Groundwater Well Installation and Monitoring Work Plan

Park Laundry Site, Ridgefield Washington

Prepared for:

City of Ridgefield

July 3, 2024

Project No. M0239.33.007

Prepared by:

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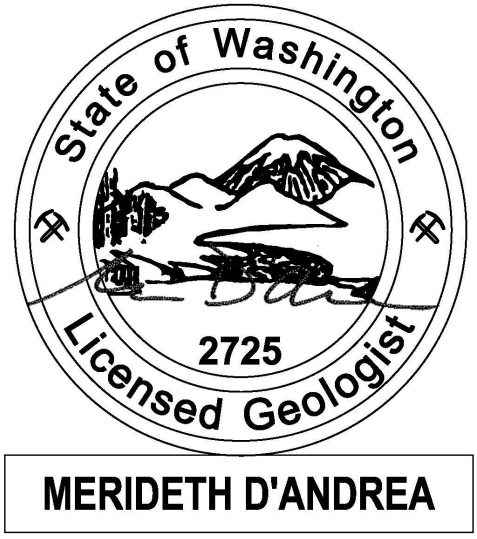
Groundwater Well Installation and Monitoring Work Plan

Park Laundry Site, Ridgefield Washington

The material and data in this report were prepared under the supervision and direction of the undersigned.

Maul Foster & Alongi, Inc.



Merideth D'Andrea, LG 07-03-2024
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Calen Busch, LG
(Project Geologist)

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Abbreviations

bgs	below ground surface
CAP	Cleanup Action Plan
City	City of Ridgefield
CUL	cleanup level
Ecology	Washington State Department of Ecology
FS	feasibility study
MFA	Maul Foster & Alongi, Inc.
Property	122 N. Main Avenue, Ridgefield, Washington
PCE	tetrachloroethene
RI	remedial investigation
Site	the Property and neighboring properties where contamination has come to be
Source Area	the Property and two vacant lots located directly north of the Park Laundry property, collectively
SOP	standard operating procedure
VOcs	volatile organic compounds
WBZ	water-bearing zone

1 Introduction

Maul Foster & Alongi, Inc. (MFA) has prepared this groundwater well installation and monitoring work plan on behalf of the City of Ridgefield (City) for the Former Park Laundry Site. The laundry operated at 122 N. Main Avenue, Ridgefield, Washington (the Property) (see Figure 1). Results of previous investigations indicate that volatile organic compounds (VOCs) are present in soil and groundwater on the Property and in groundwater hydraulically downgradient of the Property. For the purposes of this work plan, the Site is defined by the extent of Property-related contamination[1] in all media. The Source Area is defined as the former Park Laundry parcel and the two adjoining parcels to the north (see Figures 2 and 3),

1.1 Purpose and Objective

This work plan describes the scope of work to complete the installation of groundwater wells in the lower water-bearing zone (LWBZ) per the December 28, 2023, Consent Decree between the City and Washington State Department of Ecology (Ecology), which includes a Cleanup Action Plan (CAP; Ecology 2024). The CAP was developed to address the potential human health and environmental concerns associated with PCE and its degradation products based on Ecology's selected remedy (i.e., Alternative 4) from the Remedial Investigation/Feasibility Study (RI/FS) analysis conducted by MFA (MFA 2019). As part of the development of the CAP, Ecology determined that "The vertical extent of contamination in the LWBZ has not been adequately evaluated." To fill this data gap, Ecology is requiring the at least 3 groundwater monitoring wells be installed in the sandy gravel portion of the LWBZ beneath the Site to sample and analyze groundwater for VOCs.

Ecology's required remedy consists of soil excavation down to 15 feet below ground surface (bgs) in the Source Area, groundwater treatment, institutional controls, and groundwater monitoring. This work plan outlines the procedures to complete the groundwater monitoring portion of the remedy by meeting the following objectives:

- Confirm point of compliance for groundwater within and downgradient of the Source Area by evaluating for the presence of contamination in the lower water-bearing zone (WBZ).
- Complete baseline groundwater monitoring at the 19 monitoring wells at the Site (including three monitoring wells located at the Port of Ridgefield and the three new monitoring wells installed in the lower WBZ).

[1] Defined as having an exceedance of the Model Toxics Control Act Method A cleanup level.

2 Background and Physical Setting

The sections below provide a summary of background and physical setting. Detailed descriptions of site history, topography, geology, hydrogeology, and past data collection are provided in the CAP (Ecology 2024) and RI/FS (MFA 2019).

2.1 Source Area and Site Description

The Source Area is zoned as Downtown Mixed Use and is comprised of approximately 5 parcels. The parcel formerly occupied by Park Laundry was approximately 25 feet wide (north-south) and 100 feet long (east-west). To the east is a one-lane, paved alleyway, bordered by a city skate park and a former fire station. To the west is North Main Avenue and a restaurant. Land use in the downtown is primarily residential and commercial.

The groundwater plume associated with the Source Area covers an estimated 22 acres. The plume generally follows the topography of the area, extending north and west from the Property, and is bounded on the west by Lake River (MFA 2019).

2.2 Property History

Park Laundry operated at the Property from approximately 1965 to 1977. The laundry service is believed to have included dry cleaning services and self-service, coin-operated washers and dryers. Park Laundry's operations had ceased by 1978 and in 2000 the former laundry service building was removed. The City of Ridgefield acquired the Property on December 28, 2023, at which time the Consent Decree with Ecology became effective (Ecology 2023).

2.3 Site Topography, Geology and Hydrogeology

Site topography consists of upper and lower terrace areas trending north and south. The upper terrace forms a bluff above the Columbia River and the lower terrace abuts Lake River. The Source Area is located on the upper terrace in downtown Ridgefield.

Borings on and downgradient of the property have been advanced as deep as 80 and 90 feet bgs, respectively. A generalized geologic cross section was prepared as part of the RI/FS (MFA 2019) and is included in Appendix A. Figure 2 shows the location of a geologic cross section through the Site. Generally, the Site is underlain by Holocene to Tertiary age alluvial deposits. The shallow WBZ on the upper terrace is perched above a massive silt and clay deposit at about 12 to 20 feet bgs. The shallow WBZ in the upper terrace fluctuates seasonally from less than 2-feet bgs to greater than 10-feet bgs. Groundwater flow in the upper WBZ through the upper terrace is to the north, northwest and turns to the west to follow topographic slope to the lower terrace and Lake River (see potentiometric surface map; Appendix A). Groundwater elevation data from Site monitoring wells show that groundwater flow direction in the upper WBZ is consistent season to season.

In the upper terrace, the aquitard beneath the upper WBZ consists of silt and clay, and silty gravel. The silt and clay portion is about 40 feet thick, is in contact with, and overlies the silty gravel portion.

The silt and clay portion pinches out to the west only being found beneath the upper terrace and part of the slope between the terraces. The silt and clay portion is considered Pleistocene in age while the underlying silty gravel is thought to be Tertiary age. The silty gravel unit extends beneath the entire Site and extends beneath the Source area to approximately 100 feet bgs. Beneath the silt and clay and silty gravel aquitard is the Tertiary age lower WBZ. It consists of sand and sandy gravel extending beneath the entire Site. There are no monitoring wells in the lower WBZ unit so groundwater flow direction and confirmation there is no contamination is unknown.

2.4 Past Site Investigations and Contaminants of Concern

The RI/FS report (MFA 2019) provides a detailed summary of the remedial investigation and previous investigation results for the Site including the nature and extent of contaminants and the risk associated with those contaminants. Previous sample locations are shown on Figures 2 and 3. Indicator hazardous substances identified for the Site consist of PCE and its degradation products (including trichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, and vinyl chloride).

2.5 Cleanup Levels

The CAP provides final groundwater cleanup levels (CULs) for the indicator hazardous substances listed above. The CULs are based on Model Toxics Control Act Method B, the State/Federal Maximum Contaminant Levels, Title 40 Code of Federal Regulation 131.45, Washington Administrative Code 173-201A, and the Federal Clean Water Act 304. As detailed in Section 3, groundwater analytical results will be compared to the final CULs to establish baseline conditions prior to implementation of Source Area cleanup actions.

3 Groundwater Well Installation and Monitoring Scope of Work

As detailed in the CAP, Ecology requires installation of three deep monitoring wells to evaluate if contamination has migrated through the silt and clay and silty gravel units into the underlying lower WBZ along with baseline monitoring of selected wells at and near the Site. This section describes the objectives and scope of work for the groundwater well installation and baseline monitoring. The work will be completed consistent with the methods and protocol described in the attached standard operating procedures (SOPs) included in Appendix B. Field forms (boring logs, well completion, well development, and groundwater sampling) are also provided in Appendix B. Groundwater sample analyses and handling procedures, containers, preservation, holding times, method requirements and performance criteria, and field quality control procedures for sample analyses are described in Tables 1 through 3.

3.1 Deep Groundwater Well Installation

3.1.1 Utility Locate

Consistent with the SOP (Appendix B), a public utility locate will be requested. Prior to subsurface exploration, a private utility locate contractor will locate on-site utilities, including the orientation of any water and sewer mains or laterals. Sampling locations may be adjusted based on information obtained from the utility locates.

3.1.2 Boring Completion and Monitoring Well Installation

The three monitoring well borings will be advanced using a roto sonic drill rig at the locations shown on Figure 3 (MW-23D, -24D, and -25D). Monitoring wells MW-23D and MW-24D are located within the Source Area and monitoring well MW-25D is located west and downgradient of the Source Area. Groundwater monitoring wells will be completed using telescoping casing methodology to prevent drag down of contamination from the upper WBZ into the lower WBZ. Continuous core samples will be obtained and logged by a geologist or engineer, overseen by a geologist licensed in the state of Washington. Sonic drilling, geologic logging, and well installation will be completed using the general methods and protocol outlined in the SOPs included in Appendix B.

The monitoring well installation details described below are based on a review of known site geology (see Geologic Cross Section; Appendix A):

- The monitoring well borings will be drilled with 8-inch diameter casing and advanced from the surface to 5 feet into the silt and clay unit (anticipated to be 20 feet bgs). Once this depth is reached and confirmed by the onsite geologist or engineer, bentonite chips will be added so that a minimum of 5-feet of bentonite is in place at the bottom of the borehole and within the casing. Water will be added to the borehole and the bentonite chips will be allowed to hydrate for at least one hour. Following bentonite hydration, drilling will telescope through the bentonite with smaller casing (6-inch diameter) to a total depth at least 10 feet into the lower WBZ unit (sand and sandy gravel). The lower WBZ unit is anticipated to be encountered around 100 feet bgs.
- The wells will be completed with flush mount monuments and will consist of 2-inch Schedule 40 polyvinyl chloride casing with 0.01-inch machine-slotted screens prepacked with 12/20 silica sand. The prepacked screen final diameter, including the stainless-steel mesh, is 3.4 inches. Screen lengths will be 10 feet and will be set entirely in the lower WBZ.

3.1.3 Monitoring Well Development

Following monitoring well installation, the wells will be developed following the methods and protocol outlined in the SOPs included in Appendix B.

3.1.4 Survey

Following installation and development, the monitoring wells will be professionally surveyed (top-of-casing and ground surface) to tie in with the existing Site monitoring well network.

3.2 Baseline Groundwater Monitoring

A single baseline groundwater sampling event will be conducted following the installation and development of the deep monitoring wells and prior to implementing Source Area cleanup actions. As shown on Table 1 and Figure 4, the baseline groundwater sampling event will include 19 monitoring wells at the Site (including three monitoring wells located at the Port of Ridgefield and the three new monitoring wells installed in the lower WBZ). Groundwater sampling, including water level measurements will be conducted using the methods and protocol as outlined in the SOPs included in Appendix B.

As shown on Tables 1 and 2, the groundwater samples will be analyzed for PCE and its degradation products by U.S. Environmental Protection Agency Method 8260D low-level. The low-level method is required to obtain data at detection limits near the CULs established in the CAP. Field quality control procedures are detailed in Table 3.

3.3 Reporting

The results of the baseline groundwater monitoring will be validated, compiled, and added to Ecology's environmental database. Well installation field data (i.e., boring logs and well construction details) and baseline groundwater monitoring data will also be provided in the forthcoming Draft Engineering Design Report. The data will be used to confirm/evaluate the point of compliance for groundwater and establish baseline groundwater conditions in both WBZs prior to implementation of Source Area cleanup actions.

References

Ecology. 2023. *Consent Decree. Former Park Laundry.* Issued by Washington State Department of Ecology. Lacey, WA.

Ecology. 2024. *Draft Cleanup Action Plan*. *Former Park Laundry*. Issued by Washington State Department of Ecology. Lacey, WA.

MFA. 2019. *Remedial Investigation and Feasibility Study Report, former Park Laundry,* Washington State Department of Ecology Agreed Order No. DE 6829. Maul Foster & Alongi, Inc., Vancouver, Washington. July 11.

Limitations

The services undertaken in completing this plan were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This plan is solely for the use and information of our client unless otherwise noted. Any reliance on this plan by a third party is at such party's sole risk.

Opinions and recommendations contained in this plan apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this plan.

Figures

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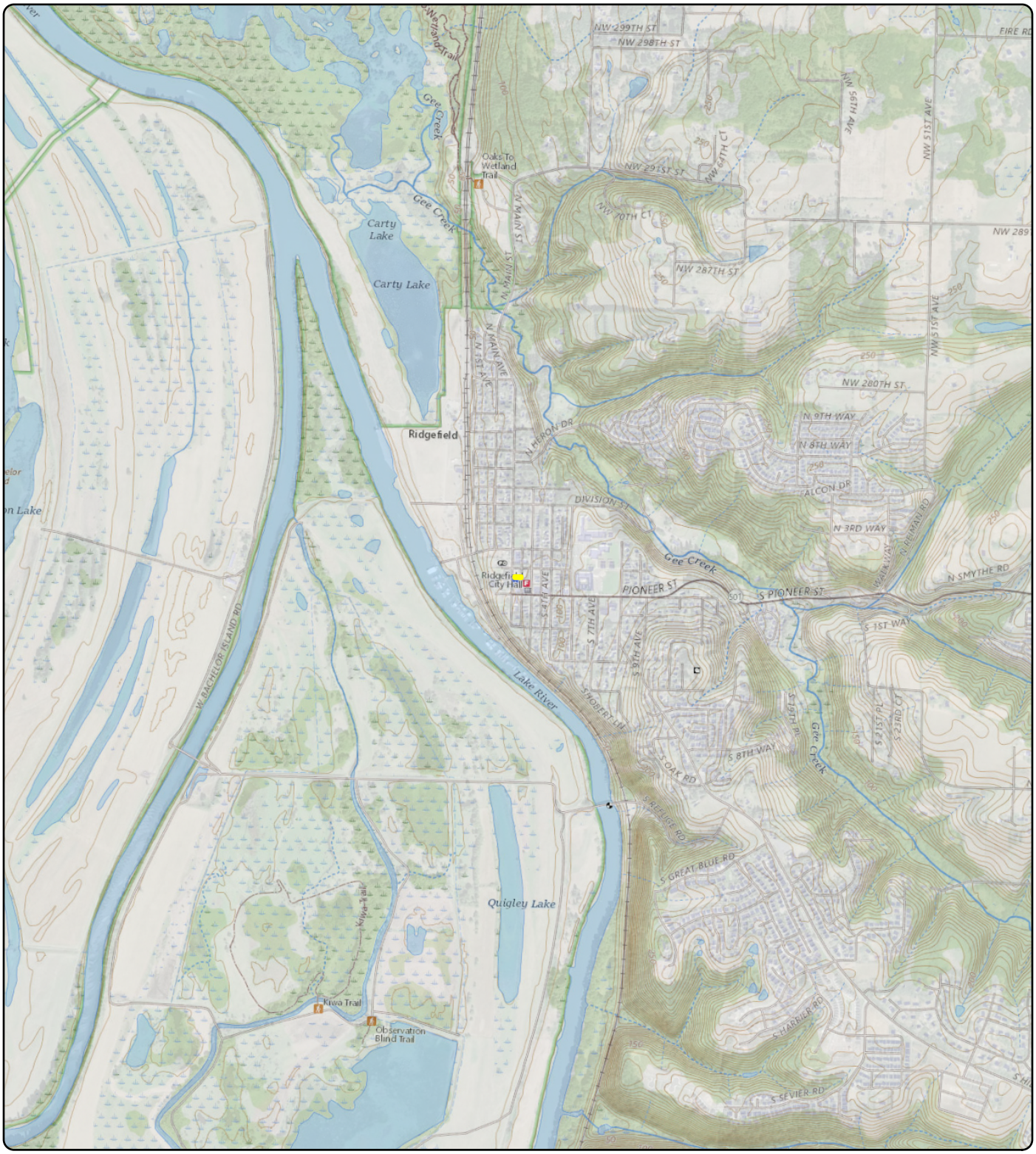

Notes
U.S. Geological Survey 7.5-minute topographic quadrangle (2020): Ridgefield.
Township 4 north, range 1 west, section 24.

Data Source
Property boundary obtained from Clark County.

Legend

Property Boundary

Figure 1
Property Location

Former Park Laundry
City of Ridgefield, WA

0 2,000
Feet

MAUL FOSTER ALONGI
p. 971 544 2139 | www.maulfoster.com

Path: X:\0239.33\007\Pro\M0239_33_007_004.aprx\Fig 1 Property Location
Print Date: 4/23/2024
Reviewed By: cbusch
Produced By: sturner
Project: M0239.33.007

Figure 2
Site Features

Former Park Laundry
City of Ridgefield, WA

Legend

- Cross Section
- Property Boundary
- Estimated Site Boundary
- Port of Ridgefield Shallow Boring, 2012
- Port of Ridgefield Monitoring Wells
- Shallow Boring, MFA 2001
- Shallow Boring, MFA March 2010
- Deep Boring, MFA March 2010
- Shallow Boring, MFA October 2010
- Shallow Boring, MFA June 2011
- Monitoring Well, MFA June 2011
- Monitoring Well, MFA March 2012
- Monitoring Well, MFA April 2013
- Shallow Boring, MFA September 2014

0 200
Feet

Data Sources
Aerial photograph obtained from Bing and Google Earth.

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Path: X:\0239.33\007\Pro\M0239_33_007_004.aprx\Fig 2 Site Features
Print Date: 4/23/2024
Reviewed By: cbusch
Produced By: sturner
Project: M0239.33.007

Figure 3
Proposed Deep Monitoring Well Locations

Former Park Laundry
City of Ridgefield, WA

Legend

Proposed Investigation Locations
- Monitoring Well

Previous Sample Locations
- Boring
- Monitoring Well
- Surface (0.5 ft bgs) Exceedance
- Mid-Depth (5 ft bgs) Exceedance
- Deep (> 12 ft bgs) Exceedance

Preliminary Excavation Demarcation
- 3' Proposed Excavation
- 6' Proposed Excavation
- 15' Proposed Excavation
- Property Boundary
- Focused Injections
- Tax Lot

Notes
Exceedance is defined as a PCE concentration in soil within the top 15 feet in excess of the selected REL for PCE in soil. REL for PCE = 0.05 mg/kg.
ft bgs = feet below ground surface.
mg/kg = milligrams per kilogram.
MTCA = Model Toxics Control Act.
PCE = tetrachloroethene.
REL = remediation level.

0 30
Feet

Data Sources
Aerial photograph (2023) obtained from Google Earth; tax lot data obtained from Clark County.

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Path: X:\0239.33\007\Proj\M0239_33_007_004.aprx\Fig 3 Proposed Deep Monitoring Well Locations
Print Date: 6/25/2024
Reviewed By: mpollock
Produced By: sturner
Project: M0239.33.007

Figure 4
Groundwater Monitoring Network

Former Park Laundry
City of Ridgefield, WA

Legend

Groundwater Wells Included in Monitoring

- Proposed Monitoring Well
- Monitoring Well, MFA June 2011
- Monitoring Well, MFA March 2012
- Monitoring Well, MFA April 2013
- Port of Ridgefield Monitoring Wells
- Property Boundary
- Estimated Site Boundary

0 100
Feet

Data Sources
Aerial photograph obtained from Bing and Google Earth.

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Path: X:\0239.33\007\Pro\M0239_33_007_004.aprx\Fig 4 Groundwater Monitoring Network
Print Date: 6/25/2024
Reviewed By: mpollock
Produced By: sturner
Project: M0239.33.007

Tables

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Table 1
Monitoring Well Sampling and Analysis Summary
Predesign Investigation Work Plan
Former Park Laundry, Ridgefield, Washington

Location	Screen Interval (ft bgs)	Sample Depth[a] (ft bgs)	Matrix	Analytical Suite					
				Tetrachloroethene (PCE)	Trichloroethene (TCE)	1,1-Dichloroethane	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW02	9.5 - 14.5	12.0	GW	X	X	X	X	X	X
MW03	10 - 15	12.5		X	X	X	X	X	X
MW04	11.5 - 16.5	14.0		X	X	X	X	X	X
MW05	12 - 17	14.5		X	X	X	X	X	X
MW06	12 - 17	14.5		X	X	X	X	X	X
MW07	11 - 16	13.5		X	X	X	X	X	X
MW09	9 - 14	11.5		X	X	X	X	X	X
MW10	25 - 30	27.5		X	X	X	X	X	X
MW11	15 - 20	17.5		X	X	X	X	X	X
MW13	15 - 20	17.5		X	X	X	X	X	X
MW15	55 - 65	60.0		X	X	X	X	X	X
MW16	55 - 65	60.0		X	X	X	X	X	X
MW20	5 - 10	7.5		X	X	X	X	X	X
MW-23D[b]	100-110	105.0		X	X	X	X	X	X
MW-24D[b]	100-110	105.0		X	X	X	X	X	X
MW-25D[b]	100-110	105.0		X	X	X	X	X	X
MW-29D	43-53	48.5		X	X	X	X	X	X
MW-46D	38-48	45.0		X	X	X	X	X	X
MW-47D	41-51	48.5		X	X	X	X	X	X

Notes

ft bgs = feet below ground surface.

GW = groundwater.

NA = not available.

VOC = volatile organic compound.

X = analyze.

[a]Sample depth is based on midpoint of screen interval and may change based on groundwater levels during monitoring.

[b]Monitoring wells to be installed in 2024. Proposed screen intervals and sampling depths are based on understanding of geological conditions and are subject to change pending site conditions at the time of monitoring well installation, development, and sampling.

Table 2
Groundwater Containers, Preservation, Holding Times, Analytical Methods and Performance Criteria
Predesign Investigation Work Plan
Former Park Laundry, Ridgefield, Washington

Sample Matrix	Method	Analyte	Container	Preservation (store all at 4°C)	Holding Time	Final Groundwater CUL[(1)] (ug/L)	MDL (ug/L)	MRL (ug/L)	LCS Accuracy (%)	MS Accuracy (%)	Precision (RPD)	Completeness (%)
Groundwater	EPA 8260D (LL)	Tetrachloroethene (PCE)	40-mL VOA vials	HCl to pH < 2	14 days	2.4	0.0100	0.0200	80-120	74-129	30	90
		Trichloroethene (TCE)				0.3	0.0100	0.0200	80-120	79-123	30	90
		1,1-Dichloroethane				7	0.0100	0.0200	80-120	77-125	30	90
		cis-1,2-Dichloroethene				16	0.0100	0.0200	80-120	78-123	30	90
		trans-1,2-Dichloroethene				100	0.0100	0.0200	80-120	75-124	30	90
		Vinyl chloride				0.02	0.0100	0.0200	80-120	58-137	30	90

Notes

Limits provided by Apex Laboratories, LLC. Actual MDLs and MRLs may differ based on sample matrix and/or dilutions.

°C = degrees Celsius.

CUL = cleanup level.

EPA = U.S. Environmental Protection Agency.

HCl = hydrochloric acid.

LCS = laboratory control sample.

LL = low level.

MDL = method detection limit.

mg/kg = milligrams per kilogram.

mL = milliliter.

MRL = method reporting limit.

MS = matrix spike.

RPD = relative percent difference.

ug/L = microgram per liter.

VOA = volatile organic analysis .

Reference

[(1)]Ecology. 2023. *Former Park Laundry: Public Review Draft Cleanup Action Plan*." Table 2-1: Park Laundry Cleanup Levels." Washington State Department of Ecology, Toxics Cleanup Program. Lacey, WA.

Table 3
Groundwater Field Quality Control Sample Summary
Predesign Investigation Work Plan
Former Park Laundry, Ridgefield, Washington

Type	Frequency	Acceptance Criteria
Equipment Rinsate Blank	One per every 20 samples (or fewer) collected with non-dedicated equipment	Below MRL[(a)]
Trip Blank	One per sample cooler containing field samples analyzed for VOC	Below MRL[(a)]
Temperature Blank	One per sample cooler	4°C (±2°C)
Field Duplicate	One per every twenty samples (or fewer) per sample matrix	50% RPD[(a)]

Notes

°C = degrees Celsius.

MRL = method reporting limit.

RPD = relative percent difference.

VOC = volatile organic compound.

[(a)]Criteria may change based on data validation.

Appendix A

Select Figures

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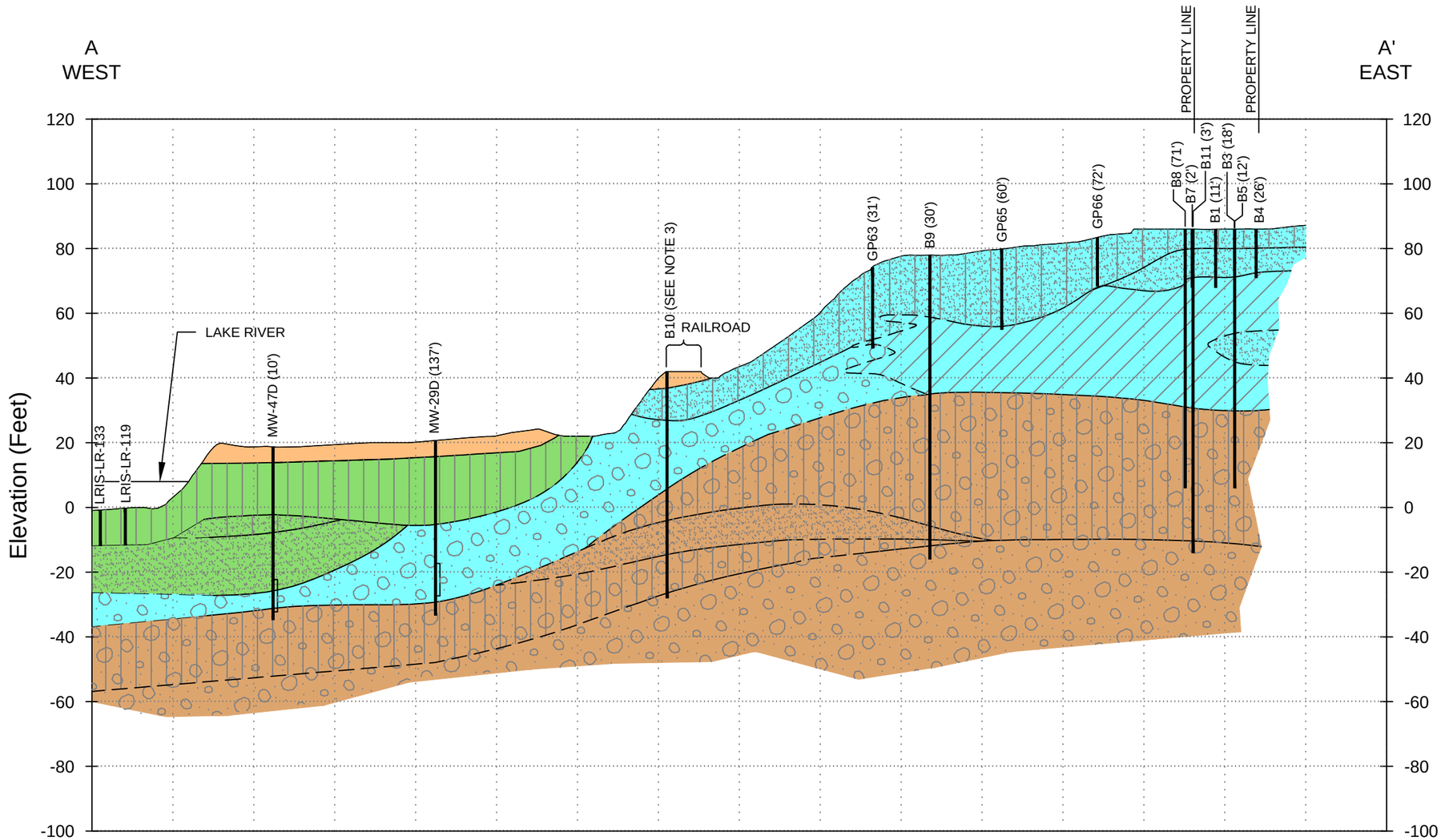
Figure 2-1
Generalized Geologic Cross Section

Former Park Laundry
City of Ridgefield, Washington



PROFILE VIEW OF SECTION
HORIZONTAL SCALE: 1" = 150' VERTICAL SCALE: 1" = 38'
VERTICAL EXAGGERATION: 4

LEGEND:

- FILL

HOLOCENE (ALLUVIUM)

- SILT
- SAND
- SILTY SAND

PLEISTOCENE (ALLUVIUM)

- SAND (UPPER WBZ)
- SILTY SAND
- CLAY (AQUITARD)
- SANDY GRAVEL (UPPER WBZ)

TERTIARY (UPPER TROUTDALE)

- SILTY GRAVEL (AQUITARD)
- SANDY GRAVEL (LOWER WBZ)
- SAND
- LITHOLOGIC CONTACT
- INFERRED LITHOLOGIC CONTACT

NOTES:

1. Borings and Wells are projected perpendicular to the cross section line. Distances in feet are projected from the cross-section line and are shown in parentheses.
2. Actual location of B10 is just east of the railroad although it is shown to the west because of projection.
3. WBZ = Water Bearing Zone.

0 150 300
FEET

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Layout: Xsect Project: 8006.31.01 Drawn By: J. Fisher Approved By: A. Hughes

Figure 2-5
Estimated Groundwater Potentiometric Surface Map
September 2016

Former Park Laundry
Union Ridge Investment Company
Ridgefield, Washington

Legend

- Park Laundry Monitoring Well
- Port of Ridgefield Monitoring Well
- Water Level Contour (Feet MSL)
- Groundwater Flow Direction
- Property Boundary

Notes:
1. Park Laundry monitoring well locations were surveyed by Minister-Glaeser on June 23, 2011, March 12, 2012, and April 4, 2013.
2. MSL = mean sea level.
3. Potentiometric surface modeled using ArcGIS 10.4 for Desktop Spatial Analyst Natural Neighbor interpolation tool.

0 100 200
Feet

Source: Aerial photograph (2014) and taxlots (2014) obtained from Clark County GIS; Port monitoring wells obtained from Port of Ridgefield.

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Print Date: 2/23/2017
Approved By: M. D'Andrea
Produced By: rroberts
Project: 8006.31.04

Appendix B

Standard Operating Procedures

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Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet

Project Name	TOC Elevation (feet)
Project Location	Surface Elevation (feet)
Start/End Date	Northing
Driller/Equipment	Easting
Geologist/Engineer	Hole Depth
Sample Method	Outer Hole Diam

Depth (feet, BGS)	Well Details	Sample Data: Interval	Sample Data: Percent Recovery	Sample Data: Collection Method	Sample Data: Number	Sample Data: Name (Type)	Sample Data: Blows/6"	Lithologic Column	Soil Description
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

NOTES:

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Boring Log Form

Boring/Well No.:	
Site:	
Location:	
Project #:	

Drill Rig		MFA Staff:		Hole Dia:		Total Depth:	
Drilling Co.:			Water Level:		WLE Note:		
Start Date:		End Date:		Water Level:		WLE Note:	

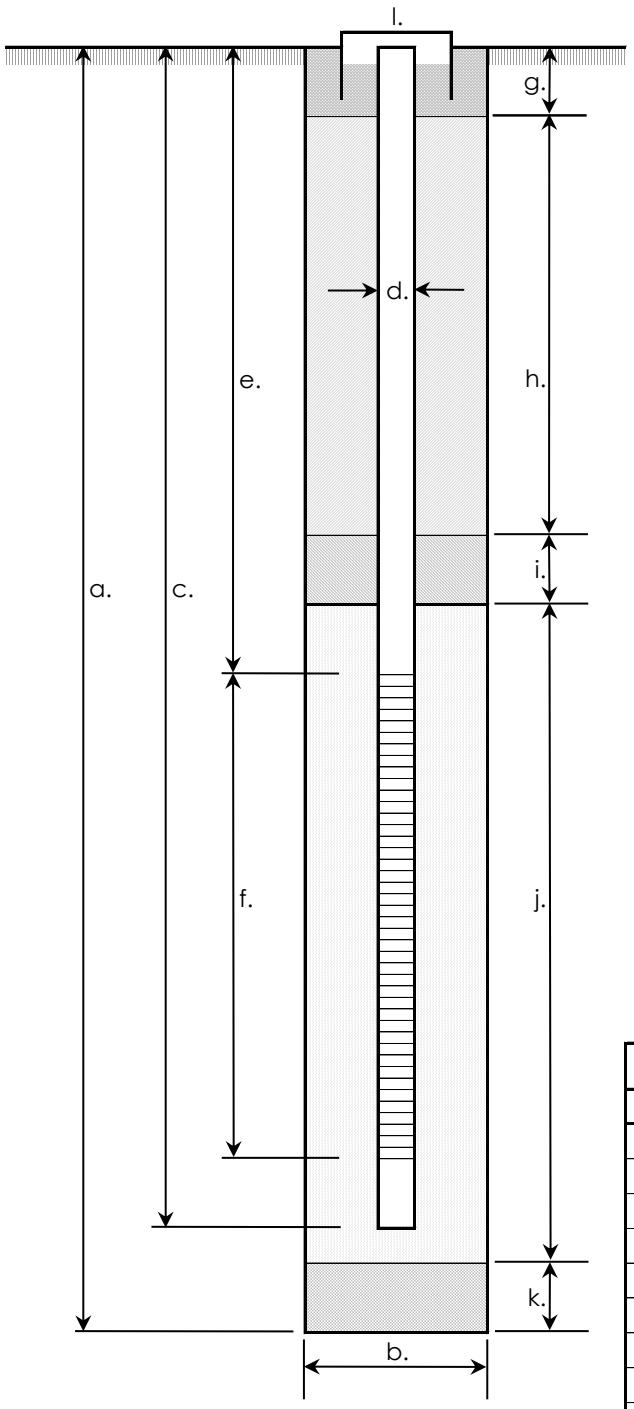
Completion	Sample				Lithology						
	Top:		Time:	Depth:	Soil Type:			Color:			
	Length:				Top:	Fines:				Moisture:	
	Type:		Sample ID		Bottom:	Sand:				PID:	
	% Recov:				Soil Class:	Gravel:				Line Type:	
					Trace:			Impacts:			
					Notes:						
	Top:		Time:	Depth:	Soil Type:			Color:			
	Length:				Top:	Fines:				Moisture:	
	Type:		Sample ID		Bottom:	Sand:				PID:	
	% Recov:				Soil Class:	Gravel:				Line Type:	
					Trace:			Impacts:			
					Notes:						
	Top:		Time:	Depth:	Soil Type:			Color:			
	Length:				Top:	Fines:				Moisture:	
	Type:		Sample ID		Bottom:	Sand:				PID:	
	% Recov:				Soil Class:	Gravel:				Line Type:	
					Trace:			Impacts:			
					Notes:						
	Top:		Time:	Depth:	Soil Type:			Color:			
	Length:				Top:	Fines:				Moisture:	
	Type:		Sample ID		Bottom:	Sand:				PID:	
	% Recov:				Soil Class:	Gravel:				Line Type:	
					Trace:			Impacts:			
					Notes:						
	Top:		Time:	Depth:	Soil Type:			Color:			
	Length:				Top:	Fines:				Moisture:	
	Type:		Sample ID		Bottom:	Sand:				PID:	
	% Recov:				Soil Class:	Gravel:				Line Type:	
					Trace:			Impacts:			
					Notes:						
	Top:		Time:	Depth:	Soil Type:			Color:			
	Length:				Top:	Fines:				Moisture:	
	Type:		Sample ID		Bottom:	Sand:				PID:	
	% Recov:				Soil Class:	Gravel:				Line Type:	
					Trace:			Impacts:			
					Notes:						
	Top:		Time:	Depth:	Soil Type:			Color:			
	Length:				Top:	Fines:				Moisture:	
	Type:		Sample ID		Bottom:	Sand:				PID:	
	% Recov:				Soil Class:	Gravel:				Line Type:	
					Trace:			Impacts:			
					Notes:						
Borehole Notes:											

MAUL FOSTER ALONGI

Boring/Well Completion Form

Boring/Well No.:
Site:
Location:
Project #:

Drilling Co.:		MFA Staff:		Start Date:		End Date:	
Drill Rig/ Method:				Well ID No.:		Start Card No.:	



Completion Details

a.	Total Depth:			ft. bgs
b.	Borehole diameter:			in.
c.	Total Casing Length:			ft.
	Material:			
d.	Well diameter:			in.
e.	Depth to top of screen:			ft. bgs
f	Screen length:			ft.
	screened interval:		ft. to	ft. bgs
	Perforation type:			
	Perforation size:			
g.	Surface completion:			ft. bgs
	Completion material:			
	Amount:			
h.	Surface Seal:		ft. to	ft. bgs
	Seal material:			
	Amount:			
i.	Secondary seal/pack:		ft. to	ft. bgs
	Material:			
	Amount:			
j.	Filter Pack:		ft. to	ft. bgs
	Material:			
	Amount:			
	Prepacked screen used:			(Yes/No)
k.	Seal or Slough:		ft. to	ft. bgs
	Material:			
	Amount:			
l.	Type of well monument:			
	Well height above/below ground surface:			ft. bgs

gINT Data		
Top	Bottom	gINT Graphic

gINT Graphic Options*

Surface Completion
- CMNT11

Borehole Seal
- BENT11

Filter Pack
- FILT11, FILT11-A

Screen
- SLOT11

Sump
- PCAP11, PCAPBENT11

Backfill
- BENTBOTT, FILTBOTT, SLUFFBOTT

*more graphics available

Note:

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Well Development Field Form

Project No.:	Date:
Project Location:	Well ID:
Project Name:	Initial DTB: Final DTB:
MFA Staff Name:	Initial DTW: Final DTW:
Development Method:	Well Casing Vol.:
Total Water Purged:	Casing Diameter:

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Time	Purge Vol. (gal)	Pump Rate (L/min)	Turbidity (NTUs)	pH	Temp. (°C)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	DTW (ft)	Comments

Groundwater Field Sampling Data Sheet

MAUL FOSTER ALONGI

Project Information

Project No.	Client Name	Project Name	Sampling Event	Sampler(s)

Well Information

Location ID	Well Type	Monument Type	Depth Measuring Point	Well Diameter (in)	Screen Interval (ft)	Sample Depth (ft)

Hydrology/Level Measurements

Date	Time	Depth to Bottom (ft)	Depth to Product (ft)	Depth to Water (ft)	Product Thickness (ft)	Water Column (ft)	Well Casing Volume (gal)	
		DTB	*DTP*	*DTW*	*DTP - DTW*	*DTB - DTW*	*(gal/ft x water column)*	
								0.75" = 0.023 gal/ft *1" = 0.041 gal/ft* *1.5" = 0.092 gal/ft* *2" = 0.163 gal/ft* *3" = 0.367 gal/ft* *4" = 0.653 gal/ft* *6" = 1.469 gal/ft* *8" = 2.611 gal/ft*

Water Quality Data

Purge Method		*Purge/Sampling Methods: peristaltic pump, submersible pump, vacuum pump, inertia pump, dedicated pump, disposable bailer, other*							
Purge Start Time		*ideally < 0.3 ft drawdown*	*± 0.1*	*± 3%*	*± 3%*	*± 10% if > 0.5*		*± 10*	*< 5 or ± 10% if > 5*
Time	**Cumulative Purge Volume**	**Flowrate**	**Water Level**	**pH**	**Temperature**	**Conductivity**	**Dissolved Oxygen**	**ORP**	**Turbidity**
	gal	*L/min*	*ft*	*SU*	*degrees C*	*uS/cm*	*mg/L*	*mV*	*NTU*

Last row of water quality data are considered final field parameters unless otherwise noted.

Water Quality Observations *(clarity, tint, odor, sheen, etc.)*

General Comments

Sample Information

Sampling Method			
Sample Name			
Sample Date		**Sample Time**	
Container Type	**Preservative**	**Filtered (Y/N)**	**No. Containers**
VOA			
Amber glass			
Poly			
		Total No. Containers:	0

Standard Operating Procedure

Decontamination of Field Equipment

SOP Number: 1
Date: 03/09/2021
Revision Number: 0.1

Scope and Application

This standard operating procedure (SOP) describes the decontamination procedure for field equipment that may come in contact with contaminated media and that Maul Foster & Alongi, Inc. (MFA) staff may reuse at multiple sample locations or sites. Decontamination is performed to reduce the potential for cross-contamination of samples that will be collected with multiuse equipment and that will undergo physical or chemical analyses. Other equipment that is multiuse—not used specifically for sample collection (e.g., water level meter, pump used for well development)—also requires decontamination. Finally, decontamination is necessary to minimize the potential for MFA staff's exposure to chemicals.

Typically, decontamination is not necessary for field equipment that is disposable and intended to be used only once (e.g., disposable bailer). Additionally, this SOP does not apply to equipment used by subcontractors, such as drilling equipment. However, MFA staff should confirm that subcontractors are implementing appropriate decontamination procedures to minimize the potential for cross-contamination of samples or MFA staff's exposure to chemicals.

Equipment and Materials Required

The following materials are necessary for this procedure:

- Nonphosphate detergent solution (e.g., Alconox, Liquinox)
- Distilled and potable water
- Personal protective equipment (as specified in the site-specific health and safety plan)
- Buckets to contain rinsate, brushes, paper towels

Depending on the site conditions and the types of contaminants that may be present, the use of other decontamination materials, such as deionized water, methanol, hexane, or isopropyl alcohol, may be necessary. The need for other materials should be determined prior to fieldwork. The decontamination procedures using other materials should be described in a site-specific sampling and analysis plan (SAP).

Methodology

When the site-specific SAP specifies additional or different requirements for decontamination, it takes precedence over this SOP. In the absence of a SAP, the following procedures shall be used.

General Sampling Procedure:

1. Rinse the equipment with potable water to remove visible soil, petroleum sheen, or contamination.

2. Scrub the equipment with a brush and solution of distilled water and nonphosphate detergent.

3. Rinse the equipment with distilled water.

4. Allow equipment to air dry, or dry it with paper towels.

5. At all times, ensure that the decontaminated equipment is stored so as to prevent it from becoming contaminated while not in use. Depending on the size of the equipment, it can be wrapped with new aluminum foil or placed in a new plastic bag.

Rinsate Storage:

All fluids resulting from equipment decontamination shall initially be contained in a bucket and then transferred to a Department of Transportation-approved container (e.g., 55-gallon drum) stored on site at a location that does not interfere with on-site activities (e.g., vehicle traffic, pedestrian areas). Place a label on each container and include the following information:

- The date on which fluids were placed in the container
- Contents (e.g., “water from equipment decontamination”)
- Contact information, including MFA staff or client phone number

Note that labels on containers exposed to sunlight or precipitation are prone to fading. Use a waterproof, indelible ink pen (e.g., Sharpie®) whenever possible. In the field notebook, keep a detailed inventory of all containers, including the number of containers, the approximate quantity of liquids generated, and a description of the source of the fluids. Provide this information to the MFA project manager. For future reference, take photographs of (1) each drum label, (2) the drum(s), and (3) the drum storage vicinity on site.

Note that some clients and site owners have specific requirements for labeling and storage of containers. The requirements should be determined in advance of the fieldwork.

Standard Operating Procedure

Lithologic Logging

SOP Number: 2
Date: 03/09/2021
Revision Number: 0.1

Scope and Application

This standard operating procedure (SOP) describes the methods for observing and documenting the physical characteristics of unconsolidated geologic materials (soil and sediment) encountered during field investigations. If a Maul Foster & Alongi, Inc. (MFA) project requires hard rock drilling and description of rock core or cuttings, procedures for describing rock should be specified in a project-specific sampling and analysis plan (SAP).

Equipment and Materials Required

The following materials are necessary for this procedure:

- Blank field forms (e.g., boring logs) for documenting observations
- Dry-erase board
- Camera
- Munsell soil color chart (where required)
- MFA field logging checklist

Methodology

When the project-specific SAP specifies additional or different requirements for lithologic logging, it takes precedence over this SOP. In the absence of a SAP, the procedures in this SOP shall be used. MFA uses a combination of the Unified Soil Classification System (USCS) and the ASTM International method D2487 for describing and classifying soil and sediment by visual and manual examination. Before beginning fieldwork, verify with the project manager the logging standard to be used.

Logging Process:

The objective of lithologic logging is to document the physical characteristics of soil and sediment encountered and the changes in characteristics with depth. Typically, changes with depth will define the strata encountered. Therefore, each stratum encountered should be identified and the following characteristics described in the order given:

- Depth interval of each stratum to the nearest tenth of a foot below ground surface
- USCS classification Group Name and Symbol
- Color, using the Munsell color chart
- Grain-size distribution, as percentages of fines (silt and clay combined), sand, and gravel
- Percentages of larger gravels (cobbles and boulders) if present.
- Consistency when the content of fines is 50 percent or greater

- Density when the combined percentage of sand and gravel is 50 percent or greater
- Sand and gravel grain shapes
- Chemical odors, if noticeable
- Structures, if present (e.g., laminae, pores)
- Presence of organic matter (e.g., roots, leaves, twigs, wood fragments)
- Moisture content as “dry,” “moist,” or “wet”
- If possible, a description of the origin of each stratum (e.g., fill, alluvium)

Standard Operating Procedure

Sonic Drilling

SOP Number: 8
Date: 03/09/2021
Revision Number: 0.1

Scope and Application

This standard operating procedure (SOP) describes the use of a sonic drilling rig to observe subsurface conditions and collect samples of various environmental media (e.g., soil, sediment, groundwater) for laboratory analysis. The sonic drilling method is ideal for sites with excessively gravelly/rocky soils or for drilling in bedrock.

Sonic drilling can be used for a variety of purposes, including:

- Retrieving cores to document subsurface soil, sediment, or bedrock conditions and to obtain samples for physical and/or chemical evaluation
- Collecting reconnaissance groundwater samples from temporary well screens
- Installing permanent monitoring wells

Equipment and Materials Required

The following materials are necessary for this procedure:

- Sonic drill rig and operator provided by a subcontractor to MFA. Ensure that the subcontractor is licensed to perform the drilling work.
- Sampling equipment appropriate for the media to be sampled (e.g., water level meter, pumps, hand tools, and pump tubing).
- Laboratory-supplied sample containers.
- Traffic cones, measuring tape, buckets.
- Department of Transportation (DOT)-approved containers (e.g., 55-gallon drum) for storing excess soil and decontamination water; the drums are typically provided by the drilling subcontractor.
- Boring log form and notebook.
- Equipment decontamination supplies if sampling equipment will be reused between sample locations (see SOP 1 for equipment decontamination procedures).
- Personal protective equipment (as required by the project health and safety plan).

Methodology

When the project-specific sampling and analysis plan (SAP) provides additional or different requirements for sonic drilling, it takes precedence over this SOP. In the absence of a SAP, the procedures in this SOP shall be used.

Utility Locate:

- Before beginning the fieldwork, assess the proposed drilling location(s) for the presence of overhead and underground utilities, and adjust the locations, as needed, to avoid identified utilities.
- See SOP 18 for the utility-locating procedures.

Sonic Drilling Process:

- The sonic drilling rig is equipped with a core barrel that retrieves a continuous soil core. A combination of high-frequency vibration and rotation is used to advance the core barrel into the subsurface.
- The core barrel is typically driven in 10-foot intervals. When each interval depth is reached, the core barrel is removed from the ground and vibrated to extrude the soil core from the core barrel. Plastic bags are placed over the end of the core barrel to collect and store the core in approximately 2-foot-long segments.
- After core retrieval, a temporary steel outer casing is driven to the bottom of the boring to prevent sloughing or collapse of the boring. The core barrel is then inserted into the casing and advanced to the next depth interval. This process is repeated until the targeted depth is reached.
- Ensure that the drilling subcontractor decontaminates all subsurface equipment before and after each boring. Document the decontamination procedures in the field notebook. Store decontamination water in DOT-approved containers for later off-site disposal.

Logging and Soil Sampling Process:

- Open each bagged segment of soil core for field screening, description, and sampling.
- Describe the lithology in accordance with SOP 2.
- Confirm the required depth interval(s) for soil sample collection and field screening with the MFA project manager, or conduct the work in accordance with the SAP. The sample interval may require adjustment based on core recovery, soil stratigraphy and characteristics, and evidence of contamination. Confirm any adjustments to the sample intervals with the project manager.
- If the project requires field screening for organic vapor, conduct it in accordance with SOP 3.
- If the project requires laboratory analyses for gasoline-range petroleum hydrocarbons or volatile organic compounds, conduct the sampling in accordance with SOP 5.
- Contain all soil core remaining after sample collection in DOT-approved containers for later off-site disposal. See SOP 1 for drum storage, labeling, and documentation procedures.

Reconnaissance Groundwater Sampling Process:

- Typically, reconnaissance groundwater samples are collected at the first occurrence of groundwater in a boring. Confirm the required depth and procedures for groundwater sample collection with the MFA project manager, or conduct the work in accordance with the SAP. If the project requires use of the low-flow sampling method, refer to SOP 9 for the low-flow sampling procedures.

- Reconnaissance groundwater samples are collected using a decontaminated stainless steel or disposable polyvinyl chloride temporary well screen placed in the boring. If the soils in the boring are fine-grained and may cause excessive turbidity in groundwater, consider using a filter pack around the screen to reduce turbidity. Alternatively, purging the well screen of groundwater before sample collection may also reduce the turbidity. See SOP 9 for purging procedures.
- Purging and sampling will be conducted using a peristaltic pump unless otherwise specified in the SAP. New tubing will be used for each boring. Field parameters (e.g., temperature, conductivity, and pH) will be recorded in accordance with SOP 9 during purging and sampling.

Monitoring Well Installation:

- If the project requires installation of a monitoring well in the boring, refer to SOP 11 for the well installation procedures. Confirm the procedures with the MFA project manager.
- If potable water was placed into the boring during drilling (e.g., to cool the core barrel), document the total volume of water placed in the boring; this information will be needed for well development (see SOP 12).

Borehole Abandonment Process:

- Abandon each borehole in accordance with local and state regulations/procedures. The abandonment will be performed by the drilling subcontractor.
- The abandonment procedure typically consists of backfilling the boring with granular bentonite and hydrating the bentonite with potable water.
- If the boring was advanced through concrete or asphalt, backfill the boring to about 6 inches below grade to allow for placement of asphalt or concrete in the remaining 6 inches to match the surface conditions.

Standard Operating Procedure

Low-Flow Groundwater Sampling

SOP Number: 9
Date: 06/29/2023
Revision Number: 0.2

Scope and Application

This standard operating procedure (SOP) describes use of the low-flow sampling method for collection of reconnaissance groundwater samples from borings and groundwater samples from monitoring wells. The method uses low pumping rates during purging and sample collection to minimize water-level drawdown and hydraulic stress at the well-aquifer interface.

Equipment and Materials Required

The following materials are necessary for this procedure:

- Personal protective equipment (as specified in the health and safety plan)
- Water quality meter (e.g., Oakton, YSI Inc. multiparameter meter)
- Turbidity meter
- Water-level meter
- Peristaltic pump and tubing
- Laboratory-supplied sample containers
- Laboratory chain-of-custody form and cooler with ice
- Filter if dissolved analyses will be performed
- Well construction logs documenting the screen depth and interval for all wells to be sampled
- Equipment decontamination supplies if sampling equipment will be reused between sample locations (see SOP 1 for equipment decontamination procedures)
- 5-gallon buckets with lids
- Department of Transportation-approved storage containers (e.g., drums, totes)
- Groundwater field sampling datasheet and notebook

Methodology

When the project-specific sampling and analysis plan (SAP) provides additional or different requirements for low-flow groundwater sampling, it takes precedence over this SOP. In the absence of a SAP, the procedures in this SOP shall be used.

General Sampling Procedure (Heading 3 No Number Style):

Water Level Measurement

- Water-level measurement procedures are described in detail in SOP 13.

- Open the well cap to allow the water level to equilibrate (approximately ten minutes).
- Measure the water level in the well, using an electronic water-level meter to the nearest 0.01 foot to determine the depth to groundwater below the top of the well casing.
- If light nonaqueous-phase liquid (LNAPL)is present (typically indicated by a dark, oily sheen on the top of the water level meter), discuss with the MFA project manager how to proceed.

Purging

- If the water level is above the top of the well screen, place the end of the sample tubing in the middle of the well screen interval. If the water level is below the top of the screen, place the end of the sample tubing at the midpoint between the water level and the bottom of the well screen.
- Typical low-flow sampling pumping rates range from 0.1 to 0.5 liters per minute, depending on the hydrogeologic characteristics at the site. The objective of the rate selected is to minimize excessive drawdown (<0.3 feet) of the water level.
- Measure water quality parameters (dissolved oxygen, pH, electrical conductivity, turbidity, and temperature) using a flow-through cell connected to the discharge end of the peristaltic pump tubing. Purging will be considered complete when the water quality parameters stabilize per the following for three consecutive readings taken over 3-minute intervals (consistent with EPA guidance)[1]:

Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

- Document the purge procedures, including pumping rates, water quality parameter measurements, and the water level during purging, on the groundwater field sampling datasheet.
- Place purge water in Department of Transportation-approved containers (e.g., 55-gallon drum) stored on site. See SOP 1 for drum storage, labeling, and documentation procedures.

Sample Collection

- Following the purging process, collect groundwater samples in laboratory-supplied containers.
- Confirm the laboratory analytical methods and sample container requirement with the MFA project manager or project chemist. If analysis for gasoline-range petroleum hydrocarbons or volatile organic compounds (VOCs) is proposed, fill the sample containers for gasoline and VOC analysis before filling sample containers for other analytical methods. Sample containers for gasoline and VOC analysis shall be filled to capacity without overfilling and capped so that no headspace or air bubbles remain in the container.

[1] EPA. 2017. Low stress (low flow) purging and sampling procedure for the collection of groundwater samples from monitoring wells. September 19.

Low Yield (Alternate Method)

- If drawdown of the water table cannot be avoided by reducing the pumping rate, and the well goes dry during purging, discontinue pumping and water quality parameter measurements.
- Collect the groundwater sample after the water level above the well bottom recovers to 90 percent of the prepurge water level. For example, if the water level was 10 feet above the well bottom before purging, begin sampling when the water level has recovered to 9 feet or more above the well bottom.
- If the water column volume is insufficient to meet the sample volume requirement, allow the water level to again recover to 90 percent before continuing sampling. Repeat this procedure until all sample containers are filled.

Standard Operating Procedure

Well Installation

SOP Number: 11
Date: 03/09/2021
Revision Number: 0.1

Scope and Application

This standard operating procedure (SOP) describes the use of conventional machine slotted polyvinyl chloride (PVC) or prepacked well screens to install monitoring wells. The screen permits water to enter the well from the saturated aquifer, prevents soil from entering the well, and serves structurally to support the aquifer material. The slot size of the well screen is typically based on selection of the filter pack material. Monitoring wells must be designed and installed to ensure that low-turbidity groundwater samples, groundwater levels, and hydraulic conductivity data that are representative of conditions in the aquifer can be obtained.

Equipment and Materials Required

The following materials are necessary for this procedure:

- Drill rig and operator provided by a subcontractor to MFA. Ensure that the subcontractor is licensed to perform the well installations.
- Personal protective equipment (as specified in the health and safety plan).
- Water-level meter.
- Monitoring well construction log and notebook.

Methodology

When the project-specific sampling and analysis plan (SAP) provides additional or different requirements for well installation, it takes precedence over this SOP. In the absence of a SAP, the procedures in this SOP shall be used.

The drilling contractor will be responsible for conforming to all applicable local and state regulations for well construction.

The proposed well construction should be provided to the driller in advance so that (1) the driller can confirm that the proposed construction is consistent with state regulations, and (2) the driller comes to the project site with sufficient materials for the well construction.

General Procedure:

Drilling and Well Construction. This SOP assumes that a boring has already been drilled and is ready for well installation. See SOPs 7 and 8 for drilling procedures. If the boring was advanced to a depth below the targeted well screen interval, backfill the boring with cement-bentonite slurry or bentonite chips so that the boring bottom is at a depth about 2 feet below the lower screen interval depth. Well construction will include flush-threaded Schedule 40 PVC casing and conventional PVC well screen or stainless steel mesh prepacked well screen, placed at the bottom of the boring.

Filter Pack. Clean silica sand pack will be placed between the boring wall and the PVC screen/riser (i.e., the annulus) from the bottom of the well to approximately 1 to 2 feet above the screened interval. The filter pack should have greater hydraulic conductivity than the surrounding formation so that water can be drawn into the well. Before installation of the seal, the well may be surged using a surge block or similar technique to consolidate the filter pack and eliminate voids. Measure and document the depth to the sand filter pack before setting the seal.

Seal. A bentonite seal 1 to 2 feet thick will be placed above the sand. The bentonite will be hydrated and allowed to sit for a minimum of 30 minutes for proper hydration and sealing. Measure and document the depth to the top of the seal before placing grout.

Grout. Cement-bentonite slurry or bentonite chips (hydrated after installation) will be placed above the bentonite seal following proper hydration of the seal. The cement-bentonite slurry will be placed to within 1 foot of the ground surface.

Surface Seal and Monument. A concrete surface seal will secure a flush-mounted, traffic-rated monument, or a bollard-protected stickup monument. Flush-mounted surface monuments will be completed slightly above grade to prevent ponding of water on the monument lid. A locking cap and lock will secure the top of the well casing in a surface monument. Tamper-resistant bolts (e.g., pentagonal) may be used to secure the lid of a flush-mounted monument. The lid of a stickup monument should be secured with a lock.

The well constructor shall permanently affix a well identification label to the wellhead. In addition, the well number should be marked on the well (e.g., punched into monument ring, written on the well casing/cap with permanent marker). A v-notch is typically cut into the north side of the PVC riser for use as a survey point and for water level measurements.

Documentation. The field representative will produce the following documentation during the well installation:

- Length of well components, including blank casing, well screen, and sump (if included).
- Preinstallation boring depth below ground surface (bgs).
- Depth bgs to top and bottom of screen.
- Depth bgs to top of filter pack and seal.
- Types, brands, and amounts of materials (sand, bentonite, grout) used.
- Decontamination procedures followed, if needed (see SOP 1 for equipment decontamination procedures).
- If potable water was placed into the boring or well during installation, document the total volume of water placed; this information will be needed for well development (see SOP 12).
- Any deviation from standard procedures or any problems encountered during the installation activities.

Standard Operating Procedure

Well Development

SOP Number: 12
Date: 03/09/2021
Revision Number: 0.1

Scope and Application

This standard operating procedure (SOP) describes the methods for developing new monitoring well installations. New wells should be developed no sooner than a period of 24 hours after the grout seal has been placed; longer periods of 48 to 72 hours may be necessary, depending on applicable local or state regulations. The objective of well development is to ensure that low-turbidity groundwater samples, groundwater levels, and hydraulic conductivity data representative of conditions in the aquifer can be obtained from the well. This SOP is also applicable to the redevelopment of existing monitoring wells.

Equipment and Materials Required

The following materials are necessary for this procedure:

- Personal protective equipment (as specified in the health and safety plan)
- Well purge equipment (e.g., Waterra Pump, bailer, and peristaltic pump)
- Water-quality meter (e.g., Oakton and turbidity meter)
- Water-level meter
- Well construction logs for all wells to be developed
- Equipment decontamination supplies if sampling equipment will be reused between sample locations (see SOP 1 for equipment decontamination procedures)
- Five-gallon buckets with lids
- Department of Transportation-approved storage containers (e.g., drums, totes)
- Well development log and notebook

Methodology

When the project-specific sampling and analysis plan (SAP) provides additional or different requirements for well development, it takes precedence over this SOP. In the absence of a SAP, the procedures in this SOP shall be used.

Owing to the potential for hazardous substances in groundwater, well development requires consideration of the work area and equipment setup, health and safety procedures, use of appropriate personal protective equipment, procedures for equipment decontamination, and disposal of expendable development supplies. Confirm all procedures in advance with the MFA project manager and the MFA health and safety professional.

1. Cut a segment of plastic sheeting to an approximate 10-foot-by-10-foot dimension. Cut a hole in the center of the sheeting and place the sheeting over the well so that the well monument can be accessed through the hole and the sheeting lies flat on the ground. The sheeting defines the

work area for well development. All equipment that may come in contact with groundwater should remain in this work area until it has been decontaminated or containerized for disposal.

2. Measure the depth to water and the total depth of the well before development. Confirm that the entire screen length is below the water level; if it is not, contact the MFA project manager to discuss potential modification of the well-development procedures.

3. Subtract the depth to water from the total well depth to determine the height of the column of groundwater present in the well casing. Multiply the height by the gallon-per-foot value in the table below, corresponding to the diameter of the well being developed, to calculate the volume of water in the well casing. Record the readings and casing volume on the well development log.

Casing Diameter (inches)	Volume (gallons per foot)
1	0.04
2	0.17
3	0.37
4	0.65
5	1.02
6	1.46

4. Surge groundwater through the entire well screen interval with a weighted bailer or Waterra pump with tubing equipped with surge block. Begin surging at the top of the well screen by vigorously moving the bailer or surge block in approximately 1-foot vertical increments. Gradually increase the surge depth until the entre screen interval has been surged. The surge time for each 1-foot increment will depend on type of drilling, lithology, and well completion details. Generally, there should be at least one minute of surging across each increment.

5. After surging the well screen, purge groundwater from the well into buckets at a higher purging rate than the expected purging rate of groundwater sampling. Ideally, purging will be completed using a method that does not continue to surge the well (i.e., peristaltic or submersible pump). If a Waterra pump is used, remove the surge block from the tubing and set the tubing intake above the well screen for purging. Measure the water level during the purging process and adjust the pumping rate to maintain a water level above the top of the screen interval if possible. Document the volume of water removed.

6. When the volume of water purged equals the casing volume, use the water-quality meter to measure the temperature, pH, conductivity, and turbidity of the purge water. Repeat the measurements for each casing volume removed. Note that a YSI water-quality meter or similar meters should not be used in highly turbid water, per the manufacturer's recommendation.

7. After the removal of five casing volumes, review the stability of the water quality meter readings. The well will be considered developed if the water quality readings have stabilized for three consecutive casing volumes for the following:

pH (± 0.1 unit),
Specific Conductance (3%),
Turbidity (10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized),

8. If the water-quality readings stabilize before a total of ten casing volumes are removed, development is complete. If the water-quality readings do not stabilize, well development will be consider complete after ten casing volumes have been removed.
9. If the water level cannot be maintained above the well screen or the well pumps dry during purging, contact the MFA project manager for further instructions.
10. If potable water was placed into the boring during drilling or into the well during installation, remove that volume of water and then begin purging as described in step 5.

Standard Operating Procedure

Monitoring Well—Water Elevation

SOP Number: 13
Date: 03/09/2021
Revision Number: 0.1

Scope and Application

This standard operating procedure (SOP) describes the methods for obtaining groundwater level measurements and light nonaqueous-phase liquid (LNAPL) measurements from monitoring wells. Measurement may be collected as an independent event or in conjunction with groundwater sampling or sampling of removed LNAPL.

Equipment and Materials Required

The following materials are necessary for this procedure:

- Personal protective equipment (as specified in the health and safety plan)
- Equipment decontamination supplies if equipment will be reused between well locations (see SOP 1 for equipment decontamination procedures)
- Field notebook
- Water-level meter or oil/water interface probe if water levels and LNAPL levels will be measured
- Bailers or tape/paste to confirm LNAPL detections if required; see SOP 10 for procedures for managing LNAPL when removing LNAPL from a well

Methodology

When the project-specific sampling and analysis plan (SAP) provides additional or different requirements for water-level and LNAPL measurements, it takes precedence over this SOP. In the absence of a SAP, the procedures in this SOP shall be used.

General Sampling Procedure:

Review well construction details and historical groundwater and LNAPL levels and thicknesses if available.

During groundwater sampling events, measurements should be collected before, during, and after purging and sampling. During purging and low-flow sampling, water-level measurements are conducted to ensure that drawdown is not occurring. Low-flow sampling methods are described in SOP 9. The following procedures should be followed when collecting groundwater-level and LNAPL measurements from wells.

Water Level Measurement

1. Test the water-level meter to ensure proper instrument response. This can be accomplished by immersing the probe tip in a small container of water.
2. Open the well cover and cap and allow the water level to equilibrate with atmospheric pressure for several minutes so that a static water level is attained. Audible air movement into or out of

the well upon loosening of the well cap is an indication that the water level is not in equilibrium with atmospheric pressure.

3. Locate the measurement reference point at the top of the well casing. Typically, this is a small notch in the casing or a point marked with a pen. If no measure point is present, measure the water level from the north side of the casing and note the result in the field notebook.
4. Lower the water-level meter probe into the well casing until the probe signal indicates that water has been contacted.
5. Observe the depth-to-water (DTW) reading from the measurement reference point at the top of the well casing to the nearest 0.01 foot. Over the course of about a minute, raise and re-lower the probe and observe the resulting DTW reading. If the reading remains unchanged to within 0.01 foot, this is an indication that the water level has equilibrated with atmospheric pressure; the reading can then be recorded in the field notebook as the static water level reading. If the reading changes, allow more time for the water level to become static.
6. If the work scope or SAP requires measurement of the depth-to-bottom (DTB), lower the probe to the bottom of the well and record the DTB reading from the reference point to the nearest 0.01 foot.
7. Remove the probe and decontaminate the probe and the portion of the probe tape inserted into the well casing.

Water Level and LNAPL Measurement

1. Repeat above steps 1 through 7.
2. Lower the interface probe into the well casing until the probe signal indicates that LNAPL has been contacted. Typically, the interface probe will signal by a repeating beep when LNAPL is present. A steady signal indicates that LNAPL is absent and that the probe is recording the DTW.
3. Observe the LNAPL reading as described in step 5 above until a static reading to the nearest 0.01 foot is achieved, and record the reading in the field notebook.
4. Lower the probe until a steady signal indicates that water has been contacted. Observe the water-level reading as described in step 5 above to confirm a static water level, and record the reading in the field notebook.
5. If LNAPL is detected in a well with no prior history of LNAPL presence, or the LNAPL thickness is greater than in prior observations, verify the presence and thickness using an alternative technique (e.g., bailer, tape, and water/petroleum colorimetric paste). See SOP 10 for procedures for managing LNAPL when removing LNAPL from a well.
6. Remove the interface probe and decontaminate the probe and the portion of the probe tape inserted into the well casing.

Standard Operating Procedure

Underground Utility Locates

SOP Number: 18
Date: 03/09/2021
Revision Number: 0.1

Scope and Application

This standard operating procedure (SOP) describes the practices for locating underground utilities. Refer to the MFA health and safety plan (HASP) for additional information regarding communication procedures to be followed when an inadvertent utility strike occurs, as well as regarding methods for mitigating hazards during a utility strike.

Equipment and Materials Required

The following materials are necessary for this procedure:

- Personal protective equipment (as specified in the HASP)
- Marking materials (e.g., marking paint, stakes, flags)
- Field documentation materials

Methodology

When the project-specific sampling and analysis plan (SAP) specifies additional or different requirements for underground utility locates, it takes precedence over this SOP. In the absence of a SAP, the procedures in this SOP shall be used.

Before Conducting Utility Locates:

- Ensure that the locate will be conducted reasonably soon before the excavation work begins, e.g., within 48 hours. There may be project-specific conditions, e.g., weather and/or ground features that could cause markings to fade, which would require scheduling of the excavation work sooner than 48 hours after the locate.
- Clearly define the boundary of the work and the locations of all proposed excavations. Prepare a map of the project area showing the excavation locations.
- Interview site managers/property owners and obtain plans or drawings, if available, showing on-site utilities.
- For project work that will not take place in the public right-of-way, ensure that the public rights-of-way nearest to the project are identified and communicated during the one-call notification.
- Identify the township and range of the project area. This information can be easily attained by a quick email to MFA's GIS Exchange.
- If feasible, conduct a site visit to identify site conditions that could cause fading or disruption of marking paint. Such conditions could include gravel or ground sensitive to erosion and high traffic.
- Check the weather forecast to assess the potential for snow or rain to make marking utilities difficult or cause the markings to fade.

One-Call Utility Notification:

- If possible, initiate the one-call utility notification at least one week before the proposed work begins.
- Include a map or GPS coordinates when submitting the notification.
- Before conducting any excavation activities, confirm with each public utility that the utility locate has been completed.
- On remote or complicated sites, consider meeting public locators on site.
- Document the one-call ticket number and results in the project files.
- Provide the one-call ticket number to subcontractors who will be doing the excavations.

Private Utility Locate:

- Conduct the private utility locate only after confirmation that the public utility locate has been completed and all public utilities have been marked and the results reviewed by MFA staff who will be overseeing the excavations.
- Meet the private locator on site and participate in the entire private utility locate. Be engaged in the process, ask questions, and take time to walk the site thoroughly with the locator.
- Bring a copy of the one-call utility ticket and results of the one-call utility locater to check against the utility markings on the ground.
- If possible, have a site/property representative knowledgeable of on-site utilities participate in the private utility locate.
- If paint alone may not suffice to ensure clear marking of utilities, add vertical markers such as stakes or flags.
- Visually assess the area of the proposed excavation(s) to identify features potentially indicative of buried utilities. Have the private utility locator examine each feature identified below to assess the presence of buried utilities.
  - Examine adjacent public rights-of-way where public utilities have been marked for evidence of utilities that may extend onto the project site.
  - Identify nearby light poles, telephone poles, electrical utility poles, or other overhead utility poles with wires or conductors that run from the overhead utility, down the pole, and into the ground.
  - Identify the location of gas meters, water meters, or other aboveground junction boxes for evidence of utilities extending from these features into the ground.
  - Examine asphalt and concrete ground surfaces for discontinuities in the surface indicative of utility installations. Discontinuities may include recent patches of asphalt or concrete inlaid within older concrete or asphalt surfaces.
  - Identify manholes and catch basins indicative of buried storm or sanitary sewer pipes. Open manholes to examine the orientation of associated pipes to assess whether the utilities may be present near proposed excavations.
  - Identify tank ports and vent pipes.

- Identify irrigation systems and associated features such as valve boxes and controllers.
- Identify any other signs indicating the presence of buried utilities.
- Be wary of utility marks that suddenly begin or dead end.

Preparing to Perform Subsurface Activities after a Locate:

- Ensure that the markings are still visible when the work begins.
- Adjust locations, as needed, to avoid identified utilities, or use alternative methods such as nonmechanical excavation means (i.e., manual excavation or air-knifing) to a minimum depth of 5 feet.

Table
APWA UNIFORM COLOR CODE

	WHITE—Proposed Excavation
	PINK—Temporary Survey Markings
	RED—Electric Power Lines, Cables, Conduit and Lighting Cables
	YELLOW—Gas, Oil, Steam, Petroleum or Gaseous Materials
	ORANGE—Communication, Alarm or Signal Lines, Cables or Conduit
	BLUE—Potable Water
	PURPLE—Reclaimed Water, Irrigation and Slurry Lines
	GREEN—Sewers and Drain Lines

Source: Uniform Color Codes, ANSI Standard Z535.1. American Public Works Association. Revised 1999.