Avon Skin So Soft Bug Guard Plus – SPF 30 Lotion
- Avoid wearing Tyvek® suits.
- Wear un-powdered nitrile gloves at all times while collecting and handling samples and change gloves often.

- Avoid unnecessary contact with automobile upholstery that may have been treated with PFAS. If practical, cover clothing and skin that has been in contact with such upholstery within non-fluorinated clothing.

Sample Containers and Shipping Materials

- Avoid the use of glass sample containers, which are believed to result in loss of PFAS from samples through adsorption to the container.
- Collect samples in laboratory-supplied plastic bottles only, typically polypropylene or HDPE.
- Confirm that Teflon®-lined caps are not used in sample containers; unlined polypropylene screw caps must be used.
- Avoid using Blue Ice® or similar items to cool samples and avoid placing such items in sample coolers for shipping. Use commercially available (e.g., from convenience stores or supermarkets) double-bagged ice instead.

7.2 Other Precautions for Sample Handling

- Avoid handling or bringing pre-wrapped food or snacks (e.g., fast food, candy bars, microwave popcorn, etc.) into the sampling area before or during sampling, because many food and snack products are packaged in wrappers treated with PFAS. Only water or hydrating drinks (e.g., Gatorade) should be brought onsite or allowed in vehicles used for PFAS sampling activities.
- Wash hands thoroughly after handling fast food, carryout food, or snacks, or other items that may contain PFAS.
- Assume that shipping tape used for securing coolers could contain PFAS; therefore, take care not to transfer PFAS from tape to samples.

These precautions should be observed during sampling activities, especially during water sample collection (groundwater and surface water), given the high solubility of PFAS in water. Examples of how these precautions may be applied to sampling of specific media are provided in the following sections.

7.3 Groundwater Sample Acquisition

The precautions and requirements identified in the previous sections must be observed for groundwater sampling. Do not proceed any further without reviewing each of those precautions and requirements.

- Collect groundwater samples for PFAS analyses in accordance with this SOP, and/or project- or client-specific requirements.

- If non-dedicated, non-disposable equipment is used between sampling locations, it should be decontaminated with Alconox® or Liquinox®, unless 1,4-dioxane (a potential component of these detergents) is also a contaminant of concern. In that case Liquinox® should not be used. Products such as Decon 90 should not be used.
- If samples are to be collected for analysis of PFAS and other analytes, determine whether the same equipment can be used for all sample analyses. If Teflon® or LDPE materials are required for the non-PFAS analytes, then use multiple sets of equipment and determine a suitable sample collection sequence and protocol for collecting the groundwater samples for the analyte groups of interest. For example, purge and sample a monitoring well for PFAS first using a peristaltic pump with HDPE and silicone tubing. Then use a bladder pump with Teflon® tape on air-line fittings to purge the well and sample for VOCs with Teflon tubing, if the VOC protocol requires it. Or use silicone tubing for all parameters, if appropriate. Protocols and order of sampling should be clearly identified in the SAPs. If the sampling sequence is unclear, consult the FOL or Project Manager and record the actual sequence in the field notes.
- If tasked to sample monitoring wells that have or had dedicated Teflon® or FEP tubing that potentially contained PFAS, after removing the tubing, evacuate at least one well volume prior to sampling using silicone or HDPE tubing. This will ensure that standing water that was in contact with the tubing is removed from the water column prior to sampling.

7.4 Soil Sample Acquisition

The precautions and requirements identified in Sections 7.1 and 7.2 must be observed for soil sampling. Do not proceed any further without reviewing each of those precautions and requirements.

- Collect soil samples for PFAS analyses in accordance with this SOP, and/or project- or client-specific requirements.
- Soil sampling equipment should not be constructed of or contain Teflon® materials. Acceptable materials for sampling include stainless steel, acetate, or polypropylene. If non-dedicated, non-disposable equipment is used between sample locations, it should be decontaminated with Alconox® or Liquinox®.
- Collect samples in laboratory-provided containers specifically designated for PFAS analysis. Do not use glass jars typically used for soil sample collection.

7.5 Surface Water and Sediment Sample Acquisition

The precautions and requirements identified in Sections 7.1 and 7.2 must be observed for surface water

and sediment sampling. Do not proceed any further without reviewing each of those precautions and requirements.

- Collect surface water and sediment samples for PFAS analysis in accordance with this SOP, and/or project- or client-specific requirements.
- Surface water and sediment samples should be collected in laboratory-supplied bottleware specifically designated for PFAS analysis (not glass). If transfer bottles are required for collection of surface water samples, the transfer bottles used should be the same material as the containers designated for submission to the laboratory.
- Surface water and sediment sampling equipment should not be constructed of or contain Teflon® or LDPE materials. Acceptable materials for sampling include HDPE, silicone, stainless steel, acetate, or polypropylene. If non-dedicated, non-disposable equipment is used between sample locations, it should be decontaminated with Alconox® or Liquinox®.

7.6 Water Supply Sampling

This section applies to sampling from taps, spigots, faucets, or similar devices. The precautions and requirements identified in Sections 7.1 and 7.2 must be observed for water supply sampling. Do not proceed any further without reviewing each of those precautions and requirements.

- Collect water supply samples for PFAS analysis in accordance with applicable portions of this SOP, and/or project- or client-specific requirements.
- Water supply samples should be collected in laboratory-supplied bottles specifically designated for PFAS analysis (not glass).
- Ensure that sample bottles used to collect chlorinated water samples contain the proper preservative; non-chlorinated water does not require chemical preservatives designed to remove chlorine.
- Water supply sampling equipment (if needed) should not be constructed of or contain Teflon® or LDPE materials. Acceptable materials for sampling include HDPE, silicone, stainless steel, acetate, or polypropylene. If non-dedicated, non-disposable equipment is used between sample locations, it should be decontaminated with Alconox® or Liquinox®.
- Locate the sampling point. If a specific sampling point has already been designated (e.g., a kitchen tap), plan to collect the sample from that point; otherwise, identify a location in the water supply line that is as close as possible to the water's point of origination (e.g., a well or other

water source) and upstream of any local water treatment unit(s) that could affect PFAS levels (e.g., water softeners, activated carbon, or reverse osmosis treatment units). If a treatment unit is in use, a post-treatment sample may also be required in some cases, per project requirements.

Note: If treatment that could affect PFAS levels (e.g., carbon filtration or reverse osmosis) is part of the water distribution system, often a spigot will be present in the plumbing line between the water source and the treatment unit and this spigot should be used

- Remove any aerator/diffuser from the faucet, if possible. If removal is not possible, record this observation in the field notes.
- Allow the water to run freely from the tap until parameter stabilization per project-specific requirements is achieved, or as otherwise required by project-specific requirements. This will often require purging for 3 to 5 minutes.
- Reduce the water flow rate to minimize aeration of the sample. The water stream should be no wider than the diameter of a pencil.
- Fill the sample bottle (typically 250 mL) directly from the tap to the bottom of the neck of the bottle and cap the bottle immediately.
- After collecting the sample, cap the bottle and, if preservative is included, agitate by hand until the preservative is dissolved.

7.7 Field Reagent Blank Collection

Note: EPA Method 537 and modifications thereof for PFAS analysis require an FRB to be handled along with each sample set. A sample set is described as samples collected from the same sample site and at the same time, but “sample site” and “same time” are not precisely defined. Therefore, it is important to verify that the correct number of FRBs will be collected. *Collection of an FRB at every sampling point may be required.*

- Verify the number of FRBs to be collected for the project and where those samples must be collected. This should be described in the project planning documents such as work plans or sampling and analysis plans. If it is not, consult the PM.
- At the sampling site, when ready to collect an FRB, open the bottle of chemically preserved FRB reagent water provided by the laboratory and a corresponding empty bottle, also provided by the laboratory.

- Pour the preserved FRB reagent water into the empty sample bottle, close the cap, and label this filled bottle as the FRB.
- Pack and ship the FRB along with site samples and the required documentation (e.g., chain of custody form) to the laboratory.

Note: Although chain of custody forms will indicate that FRBs must be analyzed for PFAS, analysis of an FRB will be required only if site samples contain PFAS above a certain concentration. *If an FRB is analyzed and any PFAS concentration in the FRB exceeds 1/3 the laboratory MRL, then all samples collected with that FRB may be considered invalid and may require recollection and analysis* of the recollected samples*. Consult the project planning documents governing sample collection for specifics as to whether resampling is necessary. Care in collection and handling of site samples and FRBs in a way that avoids contamination cannot be overemphasized.*

SOP 2

Chain of Custody Procedures

1.0 PURPOSE

Chain-of-custody procedures are established to provide sample integrity. Sample custody protocols will be based on procedures as described in "NEIC Policies and Procedures", EPA-330/9-78-DD1-R, Revised June, 1985. This custody is in two parts: sample collection and laboratory analysis. A sample is under a person's custody if it meets the following requirements:

- It is in the person's possession;
- It is in the person's view, after being in the person's possession;
- It was in the person's possession and it was placed in a secured location; or
- It is in a designated secure area.

2.0 FIELD SPECIFIC CUSTODY PROCEDURES

The sample packaging and shipment procedures summarized below will assure that the samples will arrive at the laboratory with the chain-of-custody intact.

Field procedures are as follows:

(a) The field sampler is personally responsible for the care and custody of the samples until they are transferred or properly dispatched. As few people as possible should handle the samples.

(b) All bottles should be labeled with sample numbers and locations.

(c) Sample labels should be filled out using waterproof ink for each sample.

(d) The Project Manager should review all field activities to determine whether proper custody procedures were followed during the field work and decide if additional samples are required.

Transfer of Custody and Shipment Procedures are as follows:

(a) Samples should be accompanied by a properly completed chain-of-custody form. The sample numbers will be listed on the chain-of-custody form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage area.

(b) Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis with a separate signed custody record enclosed in each sample box or cooler. Shipping containers will be locked and secured with strapping tape in at least two locations for shipment to the laboratory. Custody seals will be used for samples shipped to laboratories. When custody seals are used, two printed, numbered custody seals will be placed on each cooler and the numbers will also appear on the chain-of-custody forms, or two signed and dated seals will be placed on the cooler. Clear tape will be placed over the seals.

(c) Whenever samples are split with a source or government agency, a separate Sample Receipt is prepared for those samples and marked to indicate with whom the samples are being split. The person relinquishing the samples to the facility or agency should request the representative's signature acknowledging sample receipt. If the representative is unavailable or refuses, this is noted in the "Received By" space.

(d) If the samples are sent by common carrier, a bill of lading should be used. Receipts of bills of lading will be retained as part of the permanent documentation. If sent by mail, the package will be registered with return receipt requested. Commercial carriers are not required to sign off on the custody form as long as the custody forms are sealed inside the sample cooler. Air bill information will be recorded on chain-of-custody forms.

SOP 3

Field Equipment Use and Calibration

1.0 PURPOSE

The purpose of this procedure is to set criteria for field equipment use and calibration.

2.0 PROCEDURE

A significant number of field activities involve usage of electronic instruments to monitor for environmental screening and heath and safety purposes. It is imperative the instruments are used and maintained properly to optimize their performance and minimize the potential for inaccuracies in the data obtained, and to ensure worker's health and safety is not compromised.

This SOP provides guidance on the usage, maintenance and calibration of electronic field equipment, whether for equipment owned by the Consultant or Contractor, or equipment obtained from a rental agency.

2.1 FIELD PREPARATION

2.1.1 Forms

- Field Calibration Forms

2.1.2 Equipment

- Monitoring equipment specific to work plan tasks.
- Associated calibration gases, aqueous standards, etc.
- Appropriate shipping containers to facilitate transport without damage to equipment.

2.1.3 Documents

- Manufacturer's instructions, operation and maintenance information.

2.2 FIELD PROCEDURES

All monitoring equipment will be in proper working order, and operated for the purpose for which it was intended, in accordance manufacturer's recommendations.

Field personnel will be responsible for insuring the equipment is maintained and calibrated in the field to extent practical, or returned for office or manufacturer maintenance or calibration if warranted. Calibration is discussed in greater detail below.

A copy of the Operating Instructions, Maintenance and Service manual for each instrument used on a project will be kept on site at all times.

Instruments will be operated only by personnel trained in the proper usage and calibration. In the event certification of training is required, personnel will have documentation of such certification with them on site at all times.

Personnel must be aware that certain instruments are rated for operation within a limited range of conditions such as temperature and humidity. Usage of such instruments in conditions outside these ranges will only proceed with proper approval by a project manager and/or Health and Safety supervisor as appropriate.

Instruments that contain radioactive source material, such as x-ray fluorescence analyzers or moisture-density gauges require specific transportation, handling and usage procedures that are generally associated with a license from the Nuclear Regulatory Commission (NRC) or an NRC- Agreement State. Under no circumstance will operation of such instruments be allowed on site unless by properly authorized and trained personnel, using the proper personal dosimeter badges or monitoring instruments.

Calibration

Calibration of an electronic instrument is critical to insure it is operating properly for its intended use. Such instruments are often sensitive to changes in temperature or humidity, or chemical vapors in the working atmosphere, and as a result their response and ability to monitor conditions and provide data can change significantly.

Parameters

Calibration of instruments shall be performed in accordance with the manufacturer's recommendations. This includes the following parameters:

- Frequency
- Use of proper calibration Gases or Chemical Standards
- Requirements for Factory Calibration

Calibration Gas Safety

Several instruments such as photoionization detectors (PIDs), flame ionization detectors @!IDS), oxygen meters, explosimeters, combustible gas indicators and many others require use of calibration gasses contained in compressed gas cylinders. Many of these gases are combustible or explosive. Care shall be taken to minimize the potential for injury from the use of such compressed gases. Transport, handling and storage of cylinders, where necessary, shall be performed in accordance with applicable DOT regulations and site requirements.

Calibration will only be performed in areas free of sources of spark, flame or excessive heat. Smoking will not be allowed in the vicinity of calibration gas usage areas.

Documentation of Calibration

Instrument Calibration activities will be documented on the field calibration form.

Intrinsically Safe Requirements

Certain work locations may be such that dangerous, ignitable or explosive conditions exist. In such cases, it may be necessary to utilize only equipment that is rated as "Intrinsically Safe." Intrinsically safe instrumentation is designed with limited electrical and thermal energy levels to eliminate the potential for ignition of hazardous mixtures.

For site work requiring operation of monitoring instruments in Class I, Division I locations (as defined by the National Fire Protection Agency (NFPA)) only instrumentation rated as Intrinsically Safe will be used. Such equipment (including all accessories and ancillary equipment) must be rated to conform to Underwriter's Laboratories (UL) Standard 91 3, for use in a Class I, Division 1 Groups A, B, C, and D locations. It is also recommended the equipment conform to CSA Standard 22.2, No. 157-92.

Upon completion of the field activities, equipment shall be returned to the possession of the Consultant, Contractor or Rental Agency accompanied by a written summary of any problems encountered with its use or calibration.

Equipment shall be properly prepared for shipping, including insuring that residual gases (if applicable) are removed from the instrument, and accompanying containers of compressed gases or fluids are properly labeled and sealed.

Equipment Decontamination

Equipment that comes in contact with Site media (water level meters, water quality meters) must be cleaned before removal from the site to ensure that chemicals are not transferred to other sites. It is the responsibility of the person who requisitioned the equipment to ensure appropriate cleaning before returning the equipment. Equipment decontamination procedures are typically site-specific for unique site compounds.

SOP 4

Soil Boring and Monitoring Well Installation

1.0 PURPOSE

The purpose of this procedure is to install a soil boring or groundwater monitoring well to obtain soil and groundwater data. Monitoring wells are constructed to ensure that groundwater accessed is representative of in-situ conditions.

2.0 PROCEDURE

2.1 FIELD PREPARATION

Call Digger's Hotline or equivalent more than 72 hours in advance of field activity commencement to identify buried utilities in the area of subsurface activity.

2.1.1 Forms

- Soil Boring and Monitoring Well Logs
- Tailgate Health and Safety
- *Daily Report* Sheets

2.1.2 Equipment

- Well caps - expanding, locking
- Locks (keyed alike)
- Latex or nitrile gloves
- *Typically provided by the drillers:*
- Well screen and casing
- Sand, bentonite chips/grout
- Concrete

2.1.3 Documents

- Site Access Agreements (if necessary)
- Site maps
- Workplan
- Health and Safety Plan

2.1.4 Other

- Cellular telephone
- First aid kit
- Personal comfort items
- Stakes and flagging to mark location

2.2 FIELD PROCEDURES

Build a berm or dike, if necessary, around the drilling area to divert surface water and run-off from the borehole and avoid entry of surface water and run-off into the hole during drilling and well installation. Boreholes should not be left open (unsupported by casing, auger, or drilling fluid) if advanced through contaminated material to prevent contaminated soils from caving to the area of the well screen.

Segregate all well materials and drilling tools from potential sources of contamination. The drilling contractor should use new well casing and screen that has been sealed at the factory, or decontaminated and wrapped before arrival at the site. Handle casing and screen only while wearing clean gloves (this is most important if the wells are not expected to be in an affected area). Be sure to decontaminate all drilling tools and equipment before each well installation using a high-pressure steam cleaner.

Soil boring and monitoring well depth should be determined before field activity commencement, if appropriate. Reference the Field Service Request Form for the method to be used for field depth determination.

If nested wells (two or more closely spaced wells, screened at different depths) are installed, the deepest well in the grouping should be installed first. This allows for complete vertical characterization of the geology and verification of the proper depths for any shallower well. It also reduces the possibility of grout intrusion into the shallower wells.

For installing groundwater monitoring wells in unconsolidated geologic materials, hollow stem auger drilling is the method of choice, as vertical cross-contamination between depth intervals and extraneous handling of contaminated materials is avoided.

- Determine position and depth of well to be installed.
- As soils are retrieved from the split spoon sampling tool (or Shelby tube), the borings must be characterized based on their color, moisture content, odor, cohesive properties, grain size, and lithology.

- Well materials may be schedule 40, 2” or 4” diameter with # 10 (or 0.010-inch) slot well screen with a schedule 40, 2” or 4” diameter PVC casing or a stainless-steel screen with galvanized steel casing.
- If the well hole is advanced too far, backfill the bottom with sand before positioning the screen (unless a confining unit has been breached - then seal the breach with bentonite and grout the boring). Deposit appropriate sand filter pack around the well screen until measured at one foot above the screen. Then seal the top of the sand pack with a bentonite slurry (approx. 1-1.5 feet), bentonite chips or a grout mixture to the surface.
- A well cap with a watertight seal and lock must be affixed to the well top. For flush-mounted wells, have the drillers use a neat cement grout to form the annular seal surrounding the well casing. They should bring the grout to within 3 inches of the top of the monitoring well casing, tapering the grout away from the monitoring well to the edge of the bore hole. Place and center the metal manhole cover (minimum diameter 8”) over the monitoring well casing. Cement the cover in place inside a square 2 x 2 foot (or 12” diameter round pad) 6-inch deep pad. Slope the concrete surface away from the well to promote surface drainage away from the monitoring well.
- Develop the well before conducting sampling or performing hydraulic conductivity tests by surging, pumping, or bailing, depending on the well depth, yield, diameter, contaminants present, and depth to water.

SOP 5

Safe Drilling Practices

This document establishes safe work practices (SWP) to follow during drilling operations. These SWPs are based on suggested safety procedures provided in the National Drilling Association's "Drilling Safety Guide." Procedures to follow before, during, and after drilling are listed below.

Before beginning any drill operation, each employee must conform to the following requirements:

- Wear a hard hat, safety glasses or goggles, steel-toed work boots, a shirt and full-length pants when working with or near the drill rig. Shirts must be tucked in at the belt.
- Do not wear loose or frayed clothing, loose long hair, or loose jewelry while working with rotating equipment.
- Do not eat, drink, or smoke near the drill rig.
- Identify all underground utility and buried structure locations before drilling.
- Ensure that drill masts or other projecting devices will be farther than 25 feet in any direction from overhead power lines.
- Ensure that the drill rig and any other machinery used is inspected daily by competent, qualified individuals. The site safety coordinator (SSC) will ensure compliance with this precaution.
- Drill rig operators will be instructed to report any abnormalities, such as equipment failure, oozing liquids, and unusual odors, to their supervisors or the SSC.
- Establish hand-signal communications for use when verbal communication is difficult. One person per work team will be designated to give hand signals to equipment operators.

While the drill rig is operating, employees must:

- Wear appropriate respiratory and personal protective equipment (PPE) when conditions warrant their use.
- Avoid direct contact with known or suspected contaminated surfaces.
- Move tools, materials, cords, hoses, and debris to prevent tripping hazards and contact with moving drill rig parts.
- Adequately secure tools, materials, and equipment subject to displacement or falling.
- Store flammable materials away from ignition sources and in approved containers.

- Maintain adequate clearance of the drill rig and mast from overhead transmission lines. The minimum clearance is 25 feet unless special permission is granted by the utility company. Call the local utility company for proper clearance.
- Only qualified and licensed personnel should operate drill rigs.
- Workers should not assume that the drill rig operator is keeping track of the rig's exact location. Workers should never walk directly behind or beside heavy equipment without the operator's knowledge.
- Workers should maintain visual contact with drill rig operators at all times.
- When an operator must maneuver equipment in tight quarters, the presence of a second person is required to ensure adequate clearance. If much backing is required, two ground guides will be used: one in the direction the equipment is moving, and the other in the operator's normal field of vision to relay signals.
- Auger sections and other equipment are extremely heavy. All lifting precautions should be taken before moving heavy equipment. Appropriate equipment, such as chains, hoists, straps, and other equipment, should be used to safely transport heavy equipment too heavy to safely lift.
- Proper personal lifting techniques will be used. Workers should lift using their legs, not their backs.
- Workers will not use equipment they are not familiar with. This precaution applies to heavy as well as light equipment.
- All personnel not essential to work activities will be kept out of the work area.
- Workers will be aware of their footing at all times.
- Workers will remain alert at all times.

After drilling operations are completed, employees should do the following:

- Shut down machinery before repairing or lubricating parts (except parts that must be in motion for lubrication).
- Shut down mechanical equipment prior to and during fueling operations. When refueling or transferring fuel, containers and equipment must be bonded to prevent the buildup of static electricity.

- Keep drill rigs in the exclusion zone until work has been completed. Such equipment should then be decontaminated within the designated decontamination area.
- Engage parking brakes when equipment is not in use.
- Implement an ongoing maintenance program for all tools and equipment. All tools and moving equipment should be inspected regularly to ensure that parts are secured, are intact, and have no cracks or areas of weakness. The equipment must turn smoothly without wobbling and must operate in accordance with manufacturer specifications. Defective items should be promptly repaired or replaced. Maintenance and repair logs will be kept.
- Store tools in clean, secure areas to prevent damage, loss, or theft.

Disclaimer: This safe work practice (SWP) is the property of Tetra Tech, Inc. Any reuse of the SWP without Tetra Tech's permission is at the sole risk of the user. The user will hold harmless Tetra Tech for any damages that result from unauthorized reuse of this SWP. Authorized users are responsible for obtaining proper training and qualification from their employer before performing operations described in this SWP.

SOP 5

Well Development

1.0 PURPOSE

The purpose of this procedure is to set criteria for well development after installation of new monitoring or production wells or wells than have not been sampled or used for an extended period of time.

2.0 PROCEDURE

This procedure is for the development of groundwater monitoring wells. Before a newly constructed well can be used for water-quality sampling, measuring water levels, or aquifer testing, it must be developed. Well development refers to the procedure used to clear the well and formation around the screen of fine-grained materials (sands, silts, and clays) produced during drilling or naturally occurring in the formation.

Well development is completed to remove fine grained materials from the well casing, well screen and gravel pack. The time allotted and techniques used for well development will vary by well and depend on drilling method, well construction, geological formation and intended use for the well. In general, well development should continue until the well responds to water level changes in the formation (i.e., a good hydraulic connection is established between the well and formation) and the well produces clear, sediment-free water to the extent practical. In general, the method (disturbance) used to develop the well should be more rigorous than the amount of disturbance the well will experience during its regular or intended use. For example, if a well develops clear, sediment free water using a bailer, it is very well developed for low-flow sampling using a peristaltic pump. Please note that well development is especially important when contaminants of concern are sensitive to suspended solids (e.g., metals, PCBs, SVOCs).

2.1 FIELD PREPARATION

2.1.1 Forms

- Daily Log
- Well Development Form

2.1.2 Equipment

- Required Health and Safety Equipment and PPE
- Well Keys
- General Tools: knife, socket set, vise grips, screwdriver, etc.
- Power Source: generator, extension cord
- Well Development Device: water truck with hoist, surge block, bailer, submersible pump
- Discharge Line: tubing or hose (suitable for expected flow rates and chemicals of concern)

- Purge Water Container: Clear glass jars (e.g., drillers' jars), graduated pail, 55- gallon drum, poly tank or frac tank
- Cleaning Supplies: non-phosphate soap, buckets, brushes, laboratory-supplied distilled/deionized water, tap water, cleaning solvent, aluminum foil, plastic sheeting, etc.
- Meters: water level, flow
- Water Quality Meter: pH, temperature, conductivity, turbidity, etc.

2.1.3 Documents

- Detailed Scope Work Summary
- Proposal
- Work Plan

2.2 FIELD PROCEDURES

All wells must be developed and well development generally occurs with a few days of installation (please remember that some grouts require time to cure). Well development methods and procedures will vary as described above. In most cases, a monitoring well can be developed in less than one hour using a bailer, submersible pump, surge block and/or check valve and tubing (waterra tubing). Production or extraction wells may need to be developed by more rigorous methods and may require a specialized subcontractor. The following presents the minimum steps required to complete well development for a monitoring well and is generally acceptable for all well development activities. More rigorous methods may be required and will be detailed in project specific SOP.

1. Review HASP and don appropriate safety equipment and set up appropriate air monitoring equipment as needed.
2. Prior to introduction to a well, all non-dedicated equipment used for development purposes must be cleaned using a soapy wash (laboratory grade), tap water rinse, isopropyl alcohol rinse and distilled/deionized water rinse as appropriate.
3. Uncap and gauge well, record initial water level.
4. Place well development device (pump, bailer, surge block) into the well.
5. Collect a baseline groundwater sample in a glass jar, or purge bucket to determine relative turbidity. Your project manager may also request that you measure and record the temperature, pH, turbidity, specific electrical conductance, and other water quality parameters.

6. Surge the well.
7. Purge the well. If the well runs dry, stop purging and allow the well to recover. Sometimes purge water or distilled water must be added to the well initially to help clear the screen. Additional surging of the screen with the recycled purge water (or distilled water) will allow formation water to flow into the screen. Please make sure that three times the amount of water added is removed during the purging of the well.
8. Repeat steps 5 through 7 until groundwater is relatively clear (less than 4 NTUs) and if required, the water quality parameters are stable within 10%.
9. After development, the well should be allowed to rest and should not be sampled immediately. The period of rest will vary depending on the hydraulic properties of the aquifer or targeted water bearing unit and the intended use of the sample results obtained from the well. In general, a minimum of 2 to 3 days of rest should be adequate.

Waste Disposal

- All waste generated will be disposed in accordance with the methods and procedures contained in the work plan or other SOP.
- All water generated during cleaning and development procedures will be collected and contained in accordance with the site specific disposal requirements.
- All PPE, such as gloves, disposable clothing, and other disposable equipment used or generated during the development process, will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon drums or a covered roll-off box for appropriate disposal.

SOP 7

Water Sampling

1.0 PURPOSE

The purpose of this procedure is to obtain representative groundwater samples from groundwater monitoring wells or piezometers with a bailer, peristaltic, submersible, or KeckTM pump. Site-specific groundwater sampling requirements, if necessary, will be described in work plans or field sampling plans.

2.0 PROCEDURE

2.1 FIELD PREPARATION

Notify client, property owner, and agency as necessary.

2.1.1 Forms

- Water Level Data *Sheet*
- *Daily Report* Sheets
- *Chain of Custodies*
- *Water Quality Data* Sheet
- Field Service Request
- Tailgate Health and Safety

2.1.2 Equipment

- Laboratory provided containers and labels
- Laboratory-cleaned cooler
- Well keys
- Electronic water level indicator
- Interface probe (if free-product is expected at the site)
- Calculator
- Latex or nitrile gloves
- Tools to access wells
- metal detector, turkey baster or plastic cup
- Decontamination equipment including deionized or distilled water, Alconox, graduated cylinders, and paper towel

- Knife or scissors
- Garbage bags
- Two graduated 5-gallon pails to collect purge water
- pH, temperature, and specific conductivity meter

One of:

- Disposable high-density polyethylene sampling bailers and bailer rope
- Peristaltic pump and sufficient disposable Silicon (approximately 10 inches per sample) and Tygon tubing (length measured from pump head to sampling depth)
- Submersible pump and Tygon tubing
- Keck™ pump

If needed:

- DOT-approved sealed drums for storage of purged well water, or a suitable location to disperse of liquid (i.e., on-site treatment system)
- Quantab ™ and Hach™ Titration kits

2.1.3 Documents

- Well Construction Log
- Well location map/site map
- Work Plan
- Health and Safety Plan
- Signed site access agreement

2.1.4 Other

- Cellular phone
- Replacement locks
- Writing implements and an indelible marker
- Crushed ice
- Bubble wrap if required to protect samples during shipment to the laboratory

- First aid kit
- Personal comfort items
- Machete or other vegetation-clearing tools

2.2 FIELD PROCEDURES

2.2.1 Well Purge

Don a new pair of latex or nitrile gloves

First sample those wells with the lowest historical or suspected concentrations, and then advance to the wells more likely to be contaminated. Set plastic sheeting or a garbage bag near the well to set sample bottles on and to rest sampling equipment.

Obtain the water level measurement, noting any occurrence of LNAPL or DNAPL.

Calculate three or five times the volume of groundwater present in the well casing, as indicated on the *Field Service Request Form.*

Purge the well using a dedicated HDPE disposable bailer and a new length of clean rope, a peristaltic pump with new Teflon and Tygon tubing, a submersible pump with new Tygon tubing, or a Keck™ pump. Purge the groundwater monitoring well of a minimum of 3 to 5 well casing volumes prior to collecting the samples. Measure the volume of purged water using a graduated pail, or other container of known volume. Purging and sampling should be conducted using slow and steady motions to avoid excessive agitation, increased sample turbidity, and sample volatilization. Empty purge water onto the ground, away from the well, or in the event containerizing is required, transfer purged water from the pail into the appropriate storage container for storage until disposal is arranged.

NOTE: If well goes dry before 3 well volumes can be purged from the well, allow groundwater to recharge, then collect sample.

2.2.2 Field Measured Parameters

After at least 3 well volumes have been purged from the well, measure temperature, pH, conductivity, and any other field parameters as specified in the Field Service Request Form. Once three measurements are obtained within 10-percent of each other, the groundwater quality may be considered representative of the groundwater as it exists in the formation.

If well goes dry before 3 well volumes can be purged from the well, a single round of field parameter measurements will be obtained following recharge of a sufficient amount of groundwater to complete the sampling activities.

2.2.3 Bottle Preparation

Prior to sample collection, label all appropriate fields on the sample container labels with an indelible marker. Apply labels to appropriate containers.

2.2.4 Sample Collection

2.2.4.1 Bailers

Samples will be collected using the same HDPE disposable bailer used for purging. Transfer groundwater samples from the bailer to their appropriate sample bottle, minimizing turbulent flow between the bailer and the sample bottles. Place samples in the appropriate containers in decreasing order of volatility (e.g., purgeables and aromatics first, then PNAs and phenols, then cyanides, and lastly, nitrate, sulfate and metals). Samples for dissolved metals analysis may be field filtered. If there is insufficient sample volume to provide all sampling needs, retrieve additional bailer volumes until all samples are collected.

2.2.4.2 Peristaltic, Submersible, or Keck™ Pump

Samples for laboratory analysis of parameters, other than VOCs, will be collected directly from the pump tubing following purging of 3 to 5 well volumes, and stabilization of field parameter measurements. A 0.45 μm filter will be used to field filter samples for dissolved metals into a preserved laboratory container.

2.2.5 Sample Preservation

Tighten lids of sample containers and place in coolers

Wrap all glass containers in bubble wrap or foam; then place into large 1-2 gallon zip-lock bags; label the outside of the bag, and place into the coolers.

Completely fill out the Chain-of-Custody. When shipping samples, seal Chain-of-Custody in a watertight zip-lock bag, and attach to the underside of the cooler lid with packaging tape. Ship coolers or arrange delivery to the laboratory as soon as possible and before the sample “hold- time” expires.

2.2.6 Decontamination

Decontaminate electronic water level indicator, pH, temperature, and specific conductivity meter between sampling points.

If peristaltic pump is used, dispose used flow-through tubing and filters.

If submersible or Keck™ pump is used, place pump in a graduated cylinder filled with a solution of Alconox and deionized or distilled water. Allowing the soap and water solution to re-circulate through the pump and tubing for a maximum of five minutes. Rinse cylinder and outside of pump and tubing with deionized or distilled water. Fill cylinder with deionized or distilled water and allow at least 4 liters to run though the

pump and tubing and onto the ground away from the well.

NOTE: During pump use and decontamination, take care to assure tubing and pump does not come in contact with the ground or other surfaces. Following sampling of the last well, remove and throw away submersible pump tubing prior to decontamination of the pump.

Dispose of all gloves, bailers, rope/string, tubing, and filters used to collect the sample prior to accessing the next well.

3.0 QUALITY ASSURANCE

Avoid cross-contamination of wells with the water level indicator, and sampling equipment by conducting proper decontamination procedures described above.

Take care in labeling the samples, and the corresponding Chain-of-Custody with the correct sample date, time and well identification. All labeling must be consistent between samples and the Chain of Custody.

Keep samples on ice following collection, and be conscience of “hold-times” for the samples. It is imperative that samples are submitted to the laboratory prior to the exceedance of hold times.

SOP 8

EPA Low Flow (Minimum Drawdown) Groundwater Sampling Procedures

United States Environmental Protection Agency | Office of Research and Development | Office of Solid Waste and Emergency Response | EPA/540/S-95/504 April 1996

Ground Water Issue

LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES

by Robert W. Puls[1] and Michael J. Barcelona[2]

Background

The Regional Superfund Ground Water Forum is a group of ground-water scientists, representing EPA's Regional Superfund Offices, organized to exchange information related to ground-water remediation at Superfund sites. One of the major concerns of the Forum is the sampling of ground water to support site assessment and remedial performance monitoring objectives. This paper is intended to provide background information on the development of low-flow sampling procedures and its application under a variety of hydrogeologic settings. It is hoped that the paper will support the production of standard operating procedures for use by EPA Regional personnel and other environmental professionals engaged in ground-water sampling.

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I. Introduction

The methods and objectives of ground-water sampling to assess water quality have evolved over time. Initially the emphasis was on the assessment of water quality of aquifers as sources of drinking water. Large water-bearing units were identified and sampled in keeping with that objective. These were highly productive aquifers that supplied drinking water via private wells or through public water supply systems. Gradually, with the increasing awareness of subsurface pollution of these water resources, the understanding of complex hydrogeochemical processes which govern the fate and transport of contaminants in the subsurface increased. This increase in understanding was also due to advances in a number of scientific disciplines and improvements in tools used for site characterization and ground-water sampling. Ground-water quality investigations where pollution was detected initially borrowed ideas, methods, and materials for site characterization from the water supply field and water analysis from public health practices. This included the materials and manner in which monitoring wells were installed and the way in which water was brought to the surface, treated, preserved and analyzed. The prevailing conceptual ideas included convenient generalizations of ground-water resources in terms of large and relatively homogeneous hydrologic *units*. With time it became apparent that conventional water supply generalizations of *homogeneity* did not adequately represent field data regarding pollution of these subsurface resources. The important role of *heterogeneity* became increasingly clear not only in geologic terms, but also in terms of complex physical,

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chemical and biological subsurface processes. With greater appreciation of the role of heterogeneity, it became evident that subsurface pollution was ubiquitous and encompassed the unsaturated zone to the deep subsurface and included unconsolidated sediments, fractured rock, and *aquitards* or low-yielding or impermeable formations. Small-scale processes and heterogeneities were shown to be important in identifying contaminant distributions and in controlling water and contaminant flow paths.

It is beyond the scope of this paper to summarize all the advances in the field of ground-water quality investigations and remediation, but two particular issues have bearing on ground-water sampling today: aquifer heterogeneity and colloidal transport. Aquifer heterogeneities affect contaminant flow paths and include variations in geology, geochemistry, hydrology and microbiology. As methods and the tools available for subsurface investigations have become increasingly sophisticated and understanding of the subsurface environment has advanced, there is an awareness that in most cases a primary concern for site investigations is characterization of contaminant flow paths rather than entire aquifers. In fact, in many cases, plume thickness can be less than well screen lengths (e.g., 3-6 m) typically installed at hazardous waste sites to detect and monitor plume movement over time. Small-scale differences have increasingly been shown to be important and there is a general trend toward smaller diameter wells and shorter screens.

The hydrogeochemical significance of colloidal-size particles in subsurface systems has been realized during the past several years (Gschwend and Reynolds, 1987; McCarthy and Zachara, 1989; Puls, 1990; Ryan and Gschwend, 1990). This realization resulted from both field and laboratory studies that showed faster contaminant migration over greater distances and at higher concentrations than flow and transport model predictions would suggest (Buddemeier and Hunt, 1988; Enfield and Bengtsson, 1988; Penrose et al., 1990). Such models typically account for interaction between the mobile aqueous and immobile solid phases, but do not allow for a mobile, reactive solid phase. It is recognition of this third *phase* as a possible means of contaminant transport that has brought increasing attention to the manner in which samples are collected and processed for analysis (Puls et al., 1990; McCarthy and Degueldre, 1993; Backhus et al., 1993; U. S. EPA, 1995). If such a phase is present in sufficient mass, possesses high sorption reactivity, large surface area, and remains stable in suspension, it can serve as an important mechanism to facilitate contaminant transport in many types of subsurface systems.

Colloids are particles that are sufficiently small so that the surface free energy of the particle dominates the bulk free energy. Typically, in ground water, this includes particles with diameters between 1 and 1000 nm. The most commonly observed mobile particles include: secondary clay minerals; hydrous iron, aluminum, and manganese oxides; dissolved and particulate organic materials, and viruses and bacteria. These reactive particles have been shown to be mobile under a variety of conditions in both field studies and laboratory column experiments, and as such need to be included in monitoring programs where identification of the *total* mobile contaminant loading (dissolved + naturally suspended particles) at a site is an objective. To that end, sampling methodologies must be used which do not artificially bias *naturally* suspended particle concentrations.

Currently the most common ground-water purging and sampling methodology is to purge a well using bailers or high speed pumps to remove 3 to 5 casing volumes followed by sample collection. This method can cause adverse impacts on sample quality through collection of samples with high levels of turbidity. This results in the inclusion of otherwise immobile artifactual particles which produce an overestimation of certain analytes of interest (e.g., metals or hydrophobic organic compounds). Numerous documented problems associated with filtration (Danielsson, 1982; Laxen and Chandler, 1982; Horowitz et al., 1992) make this an undesirable method of rectifying the turbidity problem, and include the removal of potentially mobile (contaminant-associated) particles during filtration, thus artificially biasing contaminant concentrations low. Sampling-induced turbidity problems can often be mitigated by using low-flow purging and sampling techniques.

Current subsurface conceptual models have undergone considerable refinement due to the recent development and increased use of field screening tools. So-called hydraulic *push* technologies (e.g., cone penetrometer, Geoprobe®, QED HydroPunch®) enable relatively fast screening site characterization which can then be used to design and install a monitoring well network. Indeed, alternatives to conventional monitoring wells are now being considered for some hydrogeologic settings. The ultimate design of any monitoring system should however be based upon adequate site characterization and be consistent with established monitoring objectives.

If the sampling program objectives include accurate assessment of the magnitude and extent of subsurface contamination over time and/or accurate assessment of subsequent remedial performance, then some information regarding plume delineation in three-dimensional space is necessary prior to monitoring well network design and installation. This can be accomplished with a variety of different tools and equipment ranging from hand-operated augers to screening tools mentioned above and large drilling rigs. Detailed information on ground-water flow velocity, direction, and horizontal and vertical variability are essential baseline data requirements. Detailed soil and geologic data are required prior to and during the installation of sampling points. This includes historical as well as detailed soil and geologic logs which accumulate during the site investigation. The use of borehole geophysical techniques is also recommended. With this information (together with other site characterization data) and a clear understanding of sampling

objectives, then appropriate location, screen length, well diameter, slot size, etc. for the monitoring well network can be decided. This is especially critical for new in situ remedial approaches or natural attenuation assessments at hazardous waste sites.

In general, the overall goal of any ground-water sampling program is to collect water samples with no alteration in water chemistry; analytical data thus obtained may be used for a variety of specific monitoring programs depending on the regulatory requirements. The sampling methodology described in this paper assumes that the monitoring goal is to sample monitoring wells for the presence of contaminants and it is applicable whether mobile colloids are a concern or not and whether the analytes of concern are metals (and metalloids) or organic compounds.

II. Monitoring Objectives and Design Considerations

The following issues are important to consider prior to the design and implementation of any ground-water monitoring program, including those which anticipate using low-flow purging and sampling procedures.

A. Data Quality Objectives (DQOs)

Monitoring objectives include four main types: detection, assessment, corrective-action evaluation and resource evaluation, along with *hybrid* variations such as site-assessments for property transfers and water availability investigations. Monitoring objectives may change as contamination or water quality problems are discovered. However, there are a number of common components of monitoring programs which should be recognized as important regardless of initial objectives. These components include:

1) Development of a conceptual model that incorporates elements of the regional geology to the local geologic framework. The conceptual model development also includes initial site characterization efforts to identify hydrostratigraphic units and likely flow-paths using a minimum number of borings and well completions;

2) Cost-effective and well documented collection of high quality data utilizing simple, accurate, and reproducible techniques; and

3) Refinement of the conceptual model based on supplementary data collection and analysis.

These fundamental components serve many types of monitoring programs and provide a basis for future efforts that evolve in complexity and level of spatial detail as purposes and objectives expand. High quality, reproducible data collection is a common goal regardless of program objectives.

High quality data collection implies data of sufficient accuracy, precision, and completeness (i.e., ratio of valid analytical results to the minimum sample number called for by the program design) to meet the program objectives. Accuracy depends on the correct choice of monitoring tools and procedures to minimize sample and subsurface disturbance from collection to analysis. Precision depends on the repeatability of sampling and analytical protocols. It can be assured or improved by replication of sample analyses including blanks, field/lab standards and reference standards.

B. Sample Representativeness

An important goal of any monitoring program is collection of data that is truly representative of conditions at the site. The term *representativeness* applies to chemical and hydrogeologic data collected via wells, borings, piezometers, geophysical and soil gas measurements, lysimeters, and temporary sampling points. It involves a recognition of the statistical variability of individual subsurface physical properties, and contaminant or major ion concentration levels, while explaining extreme values. Subsurface temporal and spatial variability are facts. Good professional practice seeks to maximize representativeness by using proven accurate and reproducible techniques to define limits on the distribution of measurements collected at a site. However, measures of representativeness are dynamic and are controlled by evolving site characterization and monitoring objectives. An evolutionary site characterization model, as shown in Figure 1, provides a systematic approach to the goal of consistent data collection.

Figure 1. Evolutionary Site Characterization Model

The model emphasizes a recognition of the causes of the variability (e.g., use of inappropriate technology such as using bailers to purge wells; imprecise or operator-dependent methods) and the need to control avoidable errors.

1) Questions of Scale

A sampling plan designed to collect representative samples must take into account the potential scale of changes in site conditions through space and time as well as the chemical associations and behavior of the parameters that are targeted for investigation. In subsurface systems, physical (i.e., aquifer) and chemical properties over time or space are not statistically independent. In fact, samples taken in close proximity (i.e., within distances of a few meters) or within short time periods (i.e., more frequently than monthly) are highly auto-correlated. This means that designs employing high-sampling frequency (e.g., monthly) or dense spatial monitoring designs run the risk of redundant data collection and misleading inferences regarding trends in values that aren't statistically valid. In practice, contaminant detection and assessment monitoring programs rarely suffer these *over-sampling* concerns. In corrective-action evaluation programs, it is also possible that too little data may be collected over space or time. In these cases, false interpretation of the spatial extent of contamination or underestimation of temporal concentration variability may result.

2) Target Parameters

Parameter selection in monitoring program design is most often dictated by the regulatory status of the site. However, background water quality constituents, purging indicator parameters, and contaminants, all represent targets for data collection programs. The tools and procedures used in these programs should be equally rigorous and applicable to all categories of data, since all may be needed to determine or support regulatory action.

C. Sampling Point Design and Construction

Detailed site characterization is central to all decision-making purposes and the basis for this characterization resides in identification of the geologic framework and major hydro-stratigraphic units. Fundamental data for sample point location include: subsurface lithology, head-differences and background geochemical conditions. Each sampling point has a proper use or uses which should be documented at a level which is appropriate for the program's data quality objectives. Individual sampling points may not always be able to fulfill multiple monitoring objectives (e.g., detection, assessment, corrective action).

1) Compatibility with Monitoring Program and Data Quality Objectives

Specifics of sampling point location and design will be dictated by the complexity of subsurface lithology and variability in contaminant and/or geochemical conditions. It should be noted that, regardless of the ground-water sampling approach, few sampling points (e.g., wells, drive-points, screened augers) have zones of influence in excess of a few feet. Therefore, the spatial frequency of sampling points should be carefully selected and designed.

2) Flexibility of Sampling Point Design

In most cases *well-point* diameters in excess of 1 7/8 inches will permit the use of most types of submersible pumping devices for low-flow (minimal drawdown) sampling. It is suggested that *short* (e.g., less than 1.6 m) screens be incorporated into the monitoring design where possible so that comparable results from one device to another might be expected. *Short*, of course, is relative to the degree of vertical water quality variability expected at a site.

3) Equilibration of Sampling Point

Time should be allowed for equilibration of the well or sampling point with the formation after installation. Placement of well or sampling points in the subsurface produces some disturbance of ambient conditions. Drilling techniques (e.g., auger, rotary, etc.) are generally considered to cause more disturbance than *direct-push* technologies. In either case, there may be a period (i.e., days to months) during which water quality near the point may be distinctly different from that in the formation. Proper development of the sampling point and adjacent formation to remove fines created during emplacement will shorten this water quality *recovery* period.

III. Definition of Low-Flow Purging and Sampling

It is generally accepted that water in the well casing is non-representative of the formation water and needs to be purged prior to collection of ground-water samples. However, the water in the screened interval may indeed be representative of the formation, depending upon well construction and site hydrogeology. Wells are purged to some extent for the following reasons: the presence of the air interface at the top of the water column resulting in an oxygen concentration gradient with depth, loss of volatiles up the water column, leaching from or sorption to the casing or filter pack, chemical changes due to clay seals or backfill, and surface infiltration.

Low-flow purging, whether using portable or dedicated systems, should be done using pump-intake located in the middle or slightly above the middle of the screened interval. Placement of the pump too close to the bottom of the well will cause increased entrainment of solids which have collected in the well over time. These particles are present as a result of well development, prior purging and sampling events, and natural colloidal transport and deposition. Therefore, placement of the pump in the middle or toward the top of the screened interval is suggested. Placement of the pump at the top of the water column for sampling is only recommended in unconfined aquifers, screened across the water table, where this is the desired sampling point. Low-

flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval.

A. Low-Flow Purging and Sampling

Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface which can be affected by flow regulators or restrictions. Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective is to pump in a manner that minimizes stress (drawdown) to the system to the extent practical taking into account established site sampling objectives. Typically, flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology. Some extremely coarse-textured formations have been successfully sampled in this manner at flow rates to 1 L/min. The effectiveness of using low-flow purging is intimately linked with proper screen location, screen length, and well construction and development techniques. The reestablishment of natural flow paths in both the vertical and horizontal directions is important for correct interpretation of the data. For high resolution sampling needs, screens less than 1 m should be used. Most of the need for purging has been found to be due to passing the sampling device through the overlying casing water which causes mixing of these stagnant waters and the dynamic waters within the screened interval. Additionally, there is disturbance to suspended sediment collected in the bottom of the casing and the displacement of water out into the formation immediately adjacent to the well screen. These disturbances and impacts can be avoided using dedicated sampling equipment, which precludes the need to insert the sampling device prior to purging and sampling.

Isolation of the screened interval water from the overlying stagnant casing water may be accomplished using low-flow minimal drawdown techniques. If the pump intake is located within the screened interval, most of the water pumped will be drawn in directly from the formation with little mixing of casing water or disturbance to the sampling zone. However, if the wells are not constructed and developed properly, zones other than those intended may be sampled. At some sites where geologic heterogeneities are sufficiently different within the screened interval, higher conductivity zones may be preferentially sampled. This is another reason to use shorter screened intervals, especially where high spatial resolution is a sampling objective.

B. Water Quality Indicator Parameters

It is recommended that water quality indicator parameters be used to determine purging needs prior to sample collection in each well. Stabilization of parameters such as pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature and turbidity should be used to determine when formation water is accessed during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by oxidation-reduction potential, dissolved oxygen and turbidity. Temperature and pH, while commonly used as purging indicators, are actually quite insensitive in distinguishing between formation water and stagnant casing water; nevertheless, these are important parameters for data interpretation purposes and should also be measured. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. Instruments are available which utilize in-line flow cells to continuously measure the above parameters.

It is important to establish specific well stabilization criteria and then consistently follow the same methods thereafter, particularly with respect to drawdown, flow rate and sampling device. Generally, the time or purge volume required for parameter stabilization is independent of well depth or well volumes. Dependent variables are well diameter, sampling device, hydrogeochemistry, pump flow rate, and whether the devices are used in a portable or dedicated manner. If the sampling device is already in place (i.e., dedicated sampling systems), then the time and purge volume needed for stabilization is much shorter. Other advantages of dedicated equipment include less purge water for waste disposal, much less decontamination of equipment, less time spent in preparation of sampling as well as time in the field, and more consistency in the sampling approach which probably will translate into less variability in sampling results. The use of dedicated equipment is strongly recommended at wells which will undergo routine sampling over time.

If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. It should also be noted that turbidity is a very conservative parameter in terms of stabilization. Turbidity is always the last parameter to stabilize. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria. It should be noted that natural turbidity levels in ground water may exceed 10 nephelometric turbidity units (NTU).

C. Advantages and Disadvantages of Low-Flow (Minimum Drawdown) Purging

In general, the advantages of low-flow purging include:

- samples which are representative of the *mobile* load of contaminants present (dissolved and colloid-associated);
- minimal disturbance of the sampling point thereby minimizing sampling artifacts;
- less operator variability, greater operator control;

- reduced stress on the formation (minimal drawdown);
- less mixing of stagnant casing water with formation water;
- reduced need for filtration and, therefore, less time required for sampling;
- smaller purging volume which decreases waste disposal costs and sampling time;
- better sample consistency; reduced artificial sample variability.

Some disadvantages of low-flow purging are:

- higher initial capital costs,
- greater set-up time in the field,
- need to transport additional equipment to and from the site,
- increased training needs,
- resistance to change on the part of sampling practitioners,
- concern that new data will indicate a *change in conditions* and trigger an *action*.

IV. Low-Flow (Minimal Drawdown) Sampling Protocols

The following ground-water sampling procedure has evolved over many years of experience in ground-water sampling for organic and inorganic compound determinations and as such summarizes the authors' (and others) experiences to date (Barcelona et al., 1984, 1994; Barcelona and Helfrich, 1986; Puls and Barcelona, 1989; Puls et. al. 1990, 1992; Puls and Powell, 1992; Puls and Paul, 1995). High-quality chemical data collection is essential in ground-water monitoring and site characterization. The primary limitations to the collection of *representative* ground-water samples include: mixing of the stagnant casing and *fresh* screen waters during insertion of the sampling device or ground-water level measurement device; disturbance and resuspension of settled solids at the bottom of the well when using high pumping rates or raising and lowering a pump or bailer; introduction of atmospheric gases or degassing from the water during sample handling and transfer, or inappropriate use of vacuum sampling device, etc.

A. Sampling Recommendations

Water samples should not be taken immediately following well development. Sufficient time should be allowed for the ground-water flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

Well purging is nearly always necessary to obtain samples of water flowing through the geologic formations in the screened interval. Rather than using a general but arbitrary guideline of purging three casing volumes prior to sampling, it is recommended that an in-line water quality measurement device (e.g., flow-through cell) be used to establish the stabilization time for several parameters (e.g. , pH, specific conductance, redox, dissolved oxygen, turbidity) on a well-specific basis. Data on pumping rate, drawdown, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

The following are recommendations to be considered before, during and after sampling:

- use low-flow rates (<0.5 L/min), during both purging and sampling to maintain minimal drawdown in the well;
- maximize tubing wall thickness, minimize tubing length;
- place the sampling device intake at the desired sampling point;
- minimize disturbances of the stagnant water column above the screened interval during water level measurement and sampling device insertion;
- make proper adjustments to stabilize the flow rate as soon as possible;
- monitor water quality indicators during purging;
- collect unfiltered samples to estimate contaminant loading and transport potential in the subsurface system.

B. Equipment Calibration

Prior to sampling, all sampling device and monitoring equipment should be calibrated according to manufacturer's recommendations and the site Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). Calibration of pH should be performed with at least two buffers which bracket the expected range. Dissolved oxygen calibration must be corrected for local barometric pressure readings and elevation.

C. Water Level Measurement and Monitoring

It is recommended that a device be used which will least disturb the water surface in the casing. Well depth should be obtained from the well logs. Measuring to the bottom of the well casing will only cause resuspension of settled solids from the formation and require longer purging times for turbidity equilibration. Measure well depth after sampling is completed. The water level measurement should be taken from a permanent reference point which is surveyed relative to ground elevation.

D. Pump Type

The use of low-flow (e.g., 0.1-0.5 L/min) pumps is suggested for purging and sampling all types of analytes. All pumps have some limitation and these should be investigated with respect to application at a particular site. Bailers are inappropriate devices for low-flow sampling.

1) General Considerations

There are no unusual requirements for ground-water sampling devices when using low-flow, minimal drawdown techniques. The major concern is that the device give consistent results and minimal disturbance of the sample across a range of *low* flow rates (i.e., < 0.5 L/min). Clearly, pumping rates that cause minimal to no drawdown in one well could easily cause *significant* drawdown in another well finished in a less transmissive formation. In this sense, the pump should not cause undue pressure or temperature changes or physical disturbance on the water sample over a reasonable sampling range. Consistency in operation is critical to meet accuracy and precision goals.

2) Advantages and Disadvantages of Sampling Devices

A variety of sampling devices are available for low-flow (minimal drawdown) purging and sampling and include peristaltic pumps, bladder pumps, electrical submersible pumps, and gas-driven pumps. Devices which lend themselves to both dedication and consistent operation at definable low-flow rates are preferred. It is desirable that the pump be easily adjustable and operate reliably at these lower flow rates. The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and some volatiles loss. Gas-driven pumps should be of a type that does not allow the gas to be in direct contact with the sampled fluid.

Clearly, bailers and other *grab* type samplers are ill-suited for low-flow sampling since they will cause repeated disturbance and mixing of *stagnant* water in the casing and the *dynamic* water in the screened interval. Similarly, the use of inertial lift foot-valve type samplers may cause too much disturbance at the point of sampling. Use of these devices also tends to introduce uncontrolled and unacceptable operator variability.

Summaries of advantages and disadvantages of various sampling devices are listed in Herzog et al. (1991), U. S. EPA (1992), Parker (1994) and Thurnblad (1994).

E. Pump Installation

Dedicated sampling devices (left in the well) capable of pumping and sampling are preferred over <u>any</u> other type of device. Any portable sampling device should be slowly and carefully lowered to the middle of the screened interval or slightly above the middle (e.g., 1-1.5 m below the top of a 3 m screen). This is to minimize excessive mixing of the stagnant water in the casing above the screen with the screened interval zone water, and to minimize resuspension of solids which will have collected at the bottom of the well. These two disturbance effects have been shown to directly affect the time required for purging. There also appears to be a direct correlation between size of portable sampling devices relative to the well bore and resulting purge volumes and times. The key is to minimize disturbance of water and solids in the well casing.

F. Filtration

Decisions to filter samples should be dictated by sampling objectives rather than as a *fix* for poor sampling practices, and field-filtering of certain constituents should not be the default. Consideration should be given as to what the application of field-filtration is trying to accomplish. For assessment of truly dissolved (as opposed to operationally *dissolved* [i.e., samples filtered with 0.45 µm filters]) concentrations of major ions and trace metals, 0.1 µm filters are recommended although 0.45 µm filters are normally used for most regulatory programs. Alkalinity samples must also be filtered if significant particulate calcium carbonate is suspected, since this material is likely to impact alkalinity titration results (although filtration itself may alter the CO_2 composition of the sample and, therefore, affect the results).

Although filtration may be appropriate, filtration of a sample may cause a number of unintended changes to occur (e.g. oxidation, aeration) possibly leading to filtration-induced artifacts during sample analysis and uncertainty in the results. Some of these unintended changes may be unavoidable but the factors leading to them must be recognized. Deleterious effects can be minimized by consistent application of certain filtration guidelines. Guidelines should address selection of filter type, media, pore size, etc. in order to identify and minimize potential sources of uncertainty when filtering samples.

In-line filtration is recommended because it provides better consistency through less sample handling, and minimizes sample exposure to the atmosphere. In-line filters are available in both disposable (barrel filters) and non-disposable (in-line filter holder, flat membrane filters) formats and various filter pore sizes (0.1-5.0 µm). Disposable filter cartridges have the advantage of greater sediment handling capacity when compared to traditional membrane filters. Filters must be pre-rinsed following manufacturer's recommendations. If there are no recommendations for rinsing, pass through a minimum of 1 L of ground water following purging and prior to sampling. Once filtration has begun, a filter cake may develop as particles larger than the pore size accumulate on the filter membrane. The result is that the effective pore diameter of the membrane is reduced and particles smaller than the stated pore size are excluded from the filtrate. Possible corrective measures include prefiltering (with larger pore size filters), minimizing particle loads to begin with, and reducing sample volume.

G. Monitoring of Water Level and Water Quality Indicator Parameters

Check water level periodically to monitor drawdown in the well as a guide to flow rate adjustment. The goal is minimal drawdown (<0.1 m) during purging. This goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience. In-line water quality indicator parameters should be continuously monitored during purging. The water quality

indicator parameters monitored can include pH, redox potential, conductivity, dissolved oxygen (DO) and turbidity. The last three parameters are often most sensitive. Pumping rate, drawdown, and the time or volume required to obtain stabilization of parameter readings can be used as a future guide to purge the well. Measurements should be taken every three to five minutes if the above suggested rates are used. Stabilization is achieved after all parameters have stabilized for three successive readings. In lieu of measuring all five parameters, a minimum subset would include pH, conductivity, and turbidity or DO. Three successive readings should be within ± 0.1 for pH, ± 3% for conductivity, ± 10 mv for redox potential, and ± 10% for turbidity and DO. Stabilized purge indicator parameter trends are generally obvious and follow either an exponential or asymptotic change to stable values during purging. Dissolved oxygen and turbidity usually require the longest time for stabilization. The above stabilization guidelines are provided for rough estimates based on experience.

H. Sampling, Sample Containers, Preservation and Decontamination

Upon parameter stabilization, sampling can be initiated. If an in-line device is used to monitor water quality parameters, it should be disconnected or bypassed during sample collection. Sampling flow rate may remain at established purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or loss of volatiles due to extended residence time in tubing. Typically, flow rates less than 0.5 L/min are appropriate. The same device should be used for sampling as was used for purging. Sampling should occur in a progression from least to most contaminated well, if this is known. Generally, volatile (e.g., solvents and fuel constituents) and gas sensitive (e.g., Fe^{2+}, CH_4, H_2S/HS^-, alkalinity) parameters should be sampled first. The sequence in which samples for most inorganic parameters are collected is immaterial unless filtered (dissolved) samples are desired. Filtering should be done last and in-line filters should be used as discussed above. During both well purging and sampling, proper protective clothing and equipment must be used based upon the type and level of contaminants present.

The appropriate sample container will be prepared in advance of actual sample collection for the analytes of interest and include sample preservative where necessary. Water samples should be collected directly into this container from the pump tubing.

Immediately after a sample bottle has been filled, it must be preserved as specified in the site (QAPP). Sample preservation requirements are based on the analyses being performed (use site QAPP, FSP, RCRA guidance document [U. S. EPA, 1992] or EPA SW-846 [U. S. EPA, 1982]). It may be advisable to add preservatives to sample bottles in a controlled setting prior to entering the field in order to reduce the chances of improperly preserving sample bottles or introducing field contaminants into a sample bottle while adding the preservatives.

The preservatives should be transferred from the chemical bottle to the sample container using a disposable polyethylene pipet and the disposable pipet should be used only once and then discarded.

After a sample container has been filled with ground water, a Teflon™ (or tin)-lined cap is screwed on tightly to prevent the container from leaking. A sample label is filled out as specified in the FSP. The samples should be stored inverted at 4°C.

Specific decontamination protocols for sampling devices are dependent to some extent on the type of device used and the type of contaminants encountered. Refer to the site QAPP and FSP for specific requirements.

I. Blanks

The following blanks should be collected:

(1) field blank: one field blank should be collected from each source water (distilled/deionized water) used for sampling equipment decontamination or for assisting well development procedures.

(2) equipment blank: one equipment blank should be taken prior to the commencement of field work, from each set of sampling equipment to be used for that day. Refer to site QAPP or FSP for specific requirements.

(3) trip blank: a trip blank is required to accompany each volatile sample shipment. These blanks are prepared in the laboratory by filling a 40-mL volatile organic analysis (VOA) bottle with distilled/deionized water.

V. Low-Permeability Formations and Fractured Rock

The overall sampling program goals or sampling objectives will drive how the sampling points are located, installed, and choice of sampling device. Likewise, site-specific hydrogeologic factors will affect these decisions. Sites with very low permeability formations or fractures causing discrete flow channels may require a unique monitoring approach. Unlike water supply wells, wells installed for ground-water quality assessment and restoration programs are often installed in low water-yielding settings (e.g., clays, silts). Alternative types of sampling points and sampling methods are often needed in these types of environments, because low-permeability settings may require extremely low-flow purging (<0.1 L/min) and may be technology-limited. Where devices are not readily available to pump at such low flow rates, the primary consideration is to avoid dewatering of

the well screen. This may require repeated recovery of the water during purging while leaving the pump in place within the well screen.

Use of low-flow techniques may be impractical in these settings, depending upon the water recharge rates. The sampler and the end-user of data collected from such wells need to understand the limitations of the data collected; i.e., a strong potential for underestimation of actual contaminant concentrations for volatile organics, potential false negatives for filtered metals and potential false positives for unfiltered metals. It is suggested that comparisons be made between samples recovered using low-flow purging techniques and samples recovered using passive sampling techniques (i.e., two sets of samples). Passive sample collection would essentially entail acquisition of the sample with no or very little purging using a dedicated sampling system installed within the screened interval or a passive sample collection device.

A. Low-Permeability Formations (<0.1 L/min recharge)

1. Low-Flow Purging and Sampling with Pumps

   a. "portable or non-dedicated mode" - Lower the pump (one capable of pumping at <0.1 L/min) to mid-screen or slightly above and set in place for minimum of 48 hours (to lessen purge volume requirements). After 48 hours, use procedures listed in Part IV above regarding monitoring water quality parameters for stabilization, etc., but do not dewater the screen. If excessive drawdown and slow recovery is a problem, then alternate approaches such as those listed below may be better.

   b. "dedicated mode" - Set the pump as above at least a week prior to sampling; that is, operate in a dedicated pump mode. With this approach significant reductions in purge volume should be realized. Water quality parameters should stabilize quite rapidly due to less disturbance of the sampling zone.

2. Passive Sample Collection

Passive sampling collection requires insertion of the device into the screened interval for a sufficient time period to allow flow and sample equilibration before extraction for analysis. Conceptually, the extraction of water from low yielding formations seems more akin to the collection of water from the unsaturated zone and passive sampling techniques may be more appropriate in terms of obtaining "representative" samples. Satisfying usual sample volume requirements is typically a problem with this approach and some latitude will be needed on the part of regulatory entities to achieve sampling objectives.

B. Fractured Rock

In fractured rock formations, a low-flow to zero purging approach using pumps in conjunction with packers to isolate the sampling zone in the borehole is suggested. Passive multi-layer sampling devices may also provide the most "representative" samples. It is imperative in these settings to identify flow paths or water-producing fractures prior to sampling using tools such as borehole flowmeters and/or other geophysical tools.

After identification of water-bearing fractures, install packer(s) and pump assembly for sample collection using low-flow sampling in "dedicated mode" or use a passive sampling device which can isolate the identified water-bearing fractures.

VI. Documentation

The usual practices for documenting the sampling event should be used for low-flow purging and sampling techniques. This should include, at a minimum: information on the conduct of purging operations (flow-rate, drawdown, water-quality parameter values, volumes extracted and times for measurements), field instrument calibration data, water sampling forms and chain of custody forms. See Figures 2 and 3 and "Ground Water Sampling Workshop -- A Workshop Summary" (U. S. EPA, 1995) for example forms and other documentation suggestions and information. This information coupled with laboratory analytical data and validation data are needed to judge the "useability" of the sampling data.

VII. Notice

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Appendix B
Field Sampling Forms and 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/Revelopment ☐ Other ☐ _____

Page _____ of _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number

Boring Drilled By: Name of crew chief (first, last) and Firm First Name: Last Name: Firm:	Date Drilling Started m m / d d / y y y y	Date Drilling Completed m m / d d / y y y y	Drilling Method

WI Unique Well No.	DNR Well ID No.	Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
_ _ _ _ _ _	_ _ _		_____Feet MSL	_____Feet MSL	_____ inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane _____ N, _____ E
_____ 1/4 of _____ 1/4 of Section _____, T _____ N, R _____

Lat ___ ° ___ ' ___ "
Long ___ ° ___ ' ___ "

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

Facility ID	County	County Code	Civil Town/City/ or Village
		____ ____	

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	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

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

Signature	Firm

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 used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

Sample		Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	

State of Wisconsin
Department of Natural Resources

Instructions
Soil Boring Log Information Forms
Form 4400-122, Form 4400-l22A

General Instructions:

Fill out a Soil Boring Log Information Form for every boring drilled. Be sure to indicate the page number and boring number in the blanks at the top of each page. All applicable portions of the Soil Boring Log Information Form must be properly completed. The form must be signed. Form 4400-122A must only be used as an attachment to form 4400-122.

Routing:

Return this form to the project manager or plan reviewer for the Department program that required the boring. If the project manager/plan reviewer is in a Regional Office, send the original to the Regional Office and a copy to the Central Office in Madison. If the project manager/plan reviewer is in the Central Office, send the original form there and a copy to the Regional Office. If your project does not have a project manager or plan reviewer or you do not know who it is, send the form to the appropriate program in the Central Office. Check the appropriate box at the top of the form to assure proper routing once the form reaches the Department.

Facility/Project Name: List the name of the landfill, wastewater treatment facility, surface impoundment, spill or project.

License/Permit/Monitoring Number: The number assigned by the Department to the facility where the boring was drilled. If unknown, leave blank.

Boring Number: The site boring number or name (e.g., B-1).

Boring Drilled By: The name (first and last) of the drilling crew chief and the drilling firm name.

Date Drilling Started: The date the boring was started in month/day/year (mm/dd/yyyy) format.

Date Drilling Completed: The date the boring was completed in month/day/year (mm/dd/yyyy) format.

Drilling Method: List drilling method used: solid stem auger, hollow stem auger, rotary (air or mud), reverse rotary, cable tool, wash boring, vibratory, etc.

Wisconsin Unique Well Number: If a well is to be set in the boring, fill in the 2 alphabetic 3 numeric Wisconsin Unique Well Number (WUWN) on this form. In addition, attach a WUWN tag to the inside of the protective cover pipe and record that number on the Monitoring Well Construction Form 4400-113A and Monitoring Well Development Form 4400-113B. WUWN tags are available from the DNR Central or Regional Offices.

DNR Well ID Number: The 3 digit number assigned to the well by the Department.

Well Name: If a well is constructed, fill in common well name, such as B-ll, OW-13A, or MW-5R. (Use the suffix "R" for a replacement well.)

Final Static Water Level: The static water level in the borehole in tenths (0.1) of feet above mean sea level prior to abandonment or well construction.

Surface Elevation: The surface elevation of the ground surface at the borehole in tenths (0.1) of feet above mean sea level referenced to the closest USGS benchmark.

Borehole Diameter: The diameter of the borehole in tenths (0.1) of inches.

Local Grid Origin or Boring Location: Check the appropriate box behind the Local Grid Origin or the Boring Location text. Locate the grid origin at a permanent feature near the waste or source of contamination. Give the location in State Plane Coordinates or Latitude and Longitude in degrees, minutes and seconds (using 1927 North American Datum). If State Plane Coordinates are used, circle the appropriate letter for south, central, or north zone. Alternately, an acceptable method for providing this information

without surveying is to locate the Grid Origin on a USGS 7.5 minute quadrangle map. The Location of the Grid Origin can then be interpolated (estimated) using standard cartographic techniques. If the Grid Origin location is estimated, check the estimated box.

The boring location can be determined by surveying or by Global Positioning System (GPS) (with processing to be accurate within 1 foot and reported with precision to hundredths of a second). If the exact location or the boring is given in State Plane Coordinates, then leave the Local Grid Location fields blank.

Section Location of Waste/Source: Enter the quarter quarter section, quarter section, section, township, range and range direction.

Local Grid Location: The location of the boring to the nearest foot, in relation to the grid origin established for the site. If the exact location or the boring is given in State Plane Coordinates, then leave these fields blank.

Facility ID: Fill in the Facility ID (FID) assigned to the site.

County: The county in which the boring is located.

County Code: The two-digit Department county code. (The code is based alphabetically with Adams County 01 and Wood County 72 and can be found on the map included with the Monitoring Well Construction form instructions.)

Civil Town/City/or Village: The municipality in which the boring is located.

Sample Number: The number used to identify the sample. Indicate the type of sampling apparatus used (i.e. split spoon/ss, Shelby tube/st, grab/gs, piston sampler/ps, core/cs, cuttings/cu). Note the diameter of the sampler in Comments column.

Sample Length Attempted and Recovered: The length of sample attempted and the length of sample recovered reported in inches.

Blow Counts: The number of blow counts per specified length.

Depth: Indicate the depth (below ground surface) of sample collection and depth of any changes in the soil or rock type encountered.

Soil/Rock Description and Geologic Origin: List visual characteristics of soil/rock noted during boring along with any pertinent descriptive remarks. Each major soil unit and bedrock formation shall be described using both subsurface investigations and regional information. Indicate likely geologic origin and Munsell color of the material.
USCS: Indicate the Unified Soil Classification System classification of any unconsolidated units or rock type encountered during boring.

Graphic Log: Graphically illustrate soil/rock types encountered through the depth of boring and provide a key for the symbols used. Indicate the total depth of the boring on the log.

Well Diagram: Graphically show the well casing, well screen length(s), and the location of the top of the filter pack(s) if the boring is converted into a well.

PID/FID: Measurements performed on samples using a Photo-Ionization Detector or a Flame Ionization Detector. Indicate in the Comments column the type of detector and the method used.

Soil Properties:

Compressive Strength - Standard measurements in tons/ft. Indicate in the Comments column the type of test used.
Moisture Content - Laboratory measurements of percent moisture content.
Liquid Limit - Measurement in percent.
Plasticity Index - Measurement in percent.
P 200 - Measurement of percentage of soils smaller than the #200 sieve.

RQD/Comments: Where boring penetrates bedrock, indicate the Rock Quality Designation of the sample. Otherwise, place all comments or remarks in this column and the adjacent margin.

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	Local Grid Location of Well ☐ N. ☐ S. _____ ft. ☐ E. ☐ W. _____ ft.	Well Name
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or	Wis. Unique Well No. _ _ _ _ _ _ / DNR Well ID No. _ _ _
Facility ID _ _ _ _ _ _ _ _ _ _	St. Plane _____ ft. N, _____ ft. E. S/C/N	Date Well Installed ___ / ___ / ___ (m m d d y y y y)
Type of Well Well Code ___ / ___	Section Location of Waste/Source ___ 1/4 of ___ 1/4 of Sec. ___, T. ___ N, R. ___ ☐ E. ☐ W	Well Installed By: Name (first, last) and Firm
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 _ _ _ _ _ _ ft. MSL

B. Well casing, top elevation _ _ _ _ _ _ ft. MSL

C. Land surface elevation _ _ _ _ _ _ ft. MSL

D. Surface seal, bottom _ _ _ _ _ _ ft. MSL or _ _ _ _ ft.

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

13. Sieve analysis performed? ☐ 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 _ _ _ _ _ _ ft. MSL or _ _ _ _ _ ft.

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

G. Filter pack, top _ _ _ _ _ _ ft. MSL or _ _ _ _ _ ft.

H. Screen joint, top _ _ _ _ _ _ ft. MSL or _ _ _ _ _ ft.

I. Well bottom _ _ _ _ _ _ ft. MSL or _ _ _ _ _ ft.

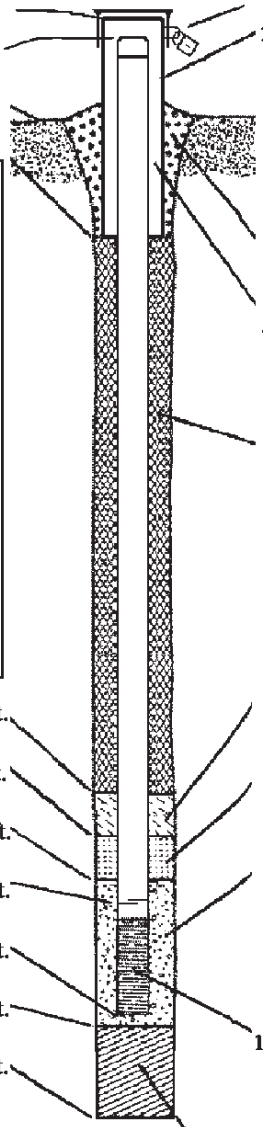
J. Filter pack, bottom _ _ _ _ _ _ ft. MSL or _ _ _ _ _ ft.

K. Borehole, bottom _ _ _ _ _ _ ft. MSL or _ _ _ _ _ ft.

L. Borehole, diameter _ _ _ _ in.

M. O.D. well casing _ _ _ _ in.

N. I.D. well casing _ _ _ _ in.



1. Cap and lock? ☐ Yes ☐ No

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

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

4. Material between well casing and protective pipe:
Bentonite ☐ 3 0
_____ 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. _____ 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. _____
b. Volume added _____ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. _____
b. Volume added _____ ft^3

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

10. Screen material: _____
a. Screen type: Factory cut ☐ 1 1
Continuous slot ☐ 0 1
_____ Other ☐
b. Manufacturer _____
c. Slot size: 0. _ _ _ in.
d. Slotted length: _ _ _ 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	Firm

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

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐ _____

Facility/Project Name	County Name	Well Name

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
	__	_ _ _ _ _ _	_ _ _

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

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☐ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐ __

3. Time spent developing well _ _ _ _ min.

4. Depth of well (from top of well casisng) _ _ _ . _ ft.

5. Inside diameter of well _ _ . _ _ in.

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

7. Volume of water removed from well _ _ _ . _ 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. _ _ _ . _ _ ft.	_ _ _ . _ _ ft.
Date	b. _ _/_ _/_ _ _ _ (m m d d y y y y)	_ _/_ _/_ _ _ _ (m m d d y y y y)
Time	c. _ _ : _ _ ☐ a.m. ☐ p.m.	_ _ : _ _ ☐ a.m. ☐ p.m.
12. Sediment in well bottom	_ _ . _ inches	_ _ . _ inches
13. Water clarity	Clear ☐ 10 Turbid ☐ 15 (Describe)	Clear ☐ 20 Turbid ☐ 25 (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: Name (first, last) and Firm
First Name: Last Name:
Firm:

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: _____ Last Name: _____

Facility/Firm: _____

Street: _____

City/State/Zip: _____

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

Signature: _____

Print Name: _____

Firm: _____

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

State of Wisconsin
Department of Natural Resources

INSTRUCTIONS
Monitoring Well Construction Form 4400-113A

General Instructions: Fill out both a monitoring well construction form (4400-113A) and a monitoring well development form (4400-113B) for each well installed. Sign each form. Please note that these forms are subject to change. (Personally identifiable information on these forms is not intended to be used for any other purpose.)

Routing: Return these forms to the project manager or plan reviewer for the DNR program who required the well installation. If the project manager/plan reviewer is in the Regional Office, send the original forms to the Regional Office and a copy to the Central Office in Madison. If the project manager/plan reviewer is in the Central Office, send the original forms there and a copy to the Regional Office. If your project does not have a project manager or plan reviewer or you don't know who it is, send the forms to the appropriate program in the Central Office. The addresses of the DNR offices are provided on the attached map.

Check the appropriate routing box at the top of the forms to assure proper routing once the forms reach DNR.

Time-saving tip: When filling out many forms at once, you can save time by using a photocopier. Fill out one form (the "original") with any information that is the same for all wells, such as facility name, section location, grid origin location, drilling method and well casing type. Photocopy both sides of the "original", making as many copies as there are wells. On the separate copies, fill in the details that are unique for each well.

TOP LEFT

Facility/Project Name: Fill in the name of landfill, wastewater treatment facility, surface impoundment, spill or project.

Facility License, Permit, or Monitoring Number: Fill in number assigned to facility by the Department. If unknown, leave blank.

Facility ID: Fill in the nine digit Facility ID (FID) assigned to the site.

Type of Well: Record the type of well code (number/initials) from the following list:

11/mw Water table observation well (monitoring well screen intersecting the water table) (non Subtitle D well)
12/pz Piezometer (monitoring well with screen sealed below the water table) (non Subtitle D well)
17/gc Gradient control
18/at Aquifer test
24/lh Leachate head well
26/ew Groundwater extraction well
27/he Horizontal groundwater extraction well
28/hw Horizontal monitoring well
29/ha Horizontal vapor extraction well
51/gp Gas probe
53/ge Gas extraction well
57/sv Soil venting wells (includes both soil vapor extraction and bioventing, includes both extraction and unsaturated zone gas phase injection wells installed in soil or fill, but not refuse
61/ij Injection well (injection of liquids not gases)
62/as In situ air sparging well (injection well to inject gases into the aquifer
63/uv Unterdruck Verdampfer Brunnen (UVB) wells (sparging wells where the gases remain in the well and are not injected into the aquifer)
64/le Groundwater and light non-aqueous phase liquid (LNAPL) extraction wells
65/de Groundwater and dense non-aqueous phase liquid (DNAPL) extraction wells
66/ve Vacuum enhanced groundwater extraction wells
67/vi Vacuum enhanced groundwater and LNAPL extraction wells
68/vd Vacuum enhanced groundwater and DNAPL extraction wells
71/dw Subtitle D water table observation well (see 11/mw above)
72/dp Subtitle D piezometer (see 12/pz above)
99/Ot Other

Distance From Waste/Source: Enter distance in feet from the monitoring well to the edge of a facility waste storage or discharge structure, e.g., from the edge of a wastewater lagoon or the approved waste fill boundary for a landfill. For a contaminant source which is not a facility, e.g., a spill, enter the distance the well is from the contaminant source.

Enf. Stds. Apply: Check this box only if enforcement standards apply at this well. Enforcement standards apply at any well beyond the Design Management Zone or the property boundary of the facility or at a water supply well. For spills, enforcement standards apply at every point at which groundwater is monitored. (For more information, see s. NR 140.22, Wis. Adm. Code.)

TOP CENTER

Local Grid Location: The location of the well to the nearest foot, in relation to the grid origin established for the site. If the exact location of the well is given in State Plane Coordinates, then leave these fields blank.

Local Grid Origin or Well Location: Check the appropriate box behind the Local Grid Origin or the Well Location text. Locate the grid origin at a permanent feature near the waste or source of contamination. Give the location in State Plane Coordinates or Latitude and Longitude in degrees, minutes and seconds (using 1927 North American Datum). If State Plane Coordinates are used, circle the appropriate letter for south, central or north zone. Alternately, an acceptable method for providing this information without surveying is to locate the Grid Origin on a USGS 7.5 minute quadrangle map. The Location of the Grid Origin can then be interpolated (estimated) using standard cartographic techniques. If the Grid Origin location is estimated, check the estimated box.

The Well Location can be determined directly by surveying or by Global Positioning System (GPS) (with processing to be accurate within 1 foot and reported with precision to hundredths of a second). If the exact location of the well is given in State Plane Coordinates, then leave the Local Grid Location fields blank.

Section Location of Waste/Source: Fill in the quarter quarter and quarter section, section, township, range and range direction of the waste or source.

Location of Well Relative to Waste/Source: Check the box which describes the location of the well in the groundwater flow system relative to the disposal site, spill, etc. If groundwater flow directions are unknown, check "not known."

Gov. Lot Number: Provide the government lot number for the property if applicable. (Government lot numbers are the legal description of a tract of land adjacent to a lake or stream where a proper quarter or quarter quarter section corner could not be established.)

TOP RIGHT

Well Name: Fill in common well name, such as B-ll, OW-13A, or MW-5R. (Use the suffix "R" for a replacement well.)

Wis. Unique Well Number: Fill in the 2 alphabetic and 3 numeric Wisconsin Unique Well Number (WUWN) on this form. In addition, attach the WUWN tag to the inside of the protective cover pipe and record that number on the Soil Boring Log Information form 4400-122 and Monitoring Well Development form 4400-113B. WUWN tags are available from the DNR Central or Regional Offices.

DNR Well ID Number: The 3 digit number assigned to the well by the Department.

Date Well Installed: List Month/Day/Year (mm/dd/yyyy) the well was installed.

Well Installed By: Fill in name (first and last) and firm of the person who supervised the drilling. The person must be a hydrogeologist, a drilling crew chief or experienced engineering technician.

LEFT SIDE

Numerical Specifications: Fill in data for letters A through N which refer to design elements on the figure on the form. Letters A, B and C must be reported as elevations in feet above mean sea level (MSL), surveyed to the nearest 0.01 foot. Letters D through K may be either elevation above MSL or depth below land surface, accurate to the nearest 0.1 foot.

A. **Protective pipe, top elevation**. With cap off. Referenced to Mean Sea Level (MSL).

B. **Well casing, top elevation**. With cap off. Referenced to MSL.

C. **Land surface elevation**. Referenced to MSL.

D. **Surface seal, bottom**. Fill in elevation, MSL or depth below land surface.

E. **Bentonite seal, top**. MSL or depth below land surface. (See NR 141.13(1) to determine if this seal is required)

F. **Fine sand, top**. MSL or depth below land surface. Cross out if not installed.

G. **Filter pack, top**. MSL or depth below land surface.

H. **Screen joint, top**. MSL or depth below land surface. (Top of the entire screen section, NOT the top slot)

L. **Well bottom**. MSL or depth below land surface.

J. **Filter pack, bottom**. MSL or depth below land surface.

K. **Borehole, bottom**. MSL or depth below land surface.

L. **Borehole, diameter**: Diameter to nearest 0.1 inch.

M. **O.D. well casing**: Outside diameter to nearest 0.01 inch.

N. **I.D. well casing**: Inside diameter to nearest 0.01 inch.

LEFT CENTER INSERT (BOX)

12. **USCS classification of soil near screen**: Check boxes for all soil types (or bedrock) found at the depths spanned by the well screen, using the Unified Soil Classification System symbols. Refer to the native soil near the screen, not to the filter pack material.

13. **Sieve analysis performed?**: Check box. A sieve analysis for soil near the screen is required for all wells.

14. **Drilling method used**: Choose from among the choices on the form or check "Other" and write in one of the choices below:

Reverse rotary	Solid stem auger	Cable tool	Driven point
Vibratory	Casing hammer	Wash boring	

15. **Drilling fluid used**: Check appropriate box or boxes.

16. **Drilling additives used**: Check box. If yes, describe.

17. **Source of water**: Cite source(s) of any water used to drill the well OR to hydrate dry bentonite OR to mix annular space sealant. Cite exact source so that a sample of the water can be obtained later, if necessary. If the well is at a solid waste facility, attach an analysis of the water according to s. NR 507.06(1), Wis. Adm. Code.

RIGHT SIDE

1. **Cap and Lock**: Check box.

2. **Protective pipe**: Provide the information below.

   a. **Inside diameter**: Give to nearest 0.1 inch.
   b. **Length**: Give to nearest 0.1 foot
   c. **Material**: Check box. If "Other", describe.
   d. **Additional protection?**: Check box. If 'Yes', describe.

3. **Surface seal**: Check box for the material used to prevent surface water from entering the borehole. If "Other," describe.

4. **Material between well casing and protective pipe**: Check box. If "Other", describe.

5. **Annular space seal**: Check boxes for both materials used and how installed, and fill in volume used.

   Material: If dry bentonite, list source of water used for hydration on line #17. For wells installed at a solid waste site, attach an analysis of water (see s. NR 507.06(1), Wis. Adm. Code.) For other choices, fill in pounds per gallon mud weight or percent bentonite as appropriate.

   e. **Volume**: Fill in volume used in cubic feet.
   f. **How installed**: Check box for how the annular space seal was installed. If dropped from the land surface, check "Gravity."

6. **Bentonite seal**: If bentonite pellets were used, also check the pellet diameter. If material installed was the same as the annular space seal, or if no filter pack seal was installed, write "none."

7. **Fine sand material**: Fine sand is used to prevent migration of annular space seal material into the filter pack.
   a. Indicate manufacturer, product name, and mesh size.
   b. Indicate volume added.

8. **Filter pack material**: General description of filter pack material, e.g., "430 grit sand," and name of filter pack manufacturer, product name or number, and volume added. Attach grain size analysis of filter pack and state quantity used.

9. **Well casing**: Check box for PVC type. If "Other", describe. Examples of "Other" include stainless steel, steel, and Teflon ©.

10. **Screen material**: If same as well casing, write "same."

    a. **Screen type**: Check box. If "Other", describe the design.
    b. **Manufacturer**: List name of manufacturer.
    c. **Slot size**: Give width of slot in thousandths (0.001) of an inch.
    d. **Slotted length**: Give distance from top slot to bottom slot to nearest 0.1 foot.

11. **Backfill material**: Check "None" or, if "Other", describe any backfill installed below the filter pack.

FAR BOTTOM

"I hereby certify that the information on this form is true and correct to the best of my knowledge.": Sign the form and indicate name of firm.

MONITORING WELL DEVELOPMENT FORM 4400-113B

TOP TWO LINES

Facility/Project Name: Fill in the name of landfill, wastewater treatment facility, surface impoundment, spill or project.

Facility License Permit, or Monitoring Number: Enter number assigned to facility by the DNR. If unknown, leave blank.

County Name: Fill in the name of the county in which the well is installed.

County Code: Fill in the two digit county code number.

1 . Adams	16. Douglas	31. Kewaunee	46. Ozaukee	61. Taylor
2. Ashland	17. Dunn	32. La Crosse	47. Pepin	62. Trempealeau
3. Barron	18. Eau Claire	33. Lafayette	48. Pierce	63. Vernon
4. Bayfield	19. Florence	34. Langlade	49. Polk	64. Vilas
5. Brown	20. Fond Du Lac	35. Lincoln	50. Portage	65. Walworth
6. Buffalo	21. Forest	36. Manitowoc	51. Price	66. Washburn
7. Burnett	22. Grant	37. Marathon	52. Racine	67. Washington
8. Calumet	23. Green	38. Marinette	53. Richland	68. Waukesha
9. Chippewa	24. Green Lake	39. Marquette	54. Rock	69. Waupaca
10. Clark	25. Iowa	40. Menominee	55. Rusk	70. Waushara
11. Columbia	26. Iron	41. Mlwaukee	56. St. Croix	71. Winnebago
12. Crawford	27. Jackson	42. Monroe	57. Sauk	72. Wood
13. Dane	28 Jefferson	43. Oconto	58. Sawyer	
14. Dodge	29. Juneau	44. Oneida	59. Shawano	
15. Door	30. Kenosha	45. Outagamie	60. Sheboygan	

Well Name: Fill in common well name, such as P-11, OW-13A, or MW-5R. (Use the suffix "R" for a replacement well.)

Wis. Unique Well Number: Record the Wisconsin Unique Well Number assigned to the well.

DNR Well ID Number: The 3 digit number assigned to the well by the Department.

LEFT COLUMN

1. **Can this well be purged dry?** Check whether well can or cannot be purged dry (all water removed).

2. **Well development method**: Check appropriate box. If "Other", describe. Note that a well shall be surged and purged for a minimum of 30 minutes.

3. **Time spent developing well**: In minutes.

4. **Depth of well**: In tenths (0.1) of feet, from top of well casing.

5. **Inside diameter of well**: In hundredths (0.01) of inches.

6. **Volume of water in filter pack and well casing**: In tenths (0.1) of gallons.

7. **Volume of water removed from well**: In tenths (0.1) of gallons.

8. **Volume of water added, if any**: In tenths (0.1) of gallons.

9. **Source of water added**: Cite exact source so that a sample of the water can be obtained later, if necessary.

10. **Analysis performed on water added?** Check appropriate box. If well is installed at a solid waste facility, attach analysis of water according to s. NR 507.06(1), Wis. Adm. Code.

RIGHT COLUMN

11. **Depth to water**:

    a. Enter distance from top of well casing to water level in well, in hundredths (0.01) of a foot, both before and after development.

    b. **Date**: Enter month/day/year (mm/dd/yyyy) development began and ended.

    c. **Time**: Enter according to a twelve hour clock the time development began and ended.

12. **Sediment in well bottom**: Compute to tenths (0.1) of inches, both before and after development.

13. **Water clarity**: Check box and describe.

14. **Total suspended solids**: Total Suspended Solids, as determined by a certified or registered analytical laboratory. Required only for wells near solid waste facilities when drilling fluids were used.

15. **COD**: Chemical oxygen demand, as determined by a certified or registered analytical laboratory. Required only for wells near solid waste facilities when drilling fluids were used.

16. **Well developed by**: Enter the name (first and last) and firm of the person who supervised the development This person must be a hydrogeologist, the drilling crew chief, or an experienced engineering technician.

BOTTOM SECTION

17. **Additional comments on development**: Describe any of the above in more detail or add information such as the relative recovery rates of wells or the amount of drilling fluid lost to the formation and the amount of water removed to account for lost drilling fluid. For example, if 150 gallons of drilling water were, lost, you should remove the volume of water in the filter pack and well casing plus 150 gallons as part of development.

Name and Address of Facility/Owner/Responsible Party Contact: Enter a contact name (first and last), or a firm name or facility name, street address, city, state, and zip code of the facility or site.

Signature, Print Name, and Firm: Signature and printed name of the person filling out the form and name of firm for which the person works.

Tetra Tech, Inc. Ground Water Sampling Log

Project _____ **Site** _____ **Well No.** _____ **Date** _____

Well Depth _____ **Screen Length** _____ **Well Diameter** _____ **Casing Type** _____

Sampling Device _____ **Tubing type** _____ **Water Level** _____

Measuring Point _____ **Other Infor** _____

_____

Sampling Personnel _____

Time	pH	Temp	Cond.	Dis.O_2	Turb.	[ ]Conc	Pump Rate		Notes

Type of Samples Collected

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: Vol = $\pi r^2 h$, Vol = $4/3 \pi r^3$