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

Technical Assistance, Environmental Liability Clarification or Post-Closure Modification Request

Form 4400-237 (R 10/21)

Notice: Use this form to request **a written response (on agency letterhead)** from the Department of Natural Resources (DNR) regarding technical assistance, a post-closure change to a site, a specialized agreement or liability clarification for Property with known or suspected environmental contamination. A fee will be required as is authorized by s. 292.55, Wis. Stats., and NR 749, Wis. Adm. Code., unless noted in the instructions below. Personal information collected will be used for administrative purposes and may be provided to requesters to the extent required by Wisconsin's Public Records law [ss. 19.31 - 19.39, Wis. Stats.].

Definitions

"Property" refers to the subject Property that is perceived to have been or has been impacted by the discharge of hazardous substances.

"Liability Clarification" refers to a written determination by the Department provided in response to a request made on this form. The response clarifies whether a person is or may become liable for the environmental contamination of a Property, as provided in s. 292.55, Wis. Stats.

"Technical Assistance" refers to the Department's assistance or comments on the planning and implementation of an environmental investigation or environmental cleanup on a Property in response to a request made on this form as provided in s. 292.55, Wis. Stats.

"Post-closure modification" refers to changes to Property boundaries and/or continuing obligations for Properties or sites that received closure letters for which continuing obligations have been applied or where contamination remains. Many, but not all, of these sites are included on the GIS Registry layer of RR Sites Map to provide public notice of residual contamination and continuing obligations.

Select the Correct Form

This from should be used to request the following from the DNR:

- Technical Assistance
- Liability Clarification
- Post-Closure Modifications
- Specialized Agreements (tax cancellation, negotiated agreements, etc.)

Do not use this form if one of the following applies:

- Request for an **off-site liability exemption or clarification** for Property that has been or is perceived to be contaminated by one or more hazardous substances that originated on another Property containing the source of the contamination. Use DNR's Off-Site Liability Exemption and Liability Clarification Application Form 4400-201.
- Submittal of an Environmental Assessment for the **Lender Liability Exemption**, s 292.21, Wis. Stats., **if no response or review by DNR is requested**. Use the Lender Liability Exemption Environmental Assessment Tracking Form 4400-196.
- Request for an **exemption to develop on a historic fill site** or licensed landfill. Use DNR's Form 4400-226 or 4400-226A.
- **Request for closure** for Property where the investigation and cleanup actions are completed. Use DNR's Case Closure - GIS Registry Form 4400-202.

All forms, publications and additional information are available on the internet at: dnr.wi.gov/topic/Brownfields/Pubs.html.

Instructions

1. Complete sections 1, 2, 6 and 7 for all requests. Be sure to provide adequate and complete information.
2. Select the type of assistance requested: Section 3 for technical assistance or post-closure modifications, Section 4 for a written determination or clarification of environmental liabilities; or Section 5 for a specialized agreement.
3. Include the fee payment that is listed in Section 3, 4, or 5, unless you are a "Voluntary Party" enrolled in the Voluntary Party Liability Exemption Program **and** the questions in Section 2 direct otherwise. Information on to whom and where to send the fee is found in Section 8 of this form.
4. Send the completed request, supporting materials and the fee to the appropriate DNR regional office where the Property is located. See the map on the last page of this form. A paper copy of the signed form and all reports and supporting materials shall be sent with an electronic copy of the form and supporting materials on a compact disk. For electronic document submittal requirements see: http://dnr.wi.gov/files/PDF/pubs/rr/RR690.pdf"

The time required for DNR's determination varies depending on the complexity of the site, and the clarity and completeness of the request and supporting documentation.

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		
Andrzejewski	Gary	M	Sun Chemical Corporation		
Mailing Address			City	State	ZIP Code
135 West Lake Street			Northlake	IL	60164
Phone # (include area code)	Fax # (include area code)		Email		
(708) 236-3713			gary.andrzejewski@sunchemical.com		

The requester listed above: (select all that apply)

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

  Previous property owner at the time of discharge reporting for BRRTS NO. 02-41-588407, FID NO. 341018810.

Contact Information (to be contacted with questions about this request)

☒ Select if same as requester

Contact Last Name	First	MI	Organization/ Business Name		
Andrzejewski	Gary	M	Sun Chemical Corporation		
Mailing Address			City	State	ZIP Code
135 West Lake Street			Northlake	IL	60164
Phone # (include area code)	Fax # (include area code)		Email		
(708) 236-3713			gary.andrzejewski@sunchemical.com		

☒ Environmental Consultant (if applicable)

Contact Last Name	First	MI	Organization/ Business Name		
Goetz	Staci	L	Ramboll		
Mailing Address			City	State	ZIP Code
234 W. Florida St., 5th Floor			Milwaukee,	WI	53204
Phone # (include area code)	Fax # (include area code)		Email		

Attorney (if applicable)

Contact Last Name	First	MI	Organization/ Business Name		
Mailing Address			City	State	ZIP Code
Phone # (include area code)	Fax # (include area code)		Email		

☒ Property Owner (if different from requester)

Contact Last Name	First	MI	Organization/ Business Name		
Komisar	Martin		GMK Realty II LLC		
Mailing Address			City	State	ZIP Code
5430 W Layton Avenue			Greenfield	WI	53220
Phone # (include area code)	Fax # (include area code)		Email		
(414) 745-3771					

Section 2. Property Information

Property Name	FID No. (if known)
DIC Imaging Products USA Inc, Liquid Compounds Facility	341018810.

BRRTS No. (if known)	Parcel Identification Number
02-41-588407	

Street Address	City	State	ZIP Code
7335 S. 10th Street	Oak Creek	WI	

County	Municipality where the Property is located	Property is composed of:	Property Size Acres
Milwaukee	◯ City ◯ Town ◯ Village of	◉ Single tax parcel ◯ Multiple tax parcels	

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).

☐ **Skip Sections 4 and 5 if the technical assistance you are requesting is listed above and complete Sections 6 and 7 of this form.**

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.

Please review and comment on the PFAS investigation work plan.

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: _____

Date of Collection: 07/28/2021

- ☐ 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: _____

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: Gary Andrzejewski
  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.

Stacie L Goetz
Signature

09/22/2022
Date Signed

Managing Geologist, Ramboll
Title

(414) 335-3563
Telephone Number (include area code)

Section 8. DNR Contacts and Addresses for Request Submittals

Send or deliver one paper copy and one electronic copy on a compact disk of the completed request, supporting materials, and fee to the region where the property is located to the address below. Contact a DNR regional brownfields specialist with any questions about this form or a specific situation involving a contaminated property. For electronic document submittal requirements see: http://dnr.wi.gov/files/PDF/pubs/rr/RR690.pdf.

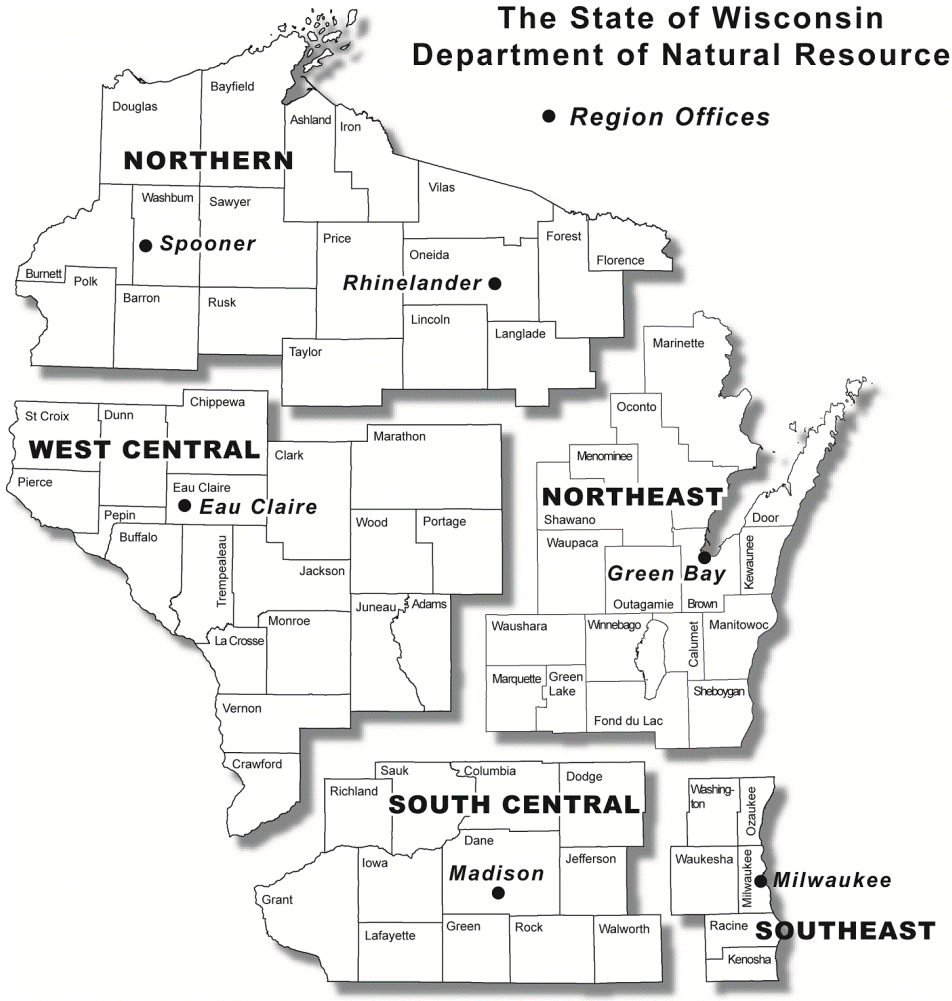
DNR NORTHERN REGION
Attn: RR Program Assistant
Department of Natural Resources
223 E Steinfest Rd Antigo, WI 54409

DNR NORTHEAST REGION
Attn: RR Program Assistant
Department of Natural Resources
2984 Shawano Avenue
Green Bay WI 54313

DNR SOUTH CENTRAL REGION
Attn: RR Program Assistant
Department of Natural Resources
3911 Fish Hatchery Road
Fitchburg WI 53711

DNR SOUTHEAST REGION
Attn: RR Program Assistant
Milwaukee DNR Office
1027 West St. Paul Ave
Milwaukee WI 53233

DNR WEST CENTRAL REGION
Attn: RR Program Assistant
Department of Natural Resources
1300 Clairemont Ave.
Eau Claire WI 54702



Note: These are the Remediation and Redevelopment Program's designated regions. Other DNR program regional boundaries may be different.

DNR Use Only			
Date Received	Date Assigned	BRRTS Activity Code	BRRTS No. (if used)
DNR Reviewer	Comments		
Fee Enclosed? ◯ Yes ◯ No	Fee Amount $	Date Additional Information Requested	Date Requested for DNR Response Letter
Date Approved	Final Determination		

Intended for:
Wisconsin Department of Natural Resources
Milwaukee, Wisconsin

Prepared for:
Sun Chemical Corporation

Prepared by:
Ramboll US Consulting, Inc.
Milwaukee, Wisconsin

Date
September 2022

Project Number:
1690027027

NR 716 SITE INVESTIGATION WORK PLAN

DIC IMAGING PRODUCT - LIQUID COMPOUNDS FACILITY

7335 S. 10TH STREET, OAK CREEK, WISCONSIN

BRRTS NO. 02-41-588407
FID NO. 341018810

RAMBOLL Bright ideas. Sustainable change.

CERTIFICATION

I, Staci L. Goetz, 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.

_____ September 22, 2022

Signature Date

Title: Managing Geologist

License Number: 1258-13

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1. INTRODUCTION

1.1 Purpose

On behalf of Sun Chemical Corporation (Sun), Ramboll US Consulting, Inc (Ramboll) prepared this NR 716 Site Investigation (SI) Work Plan (Work Plan) to propose investigation locations, methods, and procedures to be implemented at the DIC Imaging Product, Inc. Liquid Compounds Facility (Site) located at 7335 S. 10th Street, Oak Creek, Wisconsin (Figure 1). This Work Plan has been prepared in conformance with Wisconsin Administrative Code (WAC) Chapter NR 716 and is intended to define the nature, degree, and extent of known contaminants in affected media at the Site.

The Work Plan is being prepared in response to a "Responsible Party" letter received on September 23, 2021 by Sun for a hazardous substance discharge notification submitted to WDNR on September 9, 2021 by Ramboll. The discharge notification was submitted on behalf of DIC Imaging Products, INC (DIC Imaging), a subsidiary of Sun, in response to a Phase II Site investigation that included soil, groundwater, and sediment sampling and was conducted in response to a Phase I Recognized Environmental Condition (REC). The REC was the release of aqueous film forming foam (AFFF) and municipal water by a foam fire suppression system at the facility on September 25, 2005. As described in Section 2 below, the release has been identified as a potential source of per- and poly-fluoroalkyl substances (PFAS) and subsequent investigation findings confirmed the presence of PFAS in the environment.

This Work Plan presents a summary of the Site background information, proposed additional investigation approach, a detailed scope of work including laboratory methodologies, potential receptors and potentially complete pathways of exposure, reporting, and schedule. The results of the investigation will be used to assess the nature and extent of PFAS, to determine if remedial action is needed and if so, what remedial options are viable.

1.2 Site Location and Description

Site Name	DIC Imaging Product, Liquid Compounds
Responsible Party	Sun Chemical Corporation
BRRTS Number	02-41-588407
Site Location	7335 S. 10th Street in Oak Creek, Milwaukee County, Wisconsin; reference the relevant United States Geological Survey (USGS) 7.5-Minute Series Topographic Map provided as Figure 1 – Site Location Map.
Property Owner	GMK Realty II LLC
Parcel Number	7649023000
Section-Town-Range	SW 1/4 of the NW 1/4 of Sec 08, T05N, R22E
WTM(91)	X: 689,144.1, Y: 273,096.2
Land Area	2.02 acres
Prior Site Use	Former UV curable resins coatings manufacturing facility
Current Site Use	Industrial
Future Site Use	Unknown- Zoned M1 manufacturing.
Site Vicinity	A diagram depicting the Site is provided as Figure 2 – Site Layout. Nearby BRRTS sites are shown on Figure 3 and adjacent water wells are shown on Figure 4.

1.3 Physical Setting

Physical Setting Information for Site and Surrounding Area		Source
Topography (Refer to Figure 1 for an excerpt of the Topographic Map)		
Site Elevation	Ranges from approximately 725 feet near the northeast corner to 715 feet (National Geodetic Vertical Datum [NGVD]) near the eastern property boundary.	USGS 7.5-Minute Series Topographic Map, Glendale, Wisconsin Quadrangle, 2013
Surface Runoff/ Topographic Gradient	Relatively flat on-site with a gentle downward slope to the east. Regional topography slopes gently downward to the east toward Lake Michigan.	
Closest Surface Water Body	Stormwater enters catch basins that discharge to the on-site storm water retention pond, which is piped and drains to the municipal storm sewer system along 10th Street.	
USDA Soil Characteristics		
Soil Type(s)	fill; silt loam (OzaB); loam (FoB); silt loam (MmA)	United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) Web Soil Survey
Description	Silt and silt loam consist of a mixture of sand, silt, and clay.	
Geology/Hydrogeology		
Description	The regional geology in the vicinity of the Site is composed of windblown silt and sand overlying unconsolidated glacial deposits underlain by sedimentary bedrock. The glacial deposits are generally composed of clay till of the Oak Creek Formation and discontinuous sand/silty sand lenses. The bedrock underlying the Site is Silurian dolomite, which is expected at a depth of greater than 100 feet.	Skinner, E.L., and Borman, R.G., 1973. Water Resources of Wisconsin-Lake Michigan Basin. U.S. Geological Survey. Hydrologic Investigations Atlas HA-432.
Depth to Water Table	Approximately 6 to 11 feet below ground surface (bgs), deeper near the eastern boundary of the Site.	
Primary Aquifer(s)	Niagara and sandstone aquifers	Skinner, E.L., and Borman, R.G., 1973. Water Resources of Wisconsin-Lake Michigan Basin. U.S. Geological Survey. Hydrologic Investigations Atlas HA-432.
Horizontal Hydraulic Gradient	Based on prior investigation at the Site, the groundwater flow direction is southeast.	

1.4 Involved Parties

Site Owner:	GMK Realty II LLC 5430 W Layton Avenue Greenfield, WI Contact: Martin Komisar, (414) 745-3771
Responsible Party:	Sun Chemical Corporation 135 West Lake Street Northlake, IL 60164 Contact: Gary Andrzejewski, (708) 236-3713 gary.andrzejewski@sunchemical.com
Consultant:	Ramboll US Consulting, Inc. 234 W Florida Street, 5th floor Milwaukee, WI 53204 Contact: Staci Goetz , (414) 335-3563 staci.goetz@ramboll.com
Agency:	Wisconsin Department of Natural Resources 1027 W. St. Paul Avenue Milwaukee, WI 53233 Contact: Riley Neumann, (414) 750-7030 riley.newmann@wisconsin.gov

2. PRIOR INVESTIGATIONS

2.1 Background

DIC Imaging Products USA Inc, Liquid Compounds (DIC Imaging or the "Company") formerly owned and operated an ultraviolet (UV) coatings manufacturing facility in Oak Creek, Wisconsin. The Site is located in the SE ¼, NW ¼ of Section 8, Township 5 North, Range 22 East of Milwaukee County, Wisconsin (Figure 1). The approximately 2-acre Site is improved with an approximately 27,000-square foot building (Figure 2).

The Site was used for agricultural purposes until a building was constructed in the southeast portion of the Site sometime between 1963 and 1969 and occupied by an unknown entity. Flexibrick Corporation (operations unknown) occupied the Site in the early to mid-1970s. The Site was subsequently occupied by Tunnel Supports Inc. from at least 1979 until approximately 2000 (operations unknown). DIC Imaging purchased the Site in approximately 2000 and constructed the western portion of the existing building for use as a UV coatings manufacturing facility. DIC Imaging subsequently expanded the building to the east in approximately 2003/2004. DIC Imaging's production operations at the facility ceased in March 2020. DIC Imaging sold the property to GMK Realty II LLC on 10/27/21, 2021 (Milwaukee County GIS). The vicinity of the Site is currently a commercial/industrial area with approximately 100 nearby BRRTs sites (Figure 3).

2.2 Phase I ESA

A Phase I Environmental Site Assessment (ESA) site visit was performed by Ramboll in March 2021 in support of a property transaction (Ramboll 2021a). The Phase I identified one Recognized Environmental Condition (REC) associated with the Site, a past release of AFFF. A release of approximately 100 gallons of Ansulite 3x3 Low Viscosity, an AFFF product, mixed with municipally supplied water, occurred at the facility on September 25, 2005 as the result of a power failure at the Site. According to available documentation and facility personnel, the foam and water mixture was discharged into the secondary containment unit associated with the methyl ethyl ketone (MEK) tank area located west of the Site building (see Figure 2). Due to the volume released, the mixture overflowed the containment unit and flowed into a storm drain in the nearby shipping and receiving dock area that discharged to the on-site storm water retention pond on the east portion of the Site, and ultimately into an off-site storm water ditch associated with the South 10th Street median.

The release was reported to the Wisconsin Department of Natural Resources (WDNR) on September 26, 2005 (Bureau of Remediation and Redevelopment Tracking System [BRRTs] ID 04-41-547407). Approximately 5,000 gallons of foam and water mixture was vacuumed from the MEK tank containment area and retention pond and disposed of off-site by AAA Environmental Industries, Inc., DIC Imaging's emergency response contractor. An additional 15,000 gallons of water was pumped from the retention pond into the sanitary sewer, with permission from the Milwaukee Metropolitan Sewage District (MMSD). The spill activity was closed by the WDNR on June 26, 2008.

Although this BRRTS case is closed, WDNR sent out letters to all open BRRTS sites in the state for the need to evaluate for emerging contaminants August 17, 2020. The Ansulite release is a

potential source of PFAS. Thus, an emerging contaminant investigation (Phase II ESA) was performed to evaluate conditions in the area of the former AFFF release.

2.3 Phase II ESA

In July 2021, Ramboll completed a Phase II ESA at the Site (Ramboll 2021b). Soil, stormwater pond sediment, and groundwater samples were collected.

Four soil borings (SB-1 through SB-4) were advanced to a depth of 15-feet below ground surface (ft bgs) using GeoProbe® direct-push technology. Boring locations are shown on Figure 2. Soils encountered consisted of silty clay (CL-ML). SB-1 was located within the AFFF historical spill area near the former MKE tank and loading dock areas. Borings SB-2 through SB-4 were located throughout the Site to provide spatial coverage. Borings SB-2 and SB-4 were drilled through asphalt pavement, gravel basecourse, and clayey fill before encountering native soil at a depth of approximately 2.5-ft bgs. Soil boring logs are presented in Appendix A. One soil sample was collected from each boring and analyzed for PFAS using USEPA Method 537 (modified) - Fluorinated Alkyl Substances. Detected concentrations were not above WAC NR720 soil residual contaminant levels (RCLs). Appendix B presents tabulated soil concentrations and analytical reports for the soil samples collected.

Additionally, three aliquot samples were collected from sediment within the stormwater retention pond at the east end of the Site. These samples were homogenized, composited (SED-COMP) and submitted along with a corresponding field duplicate sample to an analytical laboratory for PFAS analysis. Sixteen (16) PFAS compounds were detected in the composite sediment sample and field duplicate at concentrations below their respective RCLs. Appendix B presents tabulated sediment concentrations and analytical reports for the sediment samples collected.

To characterize groundwater, the four soil borings were over drilled with a 4.25-inch hollow-stem auger and NR-141 compliant, flush-mount 2-inch outer diameter monitoring wells were installed. The monitoring wells were constructed using 2-inch diameter polyvinyl chloride (PVC) riser with a 10-foot, 0.010-inch slot size well screen. Well development occurred prior to groundwater sampling. Well construction and development forms are presented in Appendix C. One round of groundwater sampling occurred in July 2021. MW-4 did not produce sufficient groundwater for sample collection. PFOA was detected at MW-1, located near the source of the foam fire suppression system release, at concentrations exceeding the proposed WAC NR140 PAL and ES. Other PFAS compounds were detected in MW-1 and at MW-2 and MW-3, but did not exceed proposed WDNR PALs, ESs, or USEPA 2016 HALs. Appendix D presents tabulated concentrations and analytical reports on the groundwater samples collected.

2.4 Indoor Air Sampling

In 2021 indoor air sampling was conducted by LF Green Development, LLC, Milwaukee, Wisconsin, on behalf of the current owner of the Site, GMK Reality II LLC. After multiple attempts by Ramboll and Sun to obtain the results of indoor air monitoring, none were provided for inclusion in this plan. However, telephone communication from Ms. Linda Fellenz of LF Green Development, LLC in June 2021 to Ms. Staci Goetz of Ramboll, indicated no exceedances of Occupational Safety and Health Administration (OSHA) permissible exposure limits (PEL) for volatile organic compounds were reported from time weighted average samples.

3. SITE INVESTIGATION WORK PLAN

A spill notice was submitted to WDNR by Ramboll on behalf of Sun on September 9, 2021. WDNR sent Sun a Responsible Party Letter on September 23, 2021 notifying them of an obligation to scope and perform a site investigation under WAC NR 716. The following section presents a description of the work to be completed during the site investigation. The contents of this section were prepared in accordance with WAC NR 716. The objectives of the Site Investigation (SI) scope are to refine the nature and extent of PFAS identified in soil and groundwater during the Phase II Site Investigation (Ramboll 2021b). The proposed activities to achieve these goals are described below.

3.1 Overview of Sampling and Analysis

The scope of the SI activities addressed by this Work Plan includes:

- Evaluation of potential PFAS migration pathways and receptors
- Advancing two soil borings to further identify and delineate the concentrations and extent of PFAS in soil
- Conversion of the two soil borings to groundwater monitoring wells
- Slug testing of monitoring wells
- Groundwater monitoring to further define the concentrations and extent of PFAS in groundwater (6 wells)

Investigation locations, sampling frequencies, analytical parameters, and methods are summarized on Table 1. The planned field activities will be completed in accordance with Ramboll's Field Guidance Documents (FGDs). Copies of Ramboll's FGDs can be provided upon request.

Prior to field mobilization, sampling locations will be cleared for subsurface exploration by calling diggers hotline (811) and using a private utility locating company. All material generated as a result of the investigation described below will be containerized, sampled, and disposed of as appropriate at a licensed disposal facility (Section 3.9).

3.2 Health and Safety

A site-specific Health and Safety Plan (HASP) will be developed in accordance with Occupational Safety and Health Administration (OSHA) 29 CFR 1910 for the proposed field activities. Ramboll will review the HASP with all field personnel prior to commencing the field activities

3.3 Potential Migration Pathways and Receptors

The subject site is zoned as manufacturing use. Oak Creek obtains its municipal potable water supply from the Oak Creek Water and Sewer Utility. The Phase II investigation identified downgradient concentrations of PFAS at significantly lower concentrations (all below proposed standards) than found in the source area indicating on-Site migration in groundwater. As noted in Section 2.2 above, a storm drain was the conveyance pathway to a stormwater retention pond that is located on the subject property. Subsurface utility record drawings will be reviewed for this evaluation. Based on the type of contaminants identified at the site, and prior indoor air sampling, vapor intrusion is not a concern.

No known or potential receptors of PFAS in soil, surface water, or groundwater have been identified. No soil results approach or exceeded RCLs such that soil disturbing activities pose no risk. No drinking water supply users (groundwater or surface water) were identified.

3.4 Utility Clearance

Prior to initiation of any drilling or other intrusive work, underground and overhead utilities, including electric lines, gas lines, storm and sanitary sewers, and communication lines, will be identified (SWP Subsurface Utility Clearance). The general process for conducting utility clearance is outlined below however SWP Subsurface Utility Clearance will be implemented and Ramboll's HSS Department consulted prior to any intrusive work.

- Submit a request to Wisconsin's Diggers Hotline (Diggers), the utility one-call system, to initiate the utility-locating activities. Wisconsin state law requires that Diggers be notified at least three working days, and not more than 10 working days, before subsurface work is conducted.
- Coordinate with participating utility-owning companies to locate and mark all respective subsurface utility lines within the Site boundary.
- Precautions regarding safe distance from the overhead electrical lines will be reviewed and equipment offset distances flagged and marked, in accordance with the required clearances.
- Subcontract a third-party utility location service to support identification of subsurface utility infrastructure.
- The following requirements apply to all intrusive activities and will be completed before work begins:
  - Confirm that underground utilities have been located and marked, including intrusive work locations.
  - Surrounding or adjacent areas will also be cleared and marked as needed, such that cleared areas and markings extend 5 feet/1.5 meters beyond the intrusive activity in all directions to identify the Critical Zone (Ramboll required radius of utility clearance for intrusive subsurface activities).
  - Complete the required documentation (e.g., SSC Field Checklist [Attachment B of SWP Subsurface Utility Clearance] or equivalent) and keep on site.
  - Communicate all potential utility concerns, protocols and safe work distances to Ramboll employees and subcontractors, including equipment operators.
  - De-energize electrical utilities and isolate piping where possible, particularly if present in or near Critical Zones.
  - Identify emergency shutoffs and add locations to the plot plan.

3.5 PFAS Sampling Provisions

Due to the widespread use of PFAS (applications include food wrappers, water repellent outdoor gear, firefighting foams, mist suppressants, wire/cable coatings, specialty fabrics, and even car wash and ski wax materials) and the very low target detection limits (nanograms per liter, ng/L), specific measures will be implemented during sampling for PFAS to enhance sample integrity and generate representative data. Potential causes of non-representative PFAS results stem from (a)

most commonly, the inadvertent introduction of PFAS into the sample through sampling equipment/supplies, personal care products (PCAs) and personnel protective equipment (PPE), or (b) the inadvertent loss of PFAS to the environment or equipment used in sample collection, which is less common but still requires diligence on the part of the sampling team. (FGD 1.07) PFAS protocols for PPE, sampling equipment, and sampling procedures will be followed to eliminate potential PFAS cross-contamination concerns. PPE will be modified by eliminating potential PFAS compounds (e.g., select sunscreens and waterproofing materials in boots and clothing) and substituting non-PFAS containing materials (e.g., PVC boots, nonpowdered nitrile gloves). Field personal clothing will be laundered at least six times with non-PFAS containing detergents without fabric softener. Personal care products (e.g., deodorant, shaving products, cleansers, etc.) will not be used on the day of sampling. Groundwater sampling collection equipment and procedures will be adjusted to exclude potential PFAS containing materials (e.g., only use low-density polyethylene [LDPE] tubing, high-density polyethylene [HDPE], or polypropylene [PP] containers). Groundwater sampling equipment will be thoroughly decontaminated between each sampling location anionic Alconox® or similar PFAS-free detergent, PFAS-free deionized water, and new disposable tubing will be utilized for sample collection for each well location. A new pair of nitrile gloves will be used during the collection of each sample to minimize the potential for cross-contamination.

3.6 Soil Borings

Two soil borings will be advanced. The first, MW-5/SB-5, is located north of MW-1/SB-1 to further define the lateral extent of PFAS detected in the soils (Figure 2 – Site Layout/Soil Boring and Monitoring Well Locations). The second, MW-6/SB-6, is located south of MW-1/SB-1 to further define PFAS groundwater impacts. Both borings will use direct push (e.g., GeoProbe®) methods (FGD 5.07). The actual boring location may vary slightly and will be dependent on field conditions at the time of installation. The borings will be drilled to a depth of 15 ft. bgs. Ramboll field staff will classify the soil by visual observation and perform photoionization detector (PID – 11.7 eV lamp) field screening to evaluate the potential for other impacts to the soil. Recovered soils will be described in the field. Boring logs will be prepared and the soil type, grain size distribution, and color (or discoloration), odor, and moisture content (FGD 5.09) will be recorded along with PID readings and visual/olfactory evidence of impacts. The PID will be calibrated in the field according to the manufacturer's instructions, using 100 parts per million (ppm) isobutylene span gas and air (zero gas), and checked between each screening event for proper response.

Two soil samples will be collected from each soil boring (and/or new monitoring well location) for laboratory analysis. The first soil sample will be collected within the top two feet and the second soil sample will be collected in the two foot interval just above the water table interface. One sample will be collected below observed impacts but immediately above the water table. One field duplicate and one rinsate blank will also be collected for quality assurance/quality control (QA/QC) purposes.

The samples collected will be containerized in laboratory-provided sample containers, preserved appropriately, and kept on ice, cooled to 4 degrees Celsius. Following sample collection, each sample container will be labeled with the sample location identification, date and time of sample collection, and intended analysis. The sample containers will then be placed in re-sealable plastic bags and packed in an iced, insulated container (FGD 1.02).

Soil samples will be submitted to Eurofins/TestAmerica, a Wisconsin-certified laboratory, under standard chain-of-custody procedures for analysis of Wisconsin 33 PFAS analytes by Method 537 (Modified) (FGD 1.02).

Soil boring logs, corresponding well construction forms and well development forms will be provided in the Site Investigation Report. An existing waste profile will be used for disposal of the investigative-derived waste.

3.7 Groundwater Monitoring Well Installation and Slug Testing

To further characterize the areas potentially upgradient and downgradient of PFAS impacts, Ramboll proposes to overdrill borings MW/5-SB-5 and MW-6/SB-6 and install NR 141 compliant groundwater monitoring wells at the locations shown on Figure 2. Each well location boring will be logged, and PID field screened and sampled for potential impacts as described in Section 3.2

The soil borings will be overdrilled with a 4.25-inch hollow stem auger to allow for the installation of an NR-141 compliant, flush-mount 2-inch outer diameter monitoring well with a 10-foot slotted screen. The newly installed monitoring wells will be developed. Well development will be performed using a combination of mechanical surging with bailing and pumping (FGD-6.07). Development will continue until the water is visibly clear and field parameters (pH, temperature, conductivity, etc.) stabilize or 10 well volumes of water have been removed. Development water will be managed under an existing waste profile.

Following installation, the top of casing elevation of the monitoring well will be surveyed by a Wisconsin professional land surveyor to vertical accuracies of 0.01 feet using global positioning systems (GPS) to aid in the determination of groundwater flow direction and assessment of groundwater contaminant movement and distribution. The location survey will be correlated with the existing State Plane Coordinate System, 1983 adjustment, and the vertical survey correlated with the North American Vertical Datum (NAVD) of 1988.

Several weeks will pass after successful completion of well development to allow water table conditions to stabilize. At that time, slug testing will be performed on representative monitoring wells at the site (FGD 6.03). Slug tests are a means to estimate the hydraulic conductivity (K) of an aquifer immediately surrounding a test well/piezometer. Slug tests generally consist of inducing a near instantaneous head change (ΔH) in a well (relative to the water level in the formation surrounding the well) and monitoring the time required for the head (H) within the well to recover to the static water level/equilibrium with the surrounding aquifer. The timing of the head response in the well is a function of the differential head created and the hydraulic conductivity and coefficient of storage of the aquifer. Analysis of the head data, with an appropriate theoretical model provides an estimate of the saturated hydraulic conductivity of subsurface geologic strata for a limited radius surrounding the tested well. The final number of wells to be tested will be based on variability of observed lithologies and well development responses.

3.8 Groundwater Sampling

Following the installation of the two new groundwater monitoring wells and before slug testing, approximately 15 days after successful monitoring well development a round of groundwater samples will be collected from the six monitoring wells at the site. Groundwater samples will be analyzed by Method 537 (modified) for Wisconsin 33 PFAS analytes.

Prior to the groundwater sampling activities, a depth to groundwater measurement will be made using a Heron electronic water level sensor, Model ET-94 (accuracy 0.01 feet) or similar equipment from the existing and new monitoring well network, which will also be decontaminated between locations . Water levels will be recorded to assess the elevation and direction of groundwater flow when the monitoring wells are sampled, or at other times to assess flow conditions.

Groundwater samples will be collected from the monitoring wells using low-flow groundwater sampling techniques (FGD 6.02), which involve using a pump with disposable PFAS-free tubing (high density polyethylene and silicone), and a water quality meter with a flow-through cell. If a well does not support low-flow sampling, the well will be sampled with a PFAS-free bailer with a low-flow bottom emptying device. When using either a pump or a bailer, the tubing or bailer will be lowered slowly into the well to limit the amount of disturbance and associated turbidity. For low-flow sampling, the disposable tubing will be lowered into the well so that the bottom of the tubing is at the approximate center of the saturated screened interval within the well. The pump will be turned on and purging initiated at a flow rate that allows the water level of the well to remain near its static level to prevent cascading of the water down the well screen so that aeration of the water sample is reduced. The groundwater flow rate during sampling is typically 100 to 500 milliliters per minute (mL/min). Wells with lower transmissivity are purged and sampled at lower flow rates (300 mL/min or less). Field measurements of water quality parameters, including temperature, dissolved oxygen (DO), pH, specific conductivity, oxidation-reduction potential (ORP), and turbidity will be recorded every 3 to 5 minutes during well purging, prior to the collection of groundwater samples. The groundwater samples will be collected upon stabilization of the groundwater quality parameters, which typically occurs when three consecutive readings do not vary more than ± 10% for turbidity and DO, ± 3% for conductivity and temperature, ± 10 microvolts for ORP, and ± 0.1 for pH. The well will be considered stabilized and ready to be sampled after the field measurements of water quality parameters have stabilized or the well has been purged a minimum of three well volumes. PFAS sampling provisions in Section 3.4 are to be followed to avoid external PFAS sources of contamination.

A total of 9 groundwater samples (including one duplicate groundwater sample, field blank, and equipment blank) will be submitted for PFAS laboratory analysis per sampling event (FGD 1.07).

The samples collected will be containerized in laboratory-provided sample containers, preserved appropriately, and kept on ice, cooled to 4 degrees Celsius. Following sample collection, each sample container will be labeled with the sample location identification, date and time of sample collection, and intended analysis. The sample containers will then be placed in re-sealable plastic bags and packed in an iced, insulated container (FGD 1.02).

Groundwater samples will be submitted to Eurofins/TestAmerica, a Wisconsin certified laboratory on ice under standard chain-of-custody procedures to be analyzed for Wisconsin 33 PFAS analytes by Method 537 (modified).

Table 1 provides the sampling and analysis plan, including the analysis methods, container type/collection device, sample preservation and holding times. At a minimum one duplicate sample, equipment blank and a field blank will be submitted during each sampling event for quality control and quality assurance.

3.9 Investigative Derived Waste

Field staff and/or the drilling contractor will properly containerize and label all soil cuttings in 55-gallon drums (or equivalent) and temporarily store on-site pending waste contractor transportation to a licensed, permitted off-site waste disposal facility under an existing waste profile.

Decontamination water combined with well purge/development water will also be temporarily stored on-site in labeled 55-gal drums pending waste contractor transportation, as soon as practicable.

3.10 Interim and Remedial Action

No potential interim actions were determined to be necessary at the site and it has not yet been determined what remedial actions will be necessary at the site. No immediate or interim actions have been taken or are in progress at the site.

3.11 Scheduling

The field investigation activities described in Section 3 will be initiated within 60 days following the receipt of WDNR approval. The Site Investigation (SI) report will be submitted to the WDNR by 60 days after all data validation of laboratory results have been received by Ramboll.

3.12 Reporting

Following substantial completion of the site investigation, a WAC NR 716 SIR will be prepared. The SIR report will include all required WAC NR 716 site information and certification requirements as follows:

- Background information for the Site including a summary of prior investigations at the Site.
- A summary of all investigation activities at the Site which will include field measurements, a summary of geologic and hydrogeologic characteristics, observations, and a discussion of the analytical results; and figures and tables to illustrate the results of the investigations at the Site.
- A conceptual site model outlining the nature and extent of contamination, and identification of potential receptors.
- Conclusions and recommendations for additional action if appropriate or the next steps for the site.

4. REFERENCES

1958, USGS 7.5-Minute Series Topographic Map, Racine South, Wisconsin Quadrangle.

1973, Skinner, E.L., and Borman, R.G., Water Resources of Wisconsin-Lake Michigan Basin. U.S. Geological Survey. Hydrologic Investigations Atlas HA-432.

2021a, Ramboll, Phase I Environmental Site Assessment Report, DIC Imaging Products USA INC Liquid Compounds 7335 South 10th Street, Oak Creek, Wisconsin, February.

2021b, Ramboll, Phase II Environmental Site Assessment Report, DIC Imaging Products USA INC Liquid Compounds 7335 South 10th Street, Oak Creek, Wisconsin, July.

United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm).

TABLES

Table 1. Sampling and Analysis Plan

Site Investigation Work Plan
DIC Liquid Compounds Facility
7335 South 10th Street, Oak Creek, WI

Sample Type	Sample Frequency	Estimated Number of Samples per Event	Parameter	Method	Field Duplicates	Equipment Blanks	Field Blanks	TOTAL	Bottles Per Set	Estimated No. of Containers	Container Type	Minimum Volume	Preservation (Cool All Samples to 4° ± 2°C Unless 'None' Indicated)	Holding Time from Sample Date
Soil - Discrete	1 Event	2	PFAS (33 compounds)	Method 537 (modified)	1	1	1	3 soil 1 water	1 Soil 2 Field QC Water	3 Soil 4 Field QC Water	HDPE	8 oz	None	14 days
Groundwater	1 Event	6	PFAS (33 compounds)	Method 537 (modified)	1	1	1	9	2	18	HDPE	Two 250 mL	None	14 days
	1 Event	6	VOCs (IDW)	8260B	0	0	0	6	3	18	Glass Vial	Three 40 mL	HCL to pH<2, zero headspace	14 days

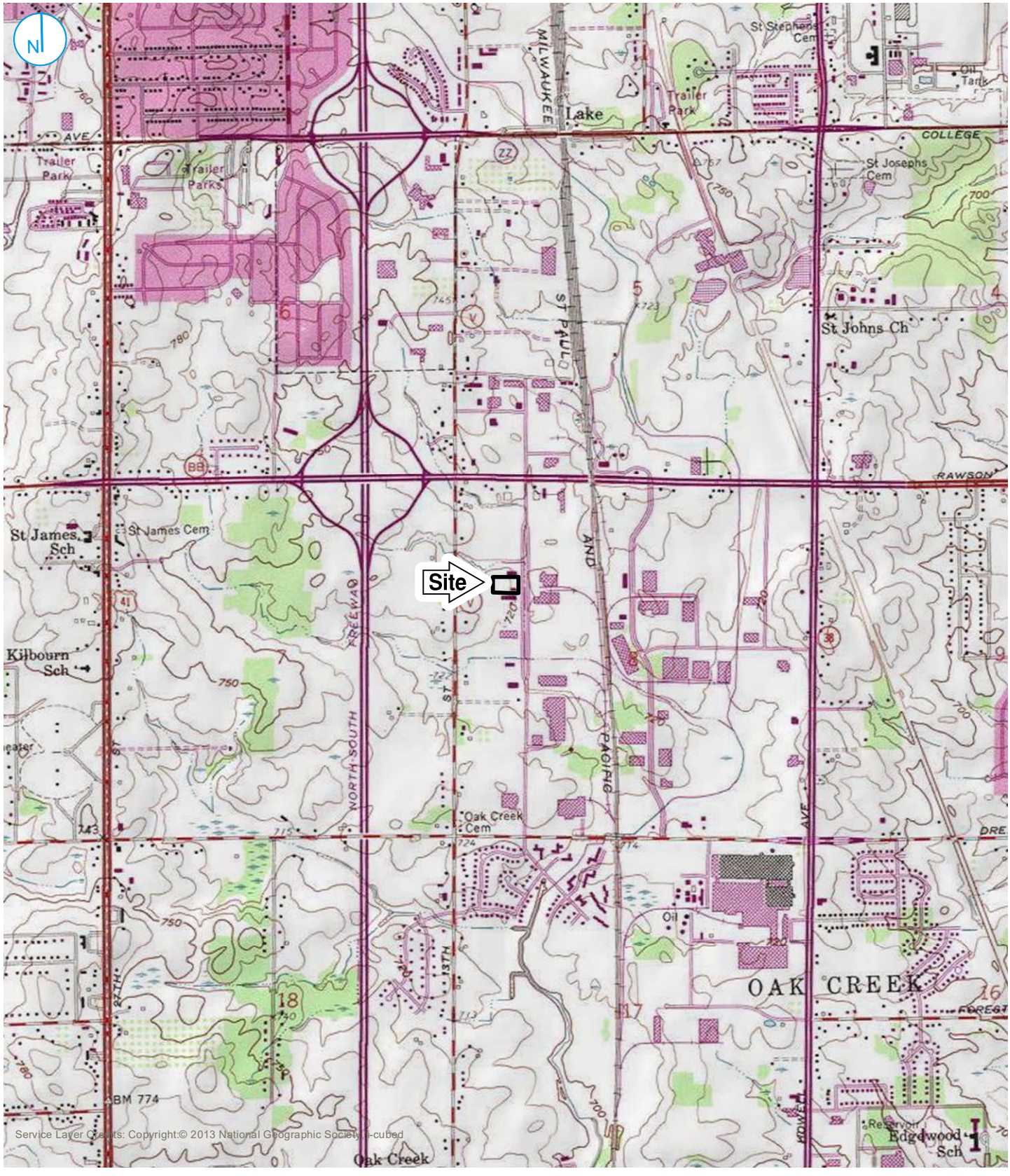
[O: AAS 6/23/21 U: AAS 7/2/21]

Notes:
1. All samples can be submitted at time of collected and submitted with standard turnaround.
2. Include note on COC and containers that samples are AFFF related samples.
PFAS - per- and polyfluoroalkyl substances. PFAS compounds to be analyzed are: Perfluorobutanoic acid, Perfluoropentanoic acid, Perfluorohexanoic acid, Perfluoroheptanoic acid, Perfluorooctanoic acid, Perfluorononanoic acid, Perfluorodecanoic acid, Perfluoroundecanoic acid, Perfluorododecanoic acid, Perfluorotridecanoic acid, Perfluorotetradecanoic acid, Perfluorobutanesulfonic acid, Perfluoropentanesulfonic acid, Perfluorohexanesulfonic acid, Perfluoroheptanesulfonic acid, Perfluorooctanesulfonic acid, Perfluorononanesulfonic acid, Perfluorodecanesulfonic acid, Perfluorododecanesulfonic acid, 4:2 fluorotelomersulfonic acid, 6:2 fluorotelomersulfonic acid, 8:2 fluorotelomersulfonic acid, Perfluorooctanesulfonamide, N Methylperfluorooctanesulfonamide, N Ethylperfluorooctanesulfonamide, N Methylperfluorooctanesulfonamidoacetic acid, N Ethylperfluorooctanesulfonamidoacetic acid, N Methylperfluorooctanesulfonamidoethanol, N Ethylperfluorooctanesulfonamidoethanol, Hexafluoropropylene oxide dimer acid, 4,8 dioxa 3H perfluorononanoic acid, 9 chlorohexadecafluoro 3 oxanonane 1 sulfonic acid, and 11 chloroeicosafluoro 3 oxaundecane 1 sulfonic acid.

IDW - investigative derived waste
TCLP - toxicity characteristic leaching procedure
VOCs - volatile organic compounds

Eurofins Contact: Sandie Fredrick, sandra.fredrick@eurofinset.com
Quote #: 50018928
Project Number: 1690027027

FIGURES



PROJECT: 169000XXXX | DATED: 6/17/2022 | DESIGNER: galarmmc

Y:\Mapping\Projects\7\171849\mxd\SWIP\Figure 1_Site Location Map.mxd

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

SITE BOUNDARY

KEY MAP

0 1,000 2,000 Feet

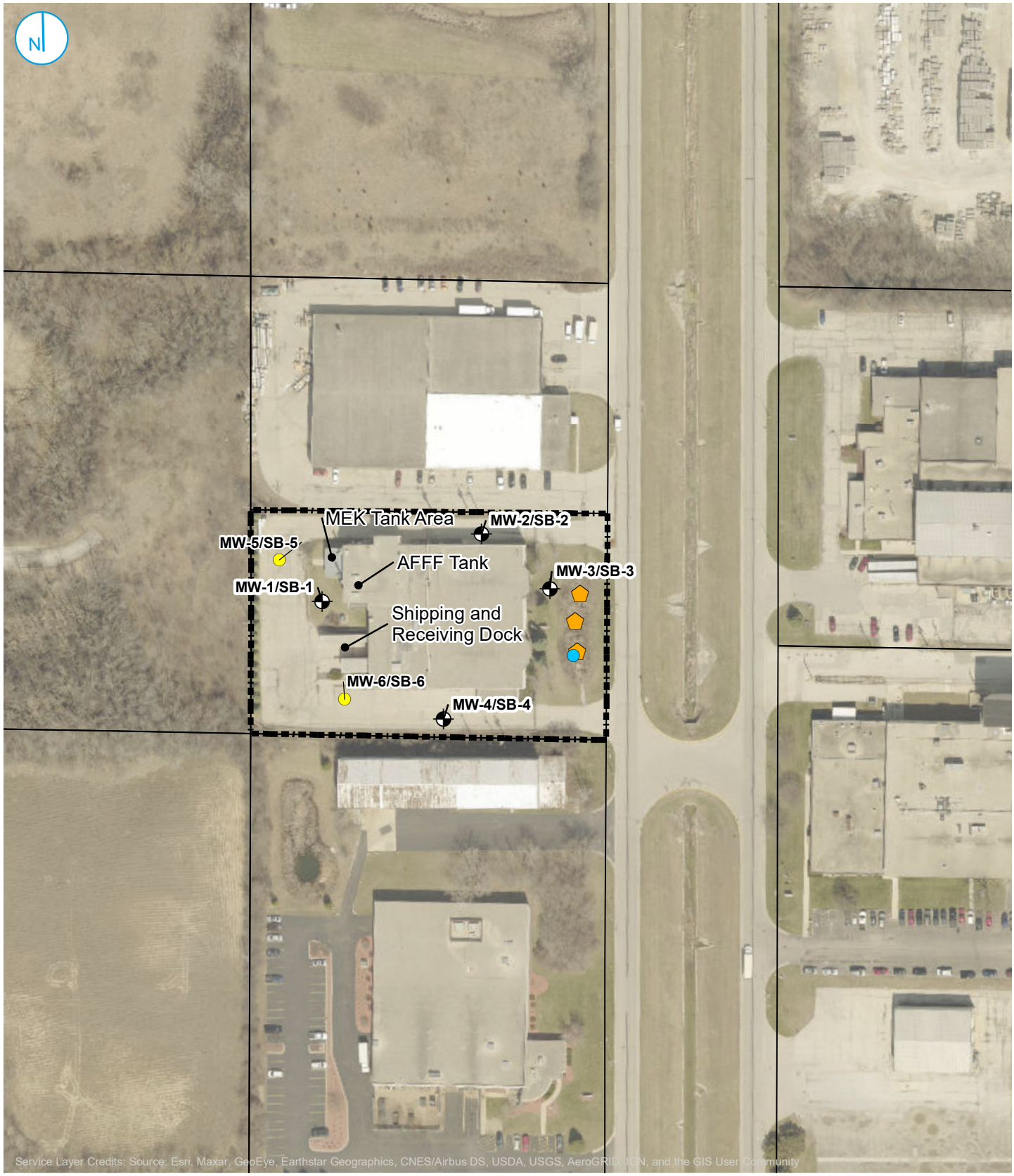
SITE LOCATION MAP

FIGURE 01

DIC IMAGING PRODUCTS US INC
LIQUID COMPOUNDS FACILITY
7335 SOUTH 10TH STREET
OAK CREEK, WISCONSIN

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



Y:\Mapping\Projects\7711849\mxd\SWIP\Figure 2_Site Layout and Locations.mxd

PROJECT: 1690021164 | DATED: 8/29/2022 | DESIGNER: CHURCHKE

- PROPOSED SOIL BORING/MONITORING WELL LOCATION
- PROPOSED SURFACE WATER SAMPLE
- SOIL BORING/MONITORING WELL LOCATION
- SEDIMENT ALIQUOT LOCATION
- SITE BOUNDARY
- PARCEL BOUNDARY

0 37.5 75
Feet

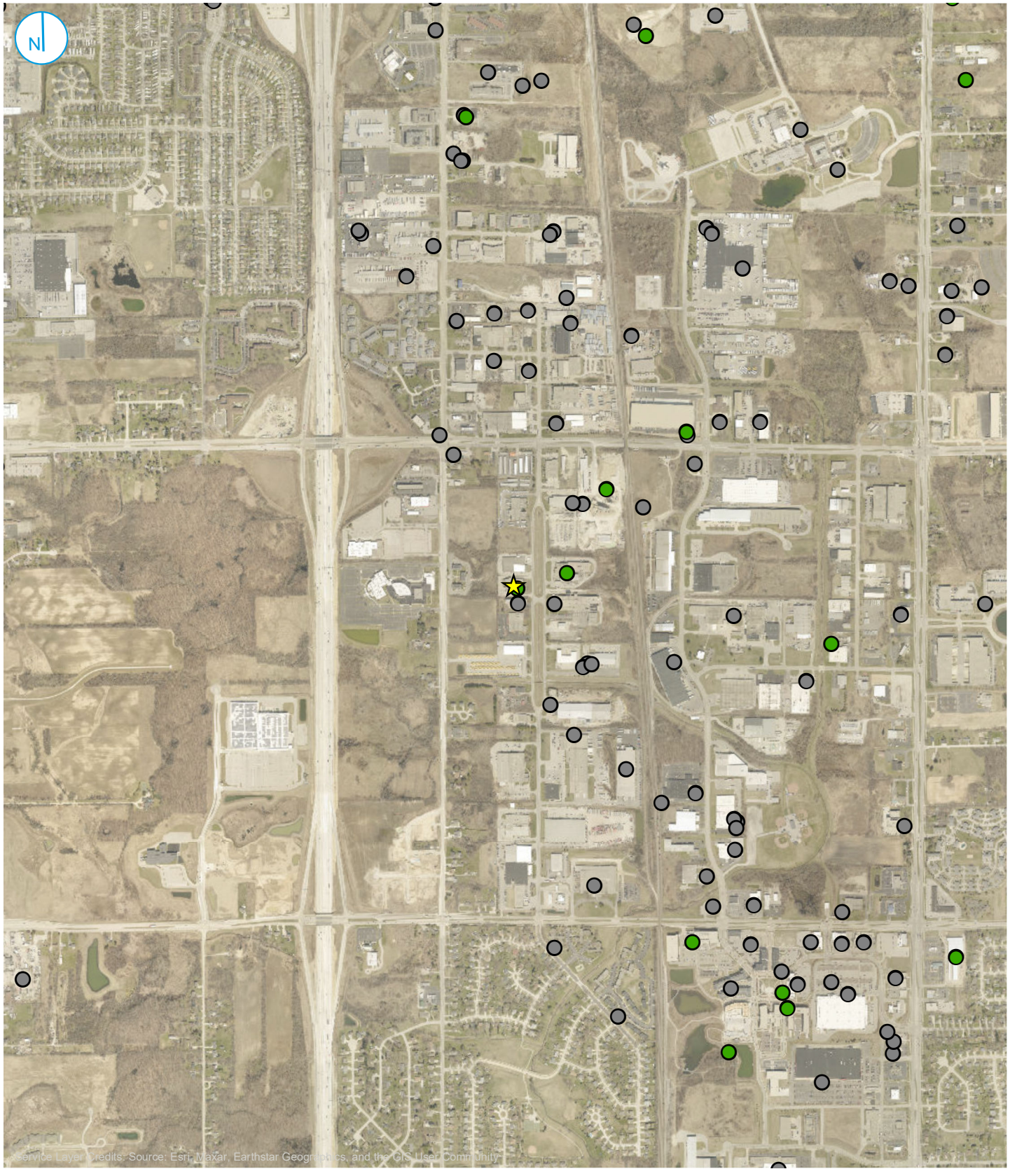
SITE LAYOUT/SOIL BORING AND MONITORING WELL LOCATIONS

DIC IMAGING PRODUCTS US INC
LIQUID COMPOUNDS FACILITY
7335 SOUTH 10TH STREET
OAK CREEK, WISCONSIN

FIGURE 02

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



Y:\Mapping\Projects\7\71849\mxd\SWIP\Figure 3_BRRTS_SitesMap.mxd

PROJECT: 1690021164 | DATED: 6/30/2022 | DESIGNER: CHURCHKE

SITE LOCATION

REMEDIATION - OPEN SITE LOCATION

REMEDIATION - CLOSE SITE LOCATION

0 750 1,500 Feet

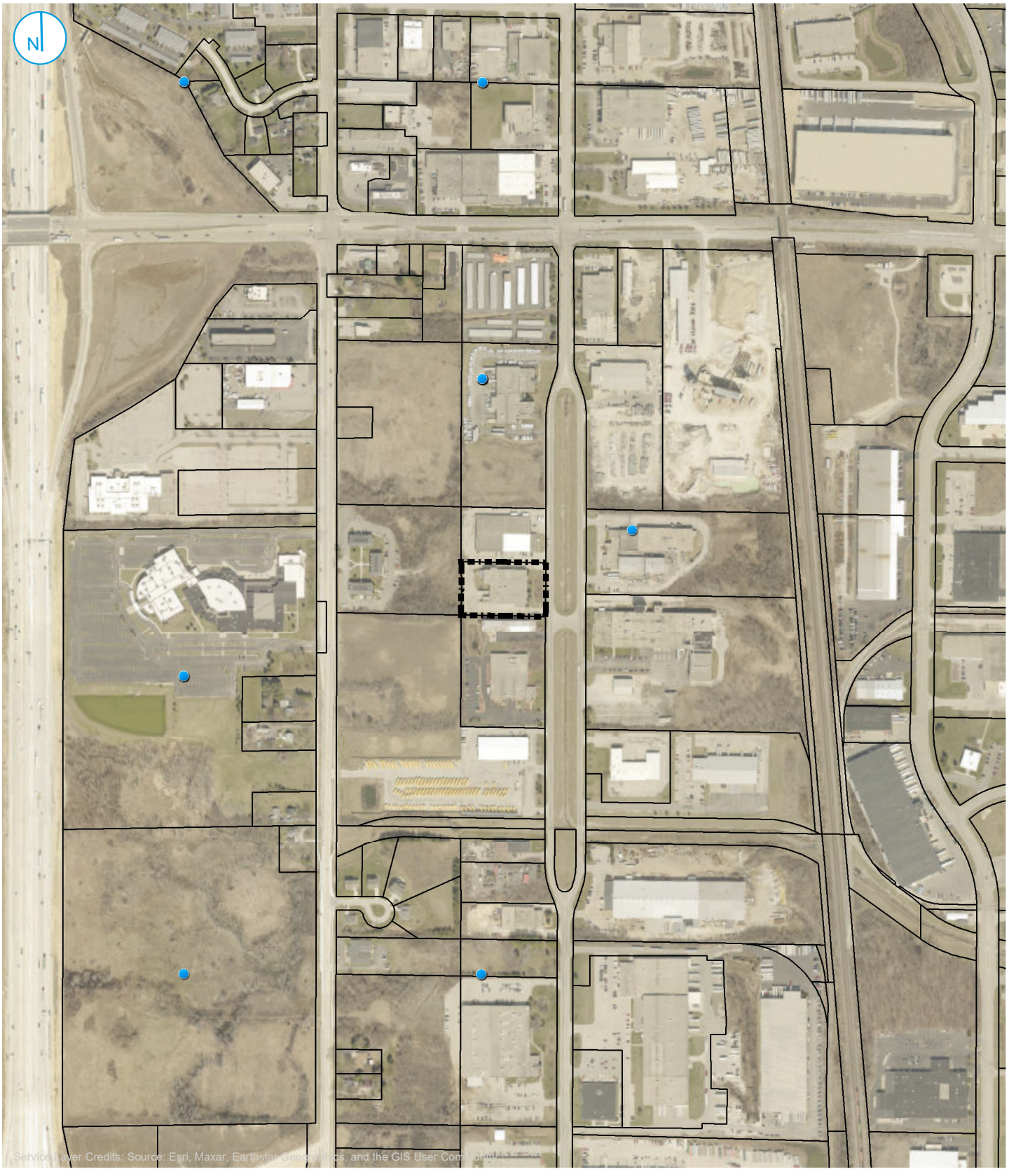
BRRTS SITES MAP

DIC IMAGING PRODUCTS US INC
LIQUID COMPOUNDS FACILITY
7335 SOUTH 10TH STREET
OAK CREEK, WISCONSIN

FIGURE 03

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



WATER SUPPLY WELL LOCATION
SITE BOUNDARY
PARCEL BOUNDARY

0 300 600 Feet

WATER SUPPLY WELL LOCATION MAP

DIC IMAGING PRODUCTS US INC
LIQUID COMPOUNDS FACILITY
7335 SOUTH 10TH STREET
OAK CREEK, WISCONSIN

FIGURE 04

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Appendix A
Soil boring logs

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

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

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
DIC Liquid Facility	1690021164	SB-1

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tony Kapugi Onsite Environmental Services, Inc.	7/14/2021	7/14/2021	DP/HSA Overdrill

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW-1	Feet MSL	723.0 Feet MSL	4.3 inches

Local Grid Origin ☒ (estimated: ☐) or Boring Location ☐
State Plane N, E Ⓢ/C/N
SE 1/4 of NW 1/4 of Section 8, T 5 N, R 22 E
Lat ° ' "
Long ° ' "
Local Grid Location ☒ N ☒ E
339242 Feet ☐ S 2523421 Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Milwaukee	41	Oak Creek

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 60		1	**TOPSOIL,** silt, some clay, trace roots and grass, brown (10YR 4/3), stiff, dry.				0.1						Soil Sample (0-0.5')
			2	**SILTY CLAY,** trace fine grained gravel, yellowish brown (10YR 5/4), stiff, dry to slightly moist.				0.1						
			3					0.1						
			4					0.1						
2 CS	60 60		5		CL-ML			0.0						
			6					0.0						
			7					0.0						
			8					0.0						
			9					0.1						
			10					0.0						
3 CS	60 60		11	**SAME AS ABOVE,** dark grayish brown (10YR 4/2).										
			12					0.0						
			13		CL-ML									
			14					0.0						
			15	End of boring at 15 ft bgs.										

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

Signature	Firm	Tel:
	Ramboll 234 W. Florida Street, 5th Floor Milwaukee, WI 53204	262-901-2722 Fax:

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

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

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
DIC Liquid Facility	1690021164	SB-2

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tony Kapugi Onsite Environmental Services, Inc.	7/14/2021	7/14/2021	DP/HSA Overdrill

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW-2	Feet MSL	722.5 Feet MSL	4.3 inches

Local Grid Origin ☒ (estimated: ☐) or Boring Location ☐
State Plane N, E Ⓢ/C/N
SE 1/4 of NW 1/4 of Section 8, T 5 N, R 22 E
Lat ° ' "
Long ° ' "
Local Grid Location ☒ N ☒ E
339313 Feet ☐ S 2523589 Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Milwaukee	41	Oak Creek

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 36		1	**ASPHALT.** **BASECOARSE,** well-graded angular gravel, gray, loose, moist.	FILL			0.0						
			2	**FILL:** Silty clay with basecoarse gravel, dark grayish brown (10YR 4/2), stiff, moist.	FILL									
			3	**SILTY CLAY,** trace fine to medium grained gravel, brown (10YR 4/3), stiff, moist.	CL-ML			0.0						
			4											
			5					0.1						
2 CS	60 48		6	**SAME AS ABOVE,** dark grayish brown (10YR 4/2).	CL-ML									
			7					0.0						
			8					0.0						
			9	**SILT,** yellowish brown (10YR 5/8), stiff, moist. **SILTY CLAY,** dark yellowish brown (10YR 4/6), stiff, moist.	ML CL-ML			0.0						Soil Sample (8-9')
3 CS	60 60		10	**SAND,** fine to coarse grained, dark yellowish brown (10YR 4/6), loose, wet to moist, (possible sluff from above).	SW			0.0						
			11	**SILTY CLAY,** dark yellowish brown (10YR 4/6), stiff, moist.	CL-ML									
			12	**SAME AS ABOVE,** dark grayish brown (10YR 4/2).	CL-ML			0.0						
			13											
			14											
			15	End of boring at 15 ft bgs.										

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

Signature	Firm	Tel:
Tiffany Bork	Ramboll 234 W. Florida Street, 5th Floor Milwaukee, WI 53204	262-901-2722 Fax:

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

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

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
DIC Liquid Facility	1690021164	SB-3

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tony Kapugi Onsite Environmental Services, Inc.	7/14/2021	7/14/2021	DP/HSA Overdrill

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW-3	Feet MSL	720.8 Feet MSL	4.3 inches

Local Grid Origin ☒ (estimated: ☐) or Boring Location ☐
State Plane N, E Ⓢ/C/N
SE 1/4 of NW 1/4 of Section 8, T 5 N, R 22 E
Lat ° ' "
Long ° ' "
Local Grid Location ☒ N ☒ E
339255 Feet ☐ S 2523661 Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Milwaukee	41	Oak Creek

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 40		1	**TOPSOIL,** silty clay with roots and grass, brown (10YR 4/3), stiff, dry.				0.0						
			2	**SILTY CLAY,** trace roots, very dark grayish brown (10YR 3/2), stiff, moist.				0.1						
			3		CL-ML			0.1						Soil Sample (3-4')
			4					0.1						
2 CS	60 60		5	**SILTY CLAY,** dark gray (10YR 4/1), stiff, moist.	CL-ML			0.0						
			6	**SAME AS ABOVE,** pale brown (10YR 6/3).	CL-ML			0.0						
			7	**SAME AS ABOVE,** yellowish brown (10YR 5/4), sand seam at 9.5 ft bgs.				0.0						
			8		CL-ML			0.0						
			9											
3 CS	60 30		10	**SAME AS ABOVE,** dark grayish brown (10YR 4/2).				0.0						
			11											
			12					0.0						
			13		CL-ML									
			14											
			15	End of boring at 15 ft bgs.										

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

Signature	Firm	Tel:
	Ramboll 234 W. Florida Street, 5th Floor Milwaukee, WI 53204	262-901-2722 Fax:

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

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

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
DIC Liquid Facility	1690021164	SB-4

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tony Kapugi Onsite Environmental Services, Inc.	7/14/2021	7/14/2021	DP/HSA Overdrill

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW-4	Feet MSL	722.7 Feet MSL	4.3 inches

Local Grid Origin ☒ (estimated: ☐) or Boring Location ☐
State Plane N, E Ⓢ/C/N
SE 1/4 of NW 1/4 of Section 8, T 5 N, R 22 E
Lat ° ' "
Long ° ' "
Local Grid Location ☒ N ☒ E
339118 Feet ☐ S 2523549 Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Milwaukee	41	Oak Creek

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 48		1	**ASPHALT.**										
				BASECOARSE, well-graded angular gravel with silt, gray, loose, moist.	FILL			0.0						
			2	**FILL:** Silty clay, trace roots, brown (10YR 4/3), stiff, moist.	FILL			0.0						
				BASECOARSE, well-graded angular gravel.	FILL			0.0						
			3	**SILTY CLAY,** trace roots, dark grayish brown (10YR 4/2), stiff, moist.				0.0						
			4					0.0						
2 CS	60 60		5					0.0						
			6		CL-ML			0.0						
			7					0.0						Soil Sample and Duplicate Soil Sample (7-9')
			8					0.0						
			9					0.0						
3 CS	60 60		10	**SAME AS ABOVE,** dark gray (10YR 4/1).				0.0						
			11					0.0						
			12		CL-ML			0.0						
			13					0.0						
			14											
			15	End of boring at 15 ft bgs.										

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

Signature	Firm	
Liz Bardi	Ramboll 234 W. Florida Street, 5th Floor Milwaukee, WI 53204	Tel: 262-901-2722 Fax:

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

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

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
DIC Liquid Facility	1690021164	SED-COMP

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Liz Borucki Ramboll US Consulting, Inc.	7/14/2021	7/14/2021	Grab Sample

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		NA	Feet MSL	Feet MSL	inches

Local Grid Origin ☒ (estimated: ☐) or Boring Location ☐
State Plane N, E S/C/N
SE 1/4 of NW 1/4 of Section 8, T 5 N, R 22 E
Lat ° ' "
Long ° ' "
Local Grid Location ☐ N Feet ☐ S ☐ E Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Milwaukee	41	Oak Creek

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 GB	6 6			Material composed of dark brown, saturated organics, roots, and reed material.										Composite sample obtained from material collected from the upper 6-inches at three discrete locations within the stormwater catch basin.

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

Signature	Firm	Tel:
Liz Borucki	Ramboll 234 W. Florida Street, 5th Floor Milwaukee, WI 53204	262-901-2722 Fax:

Appendix B
Analytical laboratory results

eurofins | Environment Testing America

ANALYTICAL REPORT

Eurofins TestAmerica, Sacramento
880 Riverside Parkway
West Sacramento, CA 95605
Tel: (916)373-5600

Laboratory Job ID: 320-76907-1
Client Project/Site: DIC Liquid Facility - Oak Creek 1690021164
Revision: 1

For:
Ramboll US Corporation
5050 Lincoln Drive, Suite 440
Edina, Minnesota 55436

Attn: Abby Small

Authorized for release by:
8/17/2021 11:38:59 AM

Sandie Fredrick, Project Manager II
(920)261-1660
sandra.fredrick@eurofinset.com

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Definitions/Glossary

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Qualifiers

LCMS

Qualifier	Qualifier Description
*5+	Isotope dilution analyte is outside acceptance limits, high biased.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Job ID: 320-76907-1

Laboratory: Eurofins TestAmerica, Sacramento

Narrative

Job Narrative
320-76907-1

Comments
No additional comments.

Receipt
The samples were received on 7/29/2021 9:30 AM. Unless otherwise noted below, the samples arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 3.1º C.

Receipt Exceptions
Client updated analyte list for PFAS testing

LCMS
Method 537 (modified): The "I" qualifier means the transition mass ratio for the indicated analyte was outside of the established ratio limit. The qualitative identification of the analyte has some degree of uncertainty, and the reported value may have some high bias. However, analyst judgment was used to positively identify the analyte Perfluorohexanoic acid (PFHxA), which recovered within the established limit. (CCVL 320-512174/2)

Method 537 (modified): Isotope Dilution Analyte (IDA) recovery is above the method recommended limit for the following samples: MW-2 (320-76907-2). The samples were re-analyzed with concurring results. Quantitation by isotope dilution generally precludes any adverse effect on data quality due to elevated IDA recoveries.

Method 537 (modified): The transition mass ion ratio was outside of the established limits for 6:2 FTS in (CCVL 320-513215/2) associated to this data set. This is indicated by the "I" flag in the raw data. As the flagged analyte is in control in the CCV, there is no adverse impact to the data.

Method 537 (modified): Results for samples MW-2 (320-76907-2), MW-1 (320-76907-3) and MW-2 DUP (320-76907-4) were reported from the analysis of a diluted extract due to high concentration of the matrix in the analysis of the undiluted extract. The dilution factor was applied to the labeled internal standard area counts and these area counts were within acceptance limits.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Organic Prep
Method 3535: Insufficient sample volume was available to perform a matrix spike/matrix spike duplicate (MS/MSD) associated with preparation batch 320-512164. PFC_IDA_WI Water

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Detection Summary

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Client Sample ID: MW-3 — Lab Sample ID: 320-76907-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Perfluorobutanoic acid (PFBA)	26		4.6	2.2	ng/L	1		537 (modified)	Total/NA
Perfluoropentanoic acid (PFPeA)	32		1.8	0.45	ng/L	1		537 (modified)	Total/NA
Perfluorohexanoic acid (PFHxA)	4.5		1.8	0.53	ng/L	1		537 (modified)	Total/NA
Perfluoroheptanoic acid (PFHpA)	1.4	J	1.8	0.23	ng/L	1		537 (modified)	Total/NA
Perfluorooctanoic acid (PFOA)	1.4	J	1.8	0.78	ng/L	1		537 (modified)	Total/NA
Perfluorobutanesulfonic acid (PFBS)	0.32	J	1.8	0.18	ng/L	1		537 (modified)	Total/NA

Client Sample ID: MW-2 — Lab Sample ID: 320-76907-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Perfluorobutanoic acid (PFBA)	250		4.5	2.2	ng/L	1		537 (modified)	Total/NA
Perfluorohexanoic acid (PFHxA)	240		1.8	0.52	ng/L	1		537 (modified)	Total/NA
Perfluoroheptanoic acid (PFHpA)	11		1.8	0.23	ng/L	1		537 (modified)	Total/NA
Perfluorooctanoic acid (PFOA)	1.0	J	1.8	0.77	ng/L	1		537 (modified)	Total/NA
Perfluorobutanesulfonic acid (PFBS)	0.44	J	1.8	0.18	ng/L	1		537 (modified)	Total/NA
4:2 FTS	5.3		1.8	0.22	ng/L	1		537 (modified)	Total/NA
6:2 FTS	31		4.5	2.3	ng/L	1		537 (modified)	Total/NA
Perfluoropentanoic acid (PFPeA) - DL	900		9.0	2.2	ng/L	5		537 (modified)	Total/NA

Client Sample ID: MW-1 — Lab Sample ID: 320-76907-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Perfluorooctanoic acid (PFOA)	180		1.8	0.77	ng/L	1		537 (modified)	Total/NA
Perfluorononanoic acid (PFNA)	9.7		1.8	0.24	ng/L	1		537 (modified)	Total/NA
Perfluorobutanesulfonic acid (PFBS)	0.83	J	1.8	0.18	ng/L	1		537 (modified)	Total/NA
Perfluorohexanesulfonic acid (PFHxS)	0.58	J	1.8	0.52	ng/L	1		537 (modified)	Total/NA
4:2 FTS	50		1.8	0.22	ng/L	1		537 (modified)	Total/NA
8:2 FTS	1.4	J	1.8	0.42	ng/L	1		537 (modified)	Total/NA
Perfluorobutanoic acid (PFBA) - DL	1800		450	220	ng/L	100		537 (modified)	Total/NA
Perfluoropentanoic acid (PFPeA) - DL	12000		180	44	ng/L	100		537 (modified)	Total/NA
Perfluorohexanoic acid (PFHxA) - DL	7600		180	52	ng/L	100		537 (modified)	Total/NA
Perfluoroheptanoic acid (PFHpA) - DL	980		180	23	ng/L	100		537 (modified)	Total/NA
6:2 FTS - DL	2400		450	230	ng/L	100		537 (modified)	Total/NA

Client Sample ID: MW-2 DUP — Lab Sample ID: 320-76907-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Perfluorobutanoic acid (PFBA)	300		4.5	2.2	ng/L	1		537 (modified)	Total/NA
Perfluorohexanoic acid (PFHxA)	300		1.8	0.52	ng/L	1		537 (modified)	Total/NA
Perfluoroheptanoic acid (PFHpA)	13		1.8	0.23	ng/L	1		537 (modified)	Total/NA
Perfluorooctanoic acid (PFOA)	1.5	J	1.8	0.77	ng/L	1		537 (modified)	Total/NA
Perfluorobutanesulfonic acid (PFBS)	0.65	J	1.8	0.18	ng/L	1		537 (modified)	Total/NA
4:2 FTS	9.1		1.8	0.22	ng/L	1		537 (modified)	Total/NA
6:2 FTS	35		4.5	2.3	ng/L	1		537 (modified)	Total/NA
Perfluoropentanoic acid (PFPeA) - DL	1000		9.0	2.2	ng/L	5		537 (modified)	Total/NA

Client Sample ID: FB-1 — Lab Sample ID: 320-76907-5

No Detections.

Client Sample ID: EB-1 — Lab Sample ID: 320-76907-6

No Detections.

This Detection Summary does not include radiochemical test results.

Eurofins TestAmerica, Sacramento

Client: Ramboll US Corporation
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Job ID: 320-76907-1

Client Sample ID: MW-3
Date Collected: 07/28/21 09:10
Date Received: 07/29/21 09:30

Lab Sample ID: 320-76907-1
Matrix: Water

Method: 537 (modified) - Fluorinated Alkyl Substances

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**26**		4.6	2.2	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluoropentanoic acid (PFPeA)	**32**		1.8	0.45	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluorohexanoic acid (PFHxA)	**4.5**		1.8	0.53	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluoroheptanoic acid (PFHpA)	**1.4**	**J**	1.8	0.23	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluorooctanoic acid (PFOA)	**1.4**	**J**	1.8	0.78	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluorononanoic acid (PFNA)	<0.25		1.8	0.25	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluorodecanoic acid (PFDA)	<0.28		1.8	0.28	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluoroundecanoic acid (PFUnA)	<1.0		1.8	1.0	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluorododecanoic acid (PFDoA)	<0.50		1.8	0.50	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluorotridecanoic acid (PFTriA)	<1.2		1.8	1.2	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluorotetradecanoic acid (PFTeA)	<0.67		1.8	0.67	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluorobutanesulfonic acid (PFBS)	**0.32**	**J**	1.8	0.18	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluoropentanesulfonic acid (PFPeS)	<0.27		1.8	0.27	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluorohexanesulfonic acid (PFHxS)	<0.52		1.8	0.52	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.17		1.8	0.17	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluorooctanesulfonic acid (PFOS)	<0.49		1.8	0.49	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluorononanesulfonic acid (PFNS)	<0.34		1.8	0.34	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluorodecanesulfonic acid (PFDS)	<0.29		1.8	0.29	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluorododecanesulfonic acid (PFDoS)	<0.89		1.8	0.89	ng/L		08/02/21 04:28	08/03/21 15:55	1
Perfluorooctanesulfonamide (FOSA)	<0.90		1.8	0.90	ng/L		08/02/21 04:28	08/03/21 15:55	1
NEtFOSA	<0.80		1.8	0.80	ng/L		08/02/21 04:28	08/03/21 15:55	1
NMeFOSA	<0.39		1.8	0.39	ng/L		08/02/21 04:28	08/03/21 15:55	1
NMeFOSAA	<1.1		4.6	1.1	ng/L		08/02/21 04:28	08/03/21 15:55	1
NEtFOSAA	<1.2		4.6	1.2	ng/L		08/02/21 04:28	08/03/21 15:55	1
NMeFOSE	<1.3		3.7	1.3	ng/L		08/02/21 04:28	08/03/21 15:55	1
NEtFOSE	<0.78		1.8	0.78	ng/L		08/02/21 04:28	08/03/21 15:55	1
4:2 FTS	<0.22		1.8	0.22	ng/L		08/02/21 04:28	08/03/21 15:55	1
6:2 FTS	<2.3		4.6	2.3	ng/L		08/02/21 04:28	08/03/21 15:55	1
8:2 FTS	<0.42		1.8	0.42	ng/L		08/02/21 04:28	08/03/21 15:55	1
DONA	<0.37		1.8	0.37	ng/L		08/02/21 04:28	08/03/21 15:55	1
HFPO-DA (GenX)	<1.4		3.7	1.4	ng/L		08/02/21 04:28	08/03/21 15:55	1
F-53B Major	<0.22		1.8	0.22	ng/L		08/02/21 04:28	08/03/21 15:55	1
F-53B Minor	<0.29		1.8	0.29	ng/L		08/02/21 04:28	08/03/21 15:55	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*82*		*25 - 150*	*08/02/21 04:28*	*08/03/21 15:55*	*1*
13C5 PFPeA	*57*		*25 - 150*	*08/02/21 04:28*	*08/03/21 15:55*	*1*
13C2 PFHxA	*112*		*25 - 150*	*08/02/21 04:28*	*08/03/21 15:55*	*1*
13C4 PFHpA	*86*		*25 - 150*	*08/02/21 04:28*	*08/03/21 15:55*	*1*
13C4 PFOA	*102*		*25 - 150*	*08/02/21 04:28*	*08/03/21 15:55*	*1*
13C5 PFNA	*107*		*25 - 150*	*08/02/21 04:28*	*08/03/21 15:55*	*1*
13C2 PFDA	*127*		*25 - 150*	*08/02/21 04:28*	*08/03/21 15:55*	*1*
13C2 PFUnA	*123*		*25 - 150*	*08/02/21 04:28*	*08/03/21 15:55*	*1*
13C2 PFDoA	*109*		*25 - 150*	*08/02/21 04:28*	*08/03/21 15:55*	*1*
13C2 PFTeDA	*109*		*25 - 150*	*08/02/21 04:28*	*08/03/21 15:55*	*1*
13C3 PFBS	*87*		*25 - 150*	*08/02/21 04:28*	*08/03/21 15:55*	*1*
18O2 PFHxS	*101*		*25 - 150*	*08/02/21 04:28*	*08/03/21 15:55*	*1*

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Client Sample ID: MW-3
Lab Sample ID: 320-76907-1
Date Collected: 07/28/21 09:10
Matrix: Water
Date Received: 07/29/21 09:30

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFOS	120		25 - 150	08/02/21 04:28	08/03/21 15:55	1
13C8 FOSA	119		10 - 150	08/02/21 04:28	08/03/21 15:55	1
d3-NMeFOSAA	111		25 - 150	08/02/21 04:28	08/03/21 15:55	1
d5-NEtFOSAA	106		25 - 150	08/02/21 04:28	08/03/21 15:55	1
d-N-MeFOSA-M	104		10 - 150	08/02/21 04:28	08/03/21 15:55	1
d-N-EtFOSA-M	104		10 - 150	08/02/21 04:28	08/03/21 15:55	1
d7-N-MeFOSE-M	97		10 - 150	08/02/21 04:28	08/03/21 15:55	1
d9-N-EtFOSE-M	91		10 - 150	08/02/21 04:28	08/03/21 15:55	1
M2-4:2 FTS	137		25 - 150	08/02/21 04:28	08/03/21 15:55	1
M2-6:2 FTS	135		25 - 150	08/02/21 04:28	08/03/21 15:55	1
M2-8:2 FTS	144		25 - 150	08/02/21 04:28	08/03/21 15:55	1
13C3 HFPO-DA	89		25 - 150	08/02/21 04:28	08/03/21 15:55	1
13C2 10:2 FTS	141		25 - 150	08/02/21 04:28	08/03/21 15:55	1

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Client Sample ID: MW-2
Lab Sample ID: 320-76907-2
Date Collected: 07/28/21 10:00
Matrix: Water
Date Received: 07/29/21 09:30

Method: 537 (modified) - Fluorinated Alkyl Substances

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**250**		4.5	2.2	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluorohexanoic acid (PFHxA)	**240**		1.8	0.52	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluoroheptanoic acid (PFHpA)	**11**		1.8	0.23	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluorooctanoic acid (PFOA)	**1.0**	**J**	1.8	0.77	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluorononanoic acid (PFNA)	<0.24		1.8	0.24	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluoroundecanoic acid (PFUnA)	<0.99		1.8	0.99	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluorododecanoic acid (PFDoA)	<0.50		1.8	0.50	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluorotridecanoic acid (PFTriA)	<1.2		1.8	1.2	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluorotetradecanoic acid (PFTeA)	<0.66		1.8	0.66	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluorobutanesulfonic acid (PFBS)	**0.44**	**J**	1.8	0.18	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluoropentanesulfonic acid (PFPeS)	<0.27		1.8	0.27	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluorohexanesulfonic acid (PFHxS)	<0.51		1.8	0.51	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.17		1.8	0.17	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluorooctanesulfonic acid (PFOS)	<0.49		1.8	0.49	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluorononanesulfonic acid (PFNS)	<0.33		1.8	0.33	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluorodecanesulfonic acid (PFDS)	<0.29		1.8	0.29	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluorododecanesulfonic acid (PFDoS)	<0.87		1.8	0.87	ng/L		08/02/21 04:28	08/03/21 16:04	1
Perfluorooctanesulfonamide (FOSA)	<0.88		1.8	0.88	ng/L		08/02/21 04:28	08/03/21 16:04	1
NEtFOSA	<0.78		1.8	0.78	ng/L		08/02/21 04:28	08/03/21 16:04	1
NMeFOSA	<0.39		1.8	0.39	ng/L		08/02/21 04:28	08/03/21 16:04	1
NMeFOSAA	<1.1		4.5	1.1	ng/L		08/02/21 04:28	08/03/21 16:04	1
NEtFOSAA	<1.2		4.5	1.2	ng/L		08/02/21 04:28	08/03/21 16:04	1
NMeFOSE	<1.3		3.6	1.3	ng/L		08/02/21 04:28	08/03/21 16:04	1
NEtFOSE	<0.77		1.8	0.77	ng/L		08/02/21 04:28	08/03/21 16:04	1
4:2 FTS	**5.3**		1.8	0.22	ng/L		08/02/21 04:28	08/03/21 16:04	1
6:2 FTS	**31**		4.5	2.3	ng/L		08/02/21 04:28	08/03/21 16:04	1
8:2 FTS	<0.41		1.8	0.41	ng/L		08/02/21 04:28	08/03/21 16:04	1
DONA	<0.36		1.8	0.36	ng/L		08/02/21 04:28	08/03/21 16:04	1
HFPO-DA (GenX)	<1.4		3.6	1.4	ng/L		08/02/21 04:28	08/03/21 16:04	1
F-53B Major	<0.22		1.8	0.22	ng/L		08/02/21 04:28	08/03/21 16:04	1
F-53B Minor	<0.29		1.8	0.29	ng/L		08/02/21 04:28	08/03/21 16:04	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*96*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:04*	*1*
13C2 PFHxA	*137*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:04*	*1*
13C4 PFHpA	*110*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:04*	*1*
13C4 PFOA	*127*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:04*	*1*
13C5 PFNA	*121*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:04*	*1*
13C2 PFUnA	*154*	**5+*	*25 - 150*	*08/02/21 04:28*	*08/03/21 16:04*	*1*
13C2 PFDoA	*142*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:04*	*1*
13C2 PFTeDA	*146*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:04*	*1*
13C3 PFBS	*114*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:04*	*1*
18O2 PFHxS	*128*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:04*	*1*
13C4 PFOS	*161*	**5+*	*25 - 150*	*08/02/21 04:28*	*08/03/21 16:04*	*1*
13C8 FOSA	*150*		*10 - 150*	*08/02/21 04:28*	*08/03/21 16:04*	*1*
d3-NMeFOSAA	*131*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:04*	*1*
d5-NEtFOSAA	*137*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:04*	*1*

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Client Sample ID: MW-2
Lab Sample ID: 320-76907-2
Date Collected: 07/28/21 10:00
Matrix: Water
Date Received: 07/29/21 09:30

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
d-N-MeFOSA-M	144		10 - 150	08/02/21 04:28	08/03/21 16:04	1
d-N-EtFOSA-M	133		10 - 150	08/02/21 04:28	08/03/21 16:04	1
d7-N-MeFOSE-M	111		10 - 150	08/02/21 04:28	08/03/21 16:04	1
d9-N-EtFOSE-M	109		10 - 150	08/02/21 04:28	08/03/21 16:04	1
M2-4:2 FTS	139		25 - 150	08/02/21 04:28	08/03/21 16:04	1
M2-6:2 FTS	129		25 - 150	08/02/21 04:28	08/03/21 16:04	1
M2-8:2 FTS	170	*5+	25 - 150	08/02/21 04:28	08/03/21 16:04	1
13C3 HFPO-DA	108		25 - 150	08/02/21 04:28	08/03/21 16:04	1
13C2 10:2 FTS	169	*5+	25 - 150	08/02/21 04:28	08/03/21 16:04	1

Method: 537 (modified) - Fluorinated Alkyl Substances - DL

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoropentanoic acid (PFPeA)	**900**		9.0	2.2	ng/L		08/02/21 04:28	08/05/21 09:17	5
Perfluorodecanoic acid (PFDA)	<1.4		9.0	1.4	ng/L		08/02/21 04:28	08/05/21 09:17	5

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C5 PFPeA	92		25 - 150	08/02/21 04:28	08/05/21 09:17	5
13C2 PFDA	149		25 - 150	08/02/21 04:28	08/05/21 09:17	5

Client Sample ID: MW-1
Date Collected: 07/28/21 10:55
Date Received: 07/29/21 09:30

Lab Sample ID: 320-76907-3
Matrix: Water

Method: 537 (modified) - Fluorinated Alkyl Substances

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorooctanoic acid (PFOA)	**180**		1.8	0.77	ng/L		08/02/21 04:28	08/03/21 16:14	1
Perfluorononanoic acid (PFNA)	**9.7**		1.8	0.24	ng/L		08/02/21 04:28	08/03/21 16:14	1
Perfluorodecanoic acid (PFDA)	<0.28		1.8	0.28	ng/L		08/02/21 04:28	08/03/21 16:14	1
Perfluoroundecanoic acid (PFUnA)	<0.99		1.8	0.99	ng/L		08/02/21 04:28	08/03/21 16:14	1
Perfluorododecanoic acid (PFDoA)	<0.50		1.8	0.50	ng/L		08/02/21 04:28	08/03/21 16:14	1
Perfluorotridecanoic acid (PFTriA)	<1.2		1.8	1.2	ng/L		08/02/21 04:28	08/03/21 16:14	1
Perfluorotetradecanoic acid (PFTeA)	<0.66		1.8	0.66	ng/L		08/02/21 04:28	08/03/21 16:14	1
Perfluorobutanesulfonic acid (PFBS)	**0.83**	**J**	1.8	0.18	ng/L		08/02/21 04:28	08/03/21 16:14	1
Perfluoropentanesulfonic acid (PFPeS)	<0.27		1.8	0.27	ng/L		08/02/21 04:28	08/03/21 16:14	1
Perfluorohexanesulfonic acid (PFHxS)	**0.58**	**J**	1.8	0.52	ng/L		08/02/21 04:28	08/03/21 16:14	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.17		1.8	0.17	ng/L		08/02/21 04:28	08/03/21 16:14	1
Perfluorooctanesulfonic acid (PFOS)	<0.49		1.8	0.49	ng/L		08/02/21 04:28	08/03/21 16:14	1
Perfluorononanesulfonic acid (PFNS)	<0.33		1.8	0.33	ng/L		08/02/21 04:28	08/03/21 16:14	1
Perfluorodecanesulfonic acid (PFDS)	<0.29		1.8	0.29	ng/L		08/02/21 04:28	08/03/21 16:14	1
Perfluorododecanesulfonic acid (PFDoS)	<0.88		1.8	0.88	ng/L		08/02/21 04:28	08/03/21 16:14	1
Perfluorooctanesulfonamide (FOSA)	<0.89		1.8	0.89	ng/L		08/02/21 04:28	08/03/21 16:14	1
NEtFOSA	<0.79		1.8	0.79	ng/L		08/02/21 04:28	08/03/21 16:14	1
NMeFOSA	<0.39		1.8	0.39	ng/L		08/02/21 04:28	08/03/21 16:14	1
NMeFOSAA	<1.1		4.5	1.1	ng/L		08/02/21 04:28	08/03/21 16:14	1
NEtFOSAA	<1.2		4.5	1.2	ng/L		08/02/21 04:28	08/03/21 16:14	1
NMeFOSE	<1.3		3.6	1.3	ng/L		08/02/21 04:28	08/03/21 16:14	1
NEtFOSE	<0.77		1.8	0.77	ng/L		08/02/21 04:28	08/03/21 16:14	1
4:2 FTS	**50**		1.8	0.22	ng/L		08/02/21 04:28	08/03/21 16:14	1
8:2 FTS	**1.4**	**J**	1.8	0.42	ng/L		08/02/21 04:28	08/03/21 16:14	1
DONA	<0.36		1.8	0.36	ng/L		08/02/21 04:28	08/03/21 16:14	1
HFPO-DA (GenX)	<1.4		3.6	1.4	ng/L		08/02/21 04:28	08/03/21 16:14	1
F-53B Major	<0.22		1.8	0.22	ng/L		08/02/21 04:28	08/03/21 16:14	1
F-53B Minor	<0.29		1.8	0.29	ng/L		08/02/21 04:28	08/03/21 16:14	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFOA	*106*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
13C5 PFNA	*112*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
13C2 PFDA	*134*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
13C2 PFUnA	*134*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
13C2 PFDoA	*124*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
13C2 PFTeDA	*127*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
13C3 PFBS	*89*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
18O2 PFHxS	*110*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
13C4 PFOS	*128*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
13C8 FOSA	*140*		*10 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
d3-NMeFOSAA	*109*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
d5-NEtFOSAA	*116*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
d-N-MeFOSA-M	*126*		*10 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
d-N-EtFOSA-M	*118*		*10 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
d7-N-MeFOSE-M	*99*		*10 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
d9-N-EtFOSE-M	*103*		*10 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Client Sample ID: MW-1
Lab Sample ID: 320-76907-3
Date Collected: 07/28/21 10:55
Matrix: Water
Date Received: 07/29/21 09:30

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
M2-4:2 FTS	*71*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
M2-8:2 FTS	*144*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
13C3 HFPO-DA	*97*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*
13C2 10:2 FTS	*144*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:14*	*1*

Method: 537 (modified) - Fluorinated Alkyl Substances - DL

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**1800**		450	220	ng/L		08/02/21 04:28	08/05/21 09:36	100
Perfluoropentanoic acid (PFPeA)	**12000**		180	44	ng/L		08/02/21 04:28	08/05/21 09:36	100
Perfluorohexanoic acid (PFHxA)	**7600**		180	52	ng/L		08/02/21 04:28	08/05/21 09:36	100
Perfluoroheptanoic acid (PFHpA)	**980**		180	23	ng/L		08/02/21 04:28	08/05/21 09:36	100
6:2 FTS	**2400**		450	230	ng/L		08/02/21 04:28	08/05/21 09:36	100

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*94*		*25 - 150*	*08/02/21 04:28*	*08/05/21 09:36*	*100*
13C5 PFPeA	*96*		*25 - 150*	*08/02/21 04:28*	*08/05/21 09:36*	*100*
13C2 PFHxA	*113*		*25 - 150*	*08/02/21 04:28*	*08/05/21 09:36*	*100*
13C4 PFHpA	*96*		*25 - 150*	*08/02/21 04:28*	*08/05/21 09:36*	*100*
M2-6:2 FTS	*124*		*25 - 150*	*08/02/21 04:28*	*08/05/21 09:36*	*100*

Client: Ramboll US Corporation
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Job ID: 320-76907-1

Client Sample ID: MW-2 DUP

Date Collected: 07/28/21 10:00
Date Received: 07/29/21 09:30

Lab Sample ID: 320-76907-4

Matrix: Water

Method: 537 (modified) - Fluorinated Alkyl Substances

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**300**		4.5	2.2	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluorohexanoic acid (PFHxA)	**300**		1.8	0.52	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluoroheptanoic acid (PFHpA)	**13**		1.8	0.23	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluorooctanoic acid (PFOA)	**1.5**	**J**	1.8	0.77	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluorononanoic acid (PFNA)	<0.24		1.8	0.24	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluoroundecanoic acid (PFUnA)	<0.99		1.8	0.99	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluorododecanoic acid (PFDoA)	<0.50		1.8	0.50	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluorotridecanoic acid (PFTriA)	<1.2		1.8	1.2	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluorotetradecanoic acid (PFTeA)	<0.66		1.8	0.66	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluorobutanesulfonic acid (PFBS)	**0.65**	**J**	1.8	0.18	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluoropentanesulfonic acid (PFPeS)	<0.27		1.8	0.27	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluorohexanesulfonic acid (PFHxS)	<0.51		1.8	0.51	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.17		1.8	0.17	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluorooctanesulfonic acid (PFOS)	<0.49		1.8	0.49	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluorononanesulfonic acid (PFNS)	<0.33		1.8	0.33	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluorodecanesulfonic acid (PFDS)	<0.29		1.8	0.29	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluorododecanesulfonic acid (PFDoS)	<0.88		1.8	0.88	ng/L		08/02/21 04:28	08/03/21 16:23	1
Perfluorooctanesulfonamide (FOSA)	<0.88		1.8	0.88	ng/L		08/02/21 04:28	08/03/21 16:23	1
NEtFOSA	<0.79		1.8	0.79	ng/L		08/02/21 04:28	08/03/21 16:23	1
NMeFOSA	<0.39		1.8	0.39	ng/L		08/02/21 04:28	08/03/21 16:23	1
NMeFOSAA	<1.1		4.5	1.1	ng/L		08/02/21 04:28	08/03/21 16:23	1
NEtFOSAA	<1.2		4.5	1.2	ng/L		08/02/21 04:28	08/03/21 16:23	1
NMeFOSE	<1.3		3.6	1.3	ng/L		08/02/21 04:28	08/03/21 16:23	1
NEtFOSE	<0.77		1.8	0.77	ng/L		08/02/21 04:28	08/03/21 16:23	1
4:2 FTS	**9.1**		1.8	0.22	ng/L		08/02/21 04:28	08/03/21 16:23	1
6:2 FTS	**35**		4.5	2.3	ng/L		08/02/21 04:28	08/03/21 16:23	1
8:2 FTS	<0.42		1.8	0.42	ng/L		08/02/21 04:28	08/03/21 16:23	1
DONA	<0.36		1.8	0.36	ng/L		08/02/21 04:28	08/03/21 16:23	1
HFPO-DA (GenX)	<1.4		3.6	1.4	ng/L		08/02/21 04:28	08/03/21 16:23	1
F-53B Major	<0.22		1.8	0.22	ng/L		08/02/21 04:28	08/03/21 16:23	1
F-53B Minor	<0.29		1.8	0.29	ng/L		08/02/21 04:28	08/03/21 16:23	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*75*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:23*	*1*
13C2 PFHxA	*109*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:23*	*1*
13C4 PFHpA	*83*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:23*	*1*
13C4 PFOA	*103*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:23*	*1*
13C5 PFNA	*101*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:23*	*1*
13C2 PFUnA	*122*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:23*	*1*
13C2 PFDoA	*114*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:23*	*1*
13C2 PFTeDA	*110*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:23*	*1*
13C3 PFBS	*88*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:23*	*1*
18O2 PFHxS	*102*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:23*	*1*
13C4 PFOS	*113*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:23*	*1*
13C8 FOSA	*115*		*10 - 150*	*08/02/21 04:28*	*08/03/21 16:23*	*1*
d3-NMeFOSAA	*104*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:23*	*1*
d5-NEtFOSAA	*105*		*25 - 150*	*08/02/21 04:28*	*08/03/21 16:23*	*1*

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Client Sample ID: MW-2 DUP
Date Collected: 07/28/21 10:00
Date Received: 07/29/21 09:30

Lab Sample ID: 320-76907-4
Matrix: Water

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
d-N-MeFOSA-M	113		10 - 150	08/02/21 04:28	08/03/21 16:23	1
d-N-EtFOSA-M	103		10 - 150	08/02/21 04:28	08/03/21 16:23	1
d7-N-MeFOSE-M	84		10 - 150	08/02/21 04:28	08/03/21 16:23	1
d9-N-EtFOSE-M	93		10 - 150	08/02/21 04:28	08/03/21 16:23	1
M2-4:2 FTS	87		25 - 150	08/02/21 04:28	08/03/21 16:23	1
M2-6:2 FTS	103		25 - 150	08/02/21 04:28	08/03/21 16:23	1
M2-8:2 FTS	128		25 - 150	08/02/21 04:28	08/03/21 16:23	1
13C3 HFPO-DA	91		25 - 150	08/02/21 04:28	08/03/21 16:23	1
13C2 10:2 FTS	129		25 - 150	08/02/21 04:28	08/03/21 16:23	1

Method: 537 (modified) - Fluorinated Alkyl Substances - DL

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoropentanoic acid (PFPeA)	**1000**		9.0	2.2	ng/L		08/02/21 04:28	08/05/21 09:27	5
Perfluorodecanoic acid (PFDA)	<1.4		9.0	1.4	ng/L		08/02/21 04:28	08/05/21 09:27	5

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C5 PFPeA	73		25 - 150	08/02/21 04:28	08/05/21 09:27	5
13C2 PFDA	108		25 - 150	08/02/21 04:28	08/05/21 09:27	5

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Client Sample ID: FB-1
Date Collected: 07/28/21 11:20
Date Received: 07/29/21 09:30

Lab Sample ID: 320-76907-5
Matrix: Water

Method: 537 (modified) - Fluorinated Alkyl Substances

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	<2.1		4.5	2.1	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluoropentanoic acid (PFPeA)	<0.44		1.8	0.44	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluorohexanoic acid (PFHxA)	<0.52		1.8	0.52	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluoroheptanoic acid (PFHpA)	<0.22		1.8	0.22	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluorooctanoic acid (PFOA)	<0.76		1.8	0.76	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluorononanoic acid (PFNA)	<0.24		1.8	0.24	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluorodecanoic acid (PFDA)	<0.28		1.8	0.28	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluoroundecanoic acid (PFUnA)	<0.98		1.8	0.98	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluorododecanoic acid (PFDoA)	<0.49		1.8	0.49	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluorotridecanoic acid (PFTriA)	<1.2		1.8	1.2	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluorotetradecanoic acid (PFTeA)	<0.65		1.8	0.65	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluorobutanesulfonic acid (PFBS)	<0.18		1.8	0.18	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluoropentanesulfonic acid (PFPeS)	<0.27		1.8	0.27	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluorohexanesulfonic acid (PFHxS)	<0.51		1.8	0.51	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.17		1.8	0.17	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluorooctanesulfonic acid (PFOS)	<0.48		1.8	0.48	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluorononanesulfonic acid (PFNS)	<0.33		1.8	0.33	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluorodecanesulfonic acid (PFDS)	<0.28		1.8	0.28	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluorododecanesulfonic acid (PFDoS)	<0.86		1.8	0.86	ng/L		08/02/21 04:28	08/02/21 15:57	1
Perfluorooctanesulfonamide (FOSA)	<0.87		1.8	0.87	ng/L		08/02/21 04:28	08/02/21 15:57	1
NEtFOSA	<0.77		1.8	0.77	ng/L		08/02/21 04:28	08/02/21 15:57	1
NMeFOSA	<0.38		1.8	0.38	ng/L		08/02/21 04:28	08/02/21 15:57	1
NMeFOSAA	<1.1		4.5	1.1	ng/L		08/02/21 04:28	08/02/21 15:57	1
NEtFOSAA	<1.2		4.5	1.2	ng/L		08/02/21 04:28	08/02/21 15:57	1
NMeFOSE	<1.2		3.6	1.2	ng/L		08/02/21 04:28	08/02/21 15:57	1
NEtFOSE	<0.76		1.8	0.76	ng/L		08/02/21 04:28	08/02/21 15:57	1
4:2 FTS	<0.21		1.8	0.21	ng/L		08/02/21 04:28	08/02/21 15:57	1
6:2 FTS	<2.2		4.5	2.2	ng/L		08/02/21 04:28	08/02/21 15:57	1
8:2 FTS	<0.41		1.8	0.41	ng/L		08/02/21 04:28	08/02/21 15:57	1
DONA	<0.36		1.8	0.36	ng/L		08/02/21 04:28	08/02/21 15:57	1
HFPO-DA (GenX)	<1.3		3.6	1.3	ng/L		08/02/21 04:28	08/02/21 15:57	1
F-53B Major	<0.21		1.8	0.21	ng/L		08/02/21 04:28	08/02/21 15:57	1
F-53B Minor	<0.28		1.8	0.28	ng/L		08/02/21 04:28	08/02/21 15:57	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*95*		*25 - 150*	*08/02/21 04:28*	*08/02/21 15:57*	*1*
13C5 PFPeA	*89*		*25 - 150*	*08/02/21 04:28*	*08/02/21 15:57*	*1*
13C2 PFHxA	*118*		*25 - 150*	*08/02/21 04:28*	*08/02/21 15:57*	*1*
13C4 PFHpA	*100*		*25 - 150*	*08/02/21 04:28*	*08/02/21 15:57*	*1*
13C4 PFOA	*105*		*25 - 150*	*08/02/21 04:28*	*08/02/21 15:57*	*1*
13C5 PFNA	*106*		*25 - 150*	*08/02/21 04:28*	*08/02/21 15:57*	*1*
13C2 PFDA	*113*		*25 - 150*	*08/02/21 04:28*	*08/02/21 15:57*	*1*
13C2 PFUnA	*117*		*25 - 150*	*08/02/21 04:28*	*08/02/21 15:57*	*1*
13C2 PFDoA	*107*		*25 - 150*	*08/02/21 04:28*	*08/02/21 15:57*	*1*
13C2 PFTeDA	*117*		*25 - 150*	*08/02/21 04:28*	*08/02/21 15:57*	*1*
13C3 PFBS	*103*		*25 - 150*	*08/02/21 04:28*	*08/02/21 15:57*	*1*
18O2 PFHxS	*104*		*25 - 150*	*08/02/21 04:28*	*08/02/21 15:57*	*1*
13C4 PFOS	*121*		*25 - 150*	*08/02/21 04:28*	*08/02/21 15:57*	*1*

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Client Sample ID: FB-1
Lab Sample ID: 320-76907-5
Date Collected: 07/28/21 11:20
Matrix: Water
Date Received: 07/29/21 09:30

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C8 FOSA	116		10 - 150	08/02/21 04:28	08/02/21 15:57	1
d3-NMeFOSAA	105		25 - 150	08/02/21 04:28	08/02/21 15:57	1
d5-NEtFOSAA	110		25 - 150	08/02/21 04:28	08/02/21 15:57	1
d-N-MeFOSA-M	92		10 - 150	08/02/21 04:28	08/02/21 15:57	1
d-N-EtFOSA-M	95		10 - 150	08/02/21 04:28	08/02/21 15:57	1
d7-N-MeFOSE-M	85		10 - 150	08/02/21 04:28	08/02/21 15:57	1
d9-N-EtFOSE-M	90		10 - 150	08/02/21 04:28	08/02/21 15:57	1
M2-4:2 FTS	109		25 - 150	08/02/21 04:28	08/02/21 15:57	1
M2-6:2 FTS	114		25 - 150	08/02/21 04:28	08/02/21 15:57	1
M2-8:2 FTS	125		25 - 150	08/02/21 04:28	08/02/21 15:57	1
13C3 HFPO-DA	90		25 - 150	08/02/21 04:28	08/02/21 15:57	1
13C2 10:2 FTS	127		25 - 150	08/02/21 04:28	08/02/21 15:57	1

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Client Sample ID: EB-1
Date Collected: 07/28/21 11:25
Date Received: 07/29/21 09:30

Lab Sample ID: 320-76907-6
Matrix: Water

Method: 537 (modified) - Fluorinated Alkyl Substances

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	<2.2		4.5	2.2	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluoropentanoic acid (PFPeA)	<0.44		1.8	0.44	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluorohexanoic acid (PFHxA)	<0.52		1.8	0.52	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluoroheptanoic acid (PFHpA)	<0.22		1.8	0.22	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluorooctanoic acid (PFOA)	<0.76		1.8	0.76	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluorononanoic acid (PFNA)	<0.24		1.8	0.24	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluorodecanoic acid (PFDA)	<0.28		1.8	0.28	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluoroundecanoic acid (PFUnA)	<0.99		1.8	0.99	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluorododecanoic acid (PFDoA)	<0.49		1.8	0.49	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluorotridecanoic acid (PFTriA)	<1.2		1.8	1.2	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluorotetradecanoic acid (PFTeA)	<0.66		1.8	0.66	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluorobutanesulfonic acid (PFBS)	<0.18		1.8	0.18	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluoropentanesulfonic acid (PFPeS)	<0.27		1.8	0.27	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluorohexanesulfonic acid (PFHxS)	<0.51		1.8	0.51	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.17		1.8	0.17	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluorooctanesulfonic acid (PFOS)	<0.48		1.8	0.48	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluorononanesulfonic acid (PFNS)	<0.33		1.8	0.33	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluorodecanesulfonic acid (PFDS)	<0.29		1.8	0.29	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluorododecanesulfonic acid (PFDoS)	<0.87		1.8	0.87	ng/L		08/02/21 04:28	08/02/21 16:07	1
Perfluorooctanesulfonamide (FOSA)	<0.88		1.8	0.88	ng/L		08/02/21 04:28	08/02/21 16:07	1
NEtFOSA	<0.78		1.8	0.78	ng/L		08/02/21 04:28	08/02/21 16:07	1
NMeFOSA	<0.39		1.8	0.39	ng/L		08/02/21 04:28	08/02/21 16:07	1
NMeFOSAA	<1.1		4.5	1.1	ng/L		08/02/21 04:28	08/02/21 16:07	1
NEtFOSAA	<1.2		4.5	1.2	ng/L		08/02/21 04:28	08/02/21 16:07	1
NMeFOSE	<1.3		3.6	1.3	ng/L		08/02/21 04:28	08/02/21 16:07	1
NEtFOSE	<0.76		1.8	0.76	ng/L		08/02/21 04:28	08/02/21 16:07	1
4:2 FTS	<0.22		1.8	0.22	ng/L		08/02/21 04:28	08/02/21 16:07	1
6:2 FTS	<2.2		4.5	2.2	ng/L		08/02/21 04:28	08/02/21 16:07	1
8:2 FTS	<0.41		1.8	0.41	ng/L		08/02/21 04:28	08/02/21 16:07	1
DONA	<0.36		1.8	0.36	ng/L		08/02/21 04:28	08/02/21 16:07	1
HFPO-DA (GenX)	<1.3		3.6	1.3	ng/L		08/02/21 04:28	08/02/21 16:07	1
F-53B Major	<0.22		1.8	0.22	ng/L		08/02/21 04:28	08/02/21 16:07	1
F-53B Minor	<0.29		1.8	0.29	ng/L		08/02/21 04:28	08/02/21 16:07	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*97*		*25 - 150*	*08/02/21 04:28*	*08/02/21 16:07*	*1*
13C5 PFPeA	*96*		*25 - 150*	*08/02/21 04:28*	*08/02/21 16:07*	*1*
13C2 PFHxA	*111*		*25 - 150*	*08/02/21 04:28*	*08/02/21 16:07*	*1*
13C4 PFHpA	*98*		*25 - 150*	*08/02/21 04:28*	*08/02/21 16:07*	*1*
13C4 PFOA	*101*		*25 - 150*	*08/02/21 04:28*	*08/02/21 16:07*	*1*
13C5 PFNA	*100*		*25 - 150*	*08/02/21 04:28*	*08/02/21 16:07*	*1*
13C2 PFDA	*117*		*25 - 150*	*08/02/21 04:28*	*08/02/21 16:07*	*1*
13C2 PFUnA	*112*		*25 - 150*	*08/02/21 04:28*	*08/02/21 16:07*	*1*
13C2 PFDoA	*113*		*25 - 150*	*08/02/21 04:28*	*08/02/21 16:07*	*1*
13C2 PFTeDA	*111*		*25 - 150*	*08/02/21 04:28*	*08/02/21 16:07*	*1*
13C3 PFBS	*97*		*25 - 150*	*08/02/21 04:28*	*08/02/21 16:07*	*1*
18O2 PFHxS	*100*		*25 - 150*	*08/02/21 04:28*	*08/02/21 16:07*	*1*
13C4 PFOS	*113*		*25 - 150*	*08/02/21 04:28*	*08/02/21 16:07*	*1*

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Client Sample ID: EB-1
Lab Sample ID: 320-76907-6
Date Collected: 07/28/21 11:25
Matrix: Water
Date Received: 07/29/21 09:30

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C8 FOSA	110		10 - 150	08/02/21 04:28	08/02/21 16:07	1
d3-NMeFOSAA	105		25 - 150	08/02/21 04:28	08/02/21 16:07	1
d5-NEtFOSAA	114		25 - 150	08/02/21 04:28	08/02/21 16:07	1
d-N-MeFOSA-M	88		10 - 150	08/02/21 04:28	08/02/21 16:07	1
d-N-EtFOSA-M	99		10 - 150	08/02/21 04:28	08/02/21 16:07	1
d7-N-MeFOSE-M	89		10 - 150	08/02/21 04:28	08/02/21 16:07	1
d9-N-EtFOSE-M	93		10 - 150	08/02/21 04:28	08/02/21 16:07	1
M2-4:2 FTS	124		25 - 150	08/02/21 04:28	08/02/21 16:07	1
M2-6:2 FTS	119		25 - 150	08/02/21 04:28	08/02/21 16:07	1
M2-8:2 FTS	116		25 - 150	08/02/21 04:28	08/02/21 16:07	1
13C3 HFPO-DA	90		25 - 150	08/02/21 04:28	08/02/21 16:07	1
13C2 10:2 FTS	126		25 - 150	08/02/21 04:28	08/02/21 16:07	1

Isotope Dilution Summary

Client: Ramboll US Corporation
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Job ID: 320-76907-1

Method: 537 (modified) - Fluorinated Alkyl Substances

Matrix: Water

Prep Type: Total/NA

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFBA (25-150)	PFPeA (25-150)	PFHxA (25-150)	C4PFHA (25-150)	PFOA (25-150)	PFNA (25-150)	PFDA (25-150)	PFUnA (25-150)
320-76907-1	MW-3	82	57	112	86	102	107	127	123
320-76907-2	MW-2	96		137	110	127	121		154 *5+
320-76907-2 - DL	MW-2		92					149	
320-76907-3	MW-1					106	112	134	134
320-76907-3 - DL	MW-1	94	96	113	96				
320-76907-4	MW-2 DUP	75		109	83	103	101		122
320-76907-4 - DL	MW-2 DUP		73					108	
320-76907-5	FB-1	95	89	118	100	105	106	113	117
320-76907-6	EB-1	97	96	111	98	101	100	117	112
LCS 320-512164/2-A	Lab Control Sample	98	91	112	103	104	105	113	119
LCSD 320-512164/3-A	Lab Control Sample Dup	103	92	116	97	105	107	114	120
MB 320-512164/1-A	Method Blank	96	89	109	96	98	97	109	112

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFDoA (25-150)	PFTDA (25-150)	C3PFBS (25-150)	PFHxS (25-150)	PFOS (25-150)	PFOSA (10-150)	d3NMFOS (25-150)	d5NEFOS (25-150)
320-76907-1	MW-3	109	109	87	101	120	119	111	106
320-76907-2	MW-2	142	146	114	128	161 *5+	150	131	137
320-76907-2 - DL	MW-2								
320-76907-3	MW-1	124	127	89	110	128	140	109	116
320-76907-3 - DL	MW-1								
320-76907-4	MW-2 DUP	114	110	88	102	113	115	104	105
320-76907-4 - DL	MW-2 DUP								
320-76907-5	FB-1	107	117	103	104	121	116	105	110
320-76907-6	EB-1	113	111	97	100	113	110	105	114
LCS 320-512164/2-A	Lab Control Sample	102	115	106	109	123	109	116	108
LCSD 320-512164/3-A	Lab Control Sample Dup	115	109	106	109	115	105	111	100
MB 320-512164/1-A	Method Blank	97	97	103	102	107	105	105	107

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	dMeFOSA (10-150)	dEtFOSA (10-150)	NMFM (10-150)	NEFM (10-150)	M242FTS (25-150)	M262FTS (25-150)	M282FTS (25-150)	HFPODA (25-150)
320-76907-1	MW-3	104	104	97	91	137	135	144	89
320-76907-2	MW-2	144	133	111	109	139	129	170 *5+	108
320-76907-2 - DL	MW-2								
320-76907-3	MW-1	126	118	99	103	71		144	97
320-76907-3 - DL	MW-1						124		
320-76907-4	MW-2 DUP	113	103	84	93	87	103	128	91
320-76907-4 - DL	MW-2 DUP								
320-76907-5	FB-1	92	95	85	90	109	114	125	90
320-76907-6	EB-1	88	99	89	93	124	119	116	90
LCS 320-512164/2-A	Lab Control Sample	90	92	87	85	126	110	135	85
LCSD 320-512164/3-A	Lab Control Sample Dup	89	91	85	86	139	119	138	88
MB 320-512164/1-A	Method Blank	76	78	83	72	122	117	149	82

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	M102FTS (25-150)							
320-76907-1	MW-3	141							
320-76907-2	MW-2	169 *5+							
320-76907-2 - DL	MW-2								
320-76907-3	MW-1	144							

Isotope Dilution Summary

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Matrix: Water
Prep Type: Total/NA

		Percent Isotope Dilution Recovery (Acceptance Limits)						
Lab Sample ID	**Client Sample ID**	**M102FTS (25-150)**						
320-76907-3 - DL	MW-1							
320-76907-4	MW-2 DUP	129						
320-76907-4 - DL	MW-2 DUP							
320-76907-5	FB-1	127						
320-76907-6	EB-1	126						
LCS 320-512164/2-A	Lab Control Sample	123						
LCSD 320-512164/3-A	Lab Control Sample Dup	113						
MB 320-512164/1-A	Method Blank	129						

Surrogate Legend

PFBA = 13C4 PFBA
PFPeA = 13C5 PFPeA
PFHxA = 13C2 PFHxA
C4PFHA = 13C4 PFHpA
PFOA = 13C4 PFOA
PFNA = 13C5 PFNA
PFDA = 13C2 PFDA
PFUnA = 13C2 PFUnA
PFDoA = 13C2 PFDoA
PFTDA = 13C2 PFTeDA
C3PFBS = 13C3 PFBS
PFHxS = 18O2 PFHxS
PFOS = 13C4 PFOS
PFOSA = 13C8 FOSA
d3NMFOS = d3-NMeFOSAA
d5NEFOS = d5-NEtFOSAA
dMeFOSA = d-N-MeFOSA-M
dEtFOSA = d-N-EtFOSA-M
NMFM = d7-N-MeFOSE-M
NEFM = d9-N-EtFOSE-M
M242FTS = M2-4:2 FTS
M262FTS = M2-6:2 FTS
M282FTS = M2-8:2 FTS
HFPODA = 13C3 HFPO-DA
M102FTS = 13C2 10:2 FTS

Method: 537 (modified) - Fluorinated Alkyl Substances

Lab Sample ID: MB 320-512164/1-A
Matrix: Water
Analysis Batch: 512382

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 512164

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	<2.4		5.0	2.4	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluoropentanoic acid (PFPeA)	<0.49		2.0	0.49	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluorohexanoic acid (PFHxA)	<0.58		2.0	0.58	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluoroheptanoic acid (PFHpA)	<0.25		2.0	0.25	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluorooctanoic acid (PFOA)	<0.85		2.0	0.85	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluorononanoic acid (PFNA)	<0.27		2.0	0.27	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluorodecanoic acid (PFDA)	<0.31		2.0	0.31	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluoroundecanoic acid (PFUnA)	<1.1		2.0	1.1	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluorododecanoic acid (PFDoA)	<0.55		2.0	0.55	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluorotridecanoic acid (PFTriA)	<1.3		2.0	1.3	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluorotetradecanoic acid (PFTeA)	<0.73		2.0	0.73	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluorobutanesulfonic acid (PFBS)	<0.20		2.0	0.20	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluoropentanesulfonic acid (PFPeS)	<0.30		2.0	0.30	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluorohexanesulfonic acid (PFHxS)	<0.57		2.0	0.57	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.19		2.0	0.19	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluorooctanesulfonic acid (PFOS)	<0.54		2.0	0.54	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluorononanesulfonic acid (PFNS)	<0.37		2.0	0.37	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluorodecanesulfonic acid (PFDS)	<0.32		2.0	0.32	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluorododecanesulfonic acid (PFDoS)	<0.97		2.0	0.97	ng/L		08/02/21 04:28	08/02/21 13:08	1
Perfluorooctanesulfonamide (FOSA)	<0.98		2.0	0.98	ng/L		08/02/21 04:28	08/02/21 13:08	1
NEtFOSA	<0.87		2.0	0.87	ng/L		08/02/21 04:28	08/02/21 13:08	1
NMeFOSA	<0.43		2.0	0.43	ng/L		08/02/21 04:28	08/02/21 13:08	1
NMeFOSAA	<1.2		5.0	1.2	ng/L		08/02/21 04:28	08/02/21 13:08	1
NEtFOSAA	<1.3		5.0	1.3	ng/L		08/02/21 04:28	08/02/21 13:08	1
NMeFOSE	<1.4		4.0	1.4	ng/L		08/02/21 04:28	08/02/21 13:08	1
NEtFOSE	<0.85		2.0	0.85	ng/L		08/02/21 04:28	08/02/21 13:08	1
4:2 FTS	<0.24		2.0	0.24	ng/L		08/02/21 04:28	08/02/21 13:08	1
6:2 FTS	<2.5		5.0	2.5	ng/L		08/02/21 04:28	08/02/21 13:08	1
8:2 FTS	<0.46		2.0	0.46	ng/L		08/02/21 04:28	08/02/21 13:08	1
DONA	<0.40		2.0	0.40	ng/L		08/02/21 04:28	08/02/21 13:08	1
HFPO-DA (GenX)	<1.5		4.0	1.5	ng/L		08/02/21 04:28	08/02/21 13:08	1
F-53B Major	<0.24		2.0	0.24	ng/L		08/02/21 04:28	08/02/21 13:08	1
F-53B Minor	<0.32		2.0	0.32	ng/L		08/02/21 04:28	08/02/21 13:08	1

Isotope Dilution	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*96*		*25 - 150*	*08/02/21 04:28*	*08/02/21 13:08*	*1*
13C5 PFPeA	*89*		*25 - 150*	*08/02/21 04:28*	*08/02/21 13:08*	*1*
13C2 PFHxA	*109*		*25 - 150*	*08/02/21 04:28*	*08/02/21 13:08*	*1*
13C4 PFHpA	*96*		*25 - 150*	*08/02/21 04:28*	*08/02/21 13:08*	*1*
13C4 PFOA	*98*		*25 - 150*	*08/02/21 04:28*	*08/02/21 13:08*	*1*
13C5 PFNA	*97*		*25 - 150*	*08/02/21 04:28*	*08/02/21 13:08*	*1*
13C2 PFDA	*109*		*25 - 150*	*08/02/21 04:28*	*08/02/21 13:08*	*1*
13C2 PFUnA	*112*		*25 - 150*	*08/02/21 04:28*	*08/02/21 13:08*	*1*
13C2 PFDoA	*97*		*25 - 150*	*08/02/21 04:28*	*08/02/21 13:08*	*1*
13C2 PFTeDA	*97*		*25 - 150*	*08/02/21 04:28*	*08/02/21 13:08*	*1*
13C3 PFBS	*103*		*25 - 150*	*08/02/21 04:28*	*08/02/21 13:08*	*1*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: MB 320-512164/1-A
Matrix: Water
Analysis Batch: 512382

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 512164

Isotope Dilution	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
18O2 PFHxS	102		25 - 150	08/02/21 04:28	08/02/21 13:08	1
13C4 PFOS	107		25 - 150	08/02/21 04:28	08/02/21 13:08	1
13C8 FOSA	105		10 - 150	08/02/21 04:28	08/02/21 13:08	1
d3-NMeFOSAA	105		25 - 150	08/02/21 04:28	08/02/21 13:08	1
d5-NEtFOSAA	107		25 - 150	08/02/21 04:28	08/02/21 13:08	1
d-N-MeFOSA-M	76		10 - 150	08/02/21 04:28	08/02/21 13:08	1
d-N-EtFOSA-M	78		10 - 150	08/02/21 04:28	08/02/21 13:08	1
d7-N-MeFOSE-M	83		10 - 150	08/02/21 04:28	08/02/21 13:08	1
d9-N-EtFOSE-M	72		10 - 150	08/02/21 04:28	08/02/21 13:08	1
M2-4:2 FTS	122		25 - 150	08/02/21 04:28	08/02/21 13:08	1
M2-6:2 FTS	117		25 - 150	08/02/21 04:28	08/02/21 13:08	1
M2-8:2 FTS	149		25 - 150	08/02/21 04:28	08/02/21 13:08	1
13C3 HFPO-DA	82		25 - 150	08/02/21 04:28	08/02/21 13:08	1
13C2 10:2 FTS	129		25 - 150	08/02/21 04:28	08/02/21 13:08	1

Lab Sample ID: LCS 320-512164/2-A
Matrix: Water
Analysis Batch: 512382

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 512164

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Perfluorobutanoic acid (PFBA)	40.0	39.5		ng/L		99	60 - 135
Perfluoropentanoic acid (PFPeA)	40.0	39.2		ng/L		98	60 - 135
Perfluorohexanoic acid (PFHxA)	40.0	40.0		ng/L		100	60 - 135
Perfluoroheptanoic acid (PFHpA)	40.0	39.4		ng/L		99	60 - 135
Perfluorooctanoic acid (PFOA)	40.0	39.3		ng/L		98	60 - 135
Perfluorononanoic acid (PFNA)	40.0	41.3		ng/L		103	60 - 135
Perfluorodecanoic acid (PFDA)	40.0	37.1		ng/L		93	60 - 135
Perfluoroundecanoic acid (PFUnA)	40.0	41.6		ng/L		104	60 - 135
Perfluorododecanoic acid (PFDoA)	40.0	45.2		ng/L		113	60 - 135
Perfluorotridecanoic acid (PFTriA)	40.0	44.4		ng/L		111	60 - 135
Perfluorotetradecanoic acid (PFTeA)	40.0	36.4		ng/L		91	60 - 135
Perfluoro-n-hexadecanoic acid (PFHxDA)	40.0	39.1		ng/L		98	60 - 135
Perfluoro-n-octadecanoic acid (PFODA)	40.0	37.1		ng/L		93	60 - 135
Perfluorobutanesulfonic acid (PFBS)	35.4	35.9		ng/L		101	60 - 135
Perfluoropentanesulfonic acid (PFPeS)	37.5	34.6		ng/L		92	60 - 135
Perfluorohexanesulfonic acid (PFHxS)	36.4	35.4		ng/L		97	60 - 135
Perfluoroheptanesulfonic Acid (PFHpS)	38.1	32.9		ng/L		86	60 - 135
Perfluorooctanesulfonic acid (PFOS)	37.1	34.2		ng/L		92	60 - 135
Perfluorononanesulfonic acid (PFNS)	38.4	34.7		ng/L		90	60 - 135

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-512164/2-A
Matrix: Water
Analysis Batch: 512382

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 512164

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Perfluorodecanesulfonic acid (PFDS)	38.6	32.4		ng/L		84	60 - 135
Perfluorododecanesulfonic acid (PFDoS)	38.7	35.4		ng/L		92	60 - 135
Perfluorooctanesulfonamide (FOSA)	40.0	35.9		ng/L		90	60 - 135
NEtFOSA	40.0	38.3		ng/L		96	60 - 135
NMeFOSA	40.0	38.3		ng/L		96	60 - 135
NMeFOSAA	40.0	42.8		ng/L		107	60 - 135
NEtFOSAA	40.0	39.7		ng/L		99	60 - 135
NMeFOSE	40.0	40.8		ng/L		102	60 - 135
NEtFOSE	40.0	40.6		ng/L		101	60 - 135
4:2 FTS	37.4	38.0		ng/L		102	60 - 135
6:2 FTS	37.9	41.8		ng/L		110	60 - 135
8:2 FTS	38.3	35.9		ng/L		94	60 - 135
10:2 FTS	38.6	35.1		ng/L		91	60 - 135
DONA	37.7	30.6		ng/L		81	60 - 135
HFPO-DA (GenX)	40.0	43.8		ng/L		110	60 - 135
F-53B Major	37.3	34.3		ng/L		92	60 - 135
F-53B Minor	37.7	34.9		ng/L		93	60 - 135

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C4 PFBA	*98*		*25 - 150*
13C5 PFPeA	*91*		*25 - 150*
13C2 PFHxA	*112*		*25 - 150*
13C4 PFHpA	*103*		*25 - 150*
13C4 PFOA	*104*		*25 - 150*
13C5 PFNA	*105*		*25 - 150*
13C2 PFDA	*113*		*25 - 150*
13C2 PFUnA	*119*		*25 - 150*
13C2 PFDoA	*102*		*25 - 150*
13C2 PFTeDA	*115*		*25 - 150*
13C3 PFBS	*106*		*25 - 150*
18O2 PFHxS	*109*		*25 - 150*
13C4 PFOS	*123*		*25 - 150*
13C8 FOSA	*109*		*10 - 150*
d3-NMeFOSAA	*116*		*25 - 150*
d5-NEtFOSAA	*108*		*25 - 150*
d-N-MeFOSA-M	*90*		*10 - 150*
d-N-EtFOSA-M	*92*		*10 - 150*
d7-N-MeFOSE-M	*87*		*10 - 150*
d9-N-EtFOSE-M	*85*		*10 - 150*
M2-4:2 FTS	*126*		*25 - 150*
M2-6:2 FTS	*110*		*25 - 150*
M2-8:2 FTS	*135*		*25 - 150*
13C3 HFPO-DA	*85*		*25 - 150*
13C2 10:2 FTS	*123*		*25 - 150*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCSD 320-512164/3-A
Matrix: Water
Analysis Batch: 512382

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 512164

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Perfluorobutanoic acid (PFBA)	40.0	38.1		ng/L		95	60 - 135	3	30
Perfluoropentanoic acid (PFPeA)	40.0	41.1		ng/L		103	60 - 135	5	30
Perfluorohexanoic acid (PFHxA)	40.0	39.4		ng/L		98	60 - 135	2	30
Perfluoroheptanoic acid (PFHpA)	40.0	42.1		ng/L		105	60 - 135	7	30
Perfluorooctanoic acid (PFOA)	40.0	40.6		ng/L		101	60 - 135	3	30
Perfluorononanoic acid (PFNA)	40.0	40.7		ng/L		102	60 - 135	2	30
Perfluorodecanoic acid (PFDA)	40.0	39.1		ng/L		98	60 - 135	5	30
Perfluoroundecanoic acid (PFUnA)	40.0	42.3		ng/L		106	60 - 135	2	30
Perfluorododecanoic acid (PFDoA)	40.0	38.6		ng/L		97	60 - 135	16	30
Perfluorotridecanoic acid (PFTriA)	40.0	38.8		ng/L		97	60 - 135	14	30
Perfluorotetradecanoic acid (PFTeA)	40.0	36.8		ng/L		92	60 - 135	1	30
Perfluoro-n-hexadecanoic acid (PFHxDA)	40.0	41.6		ng/L		104	60 - 135	6	30
Perfluoro-n-octadecanoic acid (PFODA)	40.0	32.9		ng/L		82	60 - 135	12	30
Perfluorobutanesulfonic acid (PFBS)	35.4	37.8		ng/L		107	60 - 135	5	30
Perfluoropentanesulfonic acid (PFPeS)	37.5	35.7		ng/L		95	60 - 135	3	30
Perfluorohexanesulfonic acid (PFHxS)	36.4	34.4		ng/L		95	60 - 135	3	30
Perfluoroheptanesulfonic Acid (PFHpS)	38.1	39.0		ng/L		103	60 - 135	17	30
Perfluorooctanesulfonic acid (PFOS)	37.1	36.7		ng/L		99	60 - 135	7	30
Perfluorononanesulfonic acid (PFNS)	38.4	42.2		ng/L		110	60 - 135	19	30
Perfluorodecanesulfonic acid (PFDS)	38.6	33.3		ng/L		86	60 - 135	3	30
Perfluorododecanesulfonic acid (PFDoS)	38.7	38.1		ng/L		98	60 - 135	7	30
Perfluorooctanesulfonamide (FOSA)	40.0	40.5		ng/L		101	60 - 135	12	30
NEtFOSA	40.0	39.7		ng/L		99	60 - 135	4	30
NMeFOSA	40.0	38.8		ng/L		97	60 - 135	1	30
NMeFOSAA	40.0	42.0		ng/L		105	60 - 135	2	30
NEtFOSAA	40.0	44.6		ng/L		111	60 - 135	12	30
NMeFOSE	40.0	37.8		ng/L		95	60 - 135	8	30
NEtFOSE	40.0	41.7		ng/L		104	60 - 135	3	30
4:2 FTS	37.4	35.7		ng/L		95	60 - 135	6	30
6:2 FTS	37.9	35.7		ng/L		94	60 - 135	16	30
8:2 FTS	38.3	37.6		ng/L		98	60 - 135	5	30
10:2 FTS	38.6	39.6		ng/L		103	60 - 135	12	30
DONA	37.7	34.4		ng/L		91	60 - 135	12	30
HFPO-DA (GenX)	40.0	44.5		ng/L		111	60 - 135	1	30
F-53B Major	37.3	36.9		ng/L		99	60 - 135	7	30
F-53B Minor	37.7	38.7		ng/L		103	60 - 135	11	30

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	LCSD %Recovery	LCSD Qualifier	Limits
13C4 PFBA	103		25 - 150
13C5 PFPeA	92		25 - 150
13C2 PFHxA	116		25 - 150
13C4 PFHpA	97		25 - 150
13C4 PFOA	105		25 - 150
13C5 PFNA	107		25 - 150
13C2 PFDA	114		25 - 150
13C2 PFUnA	120		25 - 150
13C2 PFDoA	115		25 - 150
13C2 PFTeDA	109		25 - 150
13C3 PFBS	106		25 - 150
18O2 PFHxS	109		25 - 150
13C4 PFOS	115		25 - 150
13C8 FOSA	105		10 - 150
d3-NMeFOSAA	111		25 - 150
d5-NEtFOSAA	100		25 - 150
d-N-MeFOSA-M	89		10 - 150
d-N-EtFOSA-M	91		10 - 150
d7-N-MeFOSE-M	85		10 - 150
d9-N-EtFOSE-M	86		10 - 150
M2-4:2 FTS	139		25 - 150
M2-6:2 FTS	119		25 - 150
M2-8:2 FTS	138		25 - 150
13C3 HFPO-DA	88		25 - 150
13C2 10:2 FTS	113		25 - 150

QC Association Summary

Client: Ramboll US Corporation
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Job ID: 320-76907-1

LCMS

Prep Batch: 512164

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-76907-1	MW-3	Total/NA	Water	3535	
320-76907-2 - DL	MW-2	Total/NA	Water	3535	
320-76907-2	MW-2	Total/NA	Water	3535	
320-76907-3 - DL	MW-1	Total/NA	Water	3535	
320-76907-3	MW-1	Total/NA	Water	3535	
320-76907-4	MW-2 DUP	Total/NA	Water	3535	
320-76907-4 - DL	MW-2 DUP	Total/NA	Water	3535	
320-76907-5	FB-1	Total/NA	Water	3535	
320-76907-6	EB-1	Total/NA	Water	3535	
MB 320-512164/1-A	Method Blank	Total/NA	Water	3535	
LCS 320-512164/2-A	Lab Control Sample	Total/NA	Water	3535	
LCSD 320-512164/3-A	Lab Control Sample Dup	Total/NA	Water	3535	

Analysis Batch: 512382

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-76907-5	FB-1	Total/NA	Water	537 (modified)	512164
320-76907-6	EB-1	Total/NA	Water	537 (modified)	512164
MB 320-512164/1-A	Method Blank	Total/NA	Water	537 (modified)	512164
LCS 320-512164/2-A	Lab Control Sample	Total/NA	Water	537 (modified)	512164
LCSD 320-512164/3-A	Lab Control Sample Dup	Total/NA	Water	537 (modified)	512164

Analysis Batch: 512730

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-76907-1	MW-3	Total/NA	Water	537 (modified)	512164
320-76907-2	MW-2	Total/NA	Water	537 (modified)	512164
320-76907-3	MW-1	Total/NA	Water	537 (modified)	512164
320-76907-4	MW-2 DUP	Total/NA	Water	537 (modified)	512164

Analysis Batch: 513220

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-76907-2 - DL	MW-2	Total/NA	Water	537 (modified)	512164
320-76907-3 - DL	MW-1	Total/NA	Water	537 (modified)	512164
320-76907-4 - DL	MW-2 DUP	Total/NA	Water	537 (modified)	512164

Lab Chronicle

Client: Ramboll US Corporation
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Job ID: 320-76907-1

Client Sample ID: MW-3
Date Collected: 07/28/21 09:10
Date Received: 07/29/21 09:30

Lab Sample ID: 320-76907-1
Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3535			273.2 mL	10.0 mL	512164	08/02/21 04:28	HK	TAL SAC
Total/NA	Analysis	537 (modified)		1			512730	08/03/21 15:55	GWO	TAL SAC

Client Sample ID: MW-2
Date Collected: 07/28/21 10:00
Date Received: 07/29/21 09:30

Lab Sample ID: 320-76907-2
Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3535			277.4 mL	10.0 mL	512164	08/02/21 04:28	HK	TAL SAC
Total/NA	Analysis	537 (modified)		1			512730	08/03/21 16:04	GWO	TAL SAC
Total/NA	Prep	3535	DL		277.4 mL	10.0 mL	512164	08/02/21 04:28	HK	TAL SAC
Total/NA	Analysis	537 (modified)	DL	5			513220	08/05/21 09:17	JY1	TAL SAC

Client Sample ID: MW-1
Date Collected: 07/28/21 10:55
Date Received: 07/29/21 09:30

Lab Sample ID: 320-76907-3
Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3535			276.6 mL	10.0 mL	512164	08/02/21 04:28	HK	TAL SAC
Total/NA	Analysis	537 (modified)		1			512730	08/03/21 16:14	GWO	TAL SAC
Total/NA	Prep	3535	DL		276.6 mL	10.0 mL	512164	08/02/21 04:28	HK	TAL SAC
Total/NA	Analysis	537 (modified)	DL	100			513220	08/05/21 09:36	JY1	TAL SAC

Client Sample ID: MW-2 DUP
Date Collected: 07/28/21 10:00
Date Received: 07/29/21 09:30

Lab Sample ID: 320-76907-4
Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3535			276.9 mL	10.0 mL	512164	08/02/21 04:28	HK	TAL SAC
Total/NA	Analysis	537 (modified)		1			512730	08/03/21 16:23	GWO	TAL SAC
Total/NA	Prep	3535	DL		276.9 mL	10.0 mL	512164	08/02/21 04:28	HK	TAL SAC
Total/NA	Analysis	537 (modified)	DL	5			513220	08/05/21 09:27	JY1	TAL SAC

Client Sample ID: FB-1
Date Collected: 07/28/21 11:20
Date Received: 07/29/21 09:30

Lab Sample ID: 320-76907-5
Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3535			280.8 mL	10.0 mL	512164	08/02/21 04:28	HK	TAL SAC
Total/NA	Analysis	537 (modified)		1			512382	08/02/21 15:57	K1S	TAL SAC

Lab Chronicle

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Client Sample ID: EB-1
Date Collected: 07/28/21 11:25
Date Received: 07/29/21 09:30

Lab Sample ID: 320-76907-6
Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3535			278.5 mL	10.0 mL	512164	08/02/21 04:28	HK	TAL SAC
Total/NA	Analysis	537 (modified)		1			512382	08/02/21 16:07	K1S	TAL SAC

Laboratory References:

TAL SAC = Eurofins TestAmerica, Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Accreditation/Certification Summary

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Laboratory: Eurofins TestAmerica, Sacramento

The accreditations/certifications listed below are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Wisconsin	State	998204680	08-31-21

Method Summary

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Method	Method Description	Protocol	Laboratory
537 (modified)	Fluorinated Alkyl Substances	EPA	TAL SAC
3535	Solid-Phase Extraction (SPE)	SW846	TAL SAC

Protocol References:

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL SAC = Eurofins TestAmerica, Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Sample Summary

Client: Ramboll US Corporation
Job ID: 320-76907-1
Project/Site: DIC Liquid Facility - Oak Creek 1690021164

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
320-76907-1	MW-3	Water	07/28/21 09:10	07/29/21 09:30
320-76907-2	MW-2	Water	07/28/21 10:00	07/29/21 09:30
320-76907-3	MW-1	Water	07/28/21 10:55	07/29/21 09:30
320-76907-4	MW-2 DUP	Water	07/28/21 10:00	07/29/21 09:30
320-76907-5	FB-1	Water	07/28/21 11:20	07/29/21 09:30
320-76907-6	EB-1	Water	07/28/21 11:25	07/29/21 09:30

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Phone: 708-534-5200 Fax: 708-534-5211

Chain of Custody Record

eurofins | Environment Testing America

Client Information	Sampler: DUNCAN GUASFORD	Lab PM: Fredrick, Sandie	Carrier Tracking No(s):	COC No: 500-92910-41392.1
Client Contact: Abby Small	Phone: 2625736315	E-Mail: sandra.fredrick@eurofinset.com	State of Origin:	Page: Page 1 of 1
Company: Ramboll US Corporation	PWSID:			Job #:
Address: 5050 Lincoln Drive, Suite 440	Due Date Requested:			
City: Edina	TAT Requested (days):			
State, Zip: MN, 55436	Compliance Project: Δ Yes Δ No			
Phone:	PO #: Purchase Order not required			
Email: asmall@ramboll.com	WO #:			
Project Name: LIQUID FACILITY DIC Imaging Products USA Inc - Oak Creek	Project #: 50019134			
Site: 16900 21164	SSOW#:			

Analysis Requested

320-76907 Chain of Custody

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	PFAS	Total Number of containers	Special Instructions/Note:
			Preservation Code:						
MW-3	7-28-21	910	G	Solid			X		
MW-2		1000		Solid			X		
MW-1		1055		Solid			X		
MW-2 DUP		1000		Solid			X		
FB-1		1120		Solid			X		
EB-1		1125		Solid			X		
				Solid					
				Solid					
				Water					
				Water					
				Water					

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☐ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
1		7-28-21	Ramboll		7-28-21 1430	TA
2		7-28-21 1700	TA		7/29/21 9:30	ESTAT
3						

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.: 1600 620	Cooler Temperature(s) °C and Other Remarks: 3.1c

Ver: 11.01.2020

Login Sample Receipt Checklist

Client: Ramboll US Corporation

Job Number: 320-76907-1

Login Number: 76907
List Number: 1
Creator: Nelson, Kym D

List Source: Eurofins TestAmerica, Sacramento

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	1600620
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

eurofins | Environment Testing America

ANALYTICAL REPORT

Eurofins TestAmerica, Sacramento
880 Riverside Parkway
West Sacramento, CA 95605
Tel: (916)373-5600

Laboratory Job ID: 320-76427-1
Client Project/Site: Reichhold Oak Creek
Revision: 1

For:
Ramboll US Corporation
5050 Lincoln Drive, Suite 440
Edina, Minnesota 55436

Attn: Abby Small

Sandie Fredrick

Authorized for release by:
8/17/2021 11:56:03 AM

Sandie Fredrick, Project Manager II
(920)261-1660
sandra.fredrick@eurofinset.com

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Definitions/Glossary

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Qualifiers

LCMS

Qualifier	Qualifier Description
*5-	Isotope dilution analyte is outside acceptance limits, low biased.
*5+	Isotope dilution analyte is outside acceptance limits, high biased.
4	MS, MSD: The analyte present in the original sample is greater than 4 times the matrix spike concentration; therefore, control limits are not applicable.
F1	MS and/or MSD recovery exceeds control limits.
F2	MS/MSD RPD exceeds control limits
I	Value is EMPC (estimated maximum possible concentration).
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Job ID: 320-76427-1

Laboratory: Eurofins TestAmerica, Sacramento

Narrative

Job Narrative
320-76427-1

Comments
No additional comments.

Receipt
The samples were received on 7/19/2021 8:47 AM. Unless otherwise noted below, the samples arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 21.3º C.

Receipt Exceptions
The following samples were received at the laboratory outside the required temperature criteria: SB-1 (0-0.5) (320-76427-1), SB-2 (8-9) (320-76427-2), FB-01-210714 (320-76427-3), EB-01-210714 (320-76427-4), SB-3 (3-4) (320-76427-5), SED-COMP (320-76427-6), SED-COMP-DUP (320-76427-7), SB-4 (7-9) (320-76427-8) and SB-4 (7-9) DUP (320-76427-9).

Client updated PFAS analyte list

LCMS
Method 537 (modified): The continuing calibration verification (CCV) associated with batch 320-508954 recovered above the upper control limit for Perfluorotridecanoic acid (PFTrDA). The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The associated samples are impacted: SB-2 (8-9) (320-76427-2), FB-01-210714 (320-76427-3), EB-01-210714 (320-76427-4), SB-3 (3-4) (320-76427-5), SB-4 (7-9) (320-76427-8), SB-4 (7-9) DUP (320-76427-9) and (CCV 320-508954/3).

Method 537 (modified): The "I" qualifier means the transition mass ratio for the indicated analyte was outside of the established ratio limits. The qualitative identification of the analytes has some degree of uncertainty, and the reported value may have some high bias. However, analyst judgment was used to positively identify the analyte. (CCB 320-508954/1) and (CCVL 320-508954/2)

Method 537 (modified): The "I" qualifier means the transition mass ratio for the indicated analyte was outside of the established ratio limits. The qualitative identification of the analyte has some degree of uncertainty, and the reported value may have some high bias. However, analyst judgment was used to positively identify the analyte. (CCB 320-508965/15)

Method 537 (modified): The "I" qualifier means the transition mass ratio for the indicated analyte(s)was/ were outside of the established ratio limit(s). The qualitative identification of the analyte(s) has/ have some degree of uncertainty, and the reported value(s) may have some high bias. However, analyst judgment was used to positively identify the analytes. SB-3 (3-4) (320-76427-5), SED-COMP (320-76427-6) and (CCB 320-508979/15)

Method 537 (modified): The “I” qualifier means the transition mass ratio for the indicated analyte was outside of the established ratio limits. The qualitative identification of the analyte has some degree of uncertainty, and the reported value may have some high bias. However, analyst judgement was used to positively identify the analyte. SED-COMP (320-76427-6), SED-COMP-DUP (320-76427-7) and (CCB 320-509929/17)

Method 537 (modified): The Isotope Dilution Analyte (IDA) recovery associated with the following sample is below the method recommended limit: SED-COMP-DUP (320-76427-7). This sample was reanalyzed at dilution with improve recovery. Generally, data quality is not considered affected if the IDA signal-to-noise ratio is greater than 10:1, which is achieved for all IDA in the sample(s).

Method 537 (modified): Isotope Dilution Analyte (IDA) recovery is above the method recommended limit for the following sample: SED-COMP-DUP (320-76427-7). This sample was reanalyzed at dilution with improve recovery. Quantitation by isotope dilution generally precludes any adverse effect on data quality due to elevated IDA recoveries.

Method 537 (modified): The "I" qualifier means the transition mass ratio for the indicated analyte was outside of the established ratio limits. The qualitative identification of the analyte has some degree of uncertainty, and the reported value may have some high bias. However, analyst judgment was used to positively identify the analyte. SED-COMP-DUP (320-76427-7)

Method 537 (modified): Results for sample SED-COMP (320-76427-6) and SED-COMP-DUP (320-76427-7) were reported from the

Job ID: 320-76427-1 (Continued)

Laboratory: Eurofins TestAmerica, Sacramento (Continued)

analysis of a diluted extract due to sample matrix in the analysis of the undiluted extract. The dilution factor was applied to the labeled internal standard area counts and these area counts were within acceptance limits

Method 537 (modified): The matrix spike (MS) recoveries for preparation batch 320-510504 and analytical batch 320-510816 were outside control limits. Sample matrix interference and/or non-homogeneity are suspected because the associated laboratory control sample (LCS) recovery was within acceptance limits.

Method 537 (modified): Due to the high concentration of 8:2 FTS, the matrix spike / matrix spike duplicate (MS/MSD) for preparation batch 320-510504 and analytical batch 320-510816 could not be evaluated for accuracy and precision. The associated laboratory control sample (LCS) met acceptance criteria.

Method 537 (modified): The matrix spike / matrix spike duplicate (MS/MSD) precision for preparation batch 320-510504 and analytical batch 320-510816 was outside control limits. Sample matrix interference is suspected.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

General Chemistry
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Organic Prep
Method 3535: Insufficient sample volume was available to perform a matrix spike/matrix spike duplicate (MS/MSD) associated with preparation batch 320-508645. Method: 3535_PFC_28D Matrix: Water

Method SHAKE: The following samples were yellow after extraction/final volume: SED-COMP (320-76427-6) and SED-COMP-DUP (320-76427-7) PFC_IDA_WI Solid

Method SHAKE: Due to the matrix, the initial volumes used for the following samples deviated from the standard procedure: SB-1 (0-0.5) (320-76427-1), (320-76427-A-1 MS) and (320-76427-A-1 MSD). The reporting limits (RLs) have been adjusted proportionately. PFC_IDA Solid

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Detection Summary

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: SB-1 (0-0.5) — Lab Sample ID: 320-76427-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Perfluorobutanoic acid (PFBA)	5.3		1.2	0.27	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluoropentanoic acid (PFPeA)	18	F1	1.2	0.24	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorohexanoic acid (PFHxA)	6.7		1.2	0.18	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluoroheptanoic acid (PFHpA)	6.0		1.2	0.23	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorooctanoic acid (PFOA)	18	F2 F1	1.2	0.32	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorononanoic acid (PFNA)	7.3		1.2	0.13	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorodecanoic acid (PFDA)	2.4		1.2	0.29	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluoroundecanoic acid (PFUnA)	0.57	J	1.2	0.25	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorododecanoic acid (PFDoA)	0.48	J	1.2	0.18	ug/Kg	1	☼	537 (modified)	Total/NA
6:2 FTS	6.4		1.2	0.16	ug/Kg	1	☼	537 (modified)	Total/NA
8:2 FTS	66	F2	1.2	0.21	ug/Kg	1	☼	537 (modified)	Total/NA

Client Sample ID: SB-2 (8-9) — Lab Sample ID: 320-76427-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Perfluorobutanoic acid (PFBA)	0.084	J	0.27	0.061	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluoropentanoic acid (PFPeA)	0.27		0.27	0.055	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorohexanoic acid (PFHxA)	0.16	J	0.27	0.041	ug/Kg	1	☼	537 (modified)	Total/NA
6:2 FTS	0.065	J	0.27	0.036	ug/Kg	1	☼	537 (modified)	Total/NA

Client Sample ID: FB-01-210714 — Lab Sample ID: 320-76427-3

No Detections.

Client Sample ID: EB-01-210714 — Lab Sample ID: 320-76427-4

No Detections.

Client Sample ID: SB-3 (3-4) — Lab Sample ID: 320-76427-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Perfluorobutanoic acid (PFBA)	0.74		0.24	0.055	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluoropentanoic acid (PFPeA)	0.71		0.24	0.049	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorohexanoic acid (PFHxA)	0.065	J	0.24	0.037	ug/Kg	1	☼	537 (modified)	Total/NA

Client Sample ID: SED-COMP — Lab Sample ID: 320-76427-6

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Perfluoropentanoic acid (PFPeA)	26		1.9	0.40	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorohexanoic acid (PFHxA)	21		1.9	0.30	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluoroheptanoic acid (PFHpA)	5.4		1.9	0.37	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorooctanoic acid (PFOA)	6.6		1.9	0.52	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorononanoic acid (PFNA)	3.1		1.9	0.21	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorodecanoic acid (PFDA)	4.2		1.9	0.47	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluoroundecanoic acid (PFUnA)	4.9		1.9	0.41	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorododecanoic acid (PFDoA)	5.2		1.9	0.29	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorotridecanoic acid (PFTriA)	1.3	J	1.9	0.20	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorotetradecanoic acid (PFTeA)	1.3	J	1.9	0.36	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorooctanesulfonamide (FOSA)	0.41	J	1.9	0.32	ug/Kg	1	☼	537 (modified)	Total/NA
NMeFOSAA	0.48	J	1.9	0.22	ug/Kg	1	☼	537 (modified)	Total/NA
NMeFOSE	0.56	J	1.9	0.46	ug/Kg	1	☼	537 (modified)	Total/NA
NEtFOSE	0.64	J	1.9	0.27	ug/Kg	1	☼	537 (modified)	Total/NA
6:2 FTS	28		1.9	0.26	ug/Kg	1	☼	537 (modified)	Total/NA
8:2 FTS	47		1.9	0.34	ug/Kg	1	☼	537 (modified)	Total/NA

This Detection Summary does not include radiochemical test results.

Detection Summary

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: SED-COMP-DUP — Lab Sample ID: 320-76427-7

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Perfluorobutanoic acid (PFBA)	4.5		1.7	0.39	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluoropentanoic acid (PFPeA)	30		1.7	0.35	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorohexanoic acid (PFHxA)	25		1.7	0.26	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluoroheptanoic acid (PFHpA)	6.3		1.7	0.32	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorooctanoic acid (PFOA)	9.0		1.7	0.45	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorononanoic acid (PFNA)	4.8		1.7	0.19	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorodecanoic acid (PFDA)	6.5		1.7	0.41	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluoroundecanoic acid (PFUnA)	9.5		1.7	0.36	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorododecanoic acid (PFDoA)	7.0		1.7	0.26	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorotridecanoic acid (PFTriA)	1.6	J	1.7	0.18	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorotetradecanoic acid (PFTeA)	2.0		1.7	0.32	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorodecanesulfonic acid (PFDS)	0.65	J	1.7	0.44	ug/Kg	1	☼	537 (modified)	Total/NA
Perfluorooctanesulfonamide (FOSA)	0.75	J	1.7	0.28	ug/Kg	1	☼	537 (modified)	Total/NA
NMeFOSAA	0.66	J I	1.7	0.20	ug/Kg	1	☼	537 (modified)	Total/NA
NEtFOSE	0.76	J	1.7	0.24	ug/Kg	1	☼	537 (modified)	Total/NA
6:2 FTS	39		1.7	0.23	ug/Kg	1	☼	537 (modified)	Total/NA
8:2 FTS	65		1.7	0.30	ug/Kg	1	☼	537 (modified)	Total/NA

Client Sample ID: SB-4 (7-9) — Lab Sample ID: 320-76427-8

No Detections.

Client Sample ID: SB-4 (7-9) DUP — Lab Sample ID: 320-76427-9

No Detections.

This Detection Summary does not include radiochemical test results.

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: SB-1 (0-0.5)
Date Collected: 07/14/21 08:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-1
Matrix: Solid
Percent Solids: 81.5

Method: 537 (modified) - Fluorinated Alkyl Substances

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**5.3**		1.2	0.27	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluoropentanoic acid (PFPeA)	**18**	**F1**	1.2	0.24	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluorohexanoic acid (PFHxA)	**6.7**		1.2	0.18	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluoroheptanoic acid (PFHpA)	**6.0**		1.2	0.23	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluorooctanoic acid (PFOA)	**18**	**F2 F1**	1.2	0.32	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluorononanoic acid (PFNA)	**7.3**		1.2	0.13	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluorodecanoic acid (PFDA)	**2.4**		1.2	0.29	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluoroundecanoic acid (PFUnA)	**0.57**	**J**	1.2	0.25	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluorododecanoic acid (PFDoA)	**0.48**	**J**	1.2	0.18	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluorotridecanoic acid (PFTriA)	<0.13		1.2	0.13	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluorotetradecanoic acid (PFTeA)	<0.22		1.2	0.22	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluorobutanesulfonic acid (PFBS)	<0.23		1.2	0.23	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluoropentanesulfonic acid (PFPeS)	<0.22		1.2	0.22	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluorohexanesulfonic acid (PFHxS)	<0.17		1.2	0.17	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.29		1.2	0.29	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluorooctanesulfonic acid (PFOS)	<0.26		1.2	0.26	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluorononanesulfonic acid (PFNS)	<0.17		1.2	0.17	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluorodecanesulfonic acid (PFDS)	<0.31		1.2	0.31	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluorododecanesulfonic acid (PFDoS)	<0.28		1.2	0.28	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
Perfluorooctanesulfonamide (FOSA)	<0.20		1.2	0.20	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
NEtFOSA	<0.28		1.2	0.28	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
NMeFOSA	<0.29		1.2	0.29	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
NMeFOSAA	<0.14		1.2	0.14	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
NEtFOSAA	<0.29		1.2	0.29	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
NMeFOSE	<0.28		1.2	0.28	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
NEtFOSE	<0.17		1.2	0.17	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
4:2 FTS	<0.30		1.2	0.30	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
6:2 FTS	**6.4**		1.2	0.16	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
8:2 FTS	**66**	**F2**	1.2	0.21	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
DONA	<0.23		1.2	0.23	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
HFPO-DA (GenX)	<0.24		1.2	0.24	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
F-53B Major	<0.21		1.2	0.21	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1
F-53B Minor	<0.18		1.2	0.18	ug/Kg	☼	07/27/21 04:48	07/28/21 06:17	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*76*		*25 - 150*	*07/27/21 04:48*	*07/28/21 06:17*	*1*
13C5 PFPeA	*100*		*25 - 150*	*07/27/21 04:48*	*07/28/21 06:17*	*1*
13C2 PFHxA	*104*		*25 - 150*	*07/27/21 04:48*	*07/28/21 06:17*	*1*
13C4 PFHpA	*105*		*25 - 150*	*07/27/21 04:48*	*07/28/21 06:17*	*1*
13C4 PFOA	*99*		*25 - 150*	*07/27/21 04:48*	*07/28/21 06:17*	*1*
13C5 PFNA	*105*		*25 - 150*	*07/27/21 04:48*	*07/28/21 06:17*	*1*
13C2 PFDA	*89*		*25 - 150*	*07/27/21 04:48*	*07/28/21 06:17*	*1*
13C2 PFUnA	*107*		*25 - 150*	*07/27/21 04:48*	*07/28/21 06:17*	*1*
13C2 PFDoA	*100*		*25 - 150*	*07/27/21 04:48*	*07/28/21 06:17*	*1*
13C2 PFTeDA	*84*		*25 - 150*	*07/27/21 04:48*	*07/28/21 06:17*	*1*
13C3 PFBS	*96*		*25 - 150*	*07/27/21 04:48*	*07/28/21 06:17*	*1*

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: SB-1 (0-0.5)
Date Collected: 07/14/21 08:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-1
Matrix: Solid
Percent Solids: 81.5

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
18O2 PFHxS	99		25 - 150	07/27/21 04:48	07/28/21 06:17	1
13C4 PFOS	103		25 - 150	07/27/21 04:48	07/28/21 06:17	1
13C8 FOSA	113		10 - 150	07/27/21 04:48	07/28/21 06:17	1
d3-NMeFOSAA	87		25 - 150	07/27/21 04:48	07/28/21 06:17	1
d5-NEtFOSAA	88		25 - 150	07/27/21 04:48	07/28/21 06:17	1
d-N-MeFOSA-M	102		10 - 150	07/27/21 04:48	07/28/21 06:17	1
d-N-EtFOSA-M	99		10 - 150	07/27/21 04:48	07/28/21 06:17	1
d7-N-MeFOSE-M	69		10 - 150	07/27/21 04:48	07/28/21 06:17	1
d9-N-EtFOSE-M	73		10 - 150	07/27/21 04:48	07/28/21 06:17	1
M2-4:2 FTS	107		25 - 150	07/27/21 04:48	07/28/21 06:17	1
M2-6:2 FTS	118		25 - 150	07/27/21 04:48	07/28/21 06:17	1
M2-8:2 FTS	97		25 - 150	07/27/21 04:48	07/28/21 06:17	1
13C3 HFPO-DA	102		25 - 150	07/27/21 04:48	07/28/21 06:17	1
13C2 10:2 FTS	81		25 - 150	07/27/21 04:48	07/28/21 06:17	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	18.5		0.1	0.1	%			07/20/21 12:16	1
Percent Solids	81.5		0.1	0.1	%			07/20/21 12:16	1

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: SB-2 (8-9)
Date Collected: 07/14/21 10:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-2
Matrix: Solid
Percent Solids: 74.0

Method: 537 (modified) - Fluorinated Alkyl Substances

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**0.084**	**J**	0.27	0.061	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluoropentanoic acid (PFPeA)	**0.27**		0.27	0.055	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluorohexanoic acid (PFHxA)	**0.16**	**J**	0.27	0.041	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluoroheptanoic acid (PFHpA)	<0.051		0.27	0.051	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluorooctanoic acid (PFOA)	<0.070		0.27	0.070	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluorononanoic acid (PFNA)	<0.029		0.27	0.029	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluorodecanoic acid (PFDA)	<0.064		0.27	0.064	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluoroundecanoic acid (PFUnA)	<0.056		0.27	0.056	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluorododecanoic acid (PFDoA)	<0.040		0.27	0.040	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluorotridecanoic acid (PFTriA)	<0.028		0.27	0.028	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluorotetradecanoic acid (PFTeA)	<0.049		0.27	0.049	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluorobutanesulfonic acid (PFBS)	<0.051		0.27	0.051	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluoropentanesulfonic acid (PFPeS)	<0.049		0.27	0.049	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluorohexanesulfonic acid (PFHxS)	<0.039		0.27	0.039	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.065		0.27	0.065	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluorooctanesulfonic acid (PFOS)	<0.057		0.27	0.057	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluorononanesulfonic acid (PFNS)	<0.039		0.27	0.039	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluorodecanesulfonic acid (PFDS)	<0.069		0.27	0.069	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluorododecanesulfonic acid (PFDoS)	<0.063		0.27	0.063	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
Perfluorooctanesulfonamide (FOSA)	<0.044		0.27	0.044	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
NEtFOSA	<0.063		0.27	0.063	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
NMeFOSA	<0.065		0.27	0.065	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
NMeFOSAA	<0.031		0.27	0.031	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
NEtFOSAA	<0.064		0.27	0.064	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
NMeFOSE	<0.063		0.27	0.063	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
NEtFOSE	<0.037		0.27	0.037	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
4:2 FTS	<0.068		0.27	0.068	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
6:2 FTS	**0.065**	**J**	0.27	0.036	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
8:2 FTS	<0.047		0.27	0.047	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
DONA	<0.052		0.27	0.052	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
HFPO-DA (GenX)	<0.055		0.27	0.055	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
F-53B Major	<0.047		0.27	0.047	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1
F-53B Minor	<0.041		0.27	0.041	ug/Kg	☼	07/20/21 18:41	07/23/21 07:48	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*67*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:48*	*1*
13C5 PFPeA	*71*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:48*	*1*
13C2 PFHxA	*76*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:48*	*1*
13C4 PFHpA	*76*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:48*	*1*
13C4 PFOA	*78*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:48*	*1*
13C5 PFNA	*71*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:48*	*1*
13C2 PFDA	*80*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:48*	*1*
13C2 PFUnA	*74*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:48*	*1*
13C2 PFDoA	*79*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:48*	*1*
13C2 PFTeDA	*68*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:48*	*1*
13C3 PFBS	*83*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:48*	*1*
18O2 PFHxS	*74*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:48*	*1*
13C4 PFOS	*70*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:48*	*1*

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: SB-2 (8-9)
Date Collected: 07/14/21 10:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-2
Matrix: Solid
Percent Solids: 74.0

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C8 FOSA	75		10 - 150	07/20/21 18:41	07/23/21 07:48	1
d3-NMeFOSAA	75		25 - 150	07/20/21 18:41	07/23/21 07:48	1
d5-NEtFOSAA	85		25 - 150	07/20/21 18:41	07/23/21 07:48	1
d-N-MeFOSA-M	75		10 - 150	07/20/21 18:41	07/23/21 07:48	1
d-N-EtFOSA-M	66		10 - 150	07/20/21 18:41	07/23/21 07:48	1
d7-N-MeFOSE-M	48		10 - 150	07/20/21 18:41	07/23/21 07:48	1
d9-N-EtFOSE-M	58		10 - 150	07/20/21 18:41	07/23/21 07:48	1
M2-4:2 FTS	78		25 - 150	07/20/21 18:41	07/23/21 07:48	1
M2-6:2 FTS	82		25 - 150	07/20/21 18:41	07/23/21 07:48	1
M2-8:2 FTS	86		25 - 150	07/20/21 18:41	07/23/21 07:48	1
13C3 HFPO-DA	71		25 - 150	07/20/21 18:41	07/23/21 07:48	1
13C2 10:2 FTS	99		25 - 150	07/20/21 18:41	07/23/21 07:48	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	26.0		0.1	0.1	%			07/20/21 12:16	1
Percent Solids	74.0		0.1	0.1	%			07/20/21 12:16	1

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: FB-01-210714
Date Collected: 07/14/21 12:05
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-3
Matrix: Water

Method: 537 (modified) - Fluorinated Alkyl Substances

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	<2.0		4.2	2.0	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluoropentanoic acid (PFPeA)	<0.41		1.7	0.41	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluorohexanoic acid (PFHxA)	<0.48		1.7	0.48	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluoroheptanoic acid (PFHpA)	<0.21		1.7	0.21	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluorooctanoic acid (PFOA)	<0.71		1.7	0.71	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluorononanoic acid (PFNA)	<0.22		1.7	0.22	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluorodecanoic acid (PFDA)	<0.26		1.7	0.26	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluoroundecanoic acid (PFUnA)	<0.91		1.7	0.91	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluorododecanoic acid (PFDoA)	<0.46		1.7	0.46	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluorotridecanoic acid (PFTriA)	<1.1		1.7	1.1	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluorotetradecanoic acid (PFTeA)	<0.61		1.7	0.61	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluorobutanesulfonic acid (PFBS)	<0.17		1.7	0.17	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluoropentanesulfonic acid (PFPeS)	<0.25		1.7	0.25	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluorohexanesulfonic acid (PFHxS)	<0.47		1.7	0.47	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.16		1.7	0.16	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluorooctanesulfonic acid (PFOS)	<0.45		1.7	0.45	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluorononanesulfonic acid (PFNS)	<0.31		1.7	0.31	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluorodecanesulfonic acid (PFDS)	<0.27		1.7	0.27	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluorododecanesulfonic acid (PFDoS)	<0.81		1.7	0.81	ng/L		07/20/21 19:23	07/21/21 22:22	1
Perfluorooctanesulfonamide (FOSA)	<0.81		1.7	0.81	ng/L		07/20/21 19:23	07/21/21 22:22	1
NEtFOSA	<0.72		1.7	0.72	ng/L		07/20/21 19:23	07/21/21 22:22	1
NMeFOSA	<0.36		1.7	0.36	ng/L		07/20/21 19:23	07/21/21 22:22	1
NMeFOSAA	<1.0		4.2	1.0	ng/L		07/20/21 19:23	07/21/21 22:22	1
NEtFOSAA	<1.1		4.2	1.1	ng/L		07/20/21 19:23	07/21/21 22:22	1
NMeFOSE	<1.2		3.3	1.2	ng/L		07/20/21 19:23	07/21/21 22:22	1
NEtFOSE	<0.71		1.7	0.71	ng/L		07/20/21 19:23	07/21/21 22:22	1
4:2 FTS	<0.20		1.7	0.20	ng/L		07/20/21 19:23	07/21/21 22:22	1
6:2 FTS	<2.1		4.2	2.1	ng/L		07/20/21 19:23	07/21/21 22:22	1
8:2 FTS	<0.38		1.7	0.38	ng/L		07/20/21 19:23	07/21/21 22:22	1
DONA	<0.33		1.7	0.33	ng/L		07/20/21 19:23	07/21/21 22:22	1
HFPO-DA (GenX)	<1.2		3.3	1.2	ng/L		07/20/21 19:23	07/21/21 22:22	1
F-53B Major	<0.20		1.7	0.20	ng/L		07/20/21 19:23	07/21/21 22:22	1
F-53B Minor	<0.27		1.7	0.27	ng/L		07/20/21 19:23	07/21/21 22:22	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*103*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:22*	*1*
13C5 PFPeA	*95*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:22*	*1*
13C2 PFHxA	*92*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:22*	*1*
13C4 PFHpA	*96*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:22*	*1*
13C4 PFOA	*93*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:22*	*1*
13C5 PFNA	*88*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:22*	*1*
13C2 PFDA	*89*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:22*	*1*
13C2 PFUnA	*88*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:22*	*1*
13C2 PFDoA	*87*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:22*	*1*
13C2 PFTeDA	*95*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:22*	*1*
13C3 PFBS	*100*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:22*	*1*
18O2 PFHxS	*90*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:22*	*1*
13C4 PFOS	*96*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:22*	*1*

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: FB-01-210714
Date Collected: 07/14/21 12:05
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-3
Matrix: Water

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C8 FOSA	88		10 - 150	07/20/21 19:23	07/21/21 22:22	1
d3-NMeFOSAA	80		25 - 150	07/20/21 19:23	07/21/21 22:22	1
d5-NEtFOSAA	92		25 - 150	07/20/21 19:23	07/21/21 22:22	1
d-N-MeFOSA-M	83		10 - 150	07/20/21 19:23	07/21/21 22:22	1
d-N-EtFOSA-M	83		10 - 150	07/20/21 19:23	07/21/21 22:22	1
d7-N-MeFOSE-M	87		10 - 150	07/20/21 19:23	07/21/21 22:22	1
d9-N-EtFOSE-M	83		10 - 150	07/20/21 19:23	07/21/21 22:22	1
M2-4:2 FTS	63		25 - 150	07/20/21 19:23	07/21/21 22:22	1
M2-6:2 FTS	78		25 - 150	07/20/21 19:23	07/21/21 22:22	1
M2-8:2 FTS	76		25 - 150	07/20/21 19:23	07/21/21 22:22	1
13C3 HFPO-DA	97		25 - 150	07/20/21 19:23	07/21/21 22:22	1
13C2 10:2 FTS	89		25 - 150	07/20/21 19:23	07/21/21 22:22	1

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: EB-01-210714
Date Collected: 07/14/21 12:15
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-4
Matrix: Water

Method: 537 (modified) - Fluorinated Alkyl Substances

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	<2.1		4.3	2.1	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluoropentanoic acid (PFPeA)	<0.42		1.7	0.42	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluorohexanoic acid (PFHxA)	<0.50		1.7	0.50	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluoroheptanoic acid (PFHpA)	<0.21		1.7	0.21	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluorooctanoic acid (PFOA)	<0.73		1.7	0.73	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluorononanoic acid (PFNA)	<0.23		1.7	0.23	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluorodecanoic acid (PFDA)	<0.27		1.7	0.27	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluoroundecanoic acid (PFUnA)	<0.95		1.7	0.95	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluorododecanoic acid (PFDoA)	<0.47		1.7	0.47	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluorotridecanoic acid (PFTriA)	<1.1		1.7	1.1	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluorotetradecanoic acid (PFTeA)	<0.63		1.7	0.63	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluorobutanesulfonic acid (PFBS)	<0.17		1.7	0.17	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluoropentanesulfonic acid (PFPeS)	<0.26		1.7	0.26	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluorohexanesulfonic acid (PFHxS)	<0.49		1.7	0.49	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.16		1.7	0.16	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluorooctanesulfonic acid (PFOS)	<0.46		1.7	0.46	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluorononanesulfonic acid (PFNS)	<0.32		1.7	0.32	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluorodecanesulfonic acid (PFDS)	<0.28		1.7	0.28	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluorododecanesulfonic acid (PFDoS)	<0.83		1.7	0.83	ng/L		07/20/21 19:23	07/21/21 22:32	1
Perfluorooctanesulfonamide (FOSA)	<0.84		1.7	0.84	ng/L		07/20/21 19:23	07/21/21 22:32	1
NEtFOSA	<0.75		1.7	0.75	ng/L		07/20/21 19:23	07/21/21 22:32	1
NMeFOSA	<0.37		1.7	0.37	ng/L		07/20/21 19:23	07/21/21 22:32	1
NMeFOSAA	<1.0		4.3	1.0	ng/L		07/20/21 19:23	07/21/21 22:32	1
NEtFOSAA	<1.1		4.3	1.1	ng/L		07/20/21 19:23	07/21/21 22:32	1
NMeFOSE	<1.2		3.4	1.2	ng/L		07/20/21 19:23	07/21/21 22:32	1
NEtFOSE	<0.73		1.7	0.73	ng/L		07/20/21 19:23	07/21/21 22:32	1
4:2 FTS	<0.21		1.7	0.21	ng/L		07/20/21 19:23	07/21/21 22:32	1
6:2 FTS	<2.1		4.3	2.1	ng/L		07/20/21 19:23	07/21/21 22:32	1
8:2 FTS	<0.40		1.7	0.40	ng/L		07/20/21 19:23	07/21/21 22:32	1
DONA	<0.34		1.7	0.34	ng/L		07/20/21 19:23	07/21/21 22:32	1
HFPO-DA (GenX)	<1.3		3.4	1.3	ng/L		07/20/21 19:23	07/21/21 22:32	1
F-53B Major	<0.21		1.7	0.21	ng/L		07/20/21 19:23	07/21/21 22:32	1
F-53B Minor	<0.28		1.7	0.28	ng/L		07/20/21 19:23	07/21/21 22:32	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*98*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:32*	*1*
13C5 PFPeA	*84*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:32*	*1*
13C2 PFHxA	*83*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:32*	*1*
13C4 PFHpA	*92*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:32*	*1*
13C4 PFOA	*95*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:32*	*1*
13C5 PFNA	*86*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:32*	*1*
13C2 PFDA	*85*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:32*	*1*
13C2 PFUnA	*81*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:32*	*1*
13C2 PFDoA	*94*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:32*	*1*
13C2 PFTeDA	*90*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:32*	*1*
13C3 PFBS	*90*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:32*	*1*
18O2 PFHxS	*85*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:32*	*1*
13C4 PFOS	*87*		*25 - 150*	*07/20/21 19:23*	*07/21/21 22:32*	*1*

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: EB-01-210714
Date Collected: 07/14/21 12:15
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-4
Matrix: Water

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C8 FOSA	83		10 - 150	07/20/21 19:23	07/21/21 22:32	1
d3-NMeFOSAA	82		25 - 150	07/20/21 19:23	07/21/21 22:32	1
d5-NEtFOSAA	84		25 - 150	07/20/21 19:23	07/21/21 22:32	1
d-N-MeFOSA-M	86		10 - 150	07/20/21 19:23	07/21/21 22:32	1
d-N-EtFOSA-M	72		10 - 150	07/20/21 19:23	07/21/21 22:32	1
d7-N-MeFOSE-M	84		10 - 150	07/20/21 19:23	07/21/21 22:32	1
d9-N-EtFOSE-M	77		10 - 150	07/20/21 19:23	07/21/21 22:32	1
M2-4:2 FTS	62		25 - 150	07/20/21 19:23	07/21/21 22:32	1
M2-6:2 FTS	74		25 - 150	07/20/21 19:23	07/21/21 22:32	1
M2-8:2 FTS	73		25 - 150	07/20/21 19:23	07/21/21 22:32	1
13C3 HFPO-DA	90		25 - 150	07/20/21 19:23	07/21/21 22:32	1
13C2 10:2 FTS	81		25 - 150	07/20/21 19:23	07/21/21 22:32	1

Client Sample ID: SB-3 (3-4)
Date Collected: 07/14/21 12:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-5
Matrix: Solid
Percent Solids: 77.0

Method: 537 (modified) - Fluorinated Alkyl Substances

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**0.74**		0.24	0.055	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluoropentanoic acid (PFPeA)	**0.71**		0.24	0.049	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluorohexanoic acid (PFHxA)	**0.065**	**J**	0.24	0.037	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluoroheptanoic acid (PFHpA)	<0.046		0.24	0.046	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluorooctanoic acid (PFOA)	<0.064		0.24	0.064	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluorononanoic acid (PFNA)	<0.026		0.24	0.026	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluorodecanoic acid (PFDA)	<0.058		0.24	0.058	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluoroundecanoic acid (PFUnA)	<0.051		0.24	0.051	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluorododecanoic acid (PFDoA)	<0.036		0.24	0.036	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluorotridecanoic acid (PFTriA)	<0.025		0.24	0.025	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluorotetradecanoic acid (PFTeA)	<0.045		0.24	0.045	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluorobutanesulfonic acid (PFBS)	<0.046		0.24	0.046	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluoropentanesulfonic acid (PFPeS)	<0.045		0.24	0.045	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluorohexanesulfonic acid (PFHxS)	<0.035		0.24	0.035	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.059		0.24	0.059	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluorooctanesulfonic acid (PFOS)	<0.052		0.24	0.052	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluorononanesulfonic acid (PFNS)	<0.035		0.24	0.035	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluorodecanesulfonic acid (PFDS)	<0.063		0.24	0.063	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluorododecanesulfonic acid (PFDoS)	<0.057		0.24	0.057	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
Perfluorooctanesulfonamide (FOSA)	<0.040		0.24	0.040	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
NEtFOSA	<0.057		0.24	0.057	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
NMeFOSA	<0.059		0.24	0.059	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
NMeFOSAA	<0.028		0.24	0.028	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
NEtFOSAA	<0.058		0.24	0.058	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
NMeFOSE	<0.057		0.24	0.057	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
NEtFOSE	<0.034		0.24	0.034	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
4:2 FTS	<0.061		0.24	0.061	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
6:2 FTS	<0.032		0.24	0.032	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
8:2 FTS	<0.042		0.24	0.042	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
DONA	<0.047		0.24	0.047	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
HFPO-DA (GenX)	<0.049		0.24	0.049	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
F-53B Major	<0.042		0.24	0.042	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1
F-53B Minor	<0.037		0.24	0.037	ug/Kg	☼	07/20/21 18:41	07/23/21 07:57	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*59*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:57*	*1*
13C5 PFPeA	*67*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:57*	*1*
13C2 PFHxA	*66*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:57*	*1*
13C4 PFHpA	*69*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:57*	*1*
13C4 PFOA	*64*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:57*	*1*
13C5 PFNA	*70*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:57*	*1*
13C2 PFDA	*67*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:57*	*1*
13C2 PFUnA	*70*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:57*	*1*
13C2 PFDoA	*67*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:57*	*1*
13C2 PFTeDA	*64*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:57*	*1*
13C3 PFBS	*69*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:57*	*1*
18O2 PFHxS	*64*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:57*	*1*
13C4 PFOS	*60*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:57*	*1*

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: SB-3 (3-4)
Date Collected: 07/14/21 12:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-5
Matrix: Solid
Percent Solids: 77.0

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C8 FOSA	64		10 - 150	07/20/21 18:41	07/23/21 07:57	1
d3-NMeFOSAA	63		25 - 150	07/20/21 18:41	07/23/21 07:57	1
d5-NEtFOSAA	73		25 - 150	07/20/21 18:41	07/23/21 07:57	1
d-N-MeFOSA-M	68		10 - 150	07/20/21 18:41	07/23/21 07:57	1
d-N-EtFOSA-M	64		10 - 150	07/20/21 18:41	07/23/21 07:57	1
d7-N-MeFOSE-M	47		10 - 150	07/20/21 18:41	07/23/21 07:57	1
d9-N-EtFOSE-M	51		10 - 150	07/20/21 18:41	07/23/21 07:57	1
M2-4:2 FTS	77		25 - 150	07/20/21 18:41	07/23/21 07:57	1
M2-6:2 FTS	85		25 - 150	07/20/21 18:41	07/23/21 07:57	1
M2-8:2 FTS	87		25 - 150	07/20/21 18:41	07/23/21 07:57	1
13C3 HFPO-DA	66		25 - 150	07/20/21 18:41	07/23/21 07:57	1
13C2 10:2 FTS	88		25 - 150	07/20/21 18:41	07/23/21 07:57	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	23.0		0.1	0.1	%			07/20/21 12:16	1
Percent Solids	77.0		0.1	0.1	%			07/20/21 12:16	1

Client Sample ID: SED-COMP

Date Collected: 07/14/21 13:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-6

Matrix: Solid
Percent Solids: 9.9

Method: 537 (modified) - Fluorinated Alkyl Substances

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoropentanoic acid (PFPeA)	**26**		1.9	0.40	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluorohexanoic acid (PFHxA)	**21**		1.9	0.30	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluoroheptanoic acid (PFHpA)	**5.4**		1.9	0.37	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluorooctanoic acid (PFOA)	**6.6**		1.9	0.52	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluorononanoic acid (PFNA)	**3.1**		1.9	0.21	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluorodecanoic acid (PFDA)	**4.2**		1.9	0.47	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluoroundecanoic acid (PFUnA)	**4.9**		1.9	0.41	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluorododecanoic acid (PFDoA)	**5.2**		1.9	0.29	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluorotridecanoic acid (PFTriA)	**1.3**	**J**	1.9	0.20	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluorotetradecanoic acid (PFTeA)	**1.3**	**J**	1.9	0.36	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluorobutanesulfonic acid (PFBS)	<0.37		1.9	0.37	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluoropentanesulfonic acid (PFPeS)	<0.36		1.9	0.36	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluorohexanesulfonic acid (PFHxS)	<0.28		1.9	0.28	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.48		1.9	0.48	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluorooctanesulfonic acid (PFOS)	<0.42		1.9	0.42	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluorononanesulfonic acid (PFNS)	<0.28		1.9	0.28	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluorodecanesulfonic acid (PFDS)	<0.51		1.9	0.51	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluorododecanesulfonic acid (PFDoS)	<0.46		1.9	0.46	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
Perfluorooctanesulfonamide (FOSA)	**0.41**	**J**	1.9	0.32	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
NEtFOSA	<0.46		1.9	0.46	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
NMeFOSA	<0.48		1.9	0.48	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
NMeFOSAA	**0.48**	**J**	1.9	0.22	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
NEtFOSAA	<0.47		1.9	0.47	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
NMeFOSE	**0.56**	**J**	1.9	0.46	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
NEtFOSE	**0.64**	**J**	1.9	0.27	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
4:2 FTS	<0.50		1.9	0.50	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
6:2 FTS	**28**		1.9	0.26	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
8:2 FTS	**47**		1.9	0.34	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
DONA	<0.38		1.9	0.38	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
HFPO-DA (GenX)	<0.40		1.9	0.40	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
F-53B Major	<0.34		1.9	0.34	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1
F-53B Minor	<0.30		1.9	0.30	ug/Kg	☼	07/20/21 18:41	07/24/21 18:35	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C5 PFPeA	*45*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:35*	*1*
13C2 PFHxA	*51*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:35*	*1*
13C4 PFHpA	*48*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:35*	*1*
13C4 PFOA	*51*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:35*	*1*
13C5 PFNA	*63*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:35*	*1*
13C2 PFDA	*62*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:35*	*1*
13C2 PFUnA	*58*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:35*	*1*
13C2 PFDoA	*51*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:35*	*1*
13C2 PFTeDA	*49*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:35*	*1*
13C3 PFBS	*60*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:35*	*1*
18O2 PFHxS	*52*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:35*	*1*

Client Sample ID: SED-COMP
Date Collected: 07/14/21 13:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-6
Matrix: Solid
Percent Solids: 9.9

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFOS	58		25 - 150	07/20/21 18:41	07/24/21 18:35	1
13C8 FOSA	52		10 - 150	07/20/21 18:41	07/24/21 18:35	1
d3-NMeFOSAA	48		25 - 150	07/20/21 18:41	07/24/21 18:35	1
d5-NEtFOSAA	59		25 - 150	07/20/21 18:41	07/24/21 18:35	1
d-N-MeFOSA-M	45		10 - 150	07/20/21 18:41	07/24/21 18:35	1
d-N-EtFOSA-M	49		10 - 150	07/20/21 18:41	07/24/21 18:35	1
d7-N-MeFOSE-M	34		10 - 150	07/20/21 18:41	07/24/21 18:35	1
d9-N-EtFOSE-M	31		10 - 150	07/20/21 18:41	07/24/21 18:35	1
M2-4:2 FTS	138		25 - 150	07/20/21 18:41	07/24/21 18:35	1
M2-6:2 FTS	136		25 - 150	07/20/21 18:41	07/24/21 18:35	1
M2-8:2 FTS	139		25 - 150	07/20/21 18:41	07/24/21 18:35	1
13C3 HFPO-DA	54		25 - 150	07/20/21 18:41	07/24/21 18:35	1
13C2 10:2 FTS	86		25 - 150	07/20/21 18:41	07/24/21 18:35	1

Method: 537 (modified) - Fluorinated Alkyl Substances - DL

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	<4.5		19	4.5	ug/Kg	☼	07/20/21 18:41	07/24/21 18:16	10

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFBA	11	*5-	25 - 150	07/20/21 18:41	07/24/21 18:16	10

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	90.1		0.1	0.1	%			07/20/21 12:16	1
Percent Solids	9.9		0.1	0.1	%			07/20/21 12:16	1

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: SED-COMP-DUP
Date Collected: 07/14/21 13:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-7
Matrix: Solid
Percent Solids: 11.2

Method: 537 (modified) - Fluorinated Alkyl Substances

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**4.5**		1.7	0.39	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluoropentanoic acid (PFPeA)	**30**		1.7	0.35	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluorohexanoic acid (PFHxA)	**25**		1.7	0.26	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluoroheptanoic acid (PFHpA)	**6.3**		1.7	0.32	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluorooctanoic acid (PFOA)	**9.0**		1.7	0.45	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluorononanoic acid (PFNA)	**4.8**		1.7	0.19	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluorodecanoic acid (PFDA)	**6.5**		1.7	0.41	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluoroundecanoic acid (PFUnA)	**9.5**		1.7	0.36	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluorododecanoic acid (PFDoA)	**7.0**		1.7	0.26	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluorotridecanoic acid (PFTriA)	**1.6**	**J**	1.7	0.18	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluorotetradecanoic acid (PFTeA)	**2.0**		1.7	0.32	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluorobutanesulfonic acid (PFBS)	<0.32		1.7	0.32	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluoropentanesulfonic acid (PFPeS)	<0.32		1.7	0.32	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluorohexanesulfonic acid (PFHxS)	<0.25		1.7	0.25	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.42		1.7	0.42	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluorooctanesulfonic acid (PFOS)	<0.37		1.7	0.37	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluorononanesulfonic acid (PFNS)	<0.25		1.7	0.25	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluorodecanesulfonic acid (PFDS)	**0.65**	**J**	1.7	0.44	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluorododecanesulfonic acid (PFDoS)	<0.40		1.7	0.40	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
Perfluorooctanesulfonamide (FOSA)	**0.75**	**J**	1.7	0.28	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
NEtFOSA	<0.40		1.7	0.40	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
NMeFOSA	<0.42		1.7	0.42	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
NMeFOSAA	**0.66**	**J I**	1.7	0.20	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
NEtFOSAA	<0.41		1.7	0.41	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
NMeFOSE	<0.40		1.7	0.40	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
NEtFOSE	**0.76**	**J**	1.7	0.24	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
4:2 FTS	<0.43		1.7	0.43	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
6:2 FTS	**39**		1.7	0.23	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
8:2 FTS	**65**		1.7	0.30	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
DONA	<0.33		1.7	0.33	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
HFPO-DA (GenX)	<0.35		1.7	0.35	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
F-53B Major	<0.30		1.7	0.30	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1
F-53B Minor	<0.26		1.7	0.26	ug/Kg	☼	07/20/21 18:41	07/24/21 18:44	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*10*	**5-*	*25 - 150*	*07/20/21 18:41*	*07/24/21 18:44*	*1*
13C5 PFPeA	*57*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:44*	*1*
13C2 PFHxA	*57*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:44*	*1*
13C4 PFHpA	*56*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:44*	*1*
13C4 PFOA	*62*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:44*	*1*
13C5 PFNA	*75*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:44*	*1*
13C2 PFDA	*75*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:44*	*1*
13C2 PFUnA	*59*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:44*	*1*
13C2 PFDoA	*57*		*25 - 150*	*07/20/21 18:41*	*07/24/21 18:44*	*1*

Client Sample ID: SED-COMP-DUP
Date Collected: 07/14/21 13:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-7
Matrix: Solid
Percent Solids: 11.2

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C2 PFTeDA	55		25 - 150	07/20/21 18:41	07/24/21 18:44	1
13C3 PFBS	78		25 - 150	07/20/21 18:41	07/24/21 18:44	1
18O2 PFHxS	62		25 - 150	07/20/21 18:41	07/24/21 18:44	1
13C4 PFOS	78		25 - 150	07/20/21 18:41	07/24/21 18:44	1
13C8 FOSA	61		10 - 150	07/20/21 18:41	07/24/21 18:44	1
d3-NMeFOSAA	60		25 - 150	07/20/21 18:41	07/24/21 18:44	1
d5-NEtFOSAA	65		25 - 150	07/20/21 18:41	07/24/21 18:44	1
d-N-MeFOSA-M	58		10 - 150	07/20/21 18:41	07/24/21 18:44	1
d-N-EtFOSA-M	53		10 - 150	07/20/21 18:41	07/24/21 18:44	1
d7-N-MeFOSE-M	43		10 - 150	07/20/21 18:41	07/24/21 18:44	1
d9-N-EtFOSE-M	41		10 - 150	07/20/21 18:41	07/24/21 18:44	1
M2-4:2 FTS	155	*5+	25 - 150	07/20/21 18:41	07/24/21 18:44	1
M2-6:2 FTS	178	*5+	25 - 150	07/20/21 18:41	07/24/21 18:44	1
M2-8:2 FTS	166	*5+	25 - 150	07/20/21 18:41	07/24/21 18:44	1
13C3 HFPO-DA	62		25 - 150	07/20/21 18:41	07/24/21 18:44	1
13C2 10:2 FTS	97		25 - 150	07/20/21 18:41	07/24/21 18:44	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	88.8		0.1	0.1	%			07/20/21 12:16	1
Percent Solids	11.2		0.1	0.1	%			07/20/21 12:16	1

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: SB-4 (7-9)
Date Collected: 07/14/21 14:30
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-8
Matrix: Solid
Percent Solids: 78.8

Method: 537 (modified) - Fluorinated Alkyl Substances

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	<0.054		0.23	0.054	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluoropentanoic acid (PFPeA)	<0.048		0.23	0.048	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluorohexanoic acid (PFHxA)	<0.036		0.23	0.036	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluoroheptanoic acid (PFHpA)	<0.045		0.23	0.045	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluorooctanoic acid (PFOA)	<0.062		0.23	0.062	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluorononanoic acid (PFNA)	<0.026		0.23	0.026	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluorodecanoic acid (PFDA)	<0.056		0.23	0.056	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluoroundecanoic acid (PFUnA)	<0.049		0.23	0.049	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluorododecanoic acid (PFDoA)	<0.035		0.23	0.035	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluorotridecanoic acid (PFTriA)	<0.025		0.23	0.025	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluorotetradecanoic acid (PFTeA)	<0.043		0.23	0.043	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluorobutanesulfonic acid (PFBS)	<0.045		0.23	0.045	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluoropentanesulfonic acid (PFPeS)	<0.043		0.23	0.043	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluorohexanesulfonic acid (PFHxS)	<0.034		0.23	0.034	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.057		0.23	0.057	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluorooctanesulfonic acid (PFOS)	<0.050		0.23	0.050	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluorononanesulfonic acid (PFNS)	<0.034		0.23	0.034	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluorodecanesulfonic acid (PFDS)	<0.061		0.23	0.061	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluorododecanesulfonic acid (PFDoS)	<0.055		0.23	0.055	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
Perfluorooctanesulfonamide (FOSA)	<0.039		0.23	0.039	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
NEtFOSA	<0.055		0.23	0.055	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
NMeFOSA	<0.057		0.23	0.057	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
NMeFOSAA	<0.027		0.23	0.027	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
NEtFOSAA	<0.056		0.23	0.056	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
NMeFOSE	<0.055		0.23	0.055	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
NEtFOSE	<0.033		0.23	0.033	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
4:2 FTS	<0.060		0.23	0.060	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
6:2 FTS	<0.032		0.23	0.032	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
8:2 FTS	<0.041		0.23	0.041	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
DONA	<0.046		0.23	0.046	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
HFPO-DA (GenX)	<0.048		0.23	0.048	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
F-53B Major	<0.041		0.23	0.041	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1
F-53B Minor	<0.036		0.23	0.036	ug/Kg	☼	07/20/21 18:41	07/23/21 08:45	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*68*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:45*	*1*
13C5 PFPeA	*74*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:45*	*1*
13C2 PFHxA	*74*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:45*	*1*
13C4 PFHpA	*73*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:45*	*1*
13C4 PFOA	*76*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:45*	*1*
13C5 PFNA	*80*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:45*	*1*
13C2 PFDA	*80*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:45*	*1*
13C2 PFUnA	*77*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:45*	*1*
13C2 PFDoA	*76*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:45*	*1*
13C2 PFTeDA	*66*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:45*	*1*
13C3 PFBS	*83*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:45*	*1*
18O2 PFHxS	*76*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:45*	*1*
13C4 PFOS	*72*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:45*	*1*

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: SB-4 (7-9)
Date Collected: 07/14/21 14:30
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-8
Matrix: Solid
Percent Solids: 78.8

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C8 FOSA	77		10 - 150	07/20/21 18:41	07/23/21 08:45	1
d3-NMeFOSAA	84		25 - 150	07/20/21 18:41	07/23/21 08:45	1
d5-NEtFOSAA	84		25 - 150	07/20/21 18:41	07/23/21 08:45	1
d-N-MeFOSA-M	81		10 - 150	07/20/21 18:41	07/23/21 08:45	1
d-N-EtFOSA-M	72		10 - 150	07/20/21 18:41	07/23/21 08:45	1
d7-N-MeFOSE-M	49		10 - 150	07/20/21 18:41	07/23/21 08:45	1
d9-N-EtFOSE-M	50		10 - 150	07/20/21 18:41	07/23/21 08:45	1
M2-4:2 FTS	87		25 - 150	07/20/21 18:41	07/23/21 08:45	1
M2-6:2 FTS	99		25 - 150	07/20/21 18:41	07/23/21 08:45	1
M2-8:2 FTS	103		25 - 150	07/20/21 18:41	07/23/21 08:45	1
13C3 HFPO-DA	75		25 - 150	07/20/21 18:41	07/23/21 08:45	1
13C2 10:2 FTS	96		25 - 150	07/20/21 18:41	07/23/21 08:45	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	21.2		0.1	0.1	%			07/20/21 12:16	1
Percent Solids	78.8		0.1	0.1	%			07/20/21 12:16	1

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: SB-4 (7-9) DUP
Date Collected: 07/14/21 14:30
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-9
Matrix: Solid
Percent Solids: 79.5

Method: 537 (modified) - Fluorinated Alkyl Substances

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	<0.052		0.22	0.052	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluoropentanoic acid (PFPeA)	<0.046		0.22	0.046	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluorohexanoic acid (PFHxA)	<0.035		0.22	0.035	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluoroheptanoic acid (PFHpA)	<0.043		0.22	0.043	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluorooctanoic acid (PFOA)	<0.060		0.22	0.060	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluorononanoic acid (PFNA)	<0.025		0.22	0.025	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluorodecanoic acid (PFDA)	<0.054		0.22	0.054	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluoroundecanoic acid (PFUnA)	<0.047		0.22	0.047	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluorododecanoic acid (PFDoA)	<0.034		0.22	0.034	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluorotridecanoic acid (PFTriA)	<0.024		0.22	0.024	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluorotetradecanoic acid (PFTeA)	<0.042		0.22	0.042	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluorobutanesulfonic acid (PFBS)	<0.043		0.22	0.043	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluoropentanesulfonic acid (PFPeS)	<0.042		0.22	0.042	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluorohexanesulfonic acid (PFHxS)	<0.033		0.22	0.033	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.055		0.22	0.055	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluorooctanesulfonic acid (PFOS)	<0.048		0.22	0.048	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluorononanesulfonic acid (PFNS)	<0.033		0.22	0.033	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluorodecanesulfonic acid (PFDS)	<0.058		0.22	0.058	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluorododecanesulfonic acid (PFDoS)	<0.053		0.22	0.053	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
Perfluorooctanesulfonamide (FOSA)	<0.037		0.22	0.037	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
NEtFOSA	<0.053		0.22	0.053	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
NMeFOSA	<0.055		0.22	0.055	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
NMeFOSAA	<0.026		0.22	0.026	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
NEtFOSAA	<0.054		0.22	0.054	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
NMeFOSE	<0.053		0.22	0.053	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
NEtFOSE	<0.031		0.22	0.031	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
4:2 FTS	<0.057		0.22	0.057	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
6:2 FTS	<0.030		0.22	0.030	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
8:2 FTS	<0.039		0.22	0.039	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
DONA	<0.044		0.22	0.044	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
HFPO-DA (GenX)	<0.046		0.22	0.046	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
F-53B Major	<0.039		0.22	0.039	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1
F-53B Minor	<0.035		0.22	0.035	ug/Kg	☼	07/20/21 18:41	07/23/21 08:54	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*60*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:54*	*1*
13C5 PFPeA	*67*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:54*	*1*
13C2 PFHxA	*74*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:54*	*1*
13C4 PFHpA	*72*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:54*	*1*
13C4 PFOA	*73*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:54*	*1*
13C5 PFNA	*71*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:54*	*1*
13C2 PFDA	*72*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:54*	*1*
13C2 PFUnA	*67*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:54*	*1*
13C2 PFDoA	*66*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:54*	*1*
13C2 PFTeDA	*54*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:54*	*1*
13C3 PFBS	*74*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:54*	*1*
18O2 PFHxS	*67*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:54*	*1*
13C4 PFOS	*67*		*25 - 150*	*07/20/21 18:41*	*07/23/21 08:54*	*1*

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: SB-4 (7-9) DUP

Date Collected: 07/14/21 14:30
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-9

Matrix: Solid
Percent Solids: 79.5

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C8 FOSA	67		10 - 150	07/20/21 18:41	07/23/21 08:54	1
d3-NMeFOSAA	75		25 - 150	07/20/21 18:41	07/23/21 08:54	1
d5-NEtFOSAA	77		25 - 150	07/20/21 18:41	07/23/21 08:54	1
d-N-MeFOSA-M	71		10 - 150	07/20/21 18:41	07/23/21 08:54	1
d-N-EtFOSA-M	64		10 - 150	07/20/21 18:41	07/23/21 08:54	1
d7-N-MeFOSE-M	46		10 - 150	07/20/21 18:41	07/23/21 08:54	1
d9-N-EtFOSE-M	50		10 - 150	07/20/21 18:41	07/23/21 08:54	1
M2-4:2 FTS	73		25 - 150	07/20/21 18:41	07/23/21 08:54	1
M2-6:2 FTS	82		25 - 150	07/20/21 18:41	07/23/21 08:54	1
M2-8:2 FTS	87		25 - 150	07/20/21 18:41	07/23/21 08:54	1
13C3 HFPO-DA	73		25 - 150	07/20/21 18:41	07/23/21 08:54	1
13C2 10:2 FTS	90		25 - 150	07/20/21 18:41	07/23/21 08:54	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	20.5		0.1	0.1	%			07/20/21 12:16	1
Percent Solids	79.5		0.1	0.1	%			07/20/21 12:16	1

Isotope Dilution Summary

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Method: 537 (modified) - Fluorinated Alkyl Substances

Matrix: Solid **Prep Type: Total/NA**

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFBA (25-150)	PFPeA (25-150)	PFHxA (25-150)	C4PFHA (25-150)	PFOA (25-150)	PFNA (25-150)	PFDA (25-150)	PFUnA (25-150)
320-76427-1	SB-1 (0-0.5)	76	100	104	105	99	105	89	107
320-76427-1 MS	SB-1 (0-0.5)	73	90	97	95	97	97	88	89
320-76427-1 MSD	SB-1 (0-0.5)	76	95	96	97	96	93	83	95
320-76427-2	SB-2 (8-9)	67	71	76	76	78	71	80	74
320-76427-5	SB-3 (3-4)	59	67	66	69	64	70	67	70
320-76427-6 - DL	SED-COMP	11 *5-							
320-76427-6	SED-COMP		45	51	48	51	63	62	58
320-76427-7	SED-COMP-DUP	10 *5-	57	57	56	62	75	75	59
320-76427-8	SB-4 (7-9)	68	74	74	73	76	80	80	77
320-76427-9	SB-4 (7-9) DUP	60	67	74	72	73	71	72	67
LCS 320-508643/2-A	Lab Control Sample	70	76	76	77	77	76	75	77
LCS 320-510504/2-A	Lab Control Sample	84	94	92	96	94	99	84	89
MB 320-508643/1-A	Method Blank	64	70	71	74	71	73	73	72
MB 320-510504/1-A	Method Blank	78	82	85	88	85	87	74	89

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFDoA (25-150)	PFTDA (25-150)	C3PFBS (25-150)	PFHxS (25-150)	PFOS (25-150)	PFOSA (10-150)	d3NMFOS (25-150)	d5NEFOS (25-150)
320-76427-1	SB-1 (0-0.5)	100	84	96	99	103	113	87	88
320-76427-1 MS	SB-1 (0-0.5)	84	80	87	92	96	97	81	84
320-76427-1 MSD	SB-1 (0-0.5)	87	72	85	92	95	104	82	79
320-76427-2	SB-2 (8-9)	79	68	83	74	70	75	75	85
320-76427-5	SB-3 (3-4)	67	64	69	64	60	64	63	73
320-76427-6 - DL	SED-COMP								
320-76427-6	SED-COMP	51	49	60	52	58	52	48	59
320-76427-7	SED-COMP-DUP	57	55	78	62	78	61	60	65
320-76427-8	SB-4 (7-9)	76	66	83	76	72	77	84	84
320-76427-9	SB-4 (7-9) DUP	66	54	74	67	67	67	75	77
LCS 320-508643/2-A	Lab Control Sample	77	74	87	80	76	72	79	78
LCS 320-510504/2-A	Lab Control Sample	86	92	91	98	100	99	84	81
MB 320-508643/1-A	Method Blank	73	72	77	74	67	70	78	77
MB 320-510504/1-A	Method Blank	77	76	78	82	88	90	67	76

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	dMeFOSA (10-150)	dEtFOSA (10-150)	NMFM (10-150)	NEFM (10-150)	M242FTS (25-150)	M262FTS (25-150)	M282FTS (25-150)	HFPODA (25-150)
320-76427-1	SB-1 (0-0.5)	102	99	69	73	107	118	97	102
320-76427-1 MS	SB-1 (0-0.5)	93	89	72	71	99	103	100	99
320-76427-1 MSD	SB-1 (0-0.5)	93	90	70	72	100	101	87	99
320-76427-2	SB-2 (8-9)	75	66	48	58	78	82	86	71
320-76427-5	SB-3 (3-4)	68	64	47	51	77	85	87	66
320-76427-6 - DL	SED-COMP								
320-76427-6	SED-COMP	45	49	34	31	138	136	139	54
320-76427-7	SED-COMP-DUP	58	53	43	41	155 *5+	178 *5+	166 *5+	62
320-76427-8	SB-4 (7-9)	81	72	49	50	87	99	103	75
320-76427-9	SB-4 (7-9) DUP	71	64	46	50	73	82	87	73
LCS 320-508643/2-A	Lab Control Sample	74	71	66	60	76	93	80	73
LCS 320-510504/2-A	Lab Control Sample	90	95	78	75	101	100	89	93
MB 320-508643/1-A	Method Blank	73	67	56	61	79	79	87	73
MB 320-510504/1-A	Method Blank	79	79	58	64	89	91	86	86

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Matrix: Solid **Prep Type: Total/NA**

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	M102FTS (25-150)							
320-76427-1	SB-1 (0-0.5)	81							
320-76427-1 MS	SB-1 (0-0.5)	80							
320-76427-1 MSD	SB-1 (0-0.5)	74							
320-76427-2	SB-2 (8-9)	99							
320-76427-5	SB-3 (3-4)	88							
320-76427-6 - DL	SED-COMP								
320-76427-6	SED-COMP	86							
320-76427-7	SED-COMP-DUP	97							
320-76427-8	SB-4 (7-9)	96							
320-76427-9	SB-4 (7-9) DUP	90							
LCS 320-508643/2-A	Lab Control Sample	76							
LCS 320-510504/2-A	Lab Control Sample	86							
MB 320-508643/1-A	Method Blank	81							
MB 320-510504/1-A	Method Blank	74							

Surrogate Legend

PFBA = 13C4 PFBA
PFPeA = 13C5 PFPeA
PFHxA = 13C2 PFHxA
C4PFHA = 13C4 PFHpA
PFOA = 13C4 PFOA
PFNA = 13C5 PFNA
PFDA = 13C2 PFDA
PFUnA = 13C2 PFUnA
PFDoA = 13C2 PFDoA
PFTDA = 13C2 PFTeDA
C3PFBS = 13C3 PFBS
PFHxS = 18O2 PFHxS
PFOS = 13C4 PFOS
PFOSA = 13C8 FOSA
d3NMFOS = d3-NMeFOSAA
d5NEFOS = d5-NEtFOSAA
dMeFOSA = d-N-MeFOSA-M
dEtFOSA = d-N-EtFOSA-M
NMFM = d7-N-MeFOSE-M
NEFM = d9-N-EtFOSE-M
M242FTS = M2-4:2 FTS
M262FTS = M2-6:2 FTS
M282FTS = M2-8:2 FTS
HFPODA = 13C3 HFPO-DA
M102FTS = 13C2 10:2 FTS

Method: 537 (modified) - Fluorinated Alkyl Substances

Matrix: Water **Prep Type: Total/NA**

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFBA (25-150)	PFPeA (25-150)	PFHxA (25-150)	C4PFHA (25-150)	PFOA (25-150)	PFNA (25-150)	PFDA (25-150)	PFUnA (25-150)
320-76427-3	FB-01-210714	103	95	92	96	93	88	89	88
320-76427-4	EB-01-210714	98	84	83	92	95	86	85	81
LCS 320-508645/2-A	Lab Control Sample	95	87	80	85	96	82	91	81

Isotope Dilution Summary

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Matrix: Water

Prep Type: Total/NA

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFBA (25-150)	PFPeA (25-150)	PFHxA (25-150)	C4PFHA (25-150)	PFOA (25-150)	PFNA (25-150)	PFDA (25-150)	PFUnA (25-150)
LCSD 320-508645/3-A	Lab Control Sample Dup	104	92	88	95	108	92	99	94
MB 320-508645/1-A	Method Blank	100	96	83	93	101	91	88	86

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFDoA (25-150)	PFTDA (25-150)	C3PFBS (25-150)	PFHxS (25-150)	PFOS (25-150)	PFOSA (10-150)	d3NMFOS (25-150)	d5NEFOS (25-150)
320-76427-3	FB-01-210714	87	95	100	90	96	88	80	92
320-76427-4	EB-01-210714	94	90	90	85	87	83	82	84
LCS 320-508645/2-A	Lab Control Sample	89	82	91	88	89	80	77	82
LCSD 320-508645/3-A	Lab Control Sample Dup	98	89	104	98	93	87	88	96
MB 320-508645/1-A	Method Blank	88	97	100	89	90	84	79	92

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	dMeFOSA (10-150)	dEtFOSA (10-150)	NMFM (10-150)	NEFM (10-150)	M242FTS (25-150)	M262FTS (25-150)	M282FTS (25-150)	HFPODA (25-150)
320-76427-3	FB-01-210714	83	83	87	83	63	78	76	97
320-76427-4	EB-01-210714	86	72	84	77	62	74	73	90
LCS 320-508645/2-A	Lab Control Sample	80	75	85	74	65	73	66	81
LCSD 320-508645/3-A	Lab Control Sample Dup	78	69	90	83	68	83	77	92
MB 320-508645/1-A	Method Blank	77	75	86	79	69	84	92	95

		Percent Isotope Dilution Recovery (Acceptance Limits)
Lab Sample ID	Client Sample ID	M102FTS (25-150)
320-76427-3	FB-01-210714	89
320-76427-4	EB-01-210714	81
LCS 320-508645/2-A	Lab Control Sample	81
LCSD 320-508645/3-A	Lab Control Sample Dup	85
MB 320-508645/1-A	Method Blank	89

Surrogate Legend

PFBA = 13C4 PFBA
PFPeA = 13C5 PFPeA
PFHxA = 13C2 PFHxA
C4PFHA = 13C4 PFHpA
PFOA = 13C4 PFOA
PFNA = 13C5 PFNA
PFDA = 13C2 PFDA
PFUnA = 13C2 PFUnA
PFDoA = 13C2 PFDoA
PFTDA = 13C2 PFTeDA
C3PFBS = 13C3 PFBS
PFHxS = 18O2 PFHxS
PFOS = 13C4 PFOS
PFOSA = 13C8 FOSA
d3NMFOS = d3-NMeFOSAA
d5NEFOS = d5-NEtFOSAA
dMeFOSA = d-N-MeFOSA-M
dEtFOSA = d-N-EtFOSA-M
NMFM = d7-N-MeFOSE-M
NEFM = d9-N-EtFOSE-M
M242FTS = M2-4:2 FTS
M262FTS = M2-6:2 FTS

Isotope Dilution Summary

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

M282FTS = M2-8:2 FTS
HFPODA = 13C3 HFPO-DA
M102FTS = 13C2 10:2 FTS

Method: 537 (modified) - Fluorinated Alkyl Substances

Lab Sample ID: MB 320-508643/1-A
Matrix: Solid
Analysis Batch: 509929

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 508643

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	<0.046		0.20	0.046	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluoropentanoic acid (PFPeA)	<0.041		0.20	0.041	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluorohexanoic acid (PFHxA)	<0.031		0.20	0.031	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluoroheptanoic acid (PFHpA)	<0.038		0.20	0.038	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluorooctanoic acid (PFOA)	<0.053		0.20	0.053	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluorononanoic acid (PFNA)	<0.022		0.20	0.022	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluorodecanoic acid (PFDA)	<0.048		0.20	0.048	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluoroundecanoic acid (PFUnA)	<0.042		0.20	0.042	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluorododecanoic acid (PFDoA)	<0.030		0.20	0.030	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluorotridecanoic acid (PFTriA)	<0.021		0.20	0.021	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluorotetradecanoic acid (PFTeA)	<0.037		0.20	0.037	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluorobutanesulfonic acid (PFBS)	<0.038		0.20	0.038	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluoropentanesulfonic acid (PFPeS)	<0.037		0.20	0.037	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluorohexanesulfonic acid (PFHxS)	<0.029		0.20	0.029	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.049		0.20	0.049	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluorooctanesulfonic acid (PFOS)	<0.043		0.20	0.043	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluorononanesulfonic acid (PFNS)	<0.029		0.20	0.029	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluorodecanesulfonic acid (PFDS)	<0.052		0.20	0.052	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluorododecanesulfonic acid (PFDoS)	<0.047		0.20	0.047	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
Perfluorooctanesulfonamide (FOSA)	<0.033		0.20	0.033	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
NEtFOSA	<0.047		0.20	0.047	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
NMeFOSA	<0.049		0.20	0.049	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
NMeFOSAA	<0.023		0.20	0.023	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
NEtFOSAA	<0.048		0.20	0.048	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
NMeFOSE	<0.047		0.20	0.047	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
NEtFOSE	<0.028		0.20	0.028	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
4:2 FTS	<0.051		0.20	0.051	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
6:2 FTS	<0.027		0.20	0.027	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
8:2 FTS	<0.035		0.20	0.035	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
DONA	<0.039		0.20	0.039	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
HFPO-DA (GenX)	<0.041		0.20	0.041	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
F-53B Major	<0.035		0.20	0.035	ug/Kg		07/20/21 18:41	07/23/21 07:01	1
F-53B Minor	<0.031		0.20	0.031	ug/Kg		07/20/21 18:41	07/23/21 07:01	1

Isotope Dilution	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*64*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:01*	*1*
13C5 PFPeA	*70*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:01*	*1*
13C2 PFHxA	*71*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:01*	*1*
13C4 PFHpA	*74*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:01*	*1*
13C4 PFOA	*71*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:01*	*1*
13C5 PFNA	*73*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:01*	*1*
13C2 PFDA	*73*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:01*	*1*
13C2 PFUnA	*72*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:01*	*1*
13C2 PFDoA	*73*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:01*	*1*
13C2 PFTeDA	*72*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:01*	*1*
13C3 PFBS	*77*		*25 - 150*	*07/20/21 18:41*	*07/23/21 07:01*	*1*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: MB 320-508643/1-A
Matrix: Solid
Analysis Batch: 509929

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 508643

Isotope Dilution	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
18O2 PFHxS	74		25 - 150	07/20/21 18:41	07/23/21 07:01	1
13C4 PFOS	67		25 - 150	07/20/21 18:41	07/23/21 07:01	1
13C8 FOSA	70		10 - 150	07/20/21 18:41	07/23/21 07:01	1
d3-NMeFOSAA	78		25 - 150	07/20/21 18:41	07/23/21 07:01	1
d5-NEtFOSAA	77		25 - 150	07/20/21 18:41	07/23/21 07:01	1
d-N-MeFOSA-M	73		10 - 150	07/20/21 18:41	07/23/21 07:01	1
d-N-EtFOSA-M	67		10 - 150	07/20/21 18:41	07/23/21 07:01	1
d7-N-MeFOSE-M	56		10 - 150	07/20/21 18:41	07/23/21 07:01	1
d9-N-EtFOSE-M	61		10 - 150	07/20/21 18:41	07/23/21 07:01	1
M2-4:2 FTS	79		25 - 150	07/20/21 18:41	07/23/21 07:01	1
M2-6:2 FTS	79		25 - 150	07/20/21 18:41	07/23/21 07:01	1
M2-8:2 FTS	87		25 - 150	07/20/21 18:41	07/23/21 07:01	1
13C3 HFPO-DA	73		25 - 150	07/20/21 18:41	07/23/21 07:01	1
13C2 10:2 FTS	81		25 - 150	07/20/21 18:41	07/23/21 07:01	1

Lab Sample ID: LCS 320-508643/2-A
Matrix: Solid
Analysis Batch: 509929

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 508643

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Perfluorobutanoic acid (PFBA)	2.00	2.38		ug/Kg		119	60 - 135
Perfluoropentanoic acid (PFPeA)	2.00	2.16		ug/Kg		108	60 - 135
Perfluorohexanoic acid (PFHxA)	2.00	2.37		ug/Kg		118	60 - 135
Perfluoroheptanoic acid (PFHpA)	2.00	2.34		ug/Kg		117	60 - 135
Perfluorooctanoic acid (PFOA)	2.00	2.25		ug/Kg		112	60 - 135
Perfluorononanoic acid (PFNA)	2.00	2.38		ug/Kg		119	60 - 135
Perfluorodecanoic acid (PFDA)	2.00	2.07		ug/Kg		103	60 - 135
Perfluoroundecanoic acid (PFUnA)	2.00	2.27		ug/Kg		113	60 - 135
Perfluorododecanoic acid (PFDoA)	2.00	2.19		ug/Kg		110	60 - 135
Perfluorotridecanoic acid (PFTriA)	2.00	2.01		ug/Kg		100	60 - 135
Perfluorotetradecanoic acid (PFTeA)	2.00	2.23		ug/Kg		112	60 - 135
Perfluoro-n-hexadecanoic acid (PFHxDA)	2.00	2.09		ug/Kg		104	60 - 135
Perfluoro-n-octadecanoic acid (PFODA)	2.00	2.03		ug/Kg		102	60 - 135
Perfluorobutanesulfonic acid (PFBS)	1.77	1.59		ug/Kg		90	60 - 135
Perfluoropentanesulfonic acid (PFPeS)	1.88	1.71		ug/Kg		91	60 - 135
Perfluorohexanesulfonic acid (PFHxS)	1.82	1.82		ug/Kg		100	60 - 135
Perfluoroheptanesulfonic Acid (PFHpS)	1.90	2.02		ug/Kg		106	60 - 135
Perfluorooctanesulfonic acid (PFOS)	1.86	1.95		ug/Kg		105	60 - 135
Perfluorononanesulfonic acid (PFNS)	1.92	1.88		ug/Kg		98	60 - 135

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-508643/2-A
Matrix: Solid
Analysis Batch: 509929

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 508643

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Perfluorodecanesulfonic acid (PFDS)	1.93	2.03		ug/Kg		105	60 - 135
Perfluorododecanesulfonic acid (PFDoS)	1.94	1.97		ug/Kg		102	60 - 135
Perfluorooctanesulfonamide (FOSA)	2.00	2.12		ug/Kg		106	60 - 135
NEtFOSA	2.00	2.14		ug/Kg		107	60 - 135
NMeFOSA	2.00	1.84		ug/Kg		92	60 - 135
NMeFOSAA	2.00	2.36		ug/Kg		118	60 - 135
NEtFOSAA	2.00	2.06		ug/Kg		103	60 - 135
NMeFOSE	2.00	1.99		ug/Kg		99	60 - 135
NEtFOSE	2.00	2.36		ug/Kg		118	60 - 135
4:2 FTS	1.87	1.79		ug/Kg		96	60 - 135
6:2 FTS	1.90	1.62		ug/Kg		85	60 - 135
8:2 FTS	1.92	2.07		ug/Kg		108	60 - 135
10:2 FTS	1.93	1.77		ug/Kg		92	60 - 135
DONA	1.88	2.18		ug/Kg		116	60 - 135
HFPO-DA (GenX)	2.00	2.11		ug/Kg		106	60 - 135
F-53B Major	1.86	1.90		ug/Kg		102	60 - 135
F-53B Minor	1.88	1.82		ug/Kg		97	60 - 135

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C4 PFBA	*70*		*25 - 150*
13C5 PFPeA	*76*		*25 - 150*
13C2 PFHxA	*76*		*25 - 150*
13C4 PFHpA	*77*		*25 - 150*
13C4 PFOA	*77*		*25 - 150*
13C5 PFNA	*76*		*25 - 150*
13C2 PFDA	*75*		*25 - 150*
13C2 PFUnA	*77*		*25 - 150*
13C2 PFDoA	*77*		*25 - 150*
13C2 PFTeDA	*74*		*25 - 150*
13C3 PFBS	*87*		*25 - 150*
18O2 PFHxS	*80*		*25 - 150*
13C4 PFOS	*76*		*25 - 150*
13C8 FOSA	*72*		*10 - 150*
d3-NMeFOSAA	*79*		*25 - 150*
d5-NEtFOSAA	*78*		*25 - 150*
d-N-MeFOSA-M	*74*		*10 - 150*
d-N-EtFOSA-M	*71*		*10 - 150*
d7-N-MeFOSE-M	*66*		*10 - 150*
d9-N-EtFOSE-M	*60*		*10 - 150*
M2-4:2 FTS	*76*		*25 - 150*
M2-6:2 FTS	*93*		*25 - 150*
M2-8:2 FTS	*80*		*25 - 150*
13C3 HFPO-DA	*73*		*25 - 150*
13C2 10:2 FTS	*76*		*25 - 150*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: MB 320-508645/1-A
Matrix: Water
Analysis Batch: 508965

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 508645

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	<2.4		5.0	2.4	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluoropentanoic acid (PFPeA)	<0.49		2.0	0.49	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluorohexanoic acid (PFHxA)	<0.58		2.0	0.58	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluoroheptanoic acid (PFHpA)	<0.25		2.0	0.25	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluorooctanoic acid (PFOA)	<0.85		2.0	0.85	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluorononanoic acid (PFNA)	<0.27		2.0	0.27	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluorodecanoic acid (PFDA)	<0.31		2.0	0.31	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluoroundecanoic acid (PFUnA)	<1.1		2.0	1.1	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluorododecanoic acid (PFDoA)	<0.55		2.0	0.55	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluorotridecanoic acid (PFTriA)	<1.3		2.0	1.3	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluorotetradecanoic acid (PFTeA)	<0.73		2.0	0.73	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluorobutanesulfonic acid (PFBS)	<0.20		2.0	0.20	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluoropentanesulfonic acid (PFPeS)	<0.30		2.0	0.30	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluorohexanesulfonic acid (PFHxS)	<0.57		2.0	0.57	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.19		2.0	0.19	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluorooctanesulfonic acid (PFOS)	<0.54		2.0	0.54	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluorononanesulfonic acid (PFNS)	<0.37		2.0	0.37	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluorodecanesulfonic acid (PFDS)	<0.32		2.0	0.32	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluorododecanesulfonic acid (PFDoS)	<0.97		2.0	0.97	ng/L		07/20/21 19:23	07/21/21 21:07	1
Perfluorooctanesulfonamide (FOSA)	<0.98		2.0	0.98	ng/L		07/20/21 19:23	07/21/21 21:07	1
NEtFOSA	<0.87		2.0	0.87	ng/L		07/20/21 19:23	07/21/21 21:07	1
NMeFOSA	<0.43		2.0	0.43	ng/L		07/20/21 19:23	07/21/21 21:07	1
NMeFOSAA	<1.2		5.0	1.2	ng/L		07/20/21 19:23	07/21/21 21:07	1
NEtFOSAA	<1.3		5.0	1.3	ng/L		07/20/21 19:23	07/21/21 21:07	1
NMeFOSE	<1.4		4.0	1.4	ng/L		07/20/21 19:23	07/21/21 21:07	1
NEtFOSE	<0.85		2.0	0.85	ng/L		07/20/21 19:23	07/21/21 21:07	1
4:2 FTS	<0.24		2.0	0.24	ng/L		07/20/21 19:23	07/21/21 21:07	1
6:2 FTS	<2.5		5.0	2.5	ng/L		07/20/21 19:23	07/21/21 21:07	1
8:2 FTS	<0.46		2.0	0.46	ng/L		07/20/21 19:23	07/21/21 21:07	1
DONA	<0.40		2.0	0.40	ng/L		07/20/21 19:23	07/21/21 21:07	1
HFPO-DA (GenX)	<1.5		4.0	1.5	ng/L		07/20/21 19:23	07/21/21 21:07	1
F-53B Major	<0.24		2.0	0.24	ng/L		07/20/21 19:23	07/21/21 21:07	1
F-53B Minor	<0.32		2.0	0.32	ng/L		07/20/21 19:23	07/21/21 21:07	1

Isotope Dilution	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*100*		*25 - 150*	*07/20/21 19:23*	*07/21/21 21:07*	*1*
13C5 PFPeA	*96*		*25 - 150*	*07/20/21 19:23*	*07/21/21 21:07*	*1*
13C2 PFHxA	*83*		*25 - 150*	*07/20/21 19:23*	*07/21/21 21:07*	*1*
13C4 PFHpA	*93*		*25 - 150*	*07/20/21 19:23*	*07/21/21 21:07*	*1*
13C4 PFOA	*101*		*25 - 150*	*07/20/21 19:23*	*07/21/21 21:07*	*1*
13C5 PFNA	*91*		*25 - 150*	*07/20/21 19:23*	*07/21/21 21:07*	*1*
13C2 PFDA	*88*		*25 - 150*	*07/20/21 19:23*	*07/21/21 21:07*	*1*
13C2 PFUnA	*86*		*25 - 150*	*07/20/21 19:23*	*07/21/21 21:07*	*1*
13C2 PFDoA	*88*		*25 - 150*	*07/20/21 19:23*	*07/21/21 21:07*	*1*
13C2 PFTeDA	*97*		*25 - 150*	*07/20/21 19:23*	*07/21/21 21:07*	*1*
13C3 PFBS	*100*		*25 - 150*	*07/20/21 19:23*	*07/21/21 21:07*	*1*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: MB 320-508645/1-A
Matrix: Water
Analysis Batch: 508965

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 508645

Isotope Dilution	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
18O2 PFHxS	89		25 - 150	07/20/21 19:23	07/21/21 21:07	1
13C4 PFOS	90		25 - 150	07/20/21 19:23	07/21/21 21:07	1
13C8 FOSA	84		10 - 150	07/20/21 19:23	07/21/21 21:07	1
d3-NMeFOSAA	79		25 - 150	07/20/21 19:23	07/21/21 21:07	1
d5-NEtFOSAA	92		25 - 150	07/20/21 19:23	07/21/21 21:07	1
d-N-MeFOSA-M	77		10 - 150	07/20/21 19:23	07/21/21 21:07	1
d-N-EtFOSA-M	75		10 - 150	07/20/21 19:23	07/21/21 21:07	1
d7-N-MeFOSE-M	86		10 - 150	07/20/21 19:23	07/21/21 21:07	1
d9-N-EtFOSE-M	79		10 - 150	07/20/21 19:23	07/21/21 21:07	1
M2-4:2 FTS	69		25 - 150	07/20/21 19:23	07/21/21 21:07	1
M2-6:2 FTS	84		25 - 150	07/20/21 19:23	07/21/21 21:07	1
M2-8:2 FTS	92		25 - 150	07/20/21 19:23	07/21/21 21:07	1
13C3 HFPO-DA	95		25 - 150	07/20/21 19:23	07/21/21 21:07	1
13C2 10:2 FTS	89		25 - 150	07/20/21 19:23	07/21/21 21:07	1

Lab Sample ID: LCS 320-508645/2-A
Matrix: Water
Analysis Batch: 508965

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 508645

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Perfluorobutanoic acid (PFBA)	40.0	36.8		ng/L		92	60 - 135
Perfluoropentanoic acid (PFPeA)	40.0	37.4		ng/L		93	60 - 135
Perfluorohexanoic acid (PFHxA)	40.0	37.9		ng/L		95	60 - 135
Perfluoroheptanoic acid (PFHpA)	40.0	37.9		ng/L		95	60 - 135
Perfluorooctanoic acid (PFOA)	40.0	35.9		ng/L		90	60 - 135
Perfluorononanoic acid (PFNA)	40.0	39.9		ng/L		100	60 - 135
Perfluorodecanoic acid (PFDA)	40.0	33.5		ng/L		84	60 - 135
Perfluoroundecanoic acid (PFUnA)	40.0	40.2		ng/L		101	60 - 135
Perfluorododecanoic acid (PFDoA)	40.0	32.3		ng/L		81	60 - 135
Perfluorotridecanoic acid (PFTriA)	40.0	39.3		ng/L		98	60 - 135
Perfluorotetradecanoic acid (PFTeA)	40.0	38.5		ng/L		96	60 - 135
Perfluoro-n-hexadecanoic acid (PFHxDA)	40.0	35.4		ng/L		89	60 - 135
Perfluoro-n-octadecanoic acid (PFODA)	40.0	29.7		ng/L		74	60 - 135
Perfluorobutanesulfonic acid (PFBS)	35.4	27.9		ng/L		79	60 - 135
Perfluoropentanesulfonic acid (PFPeS)	37.5	29.0		ng/L		77	60 - 135
Perfluorohexanesulfonic acid (PFHxS)	36.4	31.8		ng/L		87	60 - 135
Perfluoroheptanesulfonic Acid (PFHpS)	38.1	37.7		ng/L		99	60 - 135
Perfluorooctanesulfonic acid (PFOS)	37.1	30.4		ng/L		82	60 - 135
Perfluorononanesulfonic acid (PFNS)	38.4	29.8		ng/L		78	60 - 135

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-508645/2-A
Matrix: Water
Analysis Batch: 508965

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 508645

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Perfluorodecanesulfonic acid (PFDS)	38.6	34.7		ng/L		90	60 - 135
Perfluorododecanesulfonic acid (PFDoS)	38.7	36.9		ng/L		95	60 - 135
Perfluorooctanesulfonamide (FOSA)	40.0	38.3		ng/L		96	60 - 135
NEtFOSA	40.0	35.7		ng/L		89	60 - 135
NMeFOSA	40.0	33.0		ng/L		82	60 - 135
NMeFOSAA	40.0	34.8		ng/L		87	60 - 135
NEtFOSAA	40.0	34.3		ng/L		86	60 - 135
NMeFOSE	40.0	35.6		ng/L		89	60 - 135
NEtFOSE	40.0	39.0		ng/L		97	60 - 135
4:2 FTS	37.4	31.0		ng/L		83	60 - 135
6:2 FTS	37.9	34.6		ng/L		91	60 - 135
8:2 FTS	38.3	42.3		ng/L		110	60 - 135
10:2 FTS	38.6	35.6		ng/L		92	60 - 135
DONA	37.7	37.2		ng/L		99	60 - 135
HFPO-DA (GenX)	40.0	40.1		ng/L		100	60 - 135
F-53B Major	37.3	35.7		ng/L		96	60 - 135
F-53B Minor	37.7	36.6		ng/L		97	60 - 135

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C4 PFBA	*95*		*25 - 150*
13C5 PFPeA	*87*		*25 - 150*
13C2 PFHxA	*80*		*25 - 150*
13C4 PFHpA	*85*		*25 - 150*
13C4 PFOA	*96*		*25 - 150*
13C5 PFNA	*82*		*25 - 150*
13C2 PFDA	*91*		*25 - 150*
13C2 PFUnA	*81*		*25 - 150*
13C2 PFDoA	*89*		*25 - 150*
13C2 PFTeDA	*82*		*25 - 150*
13C3 PFBS	*91*		*25 - 150*
18O2 PFHxS	*88*		*25 - 150*
13C4 PFOS	*89*		*25 - 150*
13C8 FOSA	*80*		*10 - 150*
d3-NMeFOSAA	*77*		*25 - 150*
d5-NEtFOSAA	*82*		*25 - 150*
d-N-MeFOSA-M	*80*		*10 - 150*
d-N-EtFOSA-M	*75*		*10 - 150*
d7-N-MeFOSE-M	*85*		*10 - 150*
d9-N-EtFOSE-M	*74*		*10 - 150*
M2-4:2 FTS	*65*		*25 - 150*
M2-6:2 FTS	*73*		*25 - 150*
M2-8:2 FTS	*66*		*25 - 150*
13C3 HFPO-DA	*81*		*25 - 150*
13C2 10:2 FTS	*81*		*25 - 150*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCSD 320-508645/3-A
Matrix: Water
Analysis Batch: 508965

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 508645

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Perfluorobutanoic acid (PFBA)			40.0	35.8		ng/L		90	60 - 135	3	30
Perfluoropentanoic acid (PFPeA)			40.0	39.3		ng/L		98	60 - 135	5	30
Perfluorohexanoic acid (PFHxA)			40.0	37.9		ng/L		95	60 - 135	0	30
Perfluoroheptanoic acid (PFHpA)			40.0	36.4		ng/L		91	60 - 135	4	30
Perfluorooctanoic acid (PFOA)			40.0	34.8		ng/L		87	60 - 135	3	30
Perfluorononanoic acid (PFNA)			40.0	39.2		ng/L		98	60 - 135	2	30
Perfluorodecanoic acid (PFDA)			40.0	34.4		ng/L		86	60 - 135	3	30
Perfluoroundecanoic acid (PFUnA)			40.0	35.3		ng/L		88	60 - 135	13	30
Perfluorododecanoic acid (PFDoA)			40.0	33.9		ng/L		85	60 - 135	5	30
Perfluorotridecanoic acid (PFTriA)			40.0	38.6		ng/L		97	60 - 135	2	30
Perfluorotetradecanoic acid (PFTeA)			40.0	40.4		ng/L		101	60 - 135	5	30
Perfluoro-n-hexadecanoic acid (PFHxDA)			40.0	38.6		ng/L		96	60 - 135	8	30
Perfluoro-n-octadecanoic acid (PFODA)			40.0	33.7		ng/L		84	60 - 135	13	30
Perfluorobutanesulfonic acid (PFBS)			35.4	26.4		ng/L		75	60 - 135	5	30
Perfluoropentanesulfonic acid (PFPeS)			37.5	30.1		ng/L		80	60 - 135	4	30
Perfluorohexanesulfonic acid (PFHxS)			36.4	33.0		ng/L		91	60 - 135	4	30
Perfluoroheptanesulfonic Acid (PFHpS)			38.1	38.5		ng/L		101	60 - 135	2	30
Perfluorooctanesulfonic acid (PFOS)			37.1	33.9		ng/L		91	60 - 135	11	30
Perfluorononanesulfonic acid (PFNS)			38.4	33.0		ng/L		86	60 - 135	10	30
Perfluorodecanesulfonic acid (PFDS)			38.6	37.0		ng/L		96	60 - 135	6	30
Perfluorododecanesulfonic acid (PFDoS)			38.7	40.1		ng/L		104	60 - 135	8	30
Perfluorooctanesulfonamide (FOSA)			40.0	38.5		ng/L		96	60 - 135	0	30
NEtFOSA			40.0	43.8		ng/L		110	60 - 135	21	30
NMeFOSA			40.0	36.2		ng/L		90	60 - 135	9	30
NMeFOSAA			40.0	37.4		ng/L		94	60 - 135	7	30
NEtFOSAA			40.0	33.4		ng/L		83	60 - 135	3	30
NMeFOSE			40.0	35.6		ng/L		89	60 - 135	0	30
NEtFOSE			40.0	39.1		ng/L		98	60 - 135	0	30
4:2 FTS			37.4	38.2		ng/L		102	60 - 135	21	30
6:2 FTS			37.9	33.6		ng/L		89	60 - 135	3	30
8:2 FTS			38.3	37.8		ng/L		99	60 - 135	11	30
10:2 FTS			38.6	35.6		ng/L		92	60 - 135	0	30
DONA			37.7	40.1		ng/L		107	60 - 135	8	30
HFPO-DA (GenX)			40.0	38.1		ng/L		95	60 - 135	5	30
F-53B Major			37.3	37.2		ng/L		100	60 - 135	4	30
F-53B Minor			37.7	41.5		ng/L		110	60 - 135	13	30

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	LCSD %Recovery	LCSD Qualifier	Limits
13C4 PFBA	104		25 - 150
13C5 PFPeA	92		25 - 150
13C2 PFHxA	88		25 - 150
13C4 PFHpA	95		25 - 150
13C4 PFOA	108		25 - 150
13C5 PFNA	92		25 - 150
13C2 PFDA	99		25 - 150
13C2 PFUnA	94		25 - 150
13C2 PFDoA	98		25 - 150
13C2 PFTeDA	89		25 - 150
13C3 PFBS	104		25 - 150
18O2 PFHxS	98		25 - 150
13C4 PFOS	93		25 - 150
13C8 FOSA	87		10 - 150
d3-NMeFOSAA	88		25 - 150
d5-NEtFOSAA	96		25 - 150
d-N-MeFOSA-M	78		10 - 150
d-N-EtFOSA-M	69		10 - 150
d7-N-MeFOSE-M	90		10 - 150
d9-N-EtFOSE-M	83		10 - 150
M2-4:2 FTS	68		25 - 150
M2-6:2 FTS	83		25 - 150
M2-8:2 FTS	77		25 - 150
13C3 HFPO-DA	92		25 - 150
13C2 10:2 FTS	85		25 - 150

Lab Sample ID: MB 320-510504/1-A
Matrix: Solid
Analysis Batch: 510816

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 510504

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	<0.046		0.20	0.046	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluoropentanoic acid (PFPeA)	<0.041		0.20	0.041	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluorohexanoic acid (PFHxA)	<0.031		0.20	0.031	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluoroheptanoic acid (PFHpA)	<0.038		0.20	0.038	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluorooctanoic acid (PFOA)	<0.053		0.20	0.053	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluorononanoic acid (PFNA)	<0.022		0.20	0.022	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluorodecanoic acid (PFDA)	<0.048		0.20	0.048	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluoroundecanoic acid (PFUnA)	<0.042		0.20	0.042	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluorododecanoic acid (PFDoA)	<0.030		0.20	0.030	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluorotridecanoic acid (PFTriA)	<0.021		0.20	0.021	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluorotetradecanoic acid (PFTeA)	<0.037		0.20	0.037	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluorobutanesulfonic acid (PFBS)	<0.038		0.20	0.038	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluoropentanesulfonic acid (PFPeS)	<0.037		0.20	0.037	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluorohexanesulfonic acid (PFHxS)	<0.029		0.20	0.029	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluoroheptanesulfonic Acid (PFHpS)	<0.049		0.20	0.049	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluorooctanesulfonic acid (PFOS)	<0.043		0.20	0.043	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluorononanesulfonic acid (PFNS)	<0.029		0.20	0.029	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluorodecanesulfonic acid (PFDS)	<0.052		0.20	0.052	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
Perfluorododecanesulfonic acid (PFDoS)	<0.047		0.20	0.047	ug/Kg		07/27/21 04:48	07/28/21 04:09	1

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: MB 320-510504/1-A
Matrix: Solid
Analysis Batch: 510816

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 510504

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorooctanesulfonamide (FOSA)	<0.033		0.20	0.033	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
NEtFOSA	<0.047		0.20	0.047	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
NMeFOSA	<0.049		0.20	0.049	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
NMeFOSAA	<0.023		0.20	0.023	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
NEtFOSAA	<0.048		0.20	0.048	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
NMeFOSE	<0.047		0.20	0.047	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
NEtFOSE	<0.028		0.20	0.028	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
4:2 FTS	<0.051		0.20	0.051	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
6:2 FTS	<0.027		0.20	0.027	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
8:2 FTS	<0.035		0.20	0.035	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
DONA	<0.039		0.20	0.039	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
HFPO-DA (GenX)	<0.041		0.20	0.041	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
F-53B Major	<0.035		0.20	0.035	ug/Kg		07/27/21 04:48	07/28/21 04:09	1
F-53B Minor	<0.031		0.20	0.031	ug/Kg		07/27/21 04:48	07/28/21 04:09	1

Isotope Dilution	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*78*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
13C5 PFPeA	*82*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
13C2 PFHxA	*85*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
13C4 PFHpA	*88*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
13C4 PFOA	*85*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
13C5 PFNA	*87*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
13C2 PFDA	*74*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
13C2 PFUnA	*89*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
13C2 PFDoA	*77*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
13C2 PFTeDA	*76*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
13C3 PFBS	*78*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
18O2 PFHxS	*82*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
13C4 PFOS	*88*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
13C8 FOSA	*90*		*10 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
d3-NMeFOSAA	*67*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
d5-NEtFOSAA	*76*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
d-N-MeFOSA-M	*79*		*10 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
d-N-EtFOSA-M	*79*		*10 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
d7-N-MeFOSE-M	*58*		*10 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
d9-N-EtFOSE-M	*64*		*10 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
M2-4:2 FTS	*89*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
M2-6:2 FTS	*91*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
M2-8:2 FTS	*86*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
13C3 HFPO-DA	*86*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*
13C2 10:2 FTS	*74*		*25 - 150*	*07/27/21 04:48*	*07/28/21 04:09*	*1*

Lab Sample ID: LCS 320-510504/2-A
Matrix: Solid
Analysis Batch: 510816

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 510504

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Perfluorobutanoic acid (PFBA)	2.00	2.02		ug/Kg		101	60 - 135
Perfluoropentanoic acid (PFPeA)	2.00	1.88		ug/Kg		94	60 - 135

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-510504/2-A
Matrix: Solid
Analysis Batch: 510816

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 510504

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Perfluorohexanoic acid (PFHxA)	2.00	1.85		ug/Kg		92	60 - 135
Perfluoroheptanoic acid (PFHpA)	2.00	1.95		ug/Kg		98	60 - 135
Perfluorooctanoic acid (PFOA)	2.00	2.07		ug/Kg		104	60 - 135
Perfluorononanoic acid (PFNA)	2.00	1.88		ug/Kg		94	60 - 135
Perfluorodecanoic acid (PFDA)	2.00	2.16		ug/Kg		108	60 - 135
Perfluoroundecanoic acid (PFUnA)	2.00	2.15		ug/Kg		107	60 - 135
Perfluorododecanoic acid (PFDoA)	2.00	2.27		ug/Kg		113	60 - 135
Perfluorotridecanoic acid (PFTriA)	2.00	1.87		ug/Kg		93	60 - 135
Perfluorotetradecanoic acid (PFTeA)	2.00	2.00		ug/Kg		100	60 - 135
Perfluoro-n-hexadecanoic acid (PFHxDA)	2.00	1.93		ug/Kg		97	60 - 135
Perfluoro-n-octadecanoic acid (PFODA)	2.00	2.01		ug/Kg		101	60 - 135
Perfluorobutanesulfonic acid (PFBS)	1.77	1.77		ug/Kg		100	60 - 135
Perfluoropentanesulfonic acid (PFPeS)	1.88	1.81		ug/Kg		96	60 - 135
Perfluorohexanesulfonic acid (PFHxS)	1.82	1.70		ug/Kg		93	60 - 135
Perfluoroheptanesulfonic Acid (PFHpS)	1.90	1.89		ug/Kg		99	60 - 135
Perfluorooctanesulfonic acid (PFOS)	1.86	1.85		ug/Kg		100	60 - 135
Perfluorononanesulfonic acid (PFNS)	1.92	1.77		ug/Kg		92	60 - 135
Perfluorodecanesulfonic acid (PFDS)	1.93	1.68		ug/Kg		87	60 - 135
Perfluorododecanesulfonic acid (PFDoS)	1.94	1.81		ug/Kg		94	60 - 135
Perfluorooctanesulfonamide (FOSA)	2.00	1.90		ug/Kg		95	60 - 135
NEtFOSA	2.00	1.95		ug/Kg		97	60 - 135
NMeFOSA	2.00	2.09		ug/Kg		104	60 - 135
NMeFOSAA	2.00	1.80		ug/Kg		90	60 - 135
NEtFOSAA	2.00	2.02		ug/Kg		101	60 - 135
NMeFOSE	2.00	2.07		ug/Kg		103	60 - 135
NEtFOSE	2.00	2.01		ug/Kg		101	60 - 135
4:2 FTS	1.87	1.73		ug/Kg		92	60 - 135
6:2 FTS	1.90	1.91		ug/Kg		101	60 - 135
8:2 FTS	1.92	2.12		ug/Kg		111	60 - 135
10:2 FTS	1.93	1.88		ug/Kg		98	60 - 135
DONA	1.88	1.73		ug/Kg		92	60 - 135
HFPO-DA (GenX)	2.00	1.97		ug/Kg		98	60 - 135
F-53B Major	1.86	1.82		ug/Kg		98	60 - 135
F-53B Minor	1.88	1.71		ug/Kg		91	60 - 135

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C4 PFBA	*84*		*25 - 150*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-510504/2-A
Matrix: Solid
Analysis Batch: 510816

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 510504

Isotope Dilution	LCS %Recovery	LCS Qualifier	Limits
13C5 PFPeA	94		25 - 150
13C2 PFHxA	92		25 - 150
13C4 PFHpA	96		25 - 150
13C4 PFOA	94		25 - 150
13C5 PFNA	99		25 - 150
13C2 PFDA	84		25 - 150
13C2 PFUnA	89		25 - 150
13C2 PFDoA	86		25 - 150
13C2 PFTeDA	92		25 - 150
13C3 PFBS	91		25 - 150
18O2 PFHxS	98		25 - 150
13C4 PFOS	100		25 - 150
13C8 FOSA	99		10 - 150
d3-NMeFOSAA	84		25 - 150
d5-NEtFOSAA	81		25 - 150
d-N-MeFOSA-M	90		10 - 150
d-N-EtFOSA-M	95		10 - 150
d7-N-MeFOSE-M	78		10 - 150
d9-N-EtFOSE-M	75		10 - 150
M2-4:2 FTS	101		25 - 150
M2-6:2 FTS	100		25 - 150
M2-8:2 FTS	89		25 - 150
13C3 HFPO-DA	93		25 - 150
13C2 10:2 FTS	86		25 - 150

Lab Sample ID: 320-76427-1 MS
Matrix: Solid
Analysis Batch: 510816

Client Sample ID: SB-1 (0-0.5)
Prep Type: Total/NA
Prep Batch: 510504

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Perfluorobutanoic acid (PFBA)	5.3		12.2	14.9		ug/Kg	☼	80	70 - 130
Perfluoropentanoic acid (PFPeA)	18	F1	12.2	23.0	F1	ug/Kg	☼	38	70 - 130
Perfluorohexanoic acid (PFHxA)	6.7		12.2	15.2		ug/Kg	☼	70	70 - 130
Perfluoroheptanoic acid (PFHpA)	6.0		12.2	16.1		ug/Kg	☼	83	70 - 130
Perfluorooctanoic acid (PFOA)	18	F2 F1	12.2	23.0	F1	ug/Kg	☼	42	70 - 130
Perfluorononanoic acid (PFNA)	7.3		12.2	17.1		ug/Kg	☼	81	70 - 130
Perfluorodecanoic acid (PFDA)	2.4		12.2	13.6		ug/Kg	☼	92	70 - 130
Perfluoroundecanoic acid (PFUnA)	0.57	J	12.2	12.4		ug/Kg	☼	97	70 - 130
Perfluorododecanoic acid (PFDoA)	0.48	J	12.2	13.1		ug/Kg	☼	104	70 - 130
Perfluorotridecanoic acid (PFTriA)	<0.13		12.2	12.4		ug/Kg	☼	102	70 - 130
Perfluorotetradecanoic acid (PFTeA)	<0.22		12.2	13.7		ug/Kg	☼	112	70 - 130
Perfluoro-n-hexadecanoic acid (PFHxDA)	<0.23		12.2	13.0		ug/Kg	☼	107	70 - 130
Perfluoro-n-octadecanoic acid (PFODA)	<0.39	F2	12.2	14.5		ug/Kg	☼	119	70 - 130
Perfluorobutanesulfonic acid (PFBS)	<0.23		10.7	10.4		ug/Kg	☼	97	70 - 130

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: 320-76427-1 MS
Matrix: Solid
Analysis Batch: 510816

Client Sample ID: SB-1 (0-0.5)
Prep Type: Total/NA
Prep Batch: 510504

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Perfluoropentanesulfonic acid (PFPeS)	<0.22		11.4	11.1		ug/Kg	☼	97	70 - 130
Perfluorohexanesulfonic acid (PFHxS)	<0.17		11.1	10.9		ug/Kg	☼	98	70 - 130
Perfluoroheptanesulfonic Acid (PFHpS)	<0.29		11.6	11.0		ug/Kg	☼	95	70 - 130
Perfluorooctanesulfonic acid (PFOS)	<0.26		11.3	11.2		ug/Kg	☼	99	70 - 130
Perfluorononanesulfonic acid (PFNS)	<0.17		11.7	10.3		ug/Kg	☼	88	70 - 130
Perfluorodecanesulfonic acid (PFDS)	<0.31		11.7	9.90		ug/Kg	☼	85	70 - 130
Perfluorododecanesulfonic acid (PFDoS)	<0.28		11.8	9.22		ug/Kg	☼	78	70 - 130
Perfluorooctanesulfonamide (FOSA)	<0.20		12.2	11.8		ug/Kg	☼	97	70 - 130
NEtFOSA	<0.28		12.2	12.2		ug/Kg	☼	100	70 - 130
NMeFOSA	<0.29		12.2	12.2		ug/Kg	☼	101	70 - 130
NMeFOSAA	<0.14		12.2	10.8		ug/Kg	☼	89	70 - 130
NEtFOSAA	<0.29		12.2	12.3		ug/Kg	☼	101	70 - 130
NMeFOSE	<0.28		12.2	12.3		ug/Kg	☼	101	70 - 130
NEtFOSE	<0.17		12.2	12.8		ug/Kg	☼	105	70 - 130
4:2 FTS	<0.30		11.4	11.3		ug/Kg	☼	99	70 - 130
6:2 FTS	6.4		11.5	17.0		ug/Kg	☼	92	70 - 130
8:2 FTS	66	F2	11.6	40.0	4	ug/Kg	☼	-227	70 - 130
10:2 FTS	4.3		11.7	14.8		ug/Kg	☼	90	70 - 130
DONA	<0.23		11.4	11.2		ug/Kg	☼	98	70 - 130
HFPO-DA (GenX)	<0.24		12.2	11.6		ug/Kg	☼	95	70 - 130
F-53B Major	<0.21		11.3	10.3		ug/Kg	☼	91	70 - 130
F-53B Minor	<0.18		11.4	9.95		ug/Kg	☼	87	70 - 130

Isotope Dilution	*MS %Recovery*	*MS Qualifier*	*Limits*
13C4 PFBA	*73*		*25 - 150*
13C5 PFPeA	*90*		*25 - 150*
13C2 PFHxA	*97*		*25 - 150*
13C4 PFHpA	*95*		*25 - 150*
13C4 PFOA	*97*		*25 - 150*
13C5 PFNA	*97*		*25 - 150*
13C2 PFDA	*88*		*25 - 150*
13C2 PFUnA	*89*		*25 - 150*
13C2 PFDoA	*84*		*25 - 150*
13C2 PFTeDA	*80*		*25 - 150*
13C3 PFBS	*87*		*25 - 150*
18O2 PFHxS	*92*		*25 - 150*
13C4 PFOS	*96*		*25 - 150*
13C8 FOSA	*97*		*10 - 150*
d3-NMeFOSAA	*81*		*25 - 150*
d5-NEtFOSAA	*84*		*25 - 150*
d-N-MeFOSA-M	*93*		*10 - 150*
d-N-EtFOSA-M	*89*		*10 - 150*
d7-N-MeFOSE-M	*72*		*10 - 150*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: 320-76427-1 MS
Matrix: Solid
Analysis Batch: 510816

Client Sample ID: SB-1 (0-0.5)
Prep Type: Total/NA
Prep Batch: 510504

Isotope Dilution	*MS %Recovery*	*MS Qualifier*	*Limits*
d9-N-EtFOSE-M	*71*		*10 - 150*
M2-4:2 FTS	*99*		*25 - 150*
M2-6:2 FTS	*103*		*25 - 150*
M2-8:2 FTS	*100*		*25 - 150*
13C3 HFPO-DA	*99*		*25 - 150*
13C2 10:2 FTS	*80*		*25 - 150*

Lab Sample ID: 320-76427-1 MSD
Matrix: Solid
Analysis Batch: 510816

Client Sample ID: SB-1 (0-0.5)
Prep Type: Total/NA
Prep Batch: 510504

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Perfluorobutanoic acid (PFBA)	5.3		11.9	17.2		ug/Kg	☼	101	70 - 130	14	30
Perfluoropentanoic acid (PFPeA)	18	F1	11.9	29.5		ug/Kg	☼	93	70 - 130	25	30
Perfluorohexanoic acid (PFHxA)	6.7		11.9	17.5		ug/Kg	☼	90	70 - 130	14	30
Perfluoroheptanoic acid (PFHpA)	6.0		11.9	17.7		ug/Kg	☼	98	70 - 130	9	30
Perfluorooctanoic acid (PFOA)	18	F2 F1	11.9	32.9	F2	ug/Kg	☼	126	70 - 130	35	30
Perfluorononanoic acid (PFNA)	7.3		11.9	21.3		ug/Kg	☼	118	70 - 130	22	30
Perfluorodecanoic acid (PFDA)	2.4		11.9	15.3		ug/Kg	☼	108	70 - 130	12	30
Perfluoroundecanoic acid (PFUnA)	0.57	J	11.9	10.7		ug/Kg	☼	85	70 - 130	15	30
Perfluorododecanoic acid (PFDoA)	0.48	J	11.9	11.8		ug/Kg	☼	95	70 - 130	10	30
Perfluorotridecanoic acid (PFTriA)	<0.13		11.9	11.9		ug/Kg	☼	100	70 - 130	4	30
Perfluorotetradecanoic acid (PFTeA)	<0.22		11.9	13.6		ug/Kg	☼	114	70 - 130	0	30
Perfluoro-n-hexadecanoic acid (PFHxDA)	<0.23		11.9	13.5		ug/Kg	☼	113	70 - 130	4	30
Perfluoro-n-octadecanoic acid (PFODA)	<0.39	F2	11.9	10.5	F2	ug/Kg	☼	88	70 - 130	31	30
Perfluorobutanesulfonic acid (PFBS)	<0.23		10.5	10.6		ug/Kg	☼	101	70 - 130	2	30
Perfluoropentanesulfonic acid (PFPeS)	<0.22		11.2	10.9		ug/Kg	☼	97	70 - 130	2	30
Perfluorohexanesulfonic acid (PFHxS)	<0.17		10.8	10.1		ug/Kg	☼	93	70 - 130	7	30
Perfluoroheptanesulfonic Acid (PFHpS)	<0.29		11.3	11.0		ug/Kg	☼	97	70 - 130	0	30
Perfluorooctanesulfonic acid (PFOS)	<0.26		11.1	10.6		ug/Kg	☼	96	70 - 130	5	30
Perfluorononanesulfonic acid (PFNS)	<0.17		11.4	9.58		ug/Kg	☼	84	70 - 130	7	30
Perfluorodecanesulfonic acid (PFDS)	<0.31		11.5	9.14		ug/Kg	☼	80	70 - 130	8	30
Perfluorododecanesulfonic acid (PFDoS)	<0.28		11.5	8.90		ug/Kg	☼	77	70 - 130	4	30
Perfluorooctanesulfonamide (FOSA)	<0.20		11.9	10.5		ug/Kg	☼	88	70 - 130	12	30
NEtFOSA	<0.28		11.9	11.8		ug/Kg	☼	99	70 - 130	3	30
NMeFOSA	<0.29		11.9	11.8		ug/Kg	☼	99	70 - 130	4	30
NMeFOSAA	<0.14		11.9	11.2		ug/Kg	☼	94	70 - 130	3	30
NEtFOSAA	<0.29		11.9	12.3		ug/Kg	☼	103	70 - 130	0	30

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: 320-76427-1 MSD
Matrix: Solid
Analysis Batch: 510816

Client Sample ID: SB-1 (0-0.5)
Prep Type: Total/NA
Prep Batch: 510504

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
NMeFOSE	<0.28		11.9	11.8		ug/Kg	☼	99	70 - 130	4	30
NEtFOSE	<0.17		11.9	12.0		ug/Kg	☼	100	70 - 130	7	30
4:2 FTS	<0.30		11.1	10.7		ug/Kg	☼	96	70 - 130	5	30
6:2 FTS	6.4		11.3	19.0		ug/Kg	☼	111	70 - 130	11	30
8:2 FTS	66	F2	11.4	79.8	4 F2	ug/Kg	☼	118	70 - 130	66	30
10:2 FTS	4.3		11.5	17.0		ug/Kg	☼	110	70 - 130	13	30
DONA	<0.23		11.2	11.1		ug/Kg	☼	99	70 - 130	1	30
HFPO-DA (GenX)	<0.24		11.9	11.1		ug/Kg	☼	93	70 - 130	4	30
F-53B Major	<0.21		11.1	10.2		ug/Kg	☼	92	70 - 130	2	30
F-53B Minor	<0.18		11.2	9.17		ug/Kg	☼	82	70 - 130	8	30

Isotope Dilution	*MSD %Recovery*	*MSD Qualifier*	*Limits*
13C4 PFBA	*76*		*25 - 150*
13C5 PFPeA	*95*		*25 - 150*
13C2 PFHxA	*96*		*25 - 150*
13C4 PFHpA	*97*		*25 - 150*
13C4 PFOA	*96*		*25 - 150*
13C5 PFNA	*93*		*25 - 150*
13C2 PFDA	*83*		*25 - 150*
13C2 PFUnA	*95*		*25 - 150*
13C2 PFDoA	*87*		*25 - 150*
13C2 PFTeDA	*72*		*25 - 150*
13C3 PFBS	*85*		*25 - 150*
18O2 PFHxS	*92*		*25 - 150*
13C4 PFOS	*95*		*25 - 150*
13C8 FOSA	*104*		*10 - 150*
d3-NMeFOSAA	*82*		*25 - 150*
d5-NEtFOSAA	*79*		*25 - 150*
d-N-MeFOSA-M	*93*		*10 - 150*
d-N-EtFOSA-M	*90*		*10 - 150*
d7-N-MeFOSE-M	*70*		*10 - 150*
d9-N-EtFOSE-M	*72*		*10 - 150*
M2-4:2 FTS	*100*		*25 - 150*
M2-6:2 FTS	*101*		*25 - 150*
M2-8:2 FTS	*87*		*25 - 150*
13C3 HFPO-DA	*99*		*25 - 150*
13C2 10:2 FTS	*74*		*25 - 150*

Method: D 2216 - Percent Moisture

Lab Sample ID: 320-76427-9 DU
Matrix: Solid
Analysis Batch: 508430

Client Sample ID: SB-4 (7-9) DUP
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
Percent Moisture	20.5			19.3		%				6	20
Percent Solids	79.5			80.7		%				1	20

LCMS

Prep Batch: 508643

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-76427-2	SB-2 (8-9)	Total/NA	Solid	SHAKE	
320-76427-5	SB-3 (3-4)	Total/NA	Solid	SHAKE	
320-76427-6	SED-COMP	Total/NA	Solid	SHAKE	
320-76427-6 - DL	SED-COMP	Total/NA	Solid	SHAKE	
320-76427-7	SED-COMP-DUP	Total/NA	Solid	SHAKE	
320-76427-8	SB-4 (7-9)	Total/NA	Solid	SHAKE	
320-76427-9	SB-4 (7-9) DUP	Total/NA	Solid	SHAKE	
MB 320-508643/1-A	Method Blank	Total/NA	Solid	SHAKE	
LCS 320-508643/2-A	Lab Control Sample	Total/NA	Solid	SHAKE	

Prep Batch: 508645

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-76427-3	FB-01-210714	Total/NA	Water	3535	
320-76427-4	EB-01-210714	Total/NA	Water	3535	
MB 320-508645/1-A	Method Blank	Total/NA	Water	3535	
LCS 320-508645/2-A	Lab Control Sample	Total/NA	Water	3535	
LCSD 320-508645/3-A	Lab Control Sample Dup	Total/NA	Water	3535	

Analysis Batch: 508965

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-76427-3	FB-01-210714	Total/NA	Water	537 (modified)	508645
320-76427-4	EB-01-210714	Total/NA	Water	537 (modified)	508645
MB 320-508645/1-A	Method Blank	Total/NA	Water	537 (modified)	508645
LCS 320-508645/2-A	Lab Control Sample	Total/NA	Water	537 (modified)	508645
LCSD 320-508645/3-A	Lab Control Sample Dup	Total/NA	Water	537 (modified)	508645

Analysis Batch: 509929

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-76427-2	SB-2 (8-9)	Total/NA	Solid	537 (modified)	508643
320-76427-5	SB-3 (3-4)	Total/NA	Solid	537 (modified)	508643
320-76427-8	SB-4 (7-9)	Total/NA	Solid	537 (modified)	508643
320-76427-9	SB-4 (7-9) DUP	Total/NA	Solid	537 (modified)	508643
MB 320-508643/1-A	Method Blank	Total/NA	Solid	537 (modified)	508643
LCS 320-508643/2-A	Lab Control Sample	Total/NA	Solid	537 (modified)	508643

Analysis Batch: 510022

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-76427-6 - DL	SED-COMP	Total/NA	Solid	537 (modified)	508643
320-76427-6	SED-COMP	Total/NA	Solid	537 (modified)	508643
320-76427-7	SED-COMP-DUP	Total/NA	Solid	537 (modified)	508643

Prep Batch: 510504

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-76427-1	SB-1 (0-0.5)	Total/NA	Solid	SHAKE	
MB 320-510504/1-A	Method Blank	Total/NA	Solid	SHAKE	
LCS 320-510504/2-A	Lab Control Sample	Total/NA	Solid	SHAKE	
320-76427-1 MS	SB-1 (0-0.5)	Total/NA	Solid	SHAKE	
320-76427-1 MSD	SB-1 (0-0.5)	Total/NA	Solid	SHAKE	

QC Association Summary

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

LCMS

Analysis Batch: 510816

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-76427-1	SB-1 (0-0.5)	Total/NA	Solid	537 (modified)	510504
MB 320-510504/1-A	Method Blank	Total/NA	Solid	537 (modified)	510504
LCS 320-510504/2-A	Lab Control Sample	Total/NA	Solid	537 (modified)	510504
320-76427-1 MS	SB-1 (0-0.5)	Total/NA	Solid	537 (modified)	510504
320-76427-1 MSD	SB-1 (0-0.5)	Total/NA	Solid	537 (modified)	510504

General Chemistry

Analysis Batch: 508430

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-76427-1	SB-1 (0-0.5)	Total/NA	Solid	D 2216	
320-76427-2	SB-2 (8-9)	Total/NA	Solid	D 2216	
320-76427-5	SB-3 (3-4)	Total/NA	Solid	D 2216	
320-76427-6	SED-COMP	Total/NA	Solid	D 2216	
320-76427-7	SED-COMP-DUP	Total/NA	Solid	D 2216	
320-76427-8	SB-4 (7-9)	Total/NA	Solid	D 2216	
320-76427-9	SB-4 (7-9) DUP	Total/NA	Solid	D 2216	
320-76427-9 DU	SB-4 (7-9) DUP	Total/NA	Solid	D 2216	

Lab Chronicle

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: SB-1 (0-0.5)
Date Collected: 07/14/21 08:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-1
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1			508430	07/20/21 12:16	KDB	TAL SAC

Client Sample ID: SB-1 (0-0.5)
Date Collected: 07/14/21 08:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-1
Matrix: Solid
Percent Solids: 81.5

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			1.03 g	10.0 mL	510504	07/27/21 04:48	HK	TAL SAC
Total/NA	Analysis	537 (modified)		1			510816	07/28/21 06:17	JRB	TAL SAC

Client Sample ID: SB-2 (8-9)
Date Collected: 07/14/21 10:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-2
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1			508430	07/20/21 12:16	KDB	TAL SAC

Client Sample ID: SB-2 (8-9)
Date Collected: 07/14/21 10:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-2
Matrix: Solid
Percent Solids: 74.0

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			5.08 g	10.0 mL	508643	07/20/21 18:41	AM	TAL SAC
Total/NA	Analysis	537 (modified)		1			509929	07/23/21 07:48	S1M	TAL SAC

Client Sample ID: FB-01-210714
Date Collected: 07/14/21 12:05
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-3
Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3535			300.8 mL	10.0 mL	508645	07/20/21 19:23	AP	TAL SAC
Total/NA	Analysis	537 (modified)		1			508965	07/21/21 22:22	D1R	TAL SAC

Client Sample ID: EB-01-210714
Date Collected: 07/14/21 12:15
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-4
Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3535			290.9 mL	10.0 mL	508645	07/20/21 19:23	AP	TAL SAC
Total/NA	Analysis	537 (modified)		1			508965	07/21/21 22:32	D1R	TAL SAC

Lab Chronicle

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: SB-3 (3-4)
Date Collected: 07/14/21 12:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-5
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1			508430	07/20/21 12:16	KDB	TAL SAC

Client Sample ID: SB-3 (3-4)
Date Collected: 07/14/21 12:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-5
Matrix: Solid
Percent Solids: 77.0

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			5.40 g	10.0 mL	508643	07/20/21 18:41	AM	TAL SAC
Total/NA	Analysis	537 (modified)		1			509929	07/23/21 07:57	S1M	TAL SAC

Client Sample ID: SED-COMP
Date Collected: 07/14/21 13:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-6
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1			508430	07/20/21 12:16	KDB	TAL SAC

Client Sample ID: SED-COMP
Date Collected: 07/14/21 13:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-6
Matrix: Solid
Percent Solids: 9.9

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE	DL		5.18 g	10.0 mL	508643	07/20/21 18:41	AM	TAL SAC
Total/NA	Analysis	537 (modified)	DL	10			510022	07/24/21 18:16	D1R	TAL SAC
Total/NA	Prep	SHAKE			5.18 g	10.0 mL	508643	07/20/21 18:41	AM	TAL SAC
Total/NA	Analysis	537 (modified)		1			510022	07/24/21 18:35	D1R	TAL SAC

Client Sample ID: SED-COMP-DUP
Date Collected: 07/14/21 13:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-7
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1			508430	07/20/21 12:16	KDB	TAL SAC

Client Sample ID: SED-COMP-DUP
Date Collected: 07/14/21 13:50
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-7
Matrix: Solid
Percent Solids: 11.2

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			5.23 g	10.0 mL	508643	07/20/21 18:41	AM	TAL SAC
Total/NA	Analysis	537 (modified)		1			510022	07/24/21 18:44	D1R	TAL SAC

Lab Chronicle

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Client Sample ID: SB-4 (7-9)
Date Collected: 07/14/21 14:30
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-8
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1			508430	07/20/21 12:16	KDB	TAL SAC

Client Sample ID: SB-4 (7-9)
Date Collected: 07/14/21 14:30
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-8
Matrix: Solid
Percent Solids: 78.8

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			5.41 g	10.0 mL	508643	07/20/21 18:41	AM	TAL SAC
Total/NA	Analysis	537 (modified)		1			509929	07/23/21 08:45	S1M	TAL SAC

Client Sample ID: SB-4 (7-9) DUP
Date Collected: 07/14/21 14:30
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-9
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1			508430	07/20/21 12:16	KDB	TAL SAC

Client Sample ID: SB-4 (7-9) DUP
Date Collected: 07/14/21 14:30
Date Received: 07/19/21 08:47

Lab Sample ID: 320-76427-9
Matrix: Solid
Percent Solids: 79.5

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			5.60 g	10.0 mL	508643	07/20/21 18:41	AM	TAL SAC
Total/NA	Analysis	537 (modified)		1			509929	07/23/21 08:54	S1M	TAL SAC

Laboratory References:

TAL SAC = Eurofins TestAmerica, Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Accreditation/Certification Summary

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Laboratory: Eurofins TestAmerica, Sacramento

The accreditations/certifications listed below are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Wisconsin	State	998204680	08-31-21

Method Summary

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Method	Method Description	Protocol	Laboratory
537 (modified)	Fluorinated Alkyl Substances	EPA	TAL SAC
D 2216	Percent Moisture	ASTM	TAL SAC
3535	Solid-Phase Extraction (SPE)	SW846	TAL SAC
SHAKE	Shake Extraction with Ultrasonic Bath Extraction	SW846	TAL SAC

Protocol References:

ASTM = ASTM International

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL SAC = Eurofins TestAmerica, Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Sample Summary

Client: Ramboll US Corporation
Project/Site: Reichhold Oak Creek

Job ID: 320-76427-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
320-76427-1	SB-1 (0-0.5)	Solid	07/14/21 08:50	07/19/21 08:47
320-76427-2	SB-2 (8-9)	Solid	07/14/21 10:50	07/19/21 08:47
320-76427-3	FB-01-210714	Water	07/14/21 12:05	07/19/21 08:47
320-76427-4	EB-01-210714	Water	07/14/21 12:15	07/19/21 08:47
320-76427-5	SB-3 (3-4)	Solid	07/14/21 12:50	07/19/21 08:47
320-76427-6	SED-COMP	Solid	07/14/21 13:50	07/19/21 08:47
320-76427-7	SED-COMP-DUP	Solid	07/14/21 13:50	07/19/21 08:47
320-76427-8	SB-4 (7-9)	Solid	07/14/21 14:30	07/19/21 08:47
320-76427-9	SB-4 (7-9) DUP	Solid	07/14/21 14:30	07/19/21 08:47

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Phone: 708-534-5200 Fax: 708-534-5211

Chain of Custody Record

eurofins | Environment Testing America

Client Information	Sampler: Liz Bonicki	Lab PM: Fredrick, Sandie	Carrier Tracking No(s):	COC No: 500-92911-41393.1
Client Contact: Abby Small	Phone: 262.758.1488	E-Mail: sandra.fredrick@eurofinset.com	State of Origin: Wisconsin	Page: Page 1 of 1
Company: Ramboll US Corporation	PWSID:			Job #:
Address: 5050 Lincoln Drive, Suite 440	Due Date Requested:			
City: Edina	TAT Requested (days): Standard TAT			
State, Zip: MN, 55436	Compliance Project: Δ Yes Δ No			
Phone:	PO #: Purchase Order not required			
Email: asmall@ramboll.com	WO #:			
Project Name: Reichhold Oak Creek	Project #: 50019135			
Site:	SSOW#:			

Analysis Requested

320-76427 Chain of Custody

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	PFAS	Total Number of containers	Special Instructions/Note:
			Preservation Code:						
SB-1 (0-0.5)	7.14.2021	0850	G	Solid			X		
SB-2 (8-9)	7.14.2021	1050	G	Solid			X		
FB-01-210714	7.14.2021	1205	G	Water			X		
EB-01-210714	7.14.2021	1215	G	Water			X		
SB-3 (3-4)	7.14.2021	1250	G	Solid			X		
SED-COMP	7.14.2021	1350	G	Solid			X		
SED-COMP-DUP	7.14.2021	1350	G	Solid			X		
SB-4 (7-9)	7.14.2021	1430	G	Solid			X		
SB-4 (7-9) DUP	7.14.2021	1430	G	Solid			X		
				Water					
				Water					

7.15.2021

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☐ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

	Date/Time	Company		Date/Time	Company
Relinquished by: Liz Bonicki	7.15.2021 / 1135	Ramboll	Received by:	7-15-21 1135	TA
Relinquished by:	7-15-21 1700	TA	Received by:	7/19/21 847	EA
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: X Yes Δ No | Custody Seal No.: 1600504

Cooler Temperature(s) C and Other Remarks: 21.3

Ver: 11/01/2020

Login Sample Receipt Checklist

Client: Ramboll US Corporation

Job Number: 320-76427-1

Login Number: 76427
List Number: 1
Creator: Guzman, Juan

List Source: Eurofins TestAmerica, Sacramento

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	1600504
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	False	Water present in cooler; indicates evidence of melted ice.
Cooler Temperature is acceptable.	False	Refer to Job Narrative for details.
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Appendix C
Well construction and well development forms

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

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

Facility/Project Name	County Name	Well Name
DIC Liquid Facility	Milwaukee	MW-1

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
N/A	41	_____	___

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 __60 min.

4. Depth of well (from top of well casisng) _14.9 ft.

5. Inside diameter of well _2.05 in.

6. Volume of water in filter pack and well casing __7.9 gal.

7. Volume of water removed from well __3.0 gal.

8. Volume of water added (if any) __0.0 gal.

9. Source of water added _____

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

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. __6.21 ft.	__8.50 ft.
Date	b. 07/23/2021 (m m d d y y y y)	07/23/2021 (m m d d y y y y)
Time	c. 10:06 ☒ a.m. ☐ p.m.	11:06 ☒ a.m. ☐ p.m.
12. Sediment in well bottom	_0.0 inches	_0.0 inches
13. Water clarity	Clear ☒ 10 Turbid ☐ 15 (Describe) Sediment free.	Clear ☒ 20 Turbid ☐ 25 (Describe) Sediment free.
14. Total suspended solids	____. mg/l	____. mg/l
15. COD	____. mg/l	____. mg/l

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

16. Well developed by: Name (first, last) and Firm
First Name: Kyle Last Name: Heimstead
Firm: Ramboll US Consulting, Inc.

17. Additional comments on development:
Purged well @ 150-200 ml/min.

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Gary Last Name: Andrzejewski
Facility/Firm: Sun Chemical Corporation
Street: 135 West Lake Street
City/State/Zip: Northlake, IL 60164

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: _____
Print Name: Kyle Heimstead
Firm: Ramboll US Consulting, Inc.

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

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

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

Facility/Project Name	County Name	Well Name
DIC Liquid Facility	Milwaukee	MW-2

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
N/A	41	_____	___

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 55 min.

4. Depth of well (from top of well casisng) 149 ft.

5. Inside diameter of well 2.05 in.

6. Volume of water in filter pack and well casing 4.6 gal.

7. Volume of water removed from well 2.5 gal.

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

9. Source of water added _____

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

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 93.93 ft.	12.02 ft.
Date	b. 07/23/2021 (m m d d y y y y)	07/23/2021 (m m d d y y y y)
Time	c. 9:00 ☒ a.m. ☐ p.m.	9:55 ☒ a.m. ☐ p.m.
12. Sediment in well bottom	0.1 inches	0.0 inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe) Brown with sediment.	Clear ☒ 20 Turbid ☐ 25 (Describe) Sediment free.
14. Total suspended solids	____.__ mg/l	____.__ mg/l
15. COD	____.__ mg/l	____.__ mg/l

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

16. Well developed by: Name (first, last) and Firm
First Name: Kyle Last Name: Heimstead
Firm: Ramboll US Consulting, Inc.

17. Additional comments on development:
Purged well @ 150-200 ml/min.

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Gary Last Name: Andrzejewski
Facility/Firm: Sun Chemical Corporation
Street: 135 West Lake Street
City/State/Zip: Northlake, IL 60164

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: _____
Print Name: Kyle Heimstead
Firm: Ramboll US Consulting, Inc.

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

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

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

Facility/Project Name	County Name	Well Name
DIC Liquid Facility	Milwaukee	MW-3

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
N/A	41	_____	___

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 __60 min.

4. Depth of well (from top of well casisng) _14.0 ft.

5. Inside diameter of well _2.05 in.

6. Volume of water in filter pack and well casing __2.7 gal.

7. Volume of water removed from well __2.8 gal.

8. Volume of water added (if any) __0.0 gal.

9. Source of water added _____

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

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. _11.11 ft.	_13.33 ft.
Date	b. 07/23/2021 (m m d d y y y y)	07/23/2021 (m m d d y y y y)
Time	c. _7:50 ☒ a.m. ☐ p.m.	_8:50 ☒ a.m. ☐ p.m.
12. Sediment in well bottom	_0.0 inches	_0.0 inches
13. Water clarity	Clear ☒ 10 Turbid ☐ 15 (Describe) Sediment free.	Clear ☒ 20 Turbid ☐ 25 (Describe) Sediment free.

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: Kyle Last Name: Heimstead
Firm: Ramboll US Consulting, Inc.

17. Additional comments on development:
Purged well @ 150-200 ml/min.

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Gary Last Name: Andrzejewski
Facility/Firm: Sun Chemical Corporation
Street: 135 West Lake Street
City/State/Zip: Northlake, IL 60164

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: _____
Print Name: Kyle Heimstead
Firm: Ramboll US Consulting, Inc.

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

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: DIC Liquid Facility	Local Grid Location of Well: 339241.618 ft. ☒ N. ☐ S. 2523420.708 ft. ☒ E. ☐ W.	Well Name: MW-1
Facility License, Permit or Monitoring No.: N/A	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: 07/14/2021 (m m / d d / y y y y)
Type of Well: Well Code 11 / MW	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: Tony Kapugi
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: _____ Onsite Environmental Services, Inc.

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation 722.539 ft. MSL

C. Land surface elevation 722.975 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 0.5 ft.

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

13. Sieve analysis performed? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50 / Hollow Stem Auger ☒ 41 / Other ☐ ___

15. Drilling fluid used: Water ☐ 02 / Air ☐ 01 / Drilling Mud ☐ 03 / None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe _____

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

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

F. Fine sand, top _____ ft. MSL or 3 ft.

G. Filter pack, top _____ ft. MSL or 4 ft.

H. Screen joint, top _____ ft. MSL or 5 ft.

I. Well bottom _____ ft. MSL or 15 ft.

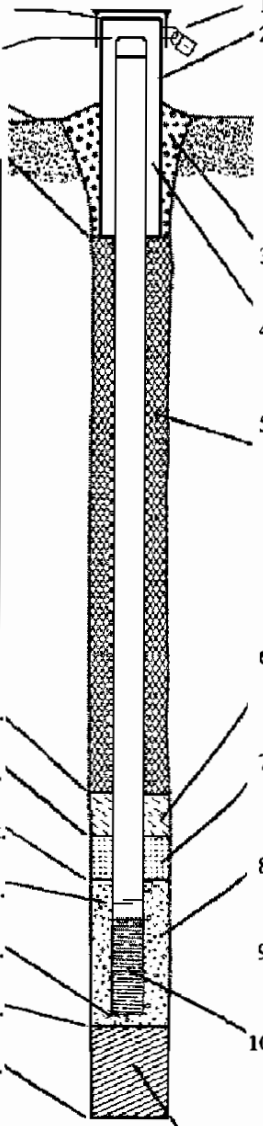
J. Filter pack, bottom _____ ft. MSL or 15 ft.

K. Borehole, bottom _____ ft. MSL or 15 ft.

L. Borehole, diameter 8.25 in.

M. O.D. well casing 2.3 in.

N. I.D. well casing 2.05 in.



1. Cap and lock? ☒ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 8 in.
b. Length: 1 ft.
c. Material: Steel ☒ 04 / Other ☐ ___
d. Additional protection? ☐ Yes ☒ No
If yes, describe: _____

3. Surface seal: Bentonite ☒ 30 / Concrete ☐ 01 / Other ☐ ___

4. Material between well casing and protective pipe: Bentonite ☒ 30 / Other ☐ ___

5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. _____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. _____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 / Tremie pumped ☐ 02 / Gravity ☒ 08

6. Bentonite seal: a. Bentonite granules ☒ 33
b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite chips ☐ 32
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 ☒ 23 / Flush threaded PVC schedule 80 ☐ 24 / Other ☐ ___

10. Screen material: PVC ___
a. Screen type: Factory cut ☒ 11 / Continuous slot ☐ 01 / Other ☐ ___
b. Manufacturer _____
c. Slot size: 0.010 in.
d. Slotted length: 10 ft.

11. Backfill material (below filter pack): None ☒ 14 / Other ☐ ___

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

Signature	Firm
Dan Goldfarb	Ramboll US Consulting, Inc.

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

State of Wisconsin
Department of Natural Resources

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

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: DIC Liquid Facility	Local Grid Location of Well: 339312.607 ft. ☒ N. ☐ S. 2523588.737 ft. ☒ E. ☐ W.	Well Name: MW-2
Facility License, Permit or Monitoring No.: N/A	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: 07/14/2021 (m m / d d / y y y y)
Type of Well: Well Code 11 / MW	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: Tony Kapugi — Onsite Environmental Services, Inc.
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 722.27 ft. MSL

C. Land surface elevation 722.522 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 0.5 ft.

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

13. Sieve analysis performed? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50 Hollow Stem Auger ☒ 41 Other ☐ _____

15. Drilling fluid used: Water ☐ 02 Air ☐ 01 Drilling Mud ☐ 03 None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No
Describe _____

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

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

F. Fine sand, top _____ ft. MSL or 3 ft.

G. Filter pack, top _____ ft. MSL or 4 ft.

H. Screen joint, top _____ ft. MSL or 5 ft.

I. Well bottom _____ ft. MSL or 15 ft.

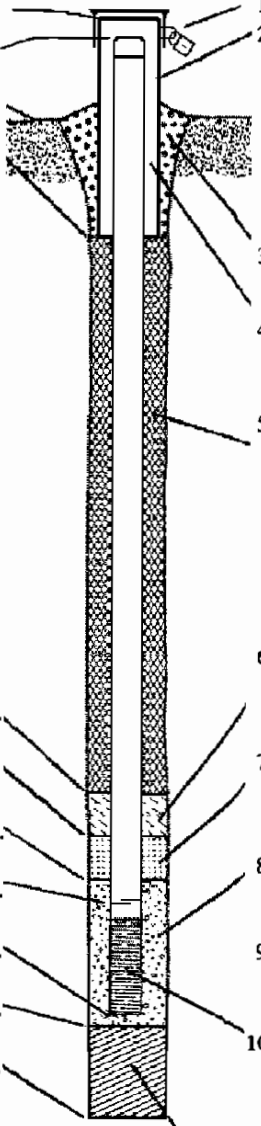
J. Filter pack, bottom _____ ft. MSL or 15 ft.

K. Borehole, bottom _____ ft. MSL or 15 ft.

L. Borehole, diameter 8.25 in.

M. O.D. well casing 2.3 in.

N. I.D. well casing 2.05 in.



1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
a. Inside diameter: 8 in.
b. Length: 1 ft.
c. Material: Steel ☒ 04 Other ☐ _____
d. Additional protection? ☐ Yes ☒ No
If yes, describe: _____
3. Surface seal: Bentonite ☒ 30 Concrete ☐ 01 Other ☐ _____
4. Material between well casing and protective pipe: Bentonite ☒ 30 Other ☐ _____
5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. _____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. _____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 Tremie pumped ☐ 02 Gravity ☒ 08
6. Bentonite seal: a. Bentonite granules ☒ 33
b. ☐1/4 in. ☐3/8 in. ☐1/2 in. Bentonite chips ☐ 32
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 ☒ 23 Flush threaded PVC schedule 80 ☐ 24 Other ☐ _____
10. Screen material: PVC
a. Screen type: Factory cut ☒ 11 Continuous slot ☐ 01 Other ☐ _____
b. Manufacturer _____
c. Slot size: 0.010 in.
d. Slotted length: 10 ft.
11. Backfill material (below filter pack): None ☒ 14 Other ☐ _____

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

Signature	Firm
Dan Gebhardt	Ramboll US Consulting, Inc.

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

State of Wisconsin
Department of Natural Resources

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

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: DIC Liquid Facility	Local Grid Location of Well: ☒ N. ☐ S. 339254.59 ft. ☒ E. ☐ W. 2523660.658 ft.	Well Name: MW-3
Facility License, Permit or Monitoring No.: N/A	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: 07/14/2021 (m m / d d / y y y y)
Type of Well: Well Code 11 / MW	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: Tony Kapugi, Onsite Environmental Services, Inc.
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 720.343 ft. MSL

C. Land surface elevation 720.753 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 0.5 ft.

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

13. Sieve analysis performed? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50 Hollow Stem Auger ☒ 41 Other ☐ _____

15. Drilling fluid used: Water ☐ 02 Air ☐ 01 Drilling Mud ☐ 03 None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No
Describe _____

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

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

F. Fine sand, top _____ ft. MSL or 2.5 ft.

G. Filter pack, top _____ ft. MSL or 3 ft.

H. Screen joint, top _____ ft. MSL or 4 ft.

I. Well bottom _____ ft. MSL or 14 ft.

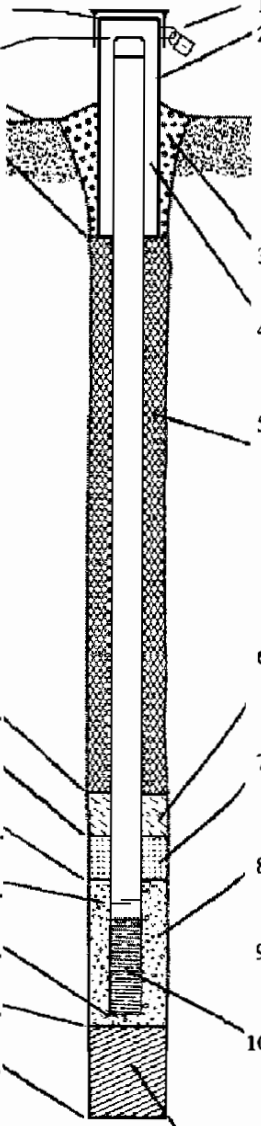
J. Filter pack, bottom _____ ft. MSL or 14 ft.

K. Borehole, bottom _____ ft. MSL or 15 ft.

L. Borehole, diameter 8.25 in.

M. O.D. well casing 2.3 in.

N. I.D. well casing 2.05 in.



1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
a. Inside diameter: 8 in.
b. Length: 1 ft.
c. Material: Steel ☒ 04 Other ☐ _____
d. Additional protection? ☐ Yes ☒ No
If yes, describe: _____
3. Surface seal: Bentonite ☒ 30 Concrete ☐ 01 Other ☐ _____
4. Material between well casing and protective pipe: Bentonite ☒ 30 Other ☐ _____
5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. _____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. _____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 Tremie pumped ☐ 02 Gravity ☒ 08
6. Bentonite seal: a. Bentonite granules ☒ 33
b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite chips ☐ 32
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 ☒ 23 Flush threaded PVC schedule 80 ☐ 24 Other ☐ _____
10. Screen material: PVC
a. Screen type: Factory cut ☒ 11 Continuous slot ☐ 01 Other ☐ _____
b. Manufacturer _____
c. Slot size: 0.010 in.
d. Slotted length: 10 ft.
11. Backfill material (below filter pack): None ☐ 14 Other ☒ Slough

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

Signature	Firm
Dan Goldsberd	Ramboll US Consulting, Inc.

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

State of Wisconsin
Department of Natural Resources

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

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: DIC Liquid Facility	Local Grid Location of Well: 339118.346 ft. ☒ N. ☐ S. 2523548.92 ft. ☒ E. ☐ W.	Well Name: MW-4
Facility License, Permit or Monitoring No.: N/A	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: 07/14/2021 (m m / d d / y y y y)
Type of Well: Well Code 11 / MW	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: Tony Kapugi
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: _____ Onsite Environmental Services, Inc.

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation 722.3 ft. MSL

C. Land surface elevation 722.701 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 0.5 ft.

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

13. Sieve analysis performed? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50 Hollow Stem Auger ☒ 41 Other ☐ _____

15. Drilling fluid used: Water ☐ 02 Air ☐ 01 Drilling Mud ☐ 03 None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No
Describe _____

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

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

F. Fine sand, top _____ ft. MSL or 3 ft.

G. Filter pack, top _____ ft. MSL or 4 ft.

H. Screen joint, top _____ ft. MSL or 5 ft.

I. Well bottom _____ ft. MSL or 15 ft.

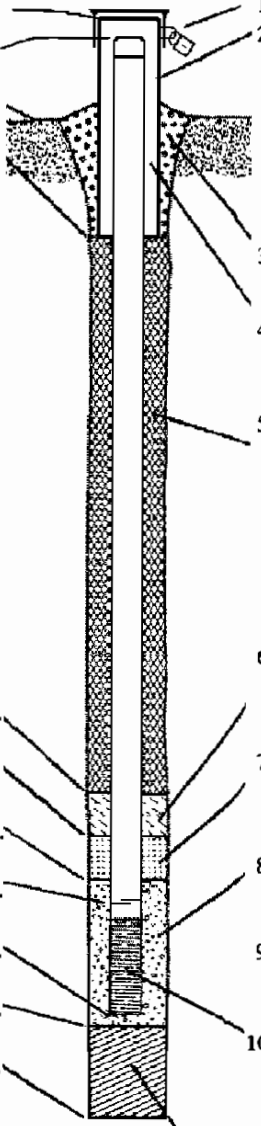
J. Filter pack, bottom _____ ft. MSL or 15 ft.

K. Borehole, bottom _____ ft. MSL or 15 ft.

L. Borehole, diameter 8.25 in.

M. O.D. well casing 2.3 in.

N. I.D. well casing 2.05 in.



1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
a. Inside diameter: 8 in.
b. Length: 1 ft.
c. Material: Steel ☒ 04 Other ☐ _____
d. Additional protection? ☐ Yes ☒ No
If yes, describe: _____
3. Surface seal: Bentonite ☒ 30 Concrete ☐ 01 Other ☐ _____
4. Material between well casing and protective pipe: Bentonite ☒ 30 Other ☐ _____
5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. _____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. _____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 Tremie pumped ☐ 02 Gravity ☒ 08
6. Bentonite seal: a. Bentonite granules ☒ 33
b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite chips ☐ 32
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 ☒ 23 Flush threaded PVC schedule 80 ☐ 24 Other ☐ _____
10. Screen material: PVC
a. Screen type: Factory cut ☒ 11 Continuous slot ☐ 01 Other ☐ _____
b. Manufacturer _____
c. Slot size: 0.010 in.
d. Slotted length: 10 ft.
11. Backfill material (below filter pack): None ☒ 14 Other ☐ _____

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

Signature	Firm
Dan Goldfield	Ramboll US Consulting, Inc.

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.

Appendix D
Field guidance documents

FIELD GUIDANCE DOCUMENT NO. 1.02

SAMPLE NAMING, LABELING, HANDLING, SHIPPING AND CHAIN OF CUSTODY

RAMBOLL ENVIRON

FIELD GUIDANCE DOCUMENT NO. 1.02

SAMPLE NAMING, LABELING, HANDLING, SHIPPING AND CHAIN OF CUSTODY

Prepared By:	Chris Buzgo Taryn Correll Melanie Charles
Peer Reviewed By:	Jose Sananes Mary Cottingham Luke Chmielecki Seema Turner Carol Serlin Nestor Soler
Approved By:	J. Mark Nielsen
Applicable To:	All North American offices
Effective Date:	September 16, 2014
Revision Date:	June 1, 2016
Revision Notes:	1. Revised company name and format.
Documents Used as Reference During Preparation:	US EPA Region 4, 2007. *Sample and Evidence Management*.

CONTENTS

1.	**INTRODUCTION**	**1**
2.	**EQUIPMENT/MATERIALS**	**2**
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ATTACHMENTS

Attachment A: Sample Completed COC Form

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines and procedures established by Ramboll Environ for sample management including identification, labeling, handling/packaging, chain-of-custody, and transport. A sampling event could be dismissed if sample containers are broken in transport, samples are improperly labeled and unable to be reconciled, or chain-of-custody practices are not followed. Therefore, proper sample management is essential to the production of data of reliable quality that can be used for decision-making.

Although this FGD provides guidelines for managing samples from the time of collection through transfer to the laboratory for analysis, it should be understood that for certain projects more specific procedures may be applicable, including state-specific or regulatory program-specific guidelines, requirements or procedures.

Similarly, these guidelines may not be applicable to ongoing projects with a previously established sample nomenclature that does not correspond to the naming conventions outlined in this FGD, which may be important to adhere to for the sake of continuity and consistency. Specific requirements for these types of projects and activities will be reviewed by the Ramboll Environ Principal-in-Charge / Project Director (PIC) and Project Manager (PM) and any additional requirements will be defined in a project-specific Work Plan, sampling plan and/or project-specific FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans but rather a general reference for developing project specific requirements. In addition, PICs and PMs are encouraged to provide additional direction or training to junior scientists and engineers for the implementation of the procedures outlined in this FGD.

Procedures discussed herein are primarily for the most common types of sampling conducted – soil, water, sediment, soil vapor, and/or air. Other types of sampling events (e.g., sampling of concrete, biota, etc.) may require additional steps to those described in this FGD. For media that are not as commonly sampled, this FGD should be reviewed in the context of project-specific sampling requirements, and modified as applicable.

It should be noted that this FGD does not supersede Ramboll Environ Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail.

2. EQUIPMENT / MATERIALS

Equipment and materials necessary to conform to this FGD include:

2.1 Sample Labeling / Chain-of-Custody

- Paper towels.
- Laboratory Sample Label.
- Bound Field Notebook – lined high-grade 50 percent rag paper with a hard-cover and water-resistant surface (e.g., "Rite-in-the-Rain") or appropriate field forms.
- All Weather Pens or (weather permitting) other indelible ballpoint pens with black or blue ink.
- Watch (or other time keeping device).
- Clear tape.
- Laboratory Chain-of-Custody (COC) Forms.
- Gallon-size or larger plastic zip top bags or other clear plastic to insert the COC form.

2.2 Sample Packaging / Transport

- Coolers (or original Summa canister shipping container for air or soil vapor sampling).
- Ice.
- Ice scoop.
- Gallon-size or larger plastic zip top bags or other clear plastic to fill with ice.
- Quart and gallon-size plastic zip top bags for sample containers (solids or aqueous).
- Padding (bubble wrap, Styrofoam packing material, etc.).
- Packing tape.
- Scissors.
- Custody seals.
- Black indelible ink pen.
- Post-it notes.
- Tape, zip tie, or other items to attach COC to coolers/sample shipping containers.
- Shipping air bill (FedEx pre-filled forms with Ramboll Environ's account info are available).

3. PROCEDURES REFERENCED

- All field sampling FGD categories.
- **FGD 1.01**, Field Notes and Records.
- **FGD 1.03**, Data Management.

4. PROCEDURES

After collection, samples will be managed in conformance with the provisions outlined in the following sections. After sample shipment, copies of the final signed COC should be kept in the project file. A completed COC (inclusive of signatures from the laboratory), which should be provided with the laboratory data deliverables, should also be kept in the project file. An example completed COC is included in **Attachment A**.

In general, a standard sample naming convention should be used. The sample identification scheme should ensure that samples, including quality control samples (e.g., trip blanks), will be uniquely identified between events. Thus, in developing the sample identification scheme, historical data and reports should be reviewed to establish a location identification scheme which ensures that locations will be uniquely identified.

4.1 Sample Identification

Every sample collected must be associated with a unique identifier. Prior to mobilization, field personnel should confirm with the PM or PIC the sample name format to be used since there may be occasions when the standard sample identification (ID) format detailed in this FGD is not applicable. For example, an ongoing project with a previously established sample nomenclature that does not correspond to the naming conventions outlined in this FGD, which may be important to adhere to for the sake of continuity and consistency. Similarly, field personnel should confirm with the laboratory any limitations on the number of characters that can be used to identify a sample (a partial list of the analytical laboratories typically used by Ramboll Environ is provided in Attachment B of **FGD 1.03**, Data Management). In the absence of project specific instructions, the following scheme, which limits the sample ID to 18 characters, is recommended.

The recommended sample name or ID will consist of an alphanumeric describer that will identify the site name, sample type, sample location, sample depth (if applicable), and sample collection date using the following convention:

- The first three identifiers in the sample name will consist of a three-letter acronym for the study site (e.g., samples collected from an ABC Industries site might have ABC as the first three identifiers in the sample ID) or alternatively, if the name of the study site is too long or the borings are being advanced on properties adjacent to the study site, the first three identifiers could also be RE (short for Ramboll Environ).
- Following the site name portion of the sample ID will be a dash and one of the following modifier designating the type of sample:
  - Outdoor Air – OA;
  - Duplicate Sample – DS;
  - Effluent – EF;
  - Indoor Air – IA;
  - Influent – IN;
  - Injection Well – IW;

  - Midfluent – MD;
  - Monitoring Well (permanent) – MW;
  - Monitoring Well (temporary) – TW;
  - Hydropunch HP;
  - Piezometer – PZ;
  - Production Well – PW;
  - Recovery or Extraction Well – RW or EW;
  - Rinse Blanks – RB;
  - Sediment Sample – SE;
  - Soil Boring – SB;
  - Soil Vapor (i.e., outside of a building) – SV;
  - Sub-Slab Soil Vapor – SSV;
  - Surface Soil – SS;
  - Surface Water – SW;
  - Trip Blank – TB;
  - Waste Characterization – WC; or
  - Investigation-Derived Waste - IDW.

- Following the sample location code will be a two or three digit numeric designation indicating a unique location for that type of sample. For example, a soil sample collected from boring number 3 would have a sample type code of SB and a two digit numeric designation of 03. Thus, samples from this location would be referred to as SB03 or SB003, rather than SB3).
- For aqueous media (i.e., groundwater, surface water, QA/QC samples), and soil vapor sampling (i.e., indoor air, ambient air, soil vapor) the depth code will be followed by a six digit numeric code indicating the date the sample was collected (yymmdd). Non-aqueous samples such as soil and sediment samples will utilize a four digit acronym designating the top of the sampling interval in feet (e.g., 07.5 representing a sample collected from 7.5 feet below the ground surface or 10.5 representing a sample collected from 10.5 feet below the ground surface).
- Field duplicates will be labeled as ordinary field samples with a unique identification number. Duplicate samples should not be identifiable by sample ID alone so as to reduce the potential for bias and allow the laboratory to analyze them as “blind” quality control samples. Thus, in the event that multiple samples are collected on the same day from the same location (i.e., a duplicate sample), the designation “DS” (duplicate sample) will be used in place of the parent sample’s sample type code and a sequential numeric designation will be assigned in place of the numeric location code. This sequential numeric designation will be “01” for the first duplicate sample collected that day, “02” for the second duplicate sample collected that day (from another sample location, media, etc.), and so on. Subsequent duplicate samples collected on multi-day

sampling events should be numbered sequentially (e.g., -"03" from the previous day's sampling).Since obvious links between the parent and duplicate samples in the Sample ID are to be avoided, it is very important to document in the field logbook or field notes which sample is the parent sample to each duplicate.

- Additional sample volumes collected for matrix spike (MS) and matrix spike duplicate (MSD) analysis will be noted on the COC forms, and no special designations will be used in the sample container labels.

For aqueous media (i.e., groundwater, surface water, QA/QC samples), the sample location code can also be followed by a single-letter acronym designating the well depth (e.g., bedrock (B), deep (D), intermediate (I) or shallow (S)) or the approximate depth the sample was collected.

Following are some sample name examples:

- A shallow soil sample collected from 3.5 feet collected from soil boring location 12 at ABC Industries on March 22, 2012 would be designated as "ABC-SB012-03.5". The complete depth sample range would be recorded in the field logbook or field notes.
- Groundwater samples collected from three different intervals at temporary well point location 3 at ABC Industries on March 22, 2012 could be designated as "ABC-TW003S-120322," "ABC-TW003I-120322," and "ABC-TW003D-120322" depending on the requirements of the project-specific Work Plan, sampling plan and/or project-specific FGDs.
- Paired indoor air and sub-slab soil vapor samples collected from location 3 at ABC Industries on March 22, 2012 would be designated as "ABC-IA03-120322" and "ABC-SSV03-120322", respectively.
- A duplicate of the groundwater sample collected from temporary well point location 3 at ABC Industries on March 22, 2012 (see example above), which is the second duplicate sample collected that day, would be designated as "ABC-DS02-120322". Document in the field logbook or field notes which sample is the parent sample to each duplicate.

4.2 Sample Labeling

Sample labels shall be attached or otherwise adhered to all sample containers. If multiple containers comprise a sample, the label should identify the container number relative to the total number of containers (e.g., 3/4 or 3 of 4). The following procedures should be followed when labeling samples:

- Properly label samples immediately before or immediately following sample collection. Record the following information on each label in indelible black or blue ink (non-Sharpie):
  - Project/Site name;
  - Sample location/sample ID;
  - Sampling date;
  - Sampling time (except for Quality Assurance/Quality Control "QA/QC" samples);

  - Analyses to be performed;
  - Preservative;
  - Ramboll Environ as the company name; and
  - Sampler initials.
- Wipe sample containers clean of any debris/water to allow the label to be attached.
- Double-check the label information to make sure it is correct. Remove the backing from the label and apply the label to the sample container. Cover label with clear tape.
- Bag the sample and place it in the designated sample cooler. Make sure there is plenty of ice in the cooler at all times. Maintain the samples at 4±2°C from the time of sample collection until delivery to the laboratory.
- Summa canisters and regulators should be returned to their original shipping container (e.g., typically cardboard boxes).
- Sampling information, including the QA/QC sampling time, should be reflected in the field notebook or on field forms, along with the following information:
  - The location of the sample in relation to reference points.
  - Field screening measurements (e.g., photoionization detector [PID] readings), when appropriate.
  - Whether the sample is a QC sample (e.g., split sample, field duplicate, or rinse sample).
  - Any unusual or pertinent observations (oily sheen on groundwater sample, odors).
  - For soil vapor samples record the summa canister and corresponding regulator serial numbers, building interior and outdoor temperatures, sample start and stop times, negative pressure start and stop readings, summa canister size, and atmospheric pressure.

4.3 Sample Packaging

While samples should be kept in the sampling cooler(s) at 4±2°C from the time of collection, it is not always feasible during sampling to pack samples as required for transport to the laboratory. At the end of the sampling day, sample packaging for transport to the laboratory should be conducted in an organized and clean area (free of potential cross-contaminants). The following procedure should be followed to prepare the sample(s) and cooler(s) for transport:

- Gather coolers/sample shipping containers, ice, zip-lock bags, and padding, as appropriate.
- Containerize ice in zip-lock bags (double bag) and place a layer of ice bags on the bottom of the cooler.
- Place a layer of padding on top of the ice bags and then begin placing the properly labeled samples in the cooler. Do not bulk pack – be sure to provide padding between sample bottles.

- Once the layer of padded sample containers is full (but not over-packed), place another layer of padding material on top of the sample containers.
- An additional layer of double-bagged ice can be added on top of the padding layer for additional cooling.
- Use multiple coolers if one cooler does not provide sufficient capacity to hold all samples along with appropriate amounts of padding and ice. It is preferable to use more coolers and more padding rather than over-packing and crowding the samples, as sample integrity may be compromised during transport.
- Confirm that each cooler used contains a temperature blank.
- Confirm that a trip blank has been included with the samples if the sampling plan and analyses (e.g., volatile organic compounds [VOCs]) call for use of a trip blank. Ensure that all samples to be analyzed for VOCs are placed in the same cooler as the associated trip blank. If necessary, use more than one trip blank.
- Close coolers/shipping containers and group them together for transport.

4.4 Sample Chain-of-Custody

Sample Chain-of-Custody (COC) forms shall be filled out as soon as practicable after collection of the samples, but can also be cross-checked during the packaging of the samples for transport to confirm that all samples/blanks have been accounted for on the COC. COCs are legal documents and should be filled out carefully and accurately. An example completed COC is included in **Attachment A**.

- The following information should be provided when completing the COC (use indelible black or blue ink ball-point):
  - Project Manager Name and Contact information for report submittal.
  - Sampler's name.
  - Analyses Turn-Around Time (typically standard unless otherwise directed).
  - Project/Site name and location (municipality/state). Try to use a consistent Project/Site Name when re-visiting a site for multiple sampling events.
  - Regulatory Program.
  - Sample ID for each sample.
  - Sample collection date and time for each sample.
  - Sample matrix for each sample.
  - Number of sample containers for each sample.
  - Analyses requested for each sample.
  - Sample matrix and air sample volume, if appropriate.
  - Sample preservation method.
  - Indicate whether samples are field filtered or require filtering in the laboratory.

  - Special instructions or notes to the laboratory (for example, expedited turnaround or holding samples for analysis pending results of other samples).
  - Signatory information when relinquishing samples (signature, company, date and time of recipient and sample releaser) – see below.
  - Note Delivery Service (e.g., laboratory courier or Federal Express) and air bill Number (if applicable).
  - For vapor samples, record the summa canister and regulator serial numbers, building interior and outdoor temperatures, sample start and stop times, negative pressure start and stop readings, summa canister size, and atmospheric pressure, if required by the laboratory, a project-specific Work Plan, sampling plan and/or project-specific FGDs.

- If a minor mistake is made when filling out the COC, cross out the error with a single line and write your initials and date next to the error. Major errors in transcription require that a new COC form be completed to ensure legibility of information on the original and carbon copy pages of the COC form.
- The use of quotation marks or other terms to indicate repetitive information within a column should be avoided. If several entries in a row are repetitive, place a continuous vertical arrow through the cells from the first entry to the next different entry.
- If additional instructions or information is necessary to provide to the laboratory, provide these details on the COC (usually within the "remarks" section) – do not enclose additional pages of instructions.
- If more than one COC form is necessary to accommodate all of the samples being transported to the laboratory use consecutive numbers to identify the additional COC forms (i.e., Page 1 of ___, Page 2 of ___, etc.).

4.5 Sample Transport

Maintaining the chain-of-custody is just as important during sample transport as it is during sampling activities. Note that a sample is considered to be in custody if:

- It is in the actual possession of an investigator (sampler);
- It is in the view of an investigator (sampler), after being in their physical possession;
- It was in the physical possession of an investigator (sampler) and then they secured it to prevent tampering; and/or
- It is placed in a designated secure area.

Option 1

The preferred method of transporting the collected samples under chain-of-custody to the laboratory is for the sampler/field personnel to hand-deliver the cooler(s)/container(s) of samples to the laboratory. When this transport method is possible, the following procedure must be followed:

- Once you have finished completing the COC, place it in a zip-lock bag without signing the "relinquished by"/"received by" (or equivalent) signatory boxes. Keep this outside of, but with, the packaged cooler(s).
- Place two (2) custody seals on opposite corners of each packaged sample cooler (across the opening) and sign/date each custody seal.
- Transport the properly packed and padded cooler(s) and the COC to the laboratory.
- The sampler/field staff must meet with the laboratory representative that accepts sample drop-offs (it is unacceptable to leave samples at a front desk or anywhere without having a laboratory representative sign off on receipt).
- Upon meeting the laboratory representative, sign your name on the COC in the "relinquished by" signatory block. Write the current date and time next to your signature.
- The laboratory representative will then sign their name in the "received by" signatory block using the same date and time. The samples are no longer under the sampler/field staff's custody and chain-of-custody will continue with the laboratory throughout analysis of the samples.
- The laboratory representative will provide you with one of the carbon copies of the COC, which you should maintain with the project files/field logbooks.

Option 2

The second most preferred method of transporting samples to the laboratory is to arrange a laboratory courier pick-up at the site at the end of the sampling day. The arrangements should be made with the laboratory in advance (usually during the ordering of sampling containers) to plan when and where the laboratory courier service will meet the field staff at the site. When this transport method is used, the following procedure must be followed:

- Once you have finished completing the COC, place it in a zip-lock bag without signing the "relinquished by"/"received by" (or equivalent) signatory boxes. Keep this outside of, but with, the packaged cooler(s).
- Take the properly packaged cooler(s) and COC and meet with the laboratory courier service representative at the predetermined time and location at the site.
- Upon meeting the laboratory courier representative, sign your name on the COC in the "relinquished by" signatory block. Write the current date and time next to your signature.
- Place two (2) custody seals on opposite corners of each packaged sample cooler (across the opening) and sign/date each custody seal.
- The laboratory courier representative will then sign their name in the "received by" signatory block using the same date and time. The samples are no longer under the sampler/field staff's custody and chain-of-custody will continue with the laboratory courier service and the laboratory throughout transport and analysis of the samples.
- The laboratory courier representative will provide you with one of the carbon copies of the COC, which you should maintain with the project files/field logbooks.

Option 3

If it is not possible for the field staff to drop off the samples at the laboratory or a laboratory courier service to pick up the samples on the same day of collection at the project site, arrangements can be made for the laboratory courier service to pick up the samples the following day at the Ramboll Environ office (assuming next day pick up is consistent with the stipulated hold time for all samples). The courier pickup arrangements should be made with the laboratory in advance (usually during the ordering of sampling containers), if possible. When this third transport method is used, the following procedure must be followed:

- Once you have finished completing the COC, place it in a zip-lock bag without signing the "relinquished by"/"received by" (or equivalent) signatory boxes. Keep this outside of, but with, the packaged cooler(s).
- Place two (2) custody seals on opposite corners of each packaged sample cooler (across the opening) and sign/date each custody seal.
- Transport the properly packaged coolers/shipping containers and COC from the site back to the Ramboll Environ office.
- Place the properly packaged coolers/shipping containers in the field room (a locked, secure space).
- Remove the COC from the zip-lock bag and sign your name on the COC in the "relinquished by" signatory block. Write the current date and time next to your signature.
- Do not write anything else or sign anywhere else in the "relinquished by" or "received by" signatory spaces.
- Place a post-it note on the COC that indicates the number of coolers/shipping containers (if more than one) that should accompany that COC. Return the COC to the zip-lock bag.
- Leave the COC with the coolers in a fashion that will ensure the COC does not get separated from the coolers. For example, the COC could be taped to the cooler/shipping container; a zip-tie could be placed through the zip-lock bag and attached to the handle of a cooler, etc.
- If there are multiple cooler/shipping containers that will be left with the one COC, place notes or some other indicator on each of the coolers to denote which coolers/shipping containers belong to the same group.
- Leave coolers/shipping containers and COC in secure field room, ensuring that the door to the field room is locked behind you.
- For sampling events that require leaving more than one cooler/shipping container in the field room with the COC, the sampler should notify and send photo-documentation of the sample locations to office personnel (those that might possibly get called when the laboratory courier arrives for pick-up the following day) to alert them to the group of coolers/shipping containers and any marks/notes placed on the coolers to group them together.
- When the pre-arranged laboratory courier pickup occurs, it is possible that another field staff member (other than the original sampler) will receive the call to transfer the

samples to the laboratory courier. Whoever receives a call to meet with the laboratory courier should meet the courier at the field room if the original sampler is not able to.

- The Ramboll Environ staff member meeting the courier should review the COC/post-it note to confirm how many coolers/shipping containers should be included in the grouping. This staff member should also confirm that the correct number of coolers/shipping containers are grouped together with the COC. If the staff member is unsure or has any questions about what coolers correspond to the COC, the staff member should call the original sampler.
- Once the staff member has confirmed that all the coolers/shipping containers are accounted for with the COC, they should remove the COC from the zip-lock bag.
- The staff member then signs the "received by" signatory block next to the original sampler's signature. The staff member should put the date and time next to their signature that was used by the original sampler on the previous day. For example, if Sampler A signed the COC at 17:55 on 3/22/12 and Staff Member B met with the courier the following day, Staff Member B signs the COC as "received by" on the same line as Sampler A signed "relinquished by" and Staff Member B also puts the date and time of their signature as 17:55 and 3/22/12. This accounts for the samples being in a secured Ramboll Environ space after the original sampler placed them there (i.e., in Ramboll Environ's custody) and Staff Member B signs off at the same time/date as the original sampler because they are acting as a representative of Ramboll Environ.
- The staff member then signs off on the second line in the "relinquished by" signatory block and writes the CURRENT date and time (current as of when the courier is there for pick-up).
- The laboratory courier representative will then sign in the "received by" block on the second line and will use the same current date/time. At this time, the samples are no longer under Ramboll Environ's custody and the chain-of-custody will continue with the laboratory courier and the laboratory through transport and analysis of the samples.
- The laboratory courier representative will provide you with one of the carbon copies of the COC, which you should maintain with the project files/field logbooks.

Option 4

Some sampling events may take place at sites that are not in the same general geographic region or that require analyses that are only performed at laboratories that are not located within driving distance. In these cases, samples may need to shipped to the laboratory from the project site (or the Ramboll Environ office). Due to the variations in out-of-state laboratories and transportation requirements based on preservatives and sample material, a specific plan for sample transport should be discussed between the sampling field team and the project's PM or PIC to ensure that all laboratory and Federal/State transportation requirements are met. In general, the following steps should be considered when planning sample transport using a shipping service (e.g., FedEx, UPS, etc.):

- Package samples with more padding than would normally be used in field vehicle/ laboratory courier road transport.
- Consider the amount of ice required to keep samples cool for the duration of the trip to the laboratory.

- Samplers should sign the "relinquished by" signatory block of the COC with the date and time when they drop off the samples for shipment. Then place the COC in a zip-lock bag and place it in the cooler to be shipped. Place signed custody seals on the cooler and then secure the cooler closed with tape around the entire seal of the opening and then around the cooler (perpendicular to the opening) to ensure the cooler is secure during shipping.
- Consider the preservatives used with the samples. Based on United States Environmental Protection Agency (USEPA) research and subsequent negotiation with the US Department of Transportation (USDOT), environmental samples do not need to be declared as "hazardous materials" when they (or the preservative used with them) fall below a certain weight percent limit for certain acids/bases. The concentration of constituents expected in samples and preservatives should be compared to regulations to see if special hazardous materials handling applies.
- Consider USDOT, International Air Transport Association (IATA), and any other Federal/State transportation regulations governing the shipment of hazardous materials or dangerous goods.
- Shipping papers need to be retained with the COC, and sampling staff must confirm tracking to receipt by lab. The sampler must verify that all of the containers shipped arrived at the lab.

5. PRECAUTIONS

All field activities require recording sufficiently detailed information throughout the implementation of field work. However, certain precautions should be taken to ensure safety while preparing samples for shipment and recording the required information.

- It is important to always remain alert and aware of your surroundings and wear a high visibility safety vest. Activities associated with the labeling and preparation of samples for shipment should be performed away from active work areas or traffic areas, preferably in a field office or on the back of a field truck.
- To prevent laboratory bias in analysis of QA/QC samples (e.g., field duplicates), do not name or assign times to quality control samples with a similar sample ID as the parent sample. Since the duplicate sample's sample ID will not have a direct indication of what parent sample it is related to, the parent and quality control sample information should be recorded in field logbooks or forms.
- Should samples need to be preserved over longer time periods (e.g., weekend), replenish ice in the cooler as needed to ensure that the samples are preserved at 4±2°C until delivery to the laboratory. Avoid placing samples in refrigerators or freezers.
- Consider potential for hazardous materials within sample media or sample preservatives. Consult Federal and State regulations to determine if special hazardous materials handling procedures must be followed on a project by project basis.

6. RECORDKEEPING

Record all information related to the release of samples in accordance with **FGD 1.01**, Field Notes and Records. After the COC is signed, by both the releaser and receiver of samples and the samples are transferred, obtain a copy of the signed COC. A completed COC (inclusive of signatures from the laboratory) should be provided with the laboratory data deliverables. Maintain both copies of the COC with the project files along with copies of associated shipping air bills (if used) and other sampling documentation.

Records should be managed in accordance with Ramboll Environ's Document Retention Policy, with copies of COCs, air bills, lab bottle order documentation, and sampling plans specific to a sampling event maintained together within the project files.

00WSITESOP\PRIN_WP\38000v2

ATTACHMENT A
SAMPLE COMPLETED COC FORM

RAMBOLL ENVIRON

CHAIN-of-CUSTODY

№ 09901

PAGE 1 of 1

☐ 18100 Von Karman Ave., Suite 600
Irvine, CA 92612
(949) 261-5151
(949) 261-6202 (fax)

☒ 707 Wilshire Blvd., Suite 4950
Los Angeles, Calif. 90017
(213) 943-6300
(213) 943-6301 (fax)

☐ 1702 E Highland Avenue, Suite 412
Phoenix, AZ 85016
(602) 734-7700
(602) 734-7701 (fax)

MSA#: SWBU-2015-123 WO#: SWBU-2014-122

PROJECT NAME / FACILITY ID: ABC INDUSTRIES

FIELD PERSON: JOHN DOE

PROJECT NUMBER: 05-12345A DATE: 03-24-14

PROJECT MANAGER: JANE SMITH

PROJECT LOCATION: 123 LOS ALAMOS RD., LOS ANGELES, CA

LABORATORY: TESTAMERICA

IS THIS A UST PROJECT OR IS EDF REQUIRED? Y (N) IF YES, GLOBAL ID #:

SAMPLER: JOHN DOE

SIGNATURE: John Doe

SAMPLE I.D. NUMBER	YEAR 2014 SAMPLE DATE	SAMPLE TIME	SAMPLE DEPTH (ft)	AIR SAMPLE VOLUME (L)	MATRIX (A) AIR (S) SOIL (G) GAS (W) WATER	NUMBER OF CONTAINERS	FILTERED/UNFILTERED (F/U)	PRESERVATION (SEE KEY)	ANALYSIS REQUIRED: VOCs 8260B	TITLE 22 METALS 6010B/7471	PERCHLORATE 314	COMMENTS
ABC-TB-140324	3/24	0715	–	–	W	2	U	H	2			
ABC-MW01-140324	↓	1000	30	–	W	5	U	H	3	1	1	Filter metals in laboratory
ABC-DS01-140324		–	–	–	W	5	U	H	3	1	1	
ABC-SB002-5.0		1300	5.0-5.5	–	S	3	–	–	3			
ABC-RB-140324		1315	–	–	W	3	U	H	3			Send EDD to
ABC-SB002-10.0	↓	1330	10.0-10.5	–	S	3	–	–	3			jsmith@environcorp.com
TOTAL	X	X	X			21						

John Doe 3/24/14

H = HCL; N = HNO_3; S = H_2SO_4; U = UNKNOWN; NO = NONE; O = OTHER

RELINQUISHED BY:	TIME/DATE:	RECEIVED BY:	TIME/DATE:
John Doe	3/24/14 1600	Bob Builder (COMPANY): TestAmerica	3/24/14 1600
Bob Builder (COMPANY): TestAmerica	3/24/14 1815	Sue Que (COMPANY): TestAmerica	3/24/14 1815

TURNAROUND TIME (CIRCLE ONE): SAME DAY, 24 HOURS, 48 HOURS, 72 HOURS, 5 DAYS, (NORMAL)

SAMPLE INTEGRITY — INTACT: (Y) N Temp 2.9°C

IF SEALED, SEAL INTEGRITY — INTACT: (Y) N

FILE: LOG FORMS\Chain_of_Custody

FIELD GUIDANCE DOCUMENT NO. 1.07

PFAS SAMPLING

RAMBOLL

FIELD GUIDANCE DOCUMENT NO. 1.07

PFAS SAMPLING

Prepared By:	Jim Fenstermacher
Peer Reviewed By:	Jose Sananes Matthew Traister Jason Wilkinson Steve Luis Paul Hare Scott Hayter Clifford Yantz Carol Serlin
Approved By:	J. Mark Nielsen, PE
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This document will be routinely evaluated and updated as new information becomes available. Updates to this FGD will be posted to the Site Solutions FGD SharePoint Site.

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ATTACHMENTS

Attachment A: Available PFAS Sampling Regulatory Guidance

Attachment B: PFAS SME Team

Attachment C: PFAS Pre-Sampling Checklist

1. INTRODUCTION

This Field Guidance Document (FGD) supplements and modifies the general guidelines provided in other FGDs developed by Ramboll US Consulting, Inc. (Ramboll) where environmental samples are to be collected for laboratory analysis of per- and polyfluoroalkyl substances (PFAS). These supplemental guidelines are based on evolving and ongoing recommendations being developed by various regulatory agencies (refer to **Attachment A**). While this document focuses primarily on groundwater sampling procedures, the guidelines presented in this FGD can be readily applied to sampling of other media (i.e., soil, surface water, sediment, storm and sanitary sewers). Consult with the PFAS Subject Matter Expert (SME) team (refer to **Attachment B**) to develop site-specific procedures for these media and other associated activities (e.g., drilling, well installation).

Due to the widespread use of PFAS (applications include food wrappers, water repellent outdoor gear, firefighting foams, mist suppressants, wire/cable coatings, specialty fabrics, and even car wash and ski wax materials) and the very low target detection limits (nanograms per liter, ng/L), specific measures should be implemented during sampling for PFAS to enhance sample integrity and generate representative data. Potential causes of non-representative PFAS results stem from (a) most commonly, the inadvertent introduction of PFAS into the sample through sampling equipment/supplies, personal care products (PCAs) and personnel protective equipment (PPE), or (b) the inadvertent loss of PFAS to the environment or equipment used in sample collection, which is less common but still requires diligence on the part of the sampling team. The procedures outlined in this FGD are to be used along with the latest versions of the PFAS Pre-Sampling Checklist in **Attachment C**.

Although this FGD supplements guidelines for collection of samples associated with typical field activities and projects, it should be understood that for certain projects, more specific sampling procedures, including site-specific or state-specific or regulatory program-specific guidelines, requirements, or procedures may be applicable. Specific requirements for each project will be reviewed by the Ramboll Principal-in-Charge/Project Director (PIC/PD) and Project Manager (PM) in consultation with the PFAS SME team (refer to **Attachment B**), and any additional requirements will be defined in a project-specific Work Plan, Field Sampling Plan, or Quality Assurance Project Plan (QAPP). It should be emphasized that this FGD is not meant to serve as a project-specific work plan, but as a reference for developing project-specific requirements.

This FGD does not supersede Ramboll health and safety procedures or site-specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. Ramboll employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP, followed by approved site-specific procedures, which may include those in this FGD. The Ramboll PIC/PD and/or PM shall verify that project field personnel review and sign the applicable HASP, and that the signed HASP and relevant project information are maintained in the project file for the duration of the project, or as established by Ramboll's applicable document handling and retention policies. The signatures of the PIC/PD and/or PM indicate approval of the methods and precautions outlined in the site-specific HASP.

For ease of reference, the procedures outlined in this FGD are color coded as follows:

- A red dot (●) identifies items or materials that are understood to contain PFAS or that PFAS are used in their manufacture and **should not be used** when sampling for PFAS.
- A yellow triangle (▲) identifies items or materials for which the potential for PFAS bias or cross-contamination is not fully understood and **may be allowable with special considerations** and/or adjustment to protocols after consultation with the PFAS SME team (refer to **Attachment B**).
- A green square (■) identifies items or materials that are understood to not be sources of PFAS bias or cross-contamination and are **allowed or preferred** when sampling.

2. EQUIPMENT/MATERIALS

Equipment and materials required for environmental sampling for PFAS analyses are generally the same as those typically required for collection of environmental samples for other analyses, except that PFAS sampling will impose certain restrictions to avoid use of PFAS containing items or material to avoid potential PFAS bias or cross-contamination. Refer to Equipment/Materials requirements detailed in the FGD for the specific sampling activity being performed, as modified in **Section 4.1** below.

Additional equipment may be specified in the site-specific HASP, Work Plan, Field Sampling Plan, or QAPP. More specialized sampling equipment may be required depending on the media being sampled, site conditions, and project-specific needs. Field personnel should understand and be familiar with the operation and safe handling of the equipment and materials that are required for PFAS sampling. A PFAS Pre-Sampling Checklist is provided in **Attachment C**. Refer to **Section 4.1** of this FGD regarding specific sampling equipment and material limitations.

3. REFERENCED GUIDANCE DOCUMENTS

The following FGDs may relate to this FGD and should be reviewed prior to mobilization, as needed, with the provision that content of this FGD supplements and modifies these FGDs due to the unique requirements related to PFAS sampling (e.g., restrictions on equipment and materials, the types and frequency of quality control [QC] samples):

- **SPI 27**, Subsurface Clearance.
- **FGD 1.01**, Field Notes and Records.
- **FGD 1.02**, Sample Handling, Shipping, and Chain of Custody.
- **FGD 1.03**, Data Management.
- **FGD 1.04**, Documenting Sampling Locations.
- **FGD 1.05**, Field Quality Control Samples.

- **FGD 4.04**, Field Screening – Water Quality.
- **FGD 4.06**, Equipment Calibration.
- **FGD 5.04**, Surface Soil Sampling.
- **FGD 5.05**, Soil Sampling for VOC Analysis.
- **FGD 5.07**, Subsurface Soil Sampling - Direct Push.
- **FGD 5.08**, Subsurface Soil Sampling - Split Spoon and Shelby Tube.
- **FGD 5.09**, Soil Boring Log Preparation.
- **FGD 5.15**, Stockpile Sampling.
- **FGD 5.16**, Soil Sampling for PCBs.
- **FGD 6.02**, Groundwater Sampling.
- **FGD 6.04**, Groundwater and Free Product Level Measurements.
- **FGD 6.06**, Temporary Overburden Well Installation and Sampling.
- **FGD 6.07**, Well Development.
- **FGD 6.09**, Groundwater Sampling - Private and Domestic Wells.
- **FGD 6.16**, Groundwater Sampling – Free Product/NAPL.
- **FGD 6.19**, Groundwater Sampling – Hydra Sleeves.
- **FGD 6.20**, Groundwater Sampling - Low Flow.
- **FGD 7.01**, Surface Water Sampling.
- **FGD 8.01**, Sediment Sampling.
- **FGD 8.05**, Sediment Pore Water Sampling.
- **FGD 14.01**, Sampling Equipment Decontamination.
- **FGD 15.01**, Waste Handling.
- **FGD 15.02**, Waste Sampling.
- **FGD 16.02**, Storm and Sanitary Sewer Grab Sampling.

The list above is not intended to be all-inclusive. Other FGDs and Standard Practice Instruction (SPI) may need to be referenced based on the specific requirements of a site-specific Work Plan, Field Sampling Plan, or QAPP (e.g., field screening FGDs, FGDs for sampling of other media, etc.).

4. PROCEDURES

4.1 Planning and Design Considerations

Strategic decisions will be approved by the PIC/PD and/or PM in consultation with the PFAS SME team before the initiation of associated field activities, and will be documented in the Work Plan, Field Sampling Plan, and/or QAPP. The Work Plan, Field Sampling Plan, and/or QAPP will be designed for the collection of quality data to meet the objectives of the site

activities and will include information such as the location, depth, number of samples per location, and the laboratory analyses to be performed on each sample, as well as quality assurance/quality control (QA/QC) requirements. The Work Plan, Field Sampling Plan, and/or QAPP will generally provide some discretion in the field depending on the conditions encountered; however, significant departure from prescribed sampling activities should be discussed with and approved by the PIC/PD and/or PM.

When planning a PFAS sampling event, the following should be considered:

- *Laboratory Analysis*. The current state of practice for laboratory analysis for PFAS is continuing to evolve. The United States Environmental Protection Agency's (EPA's) third Unregulated Contaminant Monitoring Rule (UCMR3) required that Method 537 be used to analyze UCMR3 samples for perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), and four other PFAS in drinking water. Since then, Method 537.1 has been developed to quantify 18 PFAS in drinking water (including HFPO-DA or "GenX") using solid phase extraction (SPE) and liquid chromatography/tandem mass spectrometry (LC/MS/MS). EPA has also developed Method 533 to quantify 25 PFAS in drinking water by isotope dilution, anion exchange, SPE, and LC/MS/MS.

  The EPA is currently in the process of validating laboratory methodology for analysis of PFAS in non-drinking water matrices, including surface water, groundwater, wastewater, and solids. For non-drinking water samples, some U.S. laboratories have been commonly using "modified" methods based on Method 537.1. These modified methods often lack consistent sample collection or analytical guidelines and have not been validated or systematically assessed for data quality by a regulatory agency. However, most well-known laboratories can provide analysis of non-drinking water matrices using a modified Method 537.1 where the precision and accuracy are typically suitable to meet Ramboll's project objectives, with reporting limits typically in the ng/L or micrograms per kilogram (ug/kg) range for liquids and solids, respectively. For analyzing matrices other than drinking water, regulatory acceptance may be enhanced if the laboratory complies with quality control requirements provided in Table B-15 of the United States Department of Defense and Department of Energy Consolidated Quality Systems Manual (QSM) for Laboratories Version 5.3 dated 2019 (or later).

  As of the date of this document, EPA is currently developing several analytical methods for media other than drinking water, including:

  - **Method 8327**, which is designed to measure a group of 24 PFAS compounds in groundwater, surface water, and wastewater samples and is expected to:
    - Incorporate direct injection instead of SPE.
    - Retain LC/MS/MS for analyte resolution.
    - Not incorporate isotope dilution.
    - Be similar to American Society for Testing and Materials (ASTM) Method D7979 (a currently validated method for non-potable media).
    - Include a 24-analyte target compound list, including HFPO-DA ("Gen-X").
    - Allow sample holding times of 28 days.

    - Have target quantitation limits of 10 ng/L.
  - **Method 8328**, which is being developed to measure PFAS compounds in groundwater, surface water, wastewater and solid (soils, sediments, biosolids) samples expected to:
    - Retain SPE and therefore be a more complex method relative to direct injection.
    - Retain LC/MS/MS for analyte resolution.
    - Incorporate isotope dilution to account for matrix effects (e.g., sorption).
    - Intended to be more robust for complex matrices (e.g., wastewater influents, biosolids).
    - Include a 24-analyte target compound list, including HFPO-DA ("Gen-X").
    - Allow sample holding times of 28 days.
    - Have target quantitation limits of 10 ng/L.
  - **Method 3512**, which is a preparation procedure for diluting non-potable water samples with an organic solvent prior to analysis by the appropriate determinative method for PFAS in order to minimize sample size and solvent usage. The method is currently an appendix to Method 8327, but is expected to eventually become a standalone method.

  The laboratory methods to be used in support of a site-specific PFAS sampling program should be evaluated at the earliest stages of sampling program development, and should be discussed with the PFAS SME Team and/or the local regulatory agency(ies), as appropriate (refer to **Attachment B**).

  In addition, as outlined in **Section 4.8** below, consideration for QC sampling should be discussed with the laboratory at the early stages of planning or designing a PFAS sampling program.

- *Sample Preservation*. As detailed in **Section 4.6**, Method 537.1 is a drinking water method and specifies the use of Trizma as a preservative for PFAS samples to remove any residual free chlorine. However, Trizma does not have a functional purpose for environmental samples, and **should not** be used for preservation of non-drinking water or non-chlorinated water samples. Note, however, *that laboratories will typically supply Trizma pre-preserved bottleware unless otherwise directed*. Therefore, unless Trizma is specifically required for the project *communicate early and clearly* with the laboratory to ensure that pre-preserved bottleware ***will not*** *be provided*.
- *PFAS-Free Water*. Water used for equipment decontamination should be "PFAS-free." For the purpose of this FGD, PFAS-free water is defined as water that does not contain any site-specific target PFAS analytes above laboratory detection limits. Since site or public water supplies have been identified in many instances to contain detectable levels of PFAS, confirmation of PFAS-free public water, if public water will be used for equipment decontamination on the project, through laboratory analysis should be performed prior to the commencement of work. Alternatively, laboratory-supplied and verified PFAS-free water can be used for sampling equipment decontamination.

- *Sampling Equipment*. PFAS sampling equipment can be divided into three major groups:
  - Equipment and materials to be **avoided**, which includes:
    - Polytetrafluoroethylene (PTFE), including the trademarks Teflon® and Hostaflon®.
    - Fluorinated ethylene propylene (FEP), including the trademarks Teflon® FEP, Hostaflon® FEP, and Neoflon®.
    - Polyvinylidene fluoride (PVDF), including the trademark Kynar®.
    - Polychlorotrifluoroethylene (PCTFE), including the trademark Neoflon®.
    - Ethylene-tetrafluoroethylene (ETFE), including the trademark Tefzel®.
    - Trademarks Viton®, Gore-Tex® and Decon 90® products with the term "fluoro" in the product name.
    - Waterproof field notebooks.
    - New clothing, as it may have fabric treatment applied.
    - Post-It® notes or similar.
    - Decon 90®.
  - Equipment and materials that **may be permissible** pending discussion with a PFAS SME team member, which includes:
    - Chemical or blue ice is not known to be manufactured with PFAS-containing compounds; however, its use is to be avoided because blue ice packs are typically used across multiple sites and sampling events and may cross-contaminate samples from prior exposure to PFAS.
    - Aluminum foil.
    - Low-density polyethylene (LDPE) does not contain PFAS in the raw material but may contain PFAS contamination from the manufacturing process and should be avoided unless: (a) the manufacturer certifies the LDPE as PFAS-free; (b) it has been previously tested and demonstrated not to contain PFAS; and/or (c) an equipment blank of the product has been collected before initiation of field work to confirm the LDPE product does not impart measurable PFAS mass to the sample. For example, Ramboll has found equipment blanks performed on the LDPE double-bonded tubing from Leroy Plastics (Le Roy, NY) used for operating bladder pumps has consistently yielded non-detection results.
    - Glass can sorb PFAS mass (specifically PFOS and other higher molecular weight PFSAs), potentially suppressing the analytical results. Unless alternate materials are not available, sample contact with glass surfaces should be avoided.
    - Rental equipment, pumps, pressure washers, etc., where prior uses, care of maintenance, and an understanding or control of all relevant internal parts are not known.
    - Permanent markers (e.g., Sharpies®) may be used in the staging area, but not the sampling area.

  - Equipment and materials that are **preferred for use**, which include:
    - Loose-leaf paper, or notebooks that have not been coated with waterproofing materials may be used to record field notes.
    - LDPE storage bags (e.g., Ziploc®) that do not come into direct contact with the sample media may be used.
    - High-density polyethylene (HDPE), polypropylene, silicone, or acetate may be used.
    - HDPE, polypropylene, polyurethane, polyvinylchloride (PVC), silicone, stainless steel, neoprene, and nylon twine a permissible to come in contact with sampling media.
    - Alconox®, Liquinox® and Citranox® branded products may be used for equipment decontamination.
    - Waxed fabrics and well-washed cotton fabrics are preferred materials for clothing.
    - Double-bagged water ice.
    - Ball point pens or pencils are preferred for taking notes or writing in the sampling zone.
    - Hercules Megaloc® thread compound by Oatey.
    - Poly-Sal® brand drilling fluid additive/lubricant and PFAS-free pipe thread compounds that contain degradable guar gums are preferred materials to be used by drillers.

- *Field Clothing and Personal Protective Equipment*. Due to the extensive use of PFAS in many industries and products, and their unique properties in water and oil repellency, clothing (e.g., pants, jackets, boots, shoes, gloves, and jackets) and PPE may contain PFAS. During a PFAS investigation, clothing and PPE containing PFAS should be avoided to prevent cross-contamination. While preparing for sampling and to the extent reasonably possible, avoid clothing that has been advertised as having waterproof, water-repellant, or dirt and/or stain resistant characteristics as these types of clothing are more likely to have had PFAS used in their manufacturing. Consult with a PFAS SME as necessary, and allow common sense to prevail. For instance, a treated insulating undergarment used in the winter and covered by layers of well-washed over garments should be of little concern. Well-worn, treated work boots should likewise be of limited concern, provided typical care is taken to avoid excessive boot-to-equipment contact and boots are kept away from environmental samples or clean equipment when not being worn. Conversely, use of a brand-new treated rain jacket or newly treated boots should be avoided.

  Unless required by the site-specific HASP, field clothing and PPE to be **avoided** include:

  - Clothing that has recently been washed with fabric softener.
  - Coated (i.e., yellow) Tyvek®.
  - Clothing chemically treated for insect resistance and ultraviolet protection.

- Clothing that has been treated with water and/or stain resistant coatings such as:
  - Any Teflon® fabric protectors (e.g., Gore Tex)
  - Any Scotchgard™ fabric protectors
  - Bionic Finish®
  - GreenShield®
  - High-Performance Release Teflon®
  - Lurotex Protector RL ECO®
  - NK Guard S series
  - Oleophobol CP®
  - Repel Teflon® fabric protector
  - Repellan KFC®
  - Resists Spills™ and Releases Stains™
  - RUCO®
  - RUCO-COAT®
  - RUCO-GUARD®
  - RUCO-PROTECT®
  - RUCOSTAR®
  - Rucostar® EEE6
  - RUCOTEC®
  - Ultra Release Teflon®
  - Unidyne™

  The types of field clothing and PPE that are **permissible** include:

  - ▲ Latex gloves may be used if necessary to satisfy site-specific HASP requirements; however, large sampling programs should consider submitting a sample of the glove material for testing of PFAS content. Further, some regulatory agencies or states (e.g., California) prohibit the use of latex sampling gloves, and latex gloves should not be used by individuals who are sensitive or allergic to latex.
  - ▲ Weather-proof boots may be used as they are not likely to be in significant contact or proximity to sampling equipment (assuming best practices are followed).
  - ■ Powderless nitrile gloves.
  - ■ PVC or wax-coated fabrics.
  - ■ Clothing made from, containing, or treated with neoprene, polyurethane, or PVC.
  - ■ Synthetic and natural fibers (preferably cotton) that are well-laundered (more than six times with no fabric softener) clothes and cotton overalls.
  - ■ Non-coated (i.e., white) Tyvek.

- *Sun and Biological Protection*. Because sun and biological hazards (sunburn, mosquitos, ticks, etc.) may be encountered during sampling, the elimination of specific clothing materials or PPE (sunscreens and insect repellants) could pose a health and safety hazard to staff. The safety of field and contract staff must be the primary focus of decisions around site-specific field procedures and selection of sun and biological protection. With that in mind, however, any necessary deviations from this PFAS FGD must be made in consultation with a member of the Ramboll PFAS SME team.

  Ideally, rather than repellants and sunscreens, the preferences are (a) tucking pant legs into socks and/or boots to reduce exposed skin and reduce the risk of being bitten by ticks; (b) wearing well-washed, light-colored clothing to easily see ticks during field activities; and (c) wearing light-colored clothing, long sleeves, and large-brimmed hats to avoid sunburn. However, if it is necessary to use sunscreens and insect repellants, the following guidance is provided: (a) do not apply products near the sample collection

area; (b) wash hands well following application or handling of sunscreen and/or repellents, and (c) subsequently don powderless nitrile gloves for the sampling activities.

Other entities (e.g., the states of California, Michigan and New Hampshire) are constantly testing and updating products, the most recent of which have been listed below, to evaluate PFAS content. If required, sun and biological protection products **preferred for use** (however, care should be taken to use these exact products because similar products from the same brand may contain PFAS) include:

- Alba Organics Natural Sunscreen
- Aubrey Organics
- Avon Skin So Soft Bug Guard-SPF 30
- Baby Ganics
- Banana Boat for Men Triple Defense Continuous Spray Sunscreen SPF 30
- Banana Boat Sport Performance Coolzone Broad Spectrum SPF 30
- Banana Boat Sport Performance Sunscreen Lotion Broad Spectrum SPF 30
- Banana Boat Sport Performance Sunscreen Stick SPF 50
- California Baby Natural Bug Spray
- Coppertone Sport High-Performance AccuSpray Sunscreen SPF 30
- Coppertone Sunscreen Lotion Ultra Guard Broad Spectrum SPF 50
- Coppertone Sunscreen Stick Kids SPF 55
- Herbal Armor
- Jason Natural Quit Bugging Me
- Jason Natural Sun Block
- Kiss My Face
- L'Oréal Silky Sheer Face Lotion 50+
- Meijer Clear Zinc Sunscreen Lotion Broad Spectrum SPF 15, 30 and 50
- Meijer Wet Skin Kids Sunscreen Continuous Spray Broad Spectrum SPF 70
- Neutrogena Beach Defense Water + Sun Barrier Lotion SPF 70
- Neutrogena Beach Defense Water + Sun Barrier Spray Broad Spectrum SPF 30
- Neutrogena Pure & Free Baby Sunscreen Broad Spectrum SPF 60+
- Neutrogena Ultra-Sheer Dry-Touch Sunscreen Broad Spectrum SPF 30
- Repel Lemon Eucalyptus
- Sawyer Permethrin
- Yes To Cucumbers

▲ In addition, products listed as "baby-safe, "free," or "natural" are typically PFAS-free, however any of the above products are preferred

Some sampling guidance documents recommend that personal hygiene and personal care products (PCPs; e.g., cosmetics, shampoo, sunscreens, dental floss, toothpaste, etc.) not be used prior to and on the day(s) of sampling over concerns regarding the potential presence of PFAS in these products. If sampling protocols are followed however, these items should not come into contact with sampling equipment or samples being collected, and employing best practices while sampling will minimize the potential that these products, PFAS-containing or not, bias the PFAS analytical results. The following precautions should be taken when dealing with personal hygiene or PCPs before sampling:

- Do not handle or apply PCPs in the sampling area.
- Do not handle or apply PCPs while wearing PPE that will also be worn during sampling.
- ▲ For best practices, shower at the end of the workday.
- ▲ Hair nets can be used if hair care products are a concern as a potential PFAS source.
- ■ Move to the staging area and remove PPE if applying PCPs becomes necessary.
- ■ Wash hands after the handling or application of PCPs and, when finished, put on a fresh pair of powderless nitrile gloves.

- *Food Packaging*. PFAS have been used by the paper industry as a special protective coating against grease, oil, and water for paper and paperboards, including food packaging, since the late 1950s. PFAS application for food packaging includes paper products that come into contact with food such as paper plates, food containers, bags, and wraps. In January 2016, the Food and Drug Administration banned the use of PFAS having eight or more carbon atoms (e.g., PFOA, PFOS and PFNA); however, short-chain PFAS have not been banned for use in the manufacturing of contact food materials in the U.S. and may still be present in the coating materials of some food wrappers.

  When staff require a break to eat or drink, they must remove their gloves, coveralls, and any other PPE in the staging area and move to the designated area for food and beverage consumption (e.g., the "clean zone"). When finished, staff must wash their hands, then don any coveralls or other PPE, and, lastly, put on a fresh pair of powderless nitrile gloves immediately before sampling.

  Other procedures to be followed include:

  - Avoid handling, consuming, or otherwise interacting with pre-wrapped food or snacks, carry-out food, fast food, or other food items while on-site during sampling events.
  - ■ Move to the staging area and remove PPE prior to leaving the sampling and staging areas if consuming food on site becomes necessary.

- *Filtration*. Field-filtration must be avoided as field filtering may result in potential cross contamination. Further, PFOS and higher molecular weight PFSAs may sorb onto glass filters in the field or in the lab. If field-filtered samples for PFAS or other analytes are to be collected because of a client or regulator request:

- Request clarification from the client or regulator regarding the intent of collecting filtered results (field or laboratory) and whether those results will be meaningful and/or necessary to meet the overall project goals for the PFAS sampling program.
- Use low-flow sampling to the extent practical to avoid field-filtration.
- Consider the use of centrifugation by the laboratory instead of filtration.
- If filtering cannot be avoided, do not use glass, and control for the use of field-filtration by collection of equipment blanks from the filters and filtering equipment in contact with the samples and, if possible, a spiked (positive) control provided by the laboratory.

4.2 Pre-Field Work Preparation Guidelines

Before initiating field activities, field staff should review and complete pertinent tasks identified in **FGD 2.02** (Site Preparation, Inspection and Housekeeping). Further, to the extent that non-dedicated, non-disposable equipment is to be used (e.g., water level indicator, trowel), to minimize potential cross-contamination between sampling locations (e.g., monitoring wells, soil borings), such equipment should be decontaminated before use as described in **Section 4.4** of this FGD. Used disposable equipment (e.g., tubing) that is considered investigation derived waste (IDW) should be managed in accordance with **FGD 15.01** (Waste Handling) following the sampling event.

At a minimum, the following tasks should be completed to prepare field staff for implementation of the work:

- Review and sign the site-specific HASP.
- Comply with **SPI 27**.
- Coordinate and obtain permission for site access (as necessary).
- Review the project-specific Work Plan, Field Sampling Plan, and/or QAPP, where applicable.
- Review and discuss with the PIC/PD and/or PM the proposed Work Plan, Field Sampling Plan, QAPP or other sampling and testing strategy documentation.
- Document that the equipment and materials required to complete the work have been secured and packed prior to travel.
- Confirm sampling locations.

When ordering equipment or sampling materials, be sure to specify with the rental company and laboratory representative that the equipment is to be used for a PFAS sampling program. Analytical laboratories will need to supply suitable containers without affecting the concentration of constituents in the sample. Reputable field equipment rental companies will have their own protocols for preparing and supplying equipment intended for use in PFAS sampling programs, including such things as supplying multiparameter probes and water level meters that have been modified or specially manufactured to be Teflon-free and PFAS-free. Similarly, confirm that drillers and other subcontractors are aware that the proposed field activities will include sampling for PFAS constituents, and that all materials brought on site are to be PFAS- and Teflon-free. For example, a potable or non-potable water source to

be used for equipment decontamination on a drilling program may need to be pre-tested to demonstrate that it is PFAS-free.

Particularly for large sites where equipment is driven from sampling location to sampling location, consider using two dedicated vehicles – a "dirty" vehicle used for transport and handling of ancillary equipment, and a "clean" vehicle used for transport and handling lab water, fresh tubing, ice packs, bottleware, and coolers with samples.

Prior to initiating groundwater sampling activities, field personnel should field-verify the well identity and construction against available documentation (site plans, well construction logs, etc.). Typically, groundwater sampling or testing FGDs recommend "tagging" the bottom of the well as one means to verify the correct well is being sampled. In order to minimize introduction of materials and equipment into wells during PFAS sampling, it is recommended that for PFAS sampling depth-to-water readings necessary for low-flow sampling be collected first, followed by sampling for PFAS and any other required analytes, and last of all the well bottom be "tagged" for identification verification if necessary. If the well is found to have been incorrectly sampled, discard or relabel the samples, note in the field log, and notify the PM accordingly.

If dedicated equipment is encountered inside a monitoring well, obtain depth-to-water readings prior to disturbing the equipment, remove all equipment prior to sampling, and document (with photos, recommended) equipment encountered and measures taken prior to sampling. If the equipment or materials of construction are suspected of potentially compromising the PFAS sample integrity, contact the PM and PFAS SME team. Further, prior to the commencement of the field effort, field personnel should inspect, test, and/or calibrate equipment that may be used to take field measurements (refer to **FGD 4.06**, Equipment Calibration).

A preferred sampling sequence should be established in the Work Plan, Field Sampling Plan, and/or QAPP before the sampling event to reduce the risk of cross-contamination. In general, sampling should begin in areas where PFAS concentrations are known or expected to be lowest (i.e., upgradient or farthest downgradient), proceeding systematically to areas known or expected to have the highest PFAS concentrations (i.e., source areas). Samples known to be upgradient from all source areas should be sampled first, followed by those lateral to the suspected source areas, and then by those that are farthest downgradient from the suspected sources. Remaining locations should be progressively sampled from the most distant downgradient to those closer to the known PFAS source, moving upgradient. Bear in mind "upgradient" may mean relative to groundwater movement and/or dominant air depositional directions.

When evaluating multiple aqueous media, consider carefully the order of sample collection. Assuming "typical" levels of PFAS in the environment, a multi-media sample collection scheme could be in the following order:

- Drinking water (e.g., residential wells).
- Surface water.
- Groundwater.

- Wastewater and/or leachate waters.

If collecting surface water and sediment samples, the surface water sample at a given location should be collected before the sediment sample, and the sampling should proceed from downstream sampling locations to upstream sampling locations. Since the concentration of PFAS at the air-water interface may be higher than the concentration within the water column, surface water samples should generally be collected from below the air-water interface unless defined otherwise in the Work Plan, Field Sampling Plan, and/or QAPP.

4.3 General PFAS Sampling Guidelines

This FGD provides recommended practices for sampling of environmental media for PFAS analysis in addition to those related to the sampling activity itself.

- When sampling for PFAS, avoid placing samples in direct contact with cloth surfaces inside vehicles, especially newer vehicles.

- Subcontractors, as for Ramboll staff, are required to abide to the PFAS sampling requirements and restrictions outlined in the Work Plan, Field Sampling Plan, and/or QAPP. Once on site, inspect all lubricants, detergents, and any other equipment that will or could come in contact with environmental media to confirm that the subcontractor has understood and conforms to the requirements and restrictions outlined in the Work Plan, Field Sampling Plan and/or QAPP.

- Work areas may be covered areas with plastic (HDPE or LDPE) as long as no direct contact is made with the sampled media.
- If dedicated sampling equipment is found in a well, avoid using any in-well dedicated equipment for PFAS sampling until it is established to be PFAS-free. The equipment needs should be evaluated to see if it could be a source for PFAS as follows:
  - Retrieve the equipment from the well and collect an equipment blank from the equipment.
  - Sample the well using non-dedicated equipment brought to the site for the PFAS sampling program.
- At a minimum, change gloves between each sampling location, after collecting each QC sample, and after handling any non-sampling equipment (i.e., clipboards, coolers, sample labels, etc.).

4.4 Decontamination

All non-disposable equipment to be used in a PFAS sampling event should be decontaminated prior to first use, between sampling locations, and at end of each workday as described in **FGD 14.01** (Sampling Equipment Decontamination), the project-specific Work Plan, Field Sampling Plan, and/or QAPP. In addition:

- Laboratory-supplied, PFAS-free water should be used for decontamination; commercially available deionized water in an HDPE container, or municipal drinking water, may be used for decontamination if the water is verified to be PFAS-free ahead of the field sampling program.

- Alconox®, Liquinox®, and Citranox® should be used as surfactants for equipment decontamination.
- Decon 90® should **not** be used.
- If sampling equipment requires manual scrubbing, use a polyethylene or PVC brush.
- Decontamination procedures should include a final triple-rinse with PFAS-free water.

When sampling sources (e.g., soil and/or groundwater in source areas, tanks, etc.), a more thorough decontamination should be performed between samples. In addition, increasing the frequency of equipment blanks should also be considered.

4.5 Sample Containers

As outlined in **FGD 1.02** (Sample Handling, Shipping and Chain of Custody), equipment and sample containers that will come into contact with aqueous, solid or gas media should be constructed of materials that will not affect the concentration of constituents in the sample. The sample container requirements should be outlined in the project-specific Work Plan, Field Sampling Plan, and/or QAPP.

All bottles used for PFAS sampling should come from the laboratory that will also be performing the PFAS analysis. Each sample container must be kept sealed at all times and only opened during the sample collection. The sampling container cap or lid must never be placed directly on the ground or on a surface that is not known to be PFAS-free.

The current standard is for samples to be submitted in containers (including caps/lids) made of polypropylene or HDPE. Glass sample containers should not be used due to potential loss of analyte through adsorption to glass. Most laboratories require a minimum volume of 250 milliliters (mL) to perform an analysis, with a duplicate bottle held in reserve in the event of analytical loss of the first bottle. This may change however when other methods are adopted (e.g., 15 ml vials are proposed for Method 8327, and ASTM D7979 requires the use of three vials). Coordination with the laboratory is recommended if collecting samples in an area or from a location where elevated PFAS concentrations are known or expected to occur.

4.6 Sample Preservation

Method 537.1 is a drinking water method and specifies the use of Trizma as a preservative for PFAS samples to remove any residual free chlorine. Trizma does not have a functional purpose for environmental samples and the "modified" Method 537.1 protocols of most laboratories allow for collection of non-reagent preserved samples.

For non-drinking water/non-chlorinated samples (i.e., the vast majority of samples likely to be collected at client sites), **Trizma is not to be used**. Typically, laboratories will include Trizma pre-preserved bottleware unless otherwise directed; therefore, unless Trizma is specifically required for the project, communicate early and clearly with the laboratory to ensure that pre-preserved bottleware **will not** be provided.

Although private supply wells (residential, commercial or industrial) are used for drinking water, samples collected from private groundwater wells (in the well or at the tap) **should not** be preserved with Trizma because drinking water from the well is not likely disinfected with a chlorine-containing product on a regular basis. However, it is good

practice to ask if the supply well has recently been disinfected before collecting a sample from the supply well, and if so, then Trizma should be considered for use as a preservative for that sample.

Upon receipt of sampling bottleware, field personnel should confirm receipt of the appropriate (i.e., preserved or non-preserved) bottleware. In addition, because the volume of Trizma preservative (when requested) needs to be accounted for by the laboratory when injecting internal calibration spikes into samples during sample preparation, field personnel should also confirm with the laboratory, or clearly indicate on the Chain-of-Custody record, the preservation status of the samples being shipped.

Samples should be chilled to 4°C to 6°C for preservation, using water ice that is double bagged in polyethylene plastic (i.e., Ziploc®). To avoid potential cross-contamination, reusable chemical or gel-based cooling products should not be used. Samples should be transported to the laboratory daily to maintain sample temperatures near target preservation temperatures with the limited longevity of water ice.

4.7 Sample Transport and Storage

Samples shall be handled, transported and stored in an attempt to maintain the structural integrity of the container and chemical qualities of the samples. Sample bottles should be handled as outlined in **FGD 1.02** (Sample Handling, Shipping and Chain of Custody). Samples should be kept in an ice-filled transport container during field work and covered to limit light penetration. As a typical procedure, laboratories will supply a thick plastic liner with each cooler to keep samples from contacting the inside of the cooler. Field samples and any ice are kept within the liner, which is then tucked and folded so that nothing else can contact the samples, and the Chain of Custody (COC) is placed in a polyethylene (i.e., Ziploc®) resealable storage bag that is placed on the bag and inside the cooler.

4.8 Quality Assurance/Quality Control

The QA/QC procedures should be outlined in the project-specific Work Plan, Field Sampling Plan, and/or QAPP and must be followed throughout the sample collection, processing, handling, and analysis process. In their absence, the QA/QC guidelines of **FGD 1.05** (Field Quality Control Samples) as modified below should be followed.

- *Trip Blanks*. The Trip Blank (TB) consists of a bottle of PFAS-free water that is prepared by the laboratory, shipped to the site (but not opened), and then returned to the laboratory for analysis. TBs are typically not required by regulatory agencies for PFAS analyses, and typically do not yield results meaningfully different from the field reagent blanks (below), but can be collected if requested or required by a specific agency or client.
- *Field Reagent Blanks*. Field Reagent Blanks (FRBs) should be collected during PFAS sampling events. An FRB is generated by manually pouring PFAS-free water in one sample container that is provided by the laboratory into an empty sample container that is also supplied by the laboratory in the field at the location of an environmental sample. An FRB differs from a TB in that the laboratory PFAS-free water is exposed to the sampling environment during the bottle-to-bottle transfer process. The purpose of an FRB is to quantify whether target analytes or other interferences are present in the field

environment, and can help provide insight if PFAS analytes are found in the associated Equipment Blank (EB) but not the TB.

FRBs are helpful in assessing whether the PFAS-free water supplied by the lab remains "PFAS-free" throughout the sampling event and confirming that the bottleware remains PFAS-free as well. One FRB should be collected for every 20 samples of a given medium, or once per event regardless of the number of media sampled if the sampling event is limited to one day. However, the frequency of collecting FRBs is a project-specific decision, and the location(s) of the FRB(s) should be considered in advance of the sampling event in consultation with a PFAS SME team member, with intentional bias towards location(s) where the possibility of introducing ambient PFAS is/are highest.

- *Equipment Blanks*. EBs are used to assess the potential contamination of samples by the equipment used at the site to collect those samples. To collect an EB, PFAS-free water provided by the laboratory is poured over, in, or through a particular piece of sampling equipment (for example, a new, disposable bailer, or a pump that has been decontaminated after its prior use) and collected in a sample container. Conceptually, field crews should attempt to transfer laboratory-supplied PFAS-free water to the EB sample container using the part of the equipment that comes in direct contact with the environmental samples.

  Like FRBs, one EB should be collected for every 20 samples of a given medium, or at least once per event regardless of the number of media sampled if the sampling event is limited to one day. However, the frequency of collecting EBs is a project-specific decision and when considering the number of EBs to collect, in consultation with a PFAS SME team member, thought should be given to the range of concentrations expected to be encountered (e.g., are there orders of magnitude between highest and lowest expected concentrations), the complexity of the field event (e.g., sampling of a limited number of wells, or sampling of multiple media types using multiple sampling devices and techniques), and whether EBs should be collected at the beginning, end, or randomly in the middle of the work day.

  EBs collected adequately through a sampling event can greatly increase data reliability by confirming the adequacy of decontamination methods when laboratory-reported results are consistently non-detect, and by providing insight to where, when and how any systematic issues with field procedures may have arisen if EB analytical results contain detections. For example, and as discussed in **Section 4.4**, it may be advisable to collect EBs at a higher frequency when sampling in a suspected or known source area to minimize the potential for having to qualify or discard an excessive amount of laboratory reported data.

- *Field Duplicates*. Field Duplicate (FD) samples should be collected in accordance with **FGD 1.05** (Field Quality Control Samples). In general, the frequency of FD collection for PFAS should be one per every 20 environmental samples of a given medium, or once per event regardless of the number of samples if the sampling event is limited to one day.

- *Matrix Spike and Matrix Spike Duplicates*. The Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples should be collected in accordance with **FGD 1.05** (Field Quality Control Samples), and are samples into which the laboratory adds a known mass of specific PFAS after receipt and log-in, but prior to analysis. Essentially, collecting an MS/MSD sample pair is the same as collecting two field duplicate samples at a sampling

location except that these containers are identified with the sampling location as MS and MSD samples and are not "blind" to the laboratory. Laboratories add known amounts of analytes (typically concentrations at or near the middle of the calibration range) when they perform MS and MSD analyses, so it is often most useful to use locations that are known or believed to have relatively moderate analyte concentrations for collecting the MS/MSD samples such that the laboratory results remain within the instrument calibration limits. The necessity for and frequency of collecting MS/MSD sample pairs is a project-specific decision and depends on several factors (e.g., client, regulatory agency, or regulatory program directives). However, if required or if data validation is to be performed, then a frequency of one MS/MSD sample pair for every 20 environmental samples for each medium, or once per event per sampled media if the sampling event is limited to one day, is recommended.

- *Temperature Blanks*. When used on a project, temperature blanks must be provided by the lab in a new (not previously used) sample bottle of the same type and size of the other aqueous field samples collected during the sampling program. The bottle must be filled with PFAS-free water, must be labeled clearly as the temperature blank, and should remain in the cooler throughout the sampling event.

5. PRECAUTIONS AND OTHER CONSIDERATIONS

Precautions to be taken during environmental sampling for PFAS analyses are generally the same as those typically required for collection of environmental samples for other analyses. Refer to the Precautions and Other Considerations Section of relevant FGDs for the specific sampling activity being performed. For PFAS sampling, the following additional considerations are provided:

- There are far more individual PFAS than can be currently quantitated. Determining which PFAS to quantitate during the analysis is a project-specific determination based on several factors. One important factor to consider is guidance from the relevant regulatory agency. For example, some states have a standard PFAS list (e.g., New York is currently asking for 21 PFAS, and Michigan is currently asking for 28 PFAS). Another factor is the time period of the release and whether it was a legacy event, or possibly a more recent event where quantification of replacement chemicals (e.g., GenX instead of PFOA) could require the use of an expanded analyte list.
- Some states require that only personnel licensed or certified in the state where the work is being performed perform groundwater sampling. Therefore, state regulations and guidance governing groundwater should be consulted prior to conducting the work. In addition, local Ramboll staff should be contacted for any other regional or local requirements.

6. RECORDKEEPING

Document all sampling locations in accordance with **FGD 1.04** (Documenting Sampling Locations) and record all information in accordance with **FGD 1.01** (Field Notes and Records) and **FGD 1.03** (Data Management).

ATTACHMENT A
AVAILABLE PFAS SAMPLING REGULATORY GUIDANCE

Regulatory requirements and guidance related to the sampling and analysis of PFAS are continuously evolving. Thus, recent changes to sampling procedures, target analyte lists, or regulatory requirements in the state where sampling is to occur should be confirmed. Below are links to a representative sample of some of the more active regulatory programs and guidance information.

Consult with a PFAS SME during development of site-specific procedures for environmental sampling and/or other associated activities. In addition, consult the latest guidance or requirements from the regulatory agency of the state in which the work is to be completed, and the additional resources identified below..

US Environmental Protection Agency: https://www.epa.gov/water-research/pfas-methods-and-guidance-sampling-and-analyzing-water-and-other-environmental-media or https://www.epa.gov/pfas

CA: https://www.waterboards.ca.gov/pfas/

MA: https://www.mass.gov/info-details/per-and-polyfluoroalkyl-substances-pfas

MI: https://www.michigan.gov/documents/pfasresponse/General_PFAS_Sampling_Guidance_634597_7.pdf

NH: https://www4.des.state.nh.us/nh-pfas-investigation/

NJ: https://www.nj.gov/dep/srp/emerging-contaminants/

NY: https://www.dec.ny.gov/chemical/108831.html

PA: https://www.dep.pa.gov/Citizens/My-Water/drinking_water/PFAS/Pages/default.aspx

WI: https://dnr.wi.gov/topic/contaminants/PFAS.html

Additional Resources:

Interstate Technology & Regulatory Council: https://pfas-1.itrcweb.org/

US Department of Defense and Department of Energy: https://denix.osd.mil/edqw/documents/manuals/qsm-version-5-3-final/

ATTACHMENT B
PFAS SME TEAM

PFAS Subject Matter Expert Team		
Name	**Location**	**Primary Expertise**
Eric Wood*	Westford, MA	Litigation Support/Site Investigation
Jim Fenstermacher*	Blue Bell, PA	Site Investigation/Remediation
Linda Dell	Amherst, MA	Epidemiology
Janet Egli	Nashville, TN	Water, wastewater
Paul Hare	Albany, NY	Site Investigation/Remediation
Debra Kaden	Boston, MA	Toxicology
Matt Longnecker	Raleigh, NC	Epidemiology
Steve Luis	Irvine, CA	CST/Product Stewardship
John Newsted	Lansing, MI	Ecological Risk, Site Investigation, Transport
Mark Nielsen	Princeton, NJ	Site Investigation/Remediation
Jaana Pietari	Westford, MA	Forensics
Imants Reks	Syracuse, NY	Growth Team Lead
Sonja Sax	Amherst, MA	Epidemiology
Rebecca Siebenaler	Princeton, NJ	Human Health/Eco Risk and Due Diligence
Sarah Stoneking	Arlington, VA	CST/Site Investigation
Matthew Traister	Cincinnati, OH	Air Transport
Steve Washburn	Emeryville, CA	Litigation Support
Jason Wilkinson	Westford, MA	Site Investigation/Remediation
Annette Nolan	New South Wales, AUS	ANZ PFAS Lead
Raisa Gabriela Salvi	Sao Paulo, Brazil	South America PFAS Lead
Dorte Harrekilde	Odense, Denmark	Europe PFAS Lead
Aldo Trezzi	Milan, Italy	Europe PFAS Lead
Notes: * PFAS SME team co-leaders.		

ATTACHMENT C
PFAS PRE-SAMPLING CHECKLIST

RAMBOLL

ENVIRONMENT & HEALTH

PFAS Pre-Sampling Checklist

Site Name: _____ Task: _____

Weather (temp/precip): _____ Date: _____

Pre-Mobilization:

- ☐ The QAPP or other site-specific field guidance has been consulted for sample locations, QC sampling requirements, and sample nomenclature

Field Clothing and PPE:

- ☐ Using white Tyvek®; not using yellow Tyvek®
- ☐ Clothing has not been most recently washed with fabric softeners or other treatments
- ☐ Clothing has not been permanently chemically treated for insect resistance or UV protection
- ☐ Clothing has not been treated with materials or formulations potentially containing PTFE or other PFAS products listed in Section 4.1 of FGD 1.07
- ☐ Any personal care products, if used, have been applied outside sampling zone, hands have been washed, and new nitrile gloves are being used
- ☐ Any use of sunscreens or insect repellants is consistent with the commercial products named in Section 4.1 of FGD 1.07

Field Equipment:

- ☐ Subcontractor (e.g., driller) materials and equipment conform to the requirements of FGD 1.07
- ☐ Sampling equipment is free of PTFE and other potentially PFAS-containing components listed in Section 4.1 of FGD 1.07
- ☐ Sampling equipment is made from stainless steel, HDPE, acetate, silicon, high-density polypropylene, or nylon
- ☐ Waterproof field books, waterproof paper, and Post-It Notes® are not used
- ☐ Markers (e.g., Sharpies®) are used only in the staging area or are not used

Sample Containers:

- ☐ Water ice is in use only, not chemical (blue) ice packs
- ☐ Sample containers have been received and are made of HDPE or polypropylene
- ☐ Bottleware for non-drinking water samples do not contain preservative
- ☐ Caps are unlined and made of HDPE or polypropylene

Wet Weather (as applicable):

- ☐ Wet weather gear made of polyurethane and PVC only, or is being worn under white Tyvek® covering

Equipment Decontamination:

- ☐ On-site or off-site public or private water, if to be used for equipment decontamination, has been analyzed and is "PFAS-free," as defined in Section 4.1 of FGD 1.07
- ☐ Alconox®, Liquinox®, or Citranox® are being used as decontamination cleaning agents; Decon 90® is not being used

Food Considerations:

- ☐ Any pre-wrapped food or snacks, carry-out food, fast food, or other food items will remain in the staging area
- ☐ Any food items, will be consumed outside the sampling zone, hands will be washed, and new PPE and nitrile gloves will be used

Work Area and Vehicle Considerations:

- ☐ Work areas, including vehicle interiors if used for sample handling, are covered with HDPE or LDPE plastic to prevent contact with potentially PFAS-containing materials and surfaces

If any applicable boxes cannot be checked, describe deviations below and work with field personnel to address issues prior to commencement of that day's work. Materials present and identified as potentially containing PFAS through use of this checklist should be relocated to the support area or other area of the site away from the sampling locations and noted below.

_____ _____

Field Team Leader Name and Signature Time

FIELD GUIDANCE DOCUMENT NO. 5.07

SUBSURFACE SOIL SAMPLING – DIRECT PUSH TECHNOLOGY (DPT)

RAMBOLL

FIELD GUIDANCE DOCUMENT NO. 5.07

SUBSURFACE SOIL SAMPLING – DIRECT PUSH TECHNOLOGY (DPT)

Prepared By:	Brian Bauer
Peer Reviewed By:	Carol Serlin Jose Sananes Michael Hall Aaron Hottenstein Leslie Herd Anita Locke Robert Patchett Alex Marr
Approved By:	J. Mark Nielsen, P.E.
Applicable To:	North American offices
Effective Date:	June 8, 2022
Revision Notes:	
Documents Used as Reference During Preparation:	Geoprobe Systems. 2011. "Geoprobe® Large Bore Soil Sampler Discrete Interval Soil Sampler Standard Operating Procedure". Geoprobe Systems. 2011. "Geoprobe Macro-Core® MC5 1.25-inch Light Weight Center Rod Soil Sampling System Standard Operating Procedure". Geoprobe Systems. 2013. "Geoprobe DT22 Dual Tube Soil Sampling System Standard Operating Procedure". Ohio EPA. 2005. "Technical Guidance for Ground Water Investigations Chapter 15 Use of Direct Push Technologies for Soil and Groundwater Sampling. USEPA Region 4 Laboratory Services and Applied Science Division, 2020. "Soil Sampling"

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ATTACHMENTS

Attachment A Direct Push Sampling Equipment

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines for use by Ramboll employees operating in the United States and Canada for collection of subsurface soil samples using direct push technologies (DPT). DPT is commonly used for soil sample collection at sites where there is an advantage to using a drill rig with a smaller footprint that can quickly penetrate soils while reducing the generation of investigation derived waste (IDW) (EPA, 2005). Subsurface soil sampling via DPT may be conducted as part of environmental investigations or remedial actions to:

- Collect soil samples for biological, chemical and/or geotechnical testing[1] and assess hydrogeological conditions including, but not limited to, sampling to support source identification, characterize nature and extent of contamination in soils, assess background conditions, and conduct confirmatory sampling; and
- Allow visual, odor, and volatile vapor screening of subsurface soils.

This FGD provides guidance for subsurface soil sampling using DPT associated with typical field activities and projects, however, it should be understood that for certain projects other sampling procedures or alternative methods may be required, including methods specified by state-specific or regulatory program-specific guidelines, requirements or procedures. Site-specific and state/regulatory requirements will be reviewed by the Ramboll Principal-in-Charge / Project Director (PIC / PD) and/or Project Manager (PM), and additional requirements will be defined in the project-specific Work Plan, Field Sampling Plan, Quality Assurance Project Plan (QAPP) and/or FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans but rather a reference for developing project specific procedures.

This FGD does not supersede Ramboll health and safety procedures or site-specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. Ramboll employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP followed by approved site-specific procedures, which may include those in this FGD. The Ramboll PIC/PD and/or PM shall verify that project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information are maintained in the project file for the duration of the project or as established by applicable Ramboll document handling and retention policies. The signatures of the PIC/PD and/or PM indicate approval of the methods and precautions outlined in the site-specific HASP.

[1] Note that direct push sampling does not allow collection of undisturbed samples required for certain geotechnical testing (e.g., strength, consolidation, hydraulic conductivity).

2. EQUIPMENT AND MATERIALS

A general list of equipment that may be necessary for typical subsurface soil sampling using DPT is provided below. This list provides an overall summary of general equipment which may be required for soil sampling using DPT but should not be considered exhaustive. Additional equipment may be specified in the project-specific Work Plan and/or HASP.

- Site information (e.g., maps, contact numbers, keys or lock codes for gates or access points, previous field logs).
- The DPT rig, and other drilling equipment, such as rods, samplers, liners (e.g., PVC, polyethylene, acrylic, Lexan), and caps, which should be supplied by the drilling contractor (refer to **Attachment A** for brief descriptions of commonly used samplers).
- Appropriate tools for adjusting samplers and opening liners (dual longitudinal liner ripping blade, hacksaw (with clean blades), pliers, wrench, etc.), which should be supplied by the drilling contractor.
- Pin flags or wooden stakes, or in paved areas, spray paint or nails with flagging tape, to mark sample location(s). Care should be taken not to use materials that may interfere with sampling/analytical results. Refer to **FGD 1.04** (Documenting Sampling Locations).
- Plastic sheeting.
- Folding worktable, half-pipe, or half-sheet of corrugated roofing plastic to hold and keep the samplers organized.
- Soils classification guidance chart as outlined on **FGD 5.01** (Soil Classification).
- Color chart (e.g., Munsell) as outlined on **FGD 5.01** (Soil Classification).
- Measuring tape (both long-weighted cloth type and small measuring type, preferably marked in tenths and hundredths of a foot) for measuring sample recovery and subsample intervals.
- Spatula, knife or spoon (typically stainless steel) used for splitting soil cores and collecting soil samples.
- Mixing bowl/bucket and spoons (typically stainless steel unless metal analysis will be performed) for composite sample preparation.
- Laboratory supplied certified-clean sample containers (appropriate for various analyses to be performed), as may be required in the Work Plan.
  - If soil samples are to be analyzed for Volatile Organic Compounds (VOCs) refer to **FGD 5.05** (Soil Sampling for VOC Analysis) for additional equipment requirements.
  - If soil samples are to be analyzed or screened for Non-aqueous Phase Liquid (NAPL) refer to **FGD 5.11** (Soil Sampling - NAPL Dye Tests) and/or **FGD 5.12** (Soil Sampling - NAPL Ultraviolet Light Tests) for additional equipment requirements.
  - If soil samples are to be analyzed for Polychlorinated biphenyl (PCBs) refer to **FGD 5.16** (Soil Sampling for PCB Analysis) for additional equipment requirements.
  - If soil samples are to be analyzed for poly and perfluoralkyl substances (PFAS), refer to **FGD 1.07** (PFAS Sampling).

- Sample shipment containers, labels, chain of custody forms and packing materials for sampling containers as outlined in **FGD 1.02** (Sample Handling, Shipping, and Chain of Custody).
- Trash Bags - used to dispose of gloves and other non-hazardous waste generated during sampling (refer to **FGD 15.01**, Waste Handling).
- Decontamination supplies (refer to **FGD 14.01**, Sampling Equipment Decontamination).
- Appropriate waste container and labelling materials – used to dispose of IDW and/or decontamination wastes (refer to **FGD 15.01**, Waste Handling).
- Field screening equipment (e.g., PID, XRF) as required by the site-specific Work Plan, Field Sampling Plan, QAPP and/or the site-specific HASP.
- Zip-loc® bags and/or glass jars and aluminum foil (used for field screening purposes).
- Personal Protective Equipment (PPE) in accordance with the site-specific HASP, including protective gloves which must always be worn when handling and using sample equipment.
- Field notebook and test boring and well construction field log forms (if required), and all-weather or permanent pens as outlined in **FGD 1.01** (Field Notes and Records).
- Mobile phone and camera.
- For long-term drilling projects, setting up a field station is recommended. The field station might include portable chair(s), worktable, canopy, and a first aid station/kit.

3. PROCEDURES REFERENCED

In addition to the reference and guidance documents cited above, the following Safe Work Practices (SWPs) and FGDs are related to this FGD and should be reviewed prior to mobilization, as needed:

- **SWP** Subsurface Utility Clearance
- **FGD 1.01,** Field Notes and Records
- **FGD 1.02**, Sample Handling, Shipping and Chain of Custody
- **FGD 1.03**, Data Management
- **FGD 1.04**, Documenting Sampling Locations
- **FGD 1.05**, Field Quality Control Samples
- **FGD 1.07**, PFAS Sampling
- **FGD 2.02**, Site Preparation, Inspection and Housekeeping
- **FGD 4.06**, Equipment Calibration
- **FGD 5.01**, Soil Classification
- **FGD 5.04**, Surface Soil Sampling
- **FGD 5.05**, Soil Sampling for VOC Analysis

- **FGD 5.06**, Field Analysis of Soils using Portable X-Ray Fluorescence
- **FGD 5.09**, Soil Boring Log Preparation
- **FGD 5.10**, Borehole Decommissioning
- **FGD 5.11**, Soil Sampling - NAPL Dye Tests
- **FGD 5.12**, Soil Sampling - NAPL Ultraviolet Light Tests
- **FGD 5.16**, Soil Sampling for PCB Analysis
- **FGD 5.19,** Incremental Composite Sampling (Soils/Sediments)
- **FGD 6.06**, Temporary Overburden Well Installation and Sampling
- **FGD 14.01**, Sampling Equipment Decontamination
- **FGD 14.02**, Heavy Equipment Decontamination
- **FGD 15.01**, Waste Handling

The list above is not intended to be all inclusive. Other SWPs and FGDs may need to be referenced based on the specific requirements of the site-specific Work Plan, Field Sampling Plan, and/or QAPP (e.g., field screening FGDs, FGDs for sampling of other media, etc.).

4. PROCEDURES

4.1 Planning and Design Considerations

Strategic decisions including, but not limited to, the selection of the direct push drill rig (e.g., access limitations), and the potential need to adjust boring locations (e.g., subsurface utilities), will be approved by the PIC/PD and/or PM before the initiation of associated field activities and will be documented in the Work Plan, Field Sampling Plan, and/or QAPP. The Work Plan, Field Sampling Plan, and/or QAPP will be designed for the collection of quality data to meet the objectives of the sampling program and will include information such as the number of borings, depth, number of samples per boring, and the laboratory analyses to be performed on each sample as well as quality assurance/quality control (QA/QC) requirements. The Work Plan, Field Sampling Plan, and/or QAPP will generally provide for some discretion in the field, depending on encountered conditions; however, any significant departure from prescribed sampling activities should be discussed with and approved by the PIC/PD and/or PM.

When planning a DPT sampling event, the following should be considered:

- *Type of Direct Push Rig*. DPT uses hydraulically powered rigs that utilize both hydraulic force and percussion to advance soil sampling equipment into the subsurface. Some direct push rigs are also equipped with a rotational drive that will allow the use of augers. Direct push rigs can be mounted on pickup trucks, skid loaders, tracked carriers, skids or other vehicles. The type and size of the direct push rig and associated equipment will depend on project -specific needs such as the boring depth and access limitations. The type of direct push rig and associated equipment should be specified in the work plan and discussed with the drilling contractor prior to mobilization.

- *Sampling Locations*. Consideration for placement of sampling locations should be given to the objectives of the sampling effort. However, accessibility and potential hazards (e.g., subsurface utilities, overhead clearance [including utilities, ceilings or other obstructions] traffic, surface stability, soil strength), and need to precut surfaces (e.g., asphalt or concrete) should be considered when selecting sampling locations as they could limit DPT equipment use and/or require additional controls (e.g., traffic control, clearing of vegetation, temporary mats for protection of landscaping, or delicate surfaces).
- *Sampler Type*. DPT samples can be collected using either single barrel or double tube configurations (refer to **Attachment A** for brief descriptions of commonly used DPT samplers). The dual tube system is preferable as it provides a casing that isolates the media to be sampled from the formation, thereby preventing potential cross-contamination or potential sloughing of the borehole walls. A single barrel sampler may be suitable for discrete shallow (i.e., less than 10 feet) sampling in the unsaturated zone provided that the barrel sampler is used in a sealed or closed configuration. The sampler barrel is typically five feet in length.
- *Subsurface Soils*. DPT is most suitable for sampling cohesive overburden soils that contain a low percentage of gravel and are not dense or highly compacted, or contain cobbles or weathered rock. In cases where soils to be sampled may lack cohesiveness and may fall out of the sampler, core catchers at the leading end of the sampler may help retain the sample until retrieval at the surface.
- *Liner Type*. DPT soil sampling uses a liner to facilitate sample retrieval from the barrel. Liner materials include brass, stainless steel, cellulose acetate butyrate, polyethylene terephthalate glycol, polyvinyl chloride, and Teflon. Potential interferences between the liner materials and the contaminants of concern must be evaluated when selecting the liner materials. When low reporting limits are required, use of the more inert liner materials (e.g., stainless steel) is recommended.
- *Liner Dimensions*. Liners vary in diameter (from about 1 to 3 inches) and length (from about 2 to 5 feet). Metal liners can also be obtained in shorter lengths (2-6 inches) to allow ready collection of discrete intervals. Selection of the liner dimensions should consider: (a) volume requirements for sample analyses; (b) quantity of samples and sampling intervals (ideally the sampler would be positioned at the top of the interval on interest); and (c) enhanced recovery (typically larger diameter borings will be less affected by presence of small subsurface obstructions like pebbles).
- *Borehole backfilling approach.* Factors to be considered in selecting the approach for backfilling the borehole include potential contamination of drill cuttings, local permit regulations and guidance, and client specific requirements. DPT boreholes can be backfilled using several methods, including retraction grouting with a tremie tube and a bentonite and/or Portland cement grout, gravity filling with bentonite and/or Portland cement grout, filling with hydrated bentonite pellets, or backfilling with drill cuttings.

4.2 Pre-Field Work Preparation Guidelines

Before initiating field activities, field staff should review and complete pertinent tasks identified in **FGD 2.02** (Site Preparation, Inspection and Housekeeping). In addition, to the extent that non-dedicated sampling equipment is to be used (e.g., spatula, knife or spoon, mixing bowls), such sampling equipment should be decontaminated before collection of each

sample to minimize potential cross-contamination between samples, as described in **FGD 14.01** (Sampling Equipment Decontamination), the project-specific Work Plan, Field Sampling Plan and/or QAPP. Used disposable sampling equipment should be considered IDW and should be managed in accordance with **FGD 15.01** (Waste Handling), following the sampling event.

At a minimum, the following tasks should be completed (as applicable) as field staff prepare for implementation of the work:

- Coordinate and obtain permission for site access;
- Review and sign the site-specific HASP;
- Review applicable permits and permit conditions that may affect site work including backfill requirements, air, dust or sound monitoring, agency notifications, and restricted operating hours;
- If work is being conducted under agency supervision, make appropriate advance notifications to advise of the start of work;
- Confirm soil boring/sampling locations;
- Complete subsurface clearance activities (refer to **SWP** Subsurface Utility Clearance);
- Review project-specific Work Plan, Field Sampling Plan, and/or QAPP, where applicable;
- Review and discuss with the PIC/PD and/or PM the proposed Work Plan, Field Sampling Plan or sampling strategy;
- Identify the type of sampler and drilling equipment required for project-specific tasks and review the standard instruction manual provided by the manufacturer of the specific sampling equipment being used for sampling;
- Contact the drilling contractor to verify scope and confirm sampling equipment is available and appropriately decontaminated prior to mobilization;
- Contact the laboratory to provide advance notice when sample delivery is anticipated; and
- Verify that all equipment/materials and sampleware required to complete the work have been packed prior to mobilization.

Prior to the commencement of the field effort, Ramboll oversight personnel should inspect, test, and/or calibrate equipment that will be used to take field measurements (refer to **FGD 4.06**, Equipment Calibration). To increase productivity in the field, it is recommended that prior to mobilization the laboratory-provided sampleware quantities are checked, sample containers are pre-labeled (refer to **FGD 1.02**, Sample Handling, Shipping and Chain of Custody) and non-dedicated sampling equipment is decontaminated and packaged (refer to **FGD 14.01,** Sampling Equipment Decontamination).

4.3 Direct Push Sampling Guidelines

The following provides a recommended list of practices for soil sampling using DPT.

- Where applicable, contact the identified key site personnel upon arrival to the Site and visually assess proposed work areas and decide where containerized soil cuttings and other IDW should be staged and stored.
- Review the physical location of each soil boring with the driller before initiating subsurface work. Verify that the proposed locations have been cleared in accordance with **SWP** Subsurface Utility Clearance and that the drill rig can operate safely while maintaining minimum clearance from overhead power lines, or damaging other property (e.g., equipment, fences, etc.).
- Inspect the backfill material provided by the drillers to verify it complies with potential permit requirements.
- Discuss the following with the driller:
  - Expected depth and diameter of the borings;
  - Amount and depth of the soil samples to be collected;
  - Approximate anticipated depth of groundwater;
  - Borehole backfilling procedure and materials;
  - Staging locations for soil cuttings and other IDW;
  - Location for conducting equipment decontamination; and
  - Surface materials and the need to predrill or core prior to DPT. If the surface material is asphalt, the direct push drill rig tooling may be able to penetrate the asphalt (verify with driller prior to initiating field work). However, if the surface is covered with concrete, a concrete corer or saw may be required to provide access to the subsurface.
- Prior to start of the DPT sampling, set up the sample processing/field station area, which may include placing plastic sheeting on the ground surface to prevent potential contamination of underlying soil/asphalt/concrete, setting up a worktable, core cradle, or corrugated sheets to hold the samplers, and installing a canopy.
- Although equipment will be decontaminated between uses to further limit potential cross-contamination between sampling locations, sampling should progress from suspected areas of lowest to highest concentration.
- The driller will advance the DPT sampler to the target sampling depth (refer to **Attachment A** for brief descriptions of commonly used DPT samplers). The sampler will be advanced using hydraulic pressure and percussion hammering on the driving head of the sampling assembly at a constant rate. The sampler will be advanced to a depth that is equal to its length (typically 24-inch inner sampling barrel), or less if sampler refusal is encountered (i.e., limited or no advancement of the sampler, altering the robe alignment or bending of the rod). Refusal can result from tip resistance (i.e., distinct unconsolidated deposits overlying bedrock or presence of cobbles in the subsurface), sleeve friction (i.e., the interaction of the sampler with cohesive soils, which can "grab" the outside of the sampler and limit depth penetration), subsurface heterogeneity, or

operator error (e.g., advancing the probe off vertical, which will cause the probe to bend).

- During direct push sampling, Ramboll personnel should:
  - Maintain a safe distance from the drill rig and maintain eye contact with the operator if approaching the drill rig.
  - Monitor ambient air in the work area as required by the site-specific Work Plan or Field Sampling Plan and the site-specific HASP.
  - Communicate with the operator regarding observed changes in subsurface conditions during drilling (e.g., increased or decreased resistance to DPT, groundwater first encountered) and depths where these occur.
- Have the drilling contractor retrieves the sampler from the borehole, place the sampler on the sample processing work area, and remove the liner from the sample barrel.
- Upon delivery, Ramboll personnel will
  - Don a pair of new clean nitrile gloves immediately prior to handling each core.
  - If the liner will be used as a sample container, use a decontaminated (refer to **FGD 14.01,** Sampling Equipment Decontamination) tool to cut the portion of the liner that will be used for the sample, and cover it with liner caps, which should be taped to the liner to prevent sample loss (Teflon or other tape without potential VOC-containing adhesives for VOC samples). Then cut the remainder of the liner as described below.
  - If the liner will not be used as the sample container, cut it lengthwise on either side with a decontaminated (refer to **FGD 14.01,** Sampling Equipment Decontamination) tool to separate the halves and allow for sample screening and collection. If sampling for VOCs is being performed, do not cut the liner until immediately prior to field screen/sample to minimize VOC loss.
- Once the liner is open, Ramboll personnel should:
  - Place a measuring tape alongside the liner, photo-document the core, and measure and record the soil recovery in the core. If poor soil recovery is experienced or anticipated, then evaluate the possible causes for poor recovery. Consider (a) advancing the core to the top of the desired sample interval and then advancing the core to obtain the desired interval; (b) using a catcher; (c) extending the sampler to a cohesive layer, if present; (d) using a larger split spoon barrel; and/or (e) advancing a second adjacent soil boring to target the necessary interval. Alternatively, review and discuss with the PIC/PD and/or PM other sampling approaches.
  - When the sample recovery is less than 100%, the recorded retrieved interval corresponds to the top of the target sampling interval. For example, if recovering 18 inches from the 10 to 12 feet below ground surface (bgs) sampling interval, the sampling interval recorded is 10 to 11.5 feet bgs. Exceptions may include presence of slough in the top of the sampler, when sampling compressible soils (e.g., peat), or if a rock temporarily prevents sample collection. If any of these conditions are

observed during drilling, discuss appropriate recording of the sample recovery with the PIC/PD and/or PM.

- Use a decontaminated (refer to **FGD 14.01,** Sampling Equipment Decontamination) spatula, knife or spoon to split the soil cores and to expose soil for sampling, field screening, and photo-documentation.
- Screen the soil with field instruments (e.g., PID, XRF) as required by the site-specific Work Plan, Field Sampling Plan, and/or QAPP and in accordance with instrument manufacturer recommendations and pertinent FGDs.
- Classify the soil in accordance with **FGD 5.01** (Soil and Rock Classification) and document related drilling activities in accordance with **FGD 5.09** (Field Soil Boring Log Preparation).
- If soil samples are to be field tested for the presence of NAPL refer to **FGD 5.11** (Soil Sampling - NAPL Dye Tests) and/or **FGD 5.12** (Soil Sampling - NAPL Ultraviolet Light Tests).
- Don a new pair of clean nitrile gloves immediately prior to collecting samples that will be sent for laboratory analyses.
- Collect samples as required by the site-specific Work Plan, Field Sampling Plan, and/or QAPP as follows:
  - If soil samples are to be analyzed for VOCs collect these samples first in accordance with **FGD 5.05** (Soil Sampling for VOC Analysis).
  - Homogenize sample in accordance with the homogenization procedures provided in **Section 4.4**.
  - If soil samples are to be analyzed for PCBs refer to **FGD 5.16** (Soil Sampling for PCB Analysis).
  - If soil samples are to be analyzed for PFAS, refer to **FGD 1.07** (PFAS Sampling).
  - If multiple samples are to be collected from a single liner, don a pair of new clean nitrile gloves and use a decontaminated (refer to **FGD 14.01,** Sampling Equipment Decontamination) spatula, knife or spoon to collect and prepare each sample.
- Transfer the sample to appropriate sample container(s) provided by the analytical laboratory, label and seal the sample containers, and store in an ice-filled insulated cooler pending transport to the analytical laboratory, or the laboratory courier in accordance with sample container guidelines in **Section 4.5** and sample transport and storage guidelines in **Section 4.6** and **FGD 1.02** (Sample Handling, Shipping, and Chain of Custody).

- If multiple samples are to be collected, decontaminate non-dedicated, non-disposable sampling equipment between sampling locations as described in the **FGD 14.01** (Sampling Equipment Decontamination), the project-specific Work Plan, Field Sampling Plan and/or QAPP.
- If the Work Plan or Sampling Plan requires continuous sampling, have the driller advance the sampler to a depth equal to the base of the last sample interval. If sampling is

discontinuous, have the driller advance the sampler to just above the next sample target depth.

- Upon completion of the drilling and soil sampling activities:
  - The boring shall be backfilled as required in the project-specific Work Plan, Field Sampling Plan, and/or permit(s).
  - If surfaces are to be restored (e.g., pavement, concrete, vegetation), reconstruct the surface and match to adjoining grades in accordance with the project-specific Work Plan and/or Field Sampling Plan.
  - Document the sampling location in accordance with **FGD 1.04** (Documenting Sampling Locations) and place a stake or flag at the sampling location for future reference if these do not interfere with site activities (e.g., in a parking lot or driveway).
- If required by the project-specific Work Plan or Field Sampling Plan, decontaminate the drilling rig and equipment prior to demobilization from the Site in accordance with **FGD 14.02** (Heavy Equipment Decontamination).
- If dedicated, disposable sampling equipment was used during the sampling event, it should be considered IDW and should be managed in accordance with **FGD 15.01** (Waste Handling) following the collection sampling event.

4.4 Sample Homogenization Procedures

Homogenization refers to the complete mixing of materials to obtain uniform color and consistency throughout the sample prior to analyses. Homogenization is typically performed on discrete samples (e.g., several intervals within a sampling location or several sampling locations within a specific sampling interval) to create composite samples. Compositing may be performed either in the field or at the laboratory. Homogenization should not be performed for samples designated for VOC analysis (refer to **FGD 5.05,** Soil Sampling for VOC Analysis).

- Place samples to be homogenized into a large, decontaminated (refer to **FGD 14.01**, Sampling Equipment Decontamination) or dedicated container constructed of inert material (e.g., glass, Teflon, or stainless steel) appropriate for the analyses requested.
- Prior to homogenization, remove large, unrepresentative materials such as twigs, leaves, stones, wood chips, and debris and document this encountered material in the field log.
- Mix materials as quickly and efficiently as possible using a decontaminated (refer to **FGD 14.01**, Sampling Equipment Decontamination) glass, high density polyethylene, or stainless-steel spoon until textural, color, and moisture homogeneity are achieved.
- When mixing large amounts of materials, mechanical mixers can be used as long as they are made of stainless steel, and have been decontaminated (refer to **FGD 14.01**, Sampling Equipment Decontamination).

4.5 Sample Containers

As outlined in **FGD 1.02** (Sample Handling, Shipping and Chain of Custody), equipment and sample containers that will come into contact with collected soil samples should be constructed of inert materials that will not affect the concentration of constituents in the sample (i.e., stainless steel or Lexan®). The level of care that needs to be taken with the materials used will depend on the level and types of constituents associated with the sample and the quality assurance needs and study goals. This should be outlined in the project-specific Work Plan, Field Sampling Plan and/or QAPP.

When the liners will not be used for sample collection, the laboratory will provide appropriate sample containers appropriate for each predetermined sample analysis. The sample volume is a function of the analytical requirements and will be specified in the Work Plan, Field Sampling Plan and/or QAPP. If possible, jars should be filled to capacity allowing no headspace (unless samples are to be stored frozen in which case some head space is required to allow for sample expansion). If samples are to be analyzed for VOCs, they should be collected in a manner that minimizes disturbance of the sample (refer to **FGD 5.05**, Soil Sampling for VOC Analysis).

4.6 Sample Transport and Storage

Sample containers shall be handled as outlined in **FGD 1.02** (Sample Handling, Shipping and Chain of Custody). Samples should be kept in an ice-filled transport container during fieldwork and covered to limit light penetration.

If the liners will be used for sample collection, they should be properly capped/sealed at both ends and stored to minimize sample disturbance.

4.7 QA/QC

Follow QA/QC procedures described in the project-specific Work Plan, Field Sampling Plan and/or QAPP throughout the sample collection, processing, handling, and analysis process. In their absence, the QA/QC guidelines of **FGD 1.05** (Field Quality Control Samples) should be reviewed.

5. PRECAUTIONS AND OTHER CONSIDERATIONS

Field activities require recording sufficiently detailed information throughout the implementation of field work. Certain precautions should be taken to work safely while collecting soil samples via DPT. Additionally, implementation of the work may face some difficulties, including the following:

- Direct push drilling is only suitable in unconsolidated shallow sediments. If the lithology at the site contains large amounts of gravel/cobbles, dense clay, caliche or bedrock, alternative drilling techniques may have to be considered.
- Only drillers licensed in the State where the work is being performed should be subcontracted to perform the work, if applicable. Most states have specific licensing requirements.

- In some States or local jurisdictions, drilling permits are to be procured by the driller and/or consultant prior to mobilization. In addition, boring logs and other documentation may need to be submitted to the permitting entity by the driller and/or consultant after completion of the drilling and sampling. Local Ramboll offices should be consulted to determine if specific reporting requirements apply. If the driller obtains the drilling permits, Ramboll should obtain copies of the required permits prior to mobilization. When applicable, Ramboll should also obtain copies of the driller's soil boring records after completion.
- Prior to mobilization, identify the location of soil borings and evaluate the need for security, barricading, and/or traffic control (e.g., when borings are located near the right of way).
- It is important to always remain alert and aware of your surroundings. Sampling using a direct push rig involves the use of heavy equipment, and is subject to hazards posed by equipment, vehicle traffic, industrial machinery, hazardous chemicals and contaminants, and/or other physical, mechanical, and chemical hazards.
- Stand a safe distance away from the direct push rig when taking notes. Be aware that the operator may not be able to see you, equipment accidents can happen very quickly, and you need to be alert and ready to move. Be sure to wear a high-visibility vest or clothing.
- Keep direct push equipment out of high-traffic areas and properly stored when not in use to limit trip, spill and fall hazards onsite. Use marking tools when necessary to flag or mark off possibly dangerous areas.
- If the borehole cannot be completed by the end of the day, leave the drill rig over the borehole. Where not possible (e.g., public right of way), cover the borehole and secure the area to prevent accidents and unauthorized access.
- At sites with certain contaminants and/or subsurface conditions, potentially toxic and/or explosive gases may migrate from the borehole to the surface. Field staff should perform air monitoring and confirm that PPE is used in accordance with the site-specific HASP.
- When working out of sight of the general public or when site employees are in potentially hazardous areas (e.g., wooded habitats), field staff should use the "buddy system" and ensure that the project-specific HASP includes safety measures and procedures for work in isolated areas.
- When the liners are removed from the sampler tubes, it is important to track the proper orientation of the sample and to precisely and liberally mark the depths (e.g., top of run, labeled footage marks along the length of the sample, total depth of run) at which the sample was collected. Different liner cap colors can be used to distinguish the top from the bottom of the core or the orientation can be marked on the exterior of the liner with a permanent marker. When, say a six-inch sample is cut out of a sample run from a 5-foot sleeve, the remaining sleeve portions should be sufficiently labeled so that the boring can continue to be properly logged and to avoid confusion.
- If the Work Plan or Field Sampling Plan specifies analyses requiring field preservation, be sure to avoid direct contact with laboratory-provided preservative chemicals.

- The sample processing area should minimize exposure to ambient factors (e.g., atmospheric air, wind-blown dust, vehicular exhaust).
- Background soil samples should be kept isolated from samples collected from potentially contaminated soil samples and IDW. When possible, sampling should progress from areas of lowest to highest suspected concentrations.
- When possible, designated roles should be established so that the soil sampling and logging is performed by the same person and the recording and documentation is completed by the same person throughout the sampling process.
- When backfilling boreholes below the water table, bentonite pellets or coated bentonite chips are generally easier to place than standard bentonite chips because pellets do not hydrate as quickly, hence pellets or coated bentonite chips are the preferred method for small backfill jobs where significant confining zones have not been breached. Note, however, that some pellet coatings have been known to contain acetone, which may interfere with groundwater VOC analysis. If used, samples of the coated bentonite pellets may be collected and held for future analysis if acetone is detected in the groundwater sample.

6. RECORDKEEPING

Document sampling locations in accordance with **FGD 1.04** (Documenting Sampling Locations) and record information related to soil sampling in accordance with **FGD 1.01** (Field Notes and Records) and **FGD 1.03** (Data Management). In addition, for each soil boring a soil boring log with the recorded information should be prepared and saved in the project file (refer to **FGD 5.09** – Soil Boring Logs).

ATTACHMENT A
DIRECT PUSH SAMPLING EQUIPMENT

Direct push technology (DPT) sampling involves "pushing" a hollow lined barrel into the subsurface using a combination of equipment weight and high frequency percussive or hydraulic methods. Since DPT compresses and/or rearranges soil particles to allow the barrel to advance, there is no need to remove soil thereby minimizing soil cuttings requiring offsite disposal. The depths that can be achieved by DPT sampling are dependent on the soil type, the size of the sampler, and the weight and power of the DPT rig. DPT sampling is most suitable for sand, silt and clay with some gravel. DPT technology may have difficulty penetrating dense or hard soil, hard-packed saturated sand, and soil with cobbles or boulders.

DPT devices may be driven by manual, mechanical, or hydraulic methods, and may be truck-mounted or stand-alone. A DPT tool string includes the sample collection tool and extension rods for advancement and retrieval of the sample tool. There are three types of rod systems:

A. The Large Bore DPT soil sampling system consists of a single string of rods that connect the sampling tool to the rig and is used as a discrete interval sampler. The large bore sampling system consists of a head assembly, a barrel, liner, a piston rod, a cutting shoe, and a piston tip. While it is being driven, the sampler remains closed by a piston tip that is held in placed by a reverse-threaded stop pin at the tailing end of the sampler. Once at the top of the target sampling interval, the stop pin is removed with an extension rod lowered through the drill stem. The sampler is then driven to the target depth, and the drill stem and sampler are removed from the borehole to retrieve the sample.

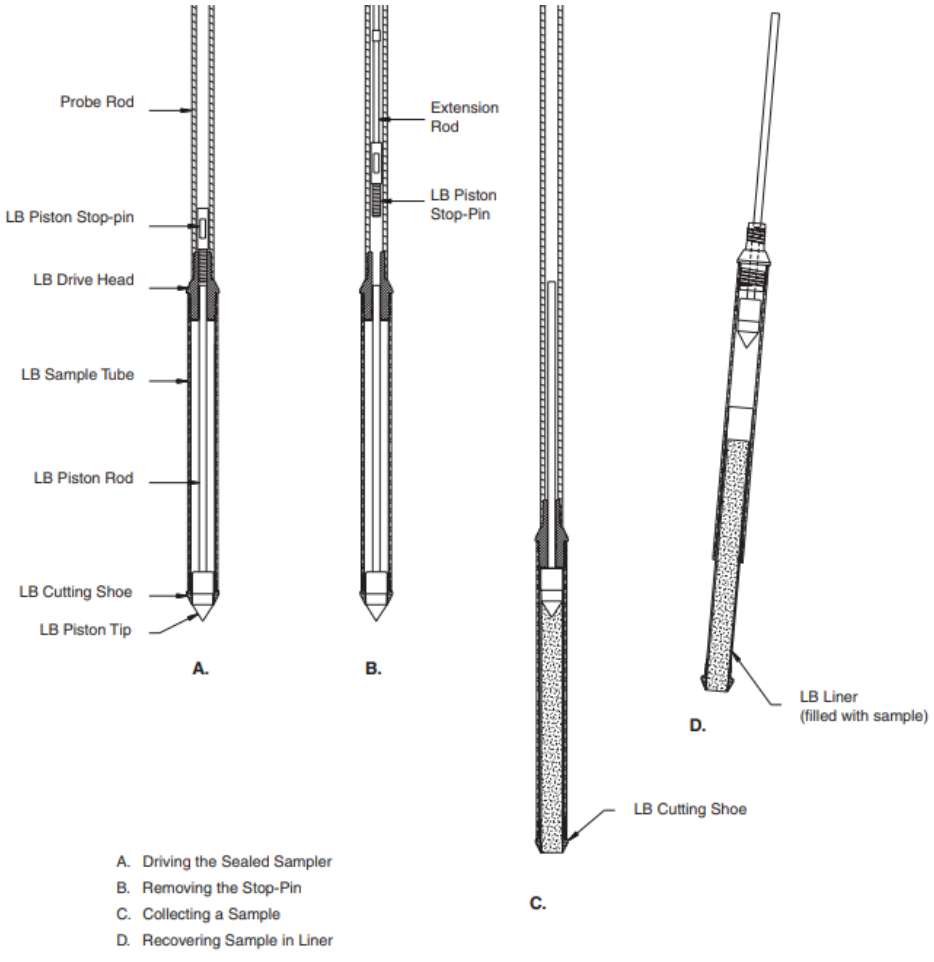


Figure 1: Large Bore DPT System (Source: Geoprobe)

B. Single tube DPT soil sampling consists of a single string of rods that connect the sampling tool to the rig and can be used as an open tube sampler or closed point sampler assembly. The open tube sampling system consists of a head assembly, a barrel, liner and a cutting shoe. The cutting shoe is affixed to the liner, which is inserted and threaded into the barrel. The drive head is threaded the opposite end of the barrel. In this configuration, coring starts at the ground surface with a sampler that is open at the leading end. The sampler is driven to the target depth in the subsurface using the DPT rig, and when retrieved, the entire string is removed from the borehole. To collect samples from greater depths when soils are stable, a new sampler is reintroduced into the open borehole and the process repeated. In unstable soils that cause borehole wall collapse, the single tube sampler can be equipped with a closed point assembly. The closed point assembly also allows collection of targeted interval samples at depth.

A closed point assembly can be inserted into the single tube DPT soil sampler. This assembly fits firmly into the cutting shoe and is held in place by center rods that prevents soil from entering the sampler as it is advanced to the bottom of an existing hole, allowing collection of a representative sample at the target depth. The barrel and closed point string are driven to the target sampling depth, after which the closed point string is retrieved leaving the barrel and open tube sampling system in-place. The sampler is driven to the target depth in the subsurface using the DPT rig, after which the entire string is removed from the borehole to retrieve the sample.

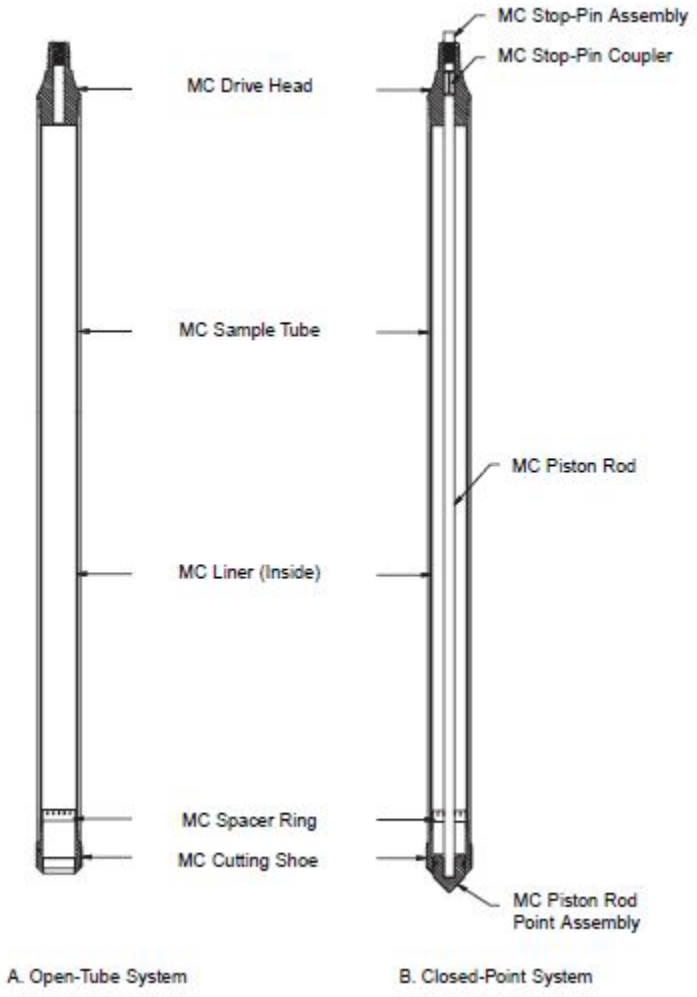
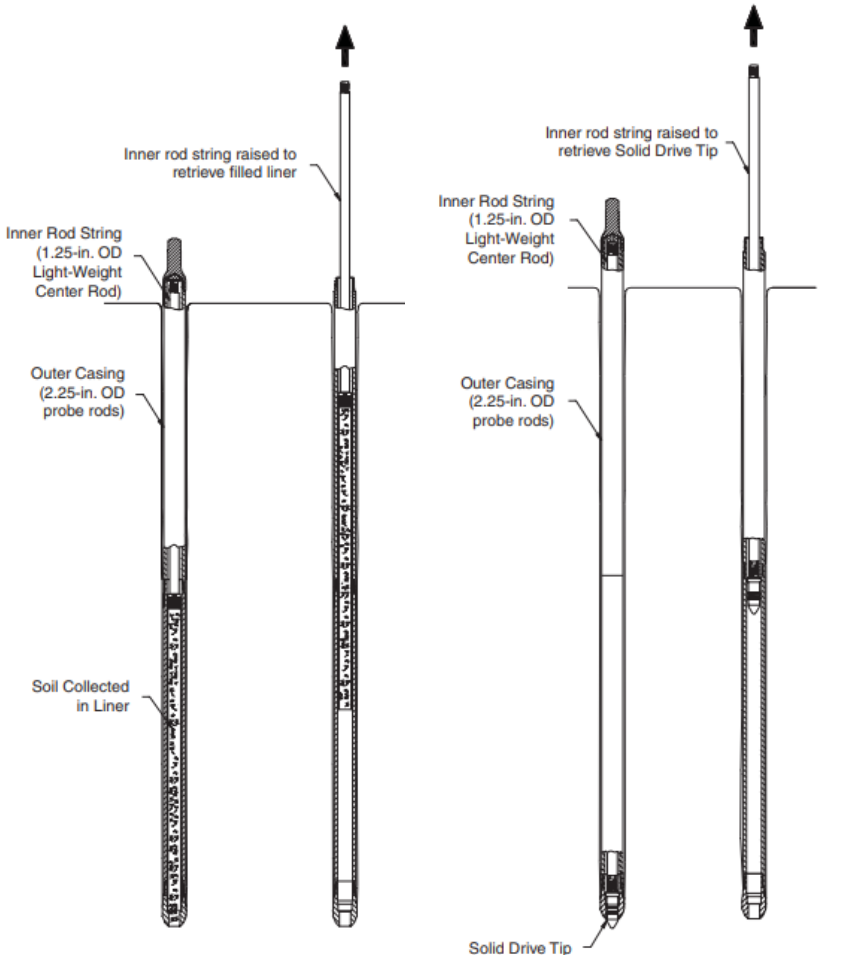


Figure 2: Single Tube DPT System (Source: Geoprobe)

C. The dual tube DPT soil sampling system allows sampling of subsurface soils from within a sealed outer casing. It uses an outer casing that remains in place during sample retrieval and an inner rod and liner string for sample collection. A cutting shoe is installed at the leading end of the outer casing probe rod. The inner string assembly (i.e., inner rod and sample liner) is installed within the outer casing. If the first sampling interval is not the ground surface, a solid drive tip (discrete point) is used on the leading end of the inner rod string instead of a sample liner to seals the assembly as it is driven into the subsurface. The dual tube system with the discrete point is then driven to the top of the target sampling interval, at which point the inner string is retrieved, and the discrete point is removed from the drive head and replaced with a liner. The inner rod with the liner is then inserted into the outer casing, which is extended with an additional casing. A drive cushion is then placed on top of the inner rod and a drive cap placed over the entire assembly. The whole string is driven to the target sampling depth, after which the inner rods and liner with sample are retrieved from the outer casing.



(a) Outer Casing Driven with Liner (b) Outer Casing Driven with Solid Drive Tip

Figure 3: Dual Tube DPT System (Source: Geoprobe)

FIELD GUIDANCE DOCUMENT NO. 5.09

FIELD SOIL BORING LOG PREPARATION

RAMBOLL ENVIRON

FIELD GUIDANCE DOCUMENT NO. 5.09

FIELD SOIL BORING LOG PREPARATION

Prepared By:	Adam Duskocy
Peer Reviewed By:	Sarah Stoneking Robert Patchett Carol Serlin Jonathan C. Johnson Jose Sananes James Moran Safaa Dergham Nestor Soler
Approved By:	J. Mark Nielsen
Applicable To:	All North American offices
Effective Date:	November 16, 2015
Revision Notes:	1. Revised company name and format.
Documents Used as Reference During Preparation:	ASTM D1586 - 11 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils; ASTM D 2487-00 Standard Practice for Classification of Soils for Engineering Purposes; ASTM D 2488-00 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure); New Jersey Department of Environmental Protection, 2005. Field Sampling Procedures Manual; Ontario Ministry of Environment and Energy Standards Development Branch. "Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario Version 1.1". December, 1996; and, Ontario Ministry of Environment Regulation 153/04 as amended by Ontario Regulation 511/09, 2011.

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ATTACHMENTS

Attachment A: Soil Boring Log Template

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll Environ for logging geologic information gathered from soil borings through unconsolidated materials[1]; and completing field logs as part of environmental field investigations. Soil logs serve to document soil types, field instrument measurements, field observations and field test results. Soil types and properties may vary at a site and accurate soil(s) identification and geologic logging is essential to the successful completion of projects. Detailed soil boring logs are critical to developing accurate conceptual site models to support characterization of the nature and extent of contamination, performing hydrogeological modeling, conducting site specific risk evaluations, evaluating the feasibility of remedial alternatives, and/or preparing remedial design specifications.

This FGD provides guidelines for geologically logging soils associated with typical field activities and projects. It should be understood that, more specific soil boring records, including those defined in state-specific or regulatory program-specific guidelines, requirements or procedures, may be applicable for certain projects. Specific requirements for these types of records or activities will be reviewed by the Ramboll Environ Principal-in-Charge / Project Director (PIC) and Project Manager (PM) and any additional requirements will be defined in a project-specific Work Plan, sampling plans and/or FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans but rather a general reference for developing project specific requirements. In addition, PICs and PMs are encouraged to provide additional direction or training to junior scientists and engineers for the implementation of the procedures outlined in this FGD.

It should be noted that this FGD does not supersede Ramboll Environ Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail.

2. EQUIPMENT / MATERIALS

A general checklist of equipment and materials that may be required for logging soil borings is provided below. This checklist includes an overall summary of general equipment typically required for documenting soil boreholes and should not be considered an exhaustive compilation. Additional equipment may be specified in the project-specific work plan, other referenced FGDs and/or the HASP.

- Field notebook and all-weather pens or permanent as outlined in **FGD 1.01** (Field Notes and Records).

[1] Unconsolidated materials refers to natural soils, fill, and unconsolidated deposits below the soil horizon. Throughout this FGD references to soils should be understood as any unconsolidated material encountered in the subsurface during boring activities.

- Field log forms (preferably produced on *Rite in the Rain*® water-resistant paper):
  - Blank Field Boring Log form (a comprehensive example is provided as **Attachment A**).
  - Blank Field Well Completion Log form (if required).
- Geotechnical Gauge (as manufactured by W. F. McCollough or equivalent) as outlined on **FGD 5.01** (Soil Classification) and **FGD 5.17** (Rock Classification).
- Color chart, as outlined on **FGD 5.01** (Soil and Rock Classification) and **FGD 5.17** (Rock Classification).
- Spatula or other instrument for splitting soil cores.
- Measuring tape or ruler.
- Plastic Sheeting to go under the cores while logging.
- Decontamination supplies.
- Digital Camera.
- Clipboard.

Based on the field activity and project, the following also may be needed:

- Field screening equipment (as required by Work Plan and/or HASP).
- Electronic water level indicator or interface probe.
- A portable table or other stable working surface.
- Duct tape to secure plastic sheeting to table.
- Stacking sieves (as required by Work Plan).
- Time keeping device.
- Water Spray bottle (to wet the soil if needed and/or wipe down surfaces).
- Paper towels.
- Corrugated roofing plastic sheet.
- Zip lock bags (used for PID readings).

3. REFERENCED GUIDANCE DOCUMENTS

The following FGDs are related to this FGD and should be referenced, as needed:

- **FGD 1.01**, Field Notes and Records.
- **FGD 1.02**, Sample Handling, Shipping and Chain of Custody.
- **FGD 1.03**, Data Management.
- **FGD 1.04**, Documenting Sampling Locations.
- **FGD 2.02**, Site Preparation, Inspection and Housekeeping.

- **FGD 4.01**, Field Screening - Combustible Gas.
- **FGD 4.02**, Field Screening - Volatile Gas.
- **FGD 4.03**, Field Screening - Landfill Gas.
- **FGD 4.06**, Equipment Calibration.
- **FGD 5.01**, Soil Classification.
- **FGD 5.02**, Subsurface Soil Sampling - Test Pits and Excavations.
- **FGD 5.03**, Soil Screening.
- **FGD 5.04**, Surface Soil Sampling.
- **FGD 5.07**, Subsurface Soil Sampling – Geoprobe®.
- **FGD 5.08**, Subsurface Soil Sampling - Split Spoon and Shelby Tube.
- **FGD 5.14**, Subsurface Soil Sampling - Thin Wall Corer.
- **FGD 5.15**, Stockpile Sampling.
- **FGD 5.17**, Rock Classification.
- **FGD 6.01**, Permanent Overburden Well Installation.
- **FGD 6.05**, Permanent Bedrock Well Installation.
- **FGD 6.06**, Temporary Overburden Well Installation and Sampling.
- **FGD 6.15**, Well Construction Record.
- **FGD 8.01**, Sediment Sampling.
- **FGD 8.02**, Grain Size Determination for Sediment Samples in the Field.
- **FGD 9.02**, Installation of Subslab Sampling Points.
- **FGD 9.03**, Installation of Soil Gas Sampling Points.
- **FGD 14.01**, Sampling Equipment Decontamination.
- **FGD 15.01**, Waste Handling.

The list above is not intended to be all inclusive. Other FGDs and Standard Practice Instruction (SPI) may need to be referenced based on the specific requirements of the site-specific sampling plan (e.g., field screening FGDs, FGDs for sampling of other media, etc.).

4. PROCEDURES

4.1 General Information

During borehole drilling, information regarding all activities related to the soil boring should be recorded in the Field Notebook or on a Field Boring Log form (refer to example provided as **Attachment A**). The Field Notes or Field Boring Log form should be populated concurrently with the soil borehole drilling activities, and the person completing the log should pay close attention to the drilling activities. The following guidelines should be considered when recording information:

- Pertinent information will be recorded in the field notebook or on the Field Boring Log form for each borehole and will include the information specified in **Section 4.2** of this FGD.
- Where applicable, field personnel should indicate in the field log book and on the Soil Boring Log form if the borehole is completed as a monitoring well, soil gas probe, or if it is backfilled and abandoned (refer to the corresponding FGD for additional information and construction details to be recorded).
- Borehole drilling activities may also require that additional forms, such as a Field Well Completion Log form (refer to **FGD 6.15**, Well Construction Record), or equipment calibration log forms (refer to field screening FGDs), also be completed. Alternatively, based on project-specific requirements, information may be recorded in the project-specific Field Logbook, as long as all information identified in the form(s) is recorded in the logbook (refer to **FGD 1.01**, Field Notes and Records).
- Any free forms or field sketches, such as Field Boring Log form, or borehole location sketches, should be appropriately referenced in the field notebook (refer to **FGD 1.01**, Field Notes and Records) and collectively, should present a complete record of the field activities observed. Thus, these records should be thorough enough to enable reviewers to reconstruct the field activities, rationales for decisions made, and observations.
- Records should be recorded in accordance with **FGD 1.01**, Field Notes and Records.
- Soil samples should be collected for field logging in accordance with the developed project-specific Work Plan and the following FGDs:
  - **FGD 5.02**, Subsurface Soil Sampling - Test Pits and Excavations.
  - **FGD 5.04**, Surface Soil Sampling.
  - **FGD 5.07**, Subsurface Soil Sampling - Geoprobe®.
  - **FGD 5.08**, Subsurface Soil Sampling - Split Spoon and Shelby Tube.
  - **FGD 5.14**, Subsurface Soil Sampling - Thin Wall Corer.
  - **FGD 5.15**, Stockpile Sampling.
  - **FGD 8.01**, Sediment Sampling.
  - **FGD 8.02**, Grain Size Determination for Sediment Samples in the Field.
  - **FGD 14.01**, Sampling Equipment Decontamination.
  - **FGD 15.01**, Waste Handling.

4.2 Requirements for Soil Boring Log Form

The Soil Boring Log summarizes and presents all data gathered during lithological sampling of soils and is a critical component of the overall record of an investigation. Field personnel should be aware of and record in the field log book or on the Soil Boring Log form (refer to example provided as **Attachment A**) the following general soil boring details:

- Soil boring unique identification number (ID).
- Name of Ramboll Environ oversight personnel completing the log.
- PIC or PM of the project.
- Project number.
- Drilling contractor and master/head driller's name.
- Date and the start and end time of drilling.
- A description of the boring location including a map depicting the boring location relative to fixed site features (e.g., building corners, utility poles, gates/fences, etc.).
- Drilling method used (e.g., hand auger, hollow stem auger, air rotary, mud rotary, direct-push [i.e., Geoprobe]) and nominal outside diameter(s) of drill string equipment.
- Drilling equipment (i.e., rig make and model).
- Borehole diameter. Note that some boreholes will have "telescoping" intervals of larger or smaller diameter (e.g., if installing a double-cased well to seal off specific water-bearing zones).
- Detailed description of ground surface conditions (e.g., 4 inches of concrete overlying 6 inches of ¾ inch stone).
- The type of soil sampling performed (e.g., split spoon, Shelby tube, direct-push) and the length of the sampler device.
- Intervals over which soil cores are being collected (e.g., continuous soil cores, one split spoon every 5 feet, etc.).
- Hammer weight and drop, if collecting split spoon samples.
- Total borehole depth (note the depth of the borehole before and after backfilling).
- Depth at which water is first encountered during drilling and any subsequent water-bearing zones.
- Depth and intervals of any drilling refusal or cavities.
- Description of fluids added during drilling and associated quantities.
- Depth of water at completion of soil boring.
- Depth of boring after cave-in (if applicable).
- Method and materials used to abandon, backfill or convert the boring to a well or monitoring probe.
- A description of any problems encountered during the drilling process and corrective actions, as applicable. For example, record if borings must be relocated during the site

inspection due to the presence of subsurface utilities or other obstructions, or if borings must be off-set to an alternative, pre-cleared location due to refusal. This information should also be recorded in the field notebook.

- A description of any notable features encountered during drilling, including depth or depth range encountered below ground surface. This information may include changes in characteristics indicated by the driller (e.g., drill chatter, softer drilling, more difficult drilling, loss of water).

For each sampling interval, field personnel should be aware of and record in the field log book or on the Soil Boring Log form the following details:

- Blow counts (when drilling and/or sampling methods allow). Record the number of blow counts per six-inch interval of the Standard Penetration Test (SPT) to provide an estimate of relative density of the penetrated material. Blow counts shall be recorded for each six-inch interval (i.e. four measurements for each 2-foot interval or three measurements for each 18-inch interval). The final log should include the N- value (the sum of the second and third blow counts over a 2-foot interval). If the blows do not represent SPT data (for example, if a 3-inch diameter split spoon is used in lieu of the standard 2-inch diameter split-spoon), this should be noted. Blow counts should only be collected in accordance with the methods set forth in ASTM D1586, which specifies a 30-inch drop of a 140 pound hammer using a 2-inch diameter sampler.
- Soil recovery, recorded as the portion of sample (in feet or inches) that is recovered out of the entire length of the coring tool utilized. The recovery must be recorded for each advanced interval and should be correlated to the size of the sample apparatus. For example, if a split-spoon sampler was driven 24 inches, but only 8 inches of material was found inside the sampler, the amount of recovery would be recorded as 8”/24”.
- Sample designation and sampling depth interval in accordance with **FGD 1.02** (Sample Handling, Shipping and Chain of Custody).
- Description of the materials sampling in accordance with **FGD 5.01** (Soil Classification) and **FGD 5.17** (Rock Classification) if appropriate. The log should clearly indicate that “Unless otherwise noted, soil classifications are based on field observations and have not been confirmed by laboratory testing.”
- Depth below ground surface corresponding to any changes in stratigraphy or notable features. When describing underlying samples, use the following where applicable:
  - (same) … if underlying materials are identical to prior sampling interval.
  - (same with ____) … when soil classification remains constant, but specific qualifiers (e.g., organics, no glass) are no longer applicable.
  - (grades to _____) when soil classification remains constant, but there is a change in color, moisture content, or relative density or consistency.
- Field screening results (e.g., photoionization detector screening), if performed. If the collection of vapor readings or other field parameters is required in the Work Plan, refer to the Work Plan for appropriate intervals over which measurements should be collected and the pertinent field screening FGDs.

- Field test results (e.g., portable chemical-specific test kits, pocket penetrometer or pocket torvane strength tests), if performed. If field testing is required in the Work Plan, refer to the pertinent field testing FGDs.
- Identification of samples submitted for laboratory analysis, as may be required in the Work Plan.
- Identification of samples sent for geotechnical testing or supplemental analysis of physical properties, as may be required in the Work Plan.
- Record of whether debris, or large particle sizes were encountered in collection of or excluded from any sample including description of those material.
- Difficulties encountered during the sample collection process, as applicable (e.g., caving of borehole, subsurface obstructions, equipment failure).

Where applicable, field personnel should record in the field notebook or on the Soil Boring Log form the following additional information:

- Whether the borehole is logged using soil cuttings descriptions rather than whole samples.
- Whether information from an adjacent boring log is used to identify depth intervals for sampling. In such case, reference should be made to the adjacent boring log.
- Whether a boring was logged based on a collocated boring. For example, if two borings are adjacent and one was formally logged and the other not formally logged (or logged in less detail) the name of the more detailed boring log should be referenced on the less detailed boring log (e.g. boring log B-1S may include the description: “Boring B-1S advanced without logging soils, adjacent boring B-1D logged”).
- Whether the borehole remained open overnight and the precautions taken to secure the borehole and the overall area.
- Time, date, and type of materials used to backfill the borehole.

If appropriate and/or required by the project, data recorded in a field log book or field Soil Boring Log form should be transferred to a final Soil Boring Log form within two weeks after the boring was drilled. Where required, a Professional Geologist and/or Professional Engineer should review the soil boring log before its finalized.

4.3 Additional Soil Boring Documentation

Upon completion of the soil boring, its location relative to fixed and reproducible landmarks should be defined in the field book or site map. A detailed dimensioned sketch should be prepared in accordance with **FGD 1.04** (Documenting Sampling Locations).

In addition to documenting field activities in a logbook, photographs (if allowed) should be taken to document each soil sample, and details of each photograph (file name, date, time, direction, and subject) should be recorded in accordance with **FGD 1.01** (Field Notes and Records).

5. PRECAUTIONS AND OTHER CONSIDERATIONS

Soil boring log preparation requires recording sufficiently detailed information throughout the borehole advancement process. Certain precautions should be taken to ensure safety while recording the required information.

- Proper personal protective equipment (PPE) must be worn and subsurface materials handled in accordance with the project HASP.
- If soil borings are discontinuous (e.g., two foot samples at five foot intervals) and differing materials are encountered in consecutive samples, approximate the transition from one layer to another by:
  - Discussing with the driller any noted changes in the advancement of the soil boring which would allow an approximation of the transition depth.
  - Estimating the transition point as the midpoint between sampling intervals.

  In either case, the approximated transition depth/elevation should be shown with a dashed rather than a solid line in the boring log to convey uncertainty in the boundary between the strata.
- It is not uncommon for sample recoveries to represent a fraction of the sampling interval. In those instances there should be some consideration to the materials immediately above and below the sampling interval, the presence of coarse grained materials, potential sloughing within the borehole, and/or potential obstructions in the sampling device which may have contributed to the reduced recovery. If additional guidance is needed, discuss with the PM and/or PIC the specific procedures to be followed in logging the specific sampling interval.
- If samples for analysis are to be collected, the field soil log should be prepared after samples collection to minimize losses due to volatilization or cross-contamination due to excessive handling of the soil.

6. RECORDKEEPING

This FGD specifically pertains to recordkeeping for soil boring drilling projects. In addition to the soil boring log preparation guidelines provided above, all information should be recorded in accordance with **FGD 1.01** (Field Notes and Records). In general, draft field forms should be scanned and saved electronically immediately following the completion of the field activities. Following review of draft documents by the PIC and/or PM, field documentation forms should be finalized and final versions may be included in project reports, if necessary. Draft and final versions of the boring logs should be managed in accordance with Ramboll Environ's Document Retention Policy and project-specific requirements, and a copy should be maintained in the Project File.

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ATTACHMENT A
SOIL BORING LOG TEMPLATE

RAMBOLL ENVIRON

FIELD SOIL BORING LOG enter ID

PROJECT NAME: _____ FIELD PERSON: _____

PROJECT NUMBER: _____ PROJECT MANAGER: _____

PROJECT LOCATION: _____ DATE: _____

BORING LOCATION MAP

DRILLING CONTRACTOR:

DRILLER:

RIG TYPE AND DRILLING METHOD :

OTHER EQUIPMENT:

SAMPLING METHODS:

TOTAL DEPTH:	BOREHOLE DIAMETER:	
START TIME:	STOP TIME: *(Date if Necessary)*	
WATER DEPTH:	SURFACE MATERIAL:	
BACKFILL DATE/TIME:	MATERIAL:	BY:

COMMENTS:

SAMPLE DEPTH	SAMPLER TYPE	BLOW COUNTS	RECOVERY (FEET/FEET)	PID/FID (PPM)	OTHER (Specify):	SAMPLE NAME	TIME	DEPTH IN FEET	USGS SYMBOL/ CONTACT	DEPTH IN FEET	SAMPLE DESCRIPTION:
								1			
								2			
								3			
								4			
								5			
								6			
								7			
								8			
								9			
								10			

RAMBOLL ENVIRON

FIELD SOIL BORING LOG enter ID
(Continued)

SAMPLE DEPTH	SAMPLER TYPE	BLOWS IN 6 INCHES	RECOVERY (FEET/FEET)	PID/FID (PPM))	OTHER (Specify):	SAMPLE NAME	TIME	DEPTH IN FEET	USGS SYMBOL/ CONTACT	DEPTH IN FEET	BORING ID: / JOB NAME/NUMBER: / SAMPLE DESCRIPTION:
								1			
								2			
								3			
								4			
								5			
								6			
								7			
								8			
								9			
								0			
								1			
								2			
								3			
								4			
								5			
								6			
								7			
								8			
								9			
								0			

Unless otherwise noted, soil classifications are based on field observations and have not been confirmed by laboratory testing

FIELD GUIDANCE DOCUMENT NO. 6.02

GROUNDWATER PURGING AND SAMPLING

RAMBOLL ENVIRON

FIELD GUIDANCE DOCUMENT NO. 6.02

GROUNDWATER PURGING AND SAMPLING

Prepared By:	Will Larrison
Peer Reviewed By:	Jose Sananes David Lis David Heidlauf Ryan Keeler Seema Turner Valerie Turner David Heinze Carol Serlin Clem Ockay Nestor Soler
Approved By:	J. Mark Nielsen
Applicable To:	All North American offices
Effective Date:	May 23, 2016
Revision Notes:	
Documents Used as Reference During Preparation:	US EPA Region 4, Science and Ecosystem Support Division, March 6, 2013. *Groundwater Sampling*, SESDPROC-301-R3. US EPA Region 9 Laboratory, September 2004. *Field Sampling Guidance Document #1220 – Groundwater Well Sampling*. US EPA OSWER, *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers*, EPA 542-S-02-001, May 2002. NJDEP, August 2005. *Field Sampling Procedures Manual*. USGS, 2006. *National Field Manual for the Collection of Water-Quality Data*, Chapter 4.

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ATTACHMENTS

Attachment A: Groundwater Purging and Sampling Equipment

Attachment B: Groundwater Purging Sheet

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll Environ for the collection of groundwater samples for laboratory analysis following well purging (other than low-flow sampling techniques which are described in **FGD 6.20**, Groundwater Sampling – Low Flow). Groundwater sampling is conducted to characterize the quality of groundwater as part of environmental investigations (e.g., investigation of potential contaminant sources, delineation of contamination, evaluation of migration pathways), remedial actions and/or monitoring programs. To ensure that groundwater samples collected are representative of the groundwater zone being investigated, samples should only be collected after appropriate purging and field parameter monitoring has been conducted. Groundwater purging and sample collection using bladder pumps is preferable (refer to **Attachment A**), as the use of bailers or vacuum systems can result in excessive disturbance to the water column in the well and potentially affect sample quality. Nonetheless, in certain cases (e.g., for collection of groundwater samples for VOC analysis when a peristaltic pump is used for groundwater sampling, when the water column is small, or when the saturated zone is very deep), groundwater purging and sampling could require the use of a bailer.

Although this FGD provides guidelines for collection of groundwater samples associated with typical sampling activities, it should be understood that for certain projects more specific sampling procedures, including site- or state-specific or regulatory program-specific guidelines, requirements or procedures, may be applicable. Specific requirements for these types of projects and activities will be reviewed by the Ramboll Environ Principal-in-Charge / Project Director (PIC) and/or Project Manager (PM) and any additional requirements will be defined in a project-specific Work Plan, Sampling Plan and/or FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans, but rather a general reference for developing project-specific requirements.

It should be noted that this FGD does not supersede Ramboll Environ Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. All Ramboll Environ employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP followed by procedures recommended in this FGD. The Ramboll Environ PIC and PM shall ensure that all project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information are maintained in the project file for the duration of the project. The signatures of the PIC and PM indicate approval of the methods and precautions outlined in the HASP.

2. EQUIPMENT/MATERIALS

A general checklist of equipment that may be required for typical groundwater well purging and sampling is provided below. Additional equipment may be specified in the project-specific HASP and/or Field Sampling Plan. This checklist includes an overall summary of general equipment typically required for groundwater sampling but should not be considered exhaustive. More specialized sampling equipment may be required depending on project-

specific preferences. Ramboll Environ oversight personnel should understand the equipment and materials that are required for groundwater sampling.

1. General Groundwater Sampling Equipment Checklist

   – Pump and associated equipment (e.g., generator, batteries, control box, compressor, tubing, CO2 or nitrogen compressed gas cylinders);

   – Bailers (if needed) constructed of material (e.g., fluorocarbon resin, Teflon®, stainless steel, HDPE, or PVC) which minimizes potential chemical alteration of groundwater or may cause a loss of analytes via sorption;

   – Water quality meter with flow-through cell that, at a minimum, measures temperature, pH, dissolved oxygen (DO), oxygen reduction potential (ORP), and specific electric conductance, and associated manuals. Turbidity measurements can be made using a separate turbidity meter;

   – Measuring container (e.g., one-gallon plastic water jug, graduated measuring cup or graduated cylinder);

   – Plastic sheeting;

   – 5-gallon buckets, preferably with graduations for accurate purge volume estimation;

   – Dedicated suspension line or tether constructed of material which minimizes interactions or alterations when in contact with groundwater or which may cause loss of analytes via sorption (e.g., poly twine, nylon string, stainless-steel, Teflon-coated stainless-steel wire, etc.) - for lowering and raising pump/bailer (pump tubing does not constitute a dedicated suspension line and should not be used for lowering and raising pump/bailer);

   – Electronic water level indicator (refer to **FGD 6.04**, Groundwater and Free Product Level Measurements);

   – Trash bags - for disposal of gloves, tubing and any other non-hazardous waste generated during sampling (refer to **FGD 15.01**, Waste Handling);

   – 55-gallon steel drums, Department of Transportation-rated (for legal waste hauling), or other appropriate waste container – for disposal of any Investigation Derived Wastes (IDW) and/or decontamination wastes (refer to **FGD 15.01**, Waste Handling);

   – Labeling materials for IDW containers as outlined in **FGD 15.01** (Waste Handling);

   – Personal Protective Equipment (PPE) and field screening equipment in accordance with the site-specific HASP;

   – Site information (e.g., maps, contact numbers, previous field logs);

   – Well construction specifications and diagrams; and

   – Field notebook and all-weather or permanent pens as outlined in **FGD 1.01** (Field Notes and Records).

2. Project or Task Specific Groundwater Sampling Equipment Checklist
   - Bucket, water, and Liquinox® (or Alconox) – used for the decontamination of sampling and monitoring equipment (refer to **FGD 14.01**, Sampling Equipment Decontamination);
   - Cable ties;
   - Well keys;
   - Sample containers (appropriate for various analysis to be performed);
   - Sample shipment containers and ancillary materials (refer to **FGD 1.02**, Sample Handling, Shipping and Chain of Custody);
   - Sample labels and clear tape;
   - Chain of custody forms (refer to **FGD 1.02**, Sample Handling, Shipping and Chain of Custody); and
   - Field measurement equipment/kits for confirmation of parameters (temperature, dissolved oxygen, Fe 2+, etc.).

3. Additional Suggested Equipment
   - Tool set: socket set, socket wrench, screw driver, multi-tool, tubing cutters, “turkey baster” and/or cup for water removal from flush mounted well vaults;
   - Spare/replacement parts: gripper plug/well cap, well lid bolts;
   - Road and site maps;
   - Mobile phone; and
   - Camera and extra batteries.

A description of groundwater purging and sampling equipment is provided in **Attachment A**.

3. REFERENCED GUIDANCE DOCUMENTS

The following FGDs are related to this FGD and should be reviewed prior to mobilization, as needed:

- **FGD 1.01**, Field Notes and Records.
- **FGD 1.02**, Sample Handling, Shipping and Chain of Custody.
- **FGD 1.03**, Analytical Data Management.
- **FGD 1.05**, Field Quality Control Samples.
- **FGD 2.02**, Site Preparation, Inspection and Housekeeping.
- **FGD 4.04**, Field Screening - Water Quality.
- **FGD 4.06**, Equipment Calibration.
- **FGD 6.04**, Groundwater and Free Product Level Measurements.

- **FGD 6.20**, Groundwater Sampling - Low Flow Purge.
- **FGD 14.01**, Sampling Equipment Decontamination.
- **FGD 15.01**, Waste Handling.

The list above is not intended to be all inclusive. Other FGDs and Standard Practice Instruction (SPIs) may need to be referenced based on the specific requirements of the site-specific Work Plan/Field Sampling Plan (e.g., field screening FGDs, FGDs for sampling of other media, etc.).

4. PROCEDURES

4.1 Planning and Design Considerations

All significant sampling strategy decisions will be approved by the PIC and/or PM before the initiation of associated field activities. The Work Plan/Field Sampling Plan will be designed for the collection of quality data to meet the goals of the study/monitoring program and will include the number of samples, locations, depths, number of sampling sites, analyses and analyte detection limits to be performed on each sample as well as quality control/quality assurance samples. The Work Plan/Field Sampling Plan will generally provide for some discretion in the field depending on conditions encountered; however, any significant departure from prescribed sampling activities should be approved by the PIC and/or PM.

When planning a groundwater sampling event for a well that will be purged, the following should be considered:

- *Purge Method*. Purging is the process of removing potentially stagnant water from a well immediately prior to sampling and allowing water from the surrounding formation that is representative of actual aquifer conditions to enter the well. This process involves the removal of several well/casing volumes of water by use of pumps or bailers. The specific purging/sampling approach to be used depends on site-specific conditions, project objectives, and/or regulatory requirements.
- *Bailer/Pump Choice*. The equipment needed for groundwater purging/sample collection can vary greatly depending on specific site conditions and project objectives. As such, bailer/pump selection should take into consideration a variety of well characteristics, including but not limited to: depth of well; diameter of well; depth to water; analytes of interest; expected recharge rate of well; and sampling objectives. For example, a peristaltic pump is not recommended for collection of groundwater samples for VOC analysis as it is a negative pressure pump. A detailed list of bailer/pump options and their advantages/limitations is provided on **Table 1** in **Attachment A**.
- *Sampling Interval*. Before conducting groundwater sampling, an appropriate well sample depth interval must be determined. Boring and well construction logs, along with historical sample collection depth and groundwater elevation data (if available), should be reviewed to determine the screen interval and relative water column status of each targeted well. For example, if the screen interval is fully submerged, the midpoint of the well screen would be considered the most representative sample depth. If the water elevation consistently falls below the top of the well screen, the midpoint between the

groundwater surface elevation and the bottom of the well screen should generally be targeted as the representative sample depth. This can also be calculated during the sampling event based on current groundwater elevations.

- *Other Considerations*. Additional requirements (e.g., targeted aquifer zones) may be defined in project-specific Work Plan, sampling plan and/or FGDs and, as such, may determine alternative sample depths from those provided by the guidelines set above.

4.2 Pre-Field Work Preparation Guidelines

Before initiating field activities, field staff should review and complete pertinent tasks identified in **FGD 2.02**, Site Preparation, Inspection and Housekeeping. To the extent that non-dedicated sampling equipment is to be used (e.g., submersible pumps, water level indicator, or bailer), such sampling equipment should be decontaminated between wells as described in **FGD 14.01** (Sampling Equipment Decontamination), the project-specific Work Plan/Field Sampling Plan and/or Quality Assurance Project Plan (QAPP) to minimize potential cross-contamination of samples among wells. Used dedicated sampling equipment is considered IDW and should be managed in accordance with **FGD 15.01**, Waste Handling following the sampling event.

At a minimum, the following tasks should be completed to prepare field staff for what may be expected during implementation of the work:

- Review and sign the site-specific HASP. Clean, chemical protective, dedicated gloves must always be worn when handling and using sample equipment;
- Coordinate and obtain permission for site access;
- Review project-specific Work Plan/ Field Sampling Plan/QAPP, where applicable;
- Review and discuss with the PIC and/or PM the proposed Work Plan/Field Sampling Plan or sampling strategy. Note that site geology and expected contaminants should be reviewed to determine if unpreserved bottles may be needed (e.g., anticipated effervescence due to high levels of dissolved calcium carbonate in groundwater reacting with acid preservatives);
- When contractors are used to perform the sampling or in states where sampling can only be performed by personnel licensed or certified by the State, discuss the Work Plan/Field Sampling Plan with the contractor;
- Review the standard instruction manual provided by the manufacturer of the specific equipment being used for groundwater sampling;
- Obtain the glassware/bottles in advance and check against sampling numbers to confirm that the appropriate containers and quantities are provided prior to mobilizing; and
- Ensure that all equipment/materials required to complete the work have been packed prior to travel.

In addition, prior to initiating the well sampling activities, Ramboll Environ oversight personnel should field-verify the well identity and construction against available documentation (Site Plans, Well Construction Logs, etc.). It is imperative that a positive well identification be made prior to sampling using measured total well depth, well labels, site

plans, and well construction records to ensure that the correct well is sampled (refer to **FGD 6.04**, Groundwater and Free Product Level Measurements). If total well depth is measured, proper decontamination of the water level indicator tape must be conducted before deploying the water level indicator into another well (refer to **FGD 14.01**, Sampling Equipment Decontamination).

Further, prior to the commencement of the field effort, Ramboll Environ oversight personnel should inspect, test, and/or calibrate equipment that may be used to take field measurements (refer to **FGD 4.06**, Equipment Calibration). Pre-measuring the pump suspension line and/or discharge tubing to the individualized targeted well depths and/or pre-labeling sample containers in advance of field efforts may increase productivity (refer to **FGD 1.02**, Sample Handling, Shipping and Chain of Custody). However, special care should be taken to ensure that the correct pre-labeled containers are used to collect each groundwater sample.

Unless otherwise required by the project-specific Work Plan/Field Sampling Plan, sampling should begin with monitoring wells with the lowest expected groundwater contamination and proceed systematically to monitoring wells with the highest expected groundwater contamination.

4.3 General Groundwater Purging and Sampling Guidelines

Groundwater samples are generally collected from monitoring wells, piezometers, or boreholes using pumps or bailers. A description of groundwater sampling equipment is provided in **Attachment A**. The following provides a general recommended list of practices for groundwater sampling activities:

- Where applicable, contact the identified key site personnel upon arrival to the Site and assess proposed work areas.
- All wells to be sampled should be inspected for damage, access constraints, and/or vehicle traffic proximate to the well location.
- Although equipment should be decontaminated between uses, to further limit potential cross-contamination between wells, perform measurements from least to most contaminated locations.
- Lay polyethylene sheeting around the well for placement of monitoring and sampling equipment and contain any accidental groundwater spilled during purging or sampling.
- Remove the well cover or equivalent protective casing cover (refer to **FGD 6.04**, Groundwater and Free Product Measurements) and measure gas concentrations in accordance with the applicable manufacturer instructions and field screening FGDs (e.g., **FGD 4.01** - Field Screening - Combustible Gas, **FGD 4.02** - Field Screening - Volatile Gas, **FGD 4.03** - Field Screening - Landfill Gas). Record field screening readings in field book. The necessity and methodology to conduct field screening should be detailed in the site-specific HASP and sampling plan.
- As detailed in **FGD 6.04**, Groundwater and Free Product Measurements, record the condition of the well, noting any damage to the well, plug, and/or protective casing, and record any evidence of pressure (positive or negative).

- Complete all depth-to-water or free product measurements prior to any planned groundwater and/or product withdrawals, sampling or disturbance of groundwater activities unless otherwise specified in the Work Plan/Field Sampling Plan (refer to **FGD 6.04**, Groundwater and Free Product Measurements).
- If using a bailer for groundwater sampling:
  - Calculate the well volume in gallons (V_w) using the following equation:

$$V_w = 7.48(\pi \frac{d_w^2}{4} \mathrm{h}_w)$$

    Where:

    d_w is the well diameter (feet)
    h_w is the height of water in the well (feet)

    In general, the volume of a 2-inch diameter well is 0.163 gallons per foot and the volume of a 4-inch diameter well is 0.653 gal/ft.

  - To prepare the bailer suspension line, measure the correct amount needed such that the bailer intake is positioned at the target depth in the well. The measurements should account for the additional length needed at ground surface to appropriately anchor the suspension line. If the suspension line and tubing were premeasured in advance of field efforts, make any necessary alterations based on field observations (e.g., unanticipated groundwater elevations).
  - Secure the tether to the eye on the upper side of the bailer.
  - Lower the bailer slowly into the well to minimize sample agitation associated with degassing, aeration, and turbidity and to the extent possible, avoid hitting the sides or bottom of the well. The bailer will fill with water when lowered into the well and should only be submerged to the depth necessary for bailer intake to be positioned at target sampling depth.
  - When the bailer is filled, slowly raise the bailer, minimizing contact with the sides of the well to the extent possible. The bailer will self-seal when raised back out of the well.
  - When transferring the sample from a bailer to a container, use a bottom emptying device to allow the water to slowly drain from the bailer. The sample should be allowed to run down the sides of the container to avoid excessive agitation of the sample.
- If using a pump for groundwater sampling
  - In the case that a dedicated pump is not used for groundwater sampling:
    - Prepare the pump suspension line and discharge tubing, measure the correct amount needed such that the pump intake or bottom of discharge tubing rests at the target depth in the well. The measurements should account for the additional length needed at ground surface to appropriately anchor the suspension line and connect discharge tubing to water quality monitoring equipment. If the suspension line and tubing were premeasured or ordered to

premeasured lengths in advance of field efforts, make any necessary alterations based on field observations (e.g., unanticipated groundwater elevations). Assemble the pump, suspension line, and tubing. Inspect all sampling equipment prior to deployment, making certain that all connections are secure and equipment is in working condition. Troubleshooting is generally easier if the pump and tubing assembly are inspected prior to deployment. If not using dedicated sampling equipment, ensure all materials are properly decontaminated prior to conducting sampling (refer to **FGD 14.01**, Sampling Equipment Decontamination).

- Slowly lower the assembly into the well using the suspension line to achieve minimal water column disturbance until the location of the tubing or pump intake reaches the predetermined depth within the well. Anchor the assembly in place by securing the suspension line at the surface and/or clamping the tubing in place via spring clamp.
- Measure and record the depth to water following insertion of the pump and tubing assembly.

– Once the pump (whether a dedicated pump or not) is ready for use, allow the water level to return to its static level prior to initiating purging.

• Calculate the well volume in gallons (V_w) using the following equation:

$$V_w = 7.48\left(\pi\frac{d_w^2}{4}\mathrm{h}_w\right)$$

Where:

d_w is the well diameter (feet)
h_w is the height of water in the well (feet)

In general, the volume of a 2-inch diameter well is 0.16 gallons per foot and the volume of a 4-inch diameter well is 0.65 gal/ft.

– Assemble the water quality meter sensor probe and flow through cell in accordance with the manufacturer's specifications.

– Carefully connect the pump's discharge tubing to the influent of the flow-through cell of the water quality meter and connect a section of clean tubing to the effluent of the cell. The influent and effluent connections to the flow-through cell are unique and based on each meter's design; orientation of flow matters and influent/effluent ports should be marked on the flow cell.

– When water fills the cell, check for leaks and make the necessary adjustments. If water is particularly turbid at the beginning of the purge it can be helpful to disassemble the water quality meter sensor probe and flow through cell and rinse them with DI water to remove any residual particulates once the turbidity decreases.

• For the standard purging method, evacuate at least three well volumes and until the water quality parameters specified (e.g., pH, DO, ORP, temperature, specific conductance, and turbidity) in the project-specific Work Plan, Field Sampling Plan, QAPP and/or FGDs developed based on state-specific or regulatory program-specific guidelines,

requirements or procedures have stabilized. In the absence of specific stabilization guidance, the following parameters or any combination thereof established by USEPA should be monitored to determine when well stability has been achieved.

pH	± 0.1 unit
Specific Conductance	± 3%
Temperature	[See Note 1]
Dissolved Oxygen	± 0.3 mg/L
Turbidity	± 10% (when turbidity is greater than 10 NTUs)
ORP/Eh	± 10 millivolts

Note 1: Temperature generally tends to stabilize rapidly and is considered a relatively insensitive indicator of stability. Nonetheless, temperature stability can be defined as ± 3%.

- Collect measurements approximately once every 5 minutes or a period defined by the time it takes for purge water to adequately replace the water quality meter's flow-through cell.
  - If the purge rate decreases, the time required for purge water replacement will increase.
  - It is generally accepted that when the measurements of the monitored parameters fall within the stated range for three consecutive readings, chemical parameter stabilization has been achieved.
  - If the anticipated "third" reading of any individual parameter does not fall within the stated range, then the process to achieve three consecutive readings for that parameter must be restarted.
- In some situations, even with slow purge rates, a well may be pumped or bailed dry. In these situations, under certain regulatory programs this constitutes an adequate purge and the well can be sampled following sufficient recovery (enough volume to allow filling of all sample containers). In such cases, it is not necessary that the well be evacuated three times or that chemical parameters stabilize before it is sampled. Nonetheless, the pH, specific conductance, temperature, and turbidity should be measured and recorded during collection of the sample from the recovered volume. These data would serve as the field measurements of record for the sampling event.
- If flow rates are to be measured when using pump and a flowmeter is not available, the discharge from the effluent of the flow-through cell could be collected in a container of known volume (i.e. one gallon plastic water jug or a graduated cylinder) and the time to fill the container noted. When flow rate measurements are complete, redirect the discharge as detailed above and dispose the contents of the graduated cylinder into 5-gallon buckets or directly into 55-gallon drums.
- Containerize purge water in accordance with **FGD 15.01**, Waste Handling. The discharge tubing should be secured such that all purge water is collected in 5-gallon buckets or directly into labeled Department of Transportation (DOT)-rated 55-gallon drums, depending on site conditions and purge volumes.

- Upon purge completion, reduce the pumping rate and disconnect the water quality meter from the discharge tubing.
- Wells should be sampled as soon as possible after purging. Collect the groundwater sample from the primary discharge tubing connected directly to the pump with no remaining purging appurtenances (e.g., fittings, flow diverters, flow-through cell). Laboratory-supplied sample containers should be filled with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside wall of the container. Record the sample time on the sample bottle-ware and in the field notebook (refer to **FGD 1.01**, Field Records and Notes). Regarding sample collection note that:
  - The ideal order of sampling (from first to last) should be VOCs, SVOCs, TPH, pesticides/herbicides, PCBs, metals, general chemistry analytes (e.g., TDS, TSS, nitrate, etc.), and filtered metals, although this order may be modified based on pump characteristics and/or site-specific or well-specific considerations (see below).
  - When collecting VOC samples, the volatile organic analysis (VOA) vials should be filled slowly to minimize agitation. Upon filling, a meniscus should be present at the top of the vial and absolutely no bubbles or headspace should be present in the vial after it is capped. After the cap is securely tightened, the vial should be inverted and tapped on the palm of one hand to see if any undetected bubbles are dislodged. If a bubble or bubbles are present, the vial should be topped off using a minimal amount of sample to re-establish the meniscus.
  - Samples collected for dissolved gases or VOC analyses must ensure that the tubing is completely full of groundwater to prevent aeration. If groundwater contains air bubbles throughout the entire purge, consult pump manual to remedy pumping issues and discuss with PIC and/or PM.
  - Filtered (dissolved) samples should be collected after all other samples are collected using the pump.
  - If using a peristaltic pump, collect a groundwater sample for VOC analysis using a bailer as described above after groundwater sampling for all other parameters has been completed.
- Effervescence (e.g., high levels of dissolved calcium carbonate in groundwater reacting with acid preservatives) observed during filling of the laboratory supplied containers should be recorded in the field notebook. Discuss with the PIC and/or PM whether samples should be collected in unpreserved containers and include a notation in the chain-of-custody.
- If a field-filtered (dissolved) sample is to be collected, an inline filter is fitted at the end of the discharge tubing and the sample is collected after the filter. The inline filter must first be flushed in accordance with manufacturer's recommendations. If there are no recommendations for flushing, a minimum of 0.5 to 1.0 liter of groundwater from the monitoring well must pass through the filter prior to sampling.
  - Groundwater filter cartridges are dedicated sampling equipment and are thus considered IDW and should be managed accordingly. A new cartridge must be used at each sampling location.

  - If the filter becomes clogged or groundwater flow is too slow, remove and replace with a new filter cartridge.

- Withdraw the sampling equipment from the well, replace the well cap, and re-secure the well. For non-dedicated equipment that has come in contact with groundwater, following sampling completion, remove the equipment from the monitoring well and decontaminate in accordance with **FGD 14.01**, Sampling Equipment Decontamination. For dedicated equipment that has come in contact with groundwater, disconnect from the non-dedicated equipment and manage as IDW.
- Record in the field book or appropriate field forms any abnormal conditions within the well (e.g., evidence of blockage, root growth into the well casing, separated casing sections, etc.). Inform the PIC or PM so necessary maintenance, redevelopment or repairs are conducted before the next planned water sampling event.

4.4 Sample Containers

As outlined in **FGD 1.02** (Sample Handling, Shipping and Chain of Custody), equipment and sample containers that will come into contact with collected groundwater should be constructed of inert materials that will not affect the concentration of constituents in the water sample (i.e., glass, stainless steel or Teflon). The level of care that needs to be taken with the materials used will depend on the level and types of constituents associated with the groundwater and the quality assurance needs and study goals. This should be outlined in the project-specific Work Plan/Field Sampling Plan or QAPP.

The laboratory will provide appropriate sample containers, prefilled with preservatives appropriate for each predetermined sample analysis. The sample volume is a function of the analytical requirements and will be specified in the Work Plan/Field Sampling Plan or QAPP. Sample VOCs first to prevent loss of volatiles due to disturbance of the water and be sure to fill VOA vials to zero headspace, as described above in Section 4.3.

4.5 Sample Transport and Storage

Samples shall be handled, transported and stored to maintain structural and chemical qualities of groundwater samples. Sampling bottles shall be handled as outlined in **FGD 1.02** (Sample Handling, Shipping and Chain of Custody). All samples should be kept in an ice-filled transport container during fieldwork and covered to limit light penetration. If the cooler size allows for space between sample bottles, bubble wrap should be used to fill annular space and prevent breakage during travel. Glass bottleware should be wrapped individually in bubble wrap for further protection. If provided, pack glass sample vials in laboratory issue foam packing cartons. If shipping groundwater samples with preservatives, confirm the sample shipments, packaging, and labeling are performed in accordance with applicable DOT-requirements.

4.6 QA/QC

Quality Assurance/Quality Control (QA/QC) procedures described in the project-specific Work Plan/ Field Sampling Plan and/or QAPP must be followed throughout the purging, sample collection, processing, handling, and analysis process. In their absence, the QA/QC guidelines of **FGD 1.05** (Field Quality Control Samples) should be reviewed.

5. PRECAUTIONS AND OTHER CONSIDERATIONS

All field activities require recording sufficiently detailed information throughout the implementation of field work. However, certain precautions should be taken to ensure safety while groundwater sampling. Additionally, implementation of the work may face some difficulties.

- Some states require that only personnel licensed or certified in the State where the work is being performed perform the sampling. Therefore, State regulations and guidance governing groundwater should be consulted prior to conducting the work. In addition, local Ramboll Environ staff should be contacted for any other regional or local requirements.
- It is important to always remain alert and aware of your surroundings. Groundwater sampling could involve the use of generators and associated equipment, and is subject to hazards posed by equipment, vehicle traffic, industrial machinery, hazardous chemicals and contaminants, and/or other physical, mechanical, and chemical hazards.
- Prior to mobilization, determine the location of wells and evaluate the need for security, barricading, and/or traffic control (e.g., when wells are located on the right of way).
- At sites with certain contaminants and/or subsurface conditions, potentially toxic and/or explosive gases may accumulate at and around the well as it is being sampled. Stay upwind of the well and ensure that air monitoring is conducted and personal protective equipment is used in accordance in the site-specific HASP.
- Keep any sampler, tether, or suspension lines untangled. Use a plastic winder or spool winder to retrieve the sampler/pump to keep the line from tangling.
- When working out of sight of the general public or when site employees are in potentially hazardous areas (e.g., wooded habitats), all field staff should utilize the “buddy system” and should ensure that the project-specific HASP includes safety measures and procedures.
- Care should be taken when opening well protective covers for the presence of spiders and insects such as wasps or hornets.
- For some wells, well keys may not work with rusted/outdated well locks. Bolt cutters may be used to remove the lock, which should be replaced upon completion of well sampling. Do not use petroleum based solvent sprays to free seized locks as it may impact water quality in the well.
- Wells with a water-tight cap may experience a buildup of pressure. Keep your face and body away from the top of the well when loosening or removing the cap.
- Certain sampling equipment configurations have tubing without a pump at the sample intake depth (e.g., peristaltic pump or a bladder pump with drop-tubing). Without a weight on the end of the tubing, the tubing can easily get caught on the joints between sections of the PVC well casing or on the open borehole wall due to the natural curl in the tubing from being stored in rolls while lowering the tubing into the well. To remedy this, fasten a stainless steel rod as a splint against the bottom few feet of tubing or simply secure a stainless steel weight to the bottom of the tubing to straighten the curl in the tubing and keep it from getting stuck. Some sampling equipment will include a

weight for this purpose. Proper decontamination of the stainless steel rod or weight is required prior to deployment into a subsequent well (refer to **FGD 14.01**, Sampling Equipment Decontamination).

- It can be helpful to utilize Microsoft Excel to simplify purge stabilization calculations in the field and eliminate the need to transcribe purge notes into electronic form for reporting purposes. An Excel-based purge sheet can also reduce potential mistakes; however, a thorough understanding of the stabilization criteria calculations is necessary prior to use in the field. An example of a low-flow sampling purge sheet with auto-calculations is presented on **Figure 1**.

21	Well Evacuation Data										
23	Stabilization Criteria			± 0.1 SU	± 3 %	± 10 %	± 3 %	± 10 mV	± 10 %	0.3 ft	
24	Time	Vol.	Rate	pH	Cond.	Turb.	Temp.	ORP	DO	DTW	Appearance or
25		L	mL/min	Std	ms/cm	NTU	C	mV	mg/L	ft	Comments
27	9:54	--	550	9.86	0.240	78.9	10.18	16	11.89	23.80	Slightly silty
28	9:59	0.0	320	7.89	0.360	70.4	11.17	77	9.98	23.50	Slightly silty
29	10:04	1.6	250	7.71	0.364	58.2	11.14	93	9.84	23.30	Slightly silty
30	10:09	2.8	250	7.68	0.361	48.6	11.04	100	9.64	23.30	Clear
31	10:14	4.1	250	7.68	0.360	30.3	10.96	107	9.59	23.30	Clear
32	10:19	5.3	250	7.66	0.360	16.0	11.11	107	9.50	23.30	Clear
33	10:24	6.6	250	7.68	0.362	9.3	11.09	111	9.87	23.30	Clear
34	10:29	7.8	250	7.69	0.363	5.7	11.26	114	9.49	23.30	Clear
35	10:34	9.1	250	7.64	0.362	5.8	11.21	115	9.50	23.30	Clear
36	10:39	10.4	250	7.65	0.362	5.6	11.20	118	9.52	23.30	Clear
37	10:44	11.6	100	7.66	0.363	5.5	11.32	118	8.82	23.30	Clear

Figure 1: Groundwater Purge Sheet

As each parameter stabilizes for three readings within its specified criteria, cells activate green. Purge rate and depth to water cells help guide adjustments needed to comply with low flow guidance. To see a report-ready completed sheet, see **Attachment B.**

- Pumping issues, particularly for deep wells using low-flow or intermittent-flow pumps, can be difficult to troubleshoot. A small cup of deionized (DI) water can be used to test for flow. Place the end of the discharge tubing into the DI water cup during pumping to see if there is a discharge (i.e., bubbles occur). As purge water fills the tubing at depth, air is displaced and forced out the top, causing bubbles in the water. If bubbles are observed, the pump is operating and there is flow.
- Bladder pumps have several O-rings and check balls that are necessary for its operation. If bubbles are observed in the DI water during compressor discharge, but water is suctioned back into the tubing during the refill cycle, the pump check ball is not working properly or may be missing. Air bubbles in the discharge water that do not go away after purging for a few minutes are usually indicative of a failed O-ring.
- A small cup of DI water can be used to monitor the purge rate of intermittent-flowing bladder pumps before having water at the surface by observing the duration and/or speed of bubbles. Monitoring the duration and speed of bubbles at the beginning of the

purge will allow the operator to make adjustments and fine-tune the air controls (refill, discharge and pressure) to bring water to the surface.

- Stabilization of parameters when pumping at low flow rates can be difficult. Several adjustments can help make stabilization easier and enhance the rate of stabilization:
  - Minimizing the length of extra tubing at ground surface can help minimize the effect of atmospheric temperatures on purge water.
  - Insulating the tubing with tin foil and/or shading from direct sunlight can help minimize the effect of atmospheric temperatures on purge water.
  - Increasing the flow rate to the maximum allowable rate (based on drawdown and regulatory requirements) will help replace water in the flow-through cell more frequently, thus reducing the severity of parameter fluctuations.
- When purging with intermittently-flowing pumps (i.e., bladder pumps), collection of readings should occur during the same portion of the flow cycle (ideally at the end of a discharge cycle, so measurements are based on fresh water entering the flow-through cell) to minimize parameter fluctuations between cycles.
- For wells with slow recovery, attempts should be made to avoid purging them dry as it may affect the quality of the sample. For example, as water enters a well that has been purged dry, it may cascade down the sand pack and/or the well screen, stripping volatile organic constituents that may be present and/or introducing soil fines into the water column. A possible remedy to purging the well dry is to reduce the purge rate.
- If possible, sampling of wells which have a slow recovery should be scheduled so that they can be purged and sampled in the same day, after adequate volume has recovered. These types of wells should, unless it is unavoidable, not be purged at the end of one day and sampled the following day.
- Sampling equipment (e.g., air compressors) are temperature sensitive and sampling in extremely cold temperatures can complicate even trivial tasks. When sampling in these conditions, keeping sampling equipment and discharge tubing from freezing is critical. Insulating the compressor from freezing temperatures and keeping it warm between use (within a vehicle, field trailer, etc.) will help keep it functioning properly. Any interruption of flow could cause purge water in the discharge tubing to freeze; insulating the tubing and maintaining higher flow rates (within regulatory guidelines) will help keep purge water from freezing.
- Adequate preparation prior to sampling each well will save time in the long run. Make sure the generator/air compressor has fuel or that spare batteries/air canisters are available in the event that stabilization takes longer than anticipated. Stopping mid-purge to refuel or acquire additional air canisters will disrupt stabilization, increasing the time required to sample a well.
- Each sampling effort should minimize exposure to ambient factors (e.g., atmospheric air, wind-blown dust, vehicular or generator exhaust). Ensure equipment and vehicles release exhaust downwind from the sampling location, especially if sampling for VOCs.
- While purging, the time between water quality measurements can be used to organize bottle-ware and confirm well-specific information (e.g., sample analyses, bottles appropriately labeled, duplicate collection, field filtering).

- If the Work Plan/Field Sampling Plan involves analyses requiring field preservation, be sure to avoid direct contact with laboratory-provided preservative chemicals.

6. RECORDKEEPING

Document all sampling locations in accordance with **FGD 1.04** (Documenting Sampling Locations) and record all information related to groundwater sampling in accordance with **FGD 1.01** (Field Notes and Records) and **FGD 1.03** (Data Management).

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ATTACHMENT A
GROUNDWATER PURGING AND SAMPLING EQUIPMENT

Several styles of well evacuation equipment exist for the collection of groundwater samples. Equipment choice will depend on a variety of factors including but not limited to cost, well specifications, and sampling parameters. The following are brief descriptions of the more commonly used groundwater purging and/or sampling equipment.

Bailer

The bailer is one of the oldest and simplest methods of sampling and consists of a rigid cylindrical length of polyethylene, PTFE or stainless steel with a check valve or other sealing mechanism at one or both ends. It is available in numerous dimensions to accommodate a wide variety of well diameters. Double check valve bottom-draining bailers are recommended as they allow for lessened sample disturbance during transfer to the container.

Figure 1 Disposable Bailers
Source: http://www.geotechenv.com/

Peristaltic Pump

A suction lift pump (negative air pressure) consisting of a rotor and ball bearing rollers. Liquid moves totally within the tubing dedicated for sampling so no part of the pump contacts the liquid. Medical-grade silastic tubing is recommended for the section in contact with the rollers. Geopump and Solinst are popular manufacturers of this pump type.

Figure 2 Peristaltic Pump
Source: http://www.geotechenv.com/

Submersible Pump

Consists of an electric motor in a stainless steel and Teflon housing that drives two or more impellers at high rates of rotation, bringing water to the surface at a continuous rate. It can be operated with a generator or a 12V battery. Grundfos is a popular manufacturer of this pump type.

Figure 3 Submersible Pump
Source: http://www.geotechenv.com/

Figure 4 Gear Pump

Source: http://www.nj.gov

Gear Pump

A small and lightweight pump that is similar to the submersible pump. It functions through the use of two or more internal gears that create positive displacement. As the gears rotate they separate on the intake side of the pump, creating a void and suction which is filled by fluid. The fluid is carried by the gears to the discharge side of the pump, where the meshing of the gears displaces the fluid. Fultz is a popular manufacturer of these pumps.

Inertial Pump

Working on the principal of inertia, this pump consists of tubing with a check valve at one end of it. The pump operates simply by lifting the pump up and dropping it back down. The check valve allows water to enter when the pump is dropped, but not escape when lifting the pump back up. Continued up and down movement advances water upward due to inertia. Waterra is a common manufacturer of this type of pump

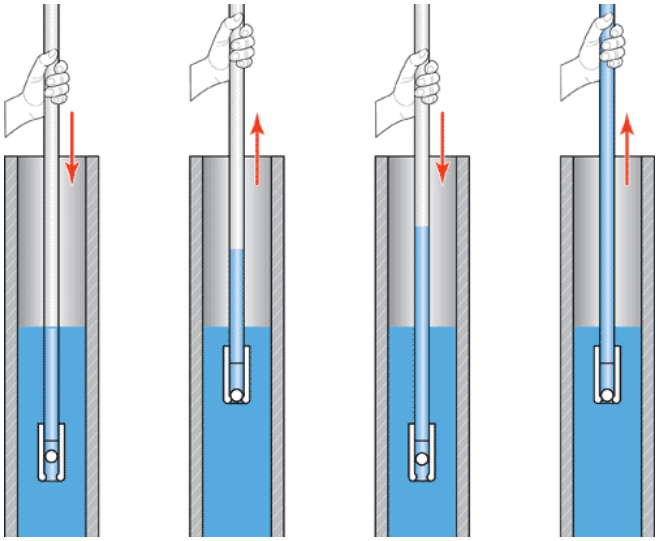

Figure 7 Ineartial Pump

Source: http://www.fao.org

A comparison of the various pump options and their advantages/limitations is provided on **Table 1**.

Table 1 - Groundwater Sampling Pumps

Pump Type	Advantages	Disadvantages	Sampling Capability	Approximate Lift Capacity
Bailers	• Simple • Low cost • No power source needed • Portable and readily available	• Disturbance of sample generally unavoidable • Cannot be relied upon for air sensitive parameters including DO, pH, CO and Fe • VOC may be biased low (due to aeration)	VOC results may be biased low due to aeration of the sample and thus this is not the preferred method for VOC sampling.	Not Applicable
Peristaltic Pump	• Speed of operation is variably controlled • No decontamination of the pump necessary • Easy to operate	• Limited to a depth of about 25 ft • Not reliable for air sensitive parameters including DO, pH, CO2 or Fe • Not reliable for VOCs and SVOCs • Needs external power source • Some devices require priming • Some devices difficult to sample through due to surges in flow	Restricted from sampling for VOCs and SVOCs due to the negative pressure imparted upon the sample.	Up to 25 feet
Bladder Pump	• Acceptable for sampling for all parameters • Simple design and operation • Minimal disturbance of sample	• Large gas volumes may be needed • Only pumps with disposable bladders may be field cleaned for portable use when approved decontamination methods are employed • Depth	Acceptable for sampling for all parameters.	Up to 500 feet

Table 1 - Groundwater Sampling Pumps

Pump Type	Advantages	Disadvantages	Sampling Capability	Approximate Lift Capacity
Submersible Centrifugal Pump	• Versatile and light weight • Variable speed control for fine tuning of flow rate • Acceptable for low-flow purging and sampling • Able to be thoroughly decontaminated due to ability of complete disassembly	• Sample temperature may be biased high during low-flow sampling due to high rotation rate of impellers • Motor stall possible at low pumping rates • Requires external power source • Impellers easily damaged by silty/sandy water • Difficult to clean and maintain in the field	May not be acceptable for sampling for trace contaminants, but useful for all other parameters.	Up to 525 feet
Gear Pump	• Good variable speed control especially at low rates • Acceptable for low flow purging and sampling • Light weight	• Difficult to decontaminate when in the field • Turbid purge water wears on the gears • Cannot properly handle suspended solids • Gears may be damaged in silty/sandy water • Gears may bind in water exceeding 85 degrees F	Acceptable for sampling for all parameters.	Up to 150 feet
Inertial Pump	• Inexpensive and easy to operate • Rapid method for sampling shallow wells Simple decontamination of valves	• Labor intensive and time consuming • Unavoidable agitation caused by pumping resulting in agitation and aeration • Uneven sample delivery. Some models are only useful in 2-inch diameter wells	May not be acceptable for sampling VOCs due to potential loss through agitation.	Between 75 to 300 feet, depending on type of pump and well

ATTACHMENT B
GROUNDWATER PURGING SHEET

RAMBOLL ENVIRON

Low Flow Groundwater Sampling Field Log

Monitoring Well - **MW-103B**

Client or Site Name
Princeton, NJ

Sampling Information

Date - March 5, 2015
Personnel - W. Larrison & T. Correll
Weather - Mostly Sunny, 28°F

Sampling Device - 2-Inch Bladder Pump
Water Quality Meter - Horiba U-52
Monitoring Equipment - MiniRAE PID 3000

Well Information

Well Vault PID - 0.0 ppm
Well Casing PID - 0.4 ppm
Measured Depth to Bottom - 75.00 ft BTOC
Well Screened Zone - 65 - 75 ft BTOC

Well Diameter - 2.0 inch
Depth to Pump Intake - 70.0 ft BTOC
Static Depth to Water - 23.14 ft BTOC
Post-Pump Depth to Water - 23.10 ft BTOC
Well Volume - 8.46 gallons

Well Evacuation Data

Stabilization Criteria			± 0.1 SU	± 3 %	± 10 %	± 3 %	± 10 mV	± 10 %	0.3 ft	
Time	**Vol.** L	**Rate** mL/min	**pH** Std	**Cond.** ms/cm	**Turb.** NTU	**Temp.** C	**ORP** mV	**DO** mg/L	**DTW** ft	**Appearance or Comments**
9:54	--	550	9.86	0.240	78.9	10.18	16	11.89	23.80	Slightly silty
9:59	0.0	320	7.89	0.360	70.4	11.17	77	9.98	23.50	Slightly silty
10:04	1.6	250	7.71	0.364	58.2	11.14	93	9.84	23.30	Slightly silty
10:09	2.8	250	7.68	0.361	48.6	11.04	100	9.64	23.30	Clear
10:14	4.1	250	7.68	0.360	30.3	10.96	107	9.59	23.30	Clear
10:19	5.3	250	7.66	0.360	16.0	11.11	107	9.50	23.30	Clear
10:24	6.6	250	7.68	0.362	9.3	11.09	111	9.87	23.30	Clear
10:29	7.8	250	7.69	0.363	5.7	11.26	114	9.49	23.30	Clear
10:34	9.1	250	7.64	0.362	5.8	11.21	115	9.50	23.30	Clear
10:39	10.4	250	7.65	0.362	5.6	11.20	118	9.52	23.30	Clear
10:44	***SAMPLE***	100	7.66	0.363	5.5	11.32	118	8.82	23.30	Clear

Notes / Sample Information

Sample ID - MW-103B-150305
Sample Time - 10:44

Appearance at Start - Slightly silty
Appearance After Purging - Clear

Additional Sample - None
Additional Sample ID - N/A

Total Volume Purged - 12.1 liters
Purge Rate - 100-550 mL/min

DTW After Purging - 23.30 ft bTOC
DTW at Time of Sampling - 23.30 ft bTOC

Analyses - TCL VOCs (8260B);
TCL SVOCs (8270C/8270C + SIM);
Dissolved Organic Carbon (SM5310);
Dissolved Mn, Mg, Ca, Na, K (200.8);

Notes

Figure 2:

Completed Groundwater Purge Sheet, finalized for printing.

FIELD GUIDANCE DOCUMENT NO. 6.03

ESTIMATION OF IN-SITU HYDRAULIC PROPERTIES – HYDRAULIC CONDUCTIVITY (SLUG) TESTS

RAMBOLL

FIELD GUIDANCE DOCUMENT NO. 6.03

ESTIMATION OF IN-SITU HYDRAULIC PROPERTIES – HYDRAULIC CONDUCTIVITY (SLUG) TESTS

Prepared By:	Justine Stumpf
Peer Reviewed By:	Nick Scala Jon Johnson Lisa Ackerman Taylor Christopher Ritchie Robert Patchett Jose Sananes Carol Serlin Nestor Soler Katie Moran Guy Swenson Paul Freyer
Approved By:	J. Mark Nielsen, PE
Applicable To:	North American offices
Effective Date:	January 7, 2020
Revision Notes:	
Documents Used as Reference During Preparation:	ASTM D4044/D4044M – 15 Standard Test Methods for (Field Procedure) Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers. Butler, James J. 1998. The Design, Performance, and Analysis of Slug Tests. Butler, J.J. 2014. Slug Tests in Wells Screened Across the Water Table: Some Additional Considerations. Groundwater. 52(2)311-316. Butler, J. J., Duffield G. F., and Kelleher D. L. 2010, Field Guide for Slug Testing and Data Analysis. Midwest Geosciences Group. Cooper, H.H., J.D. Bredehoeft and S.S. Papadopulos, 1967. Response of a finite-diameter well to an instantaneous charge of water, Water Resources Research, vol. 3, no. 1, pp. 263-269. Duffield, G.M., 2007. AQTESOLV for Windows Version 4.5 User's Guide, HydroSOLVE, Inc., Reston, VA Halford, K.J. and Kunianksy, E.L., 2002, Documentation of Spreadsheets for the Analysis of Aquifer Pumping and Slug Test Data: USGS OFR 02-197. Neville, C.J., 2008, "Hydraulic Conductivity and Specific Storage of Clay Tills, S.S. Papadopulos & Associates, Inc. United States Environmental Protection Agency, 1994, SOP #: 2046, Slug Tests, October 3. United States Geological Survey, 2002. Documentation of Spreadsheets for the Analysis of Aquifer-Test and Slug-Test Data, Open File Report 02-197. Watson, Ian. 1995. Hydrology: An Environmental Approach.

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ATTACHMENTS

Attachment A: Typical Hydraulic Conductivity Values

Attachment B: Slug Testing Data Acquisition Form

Attachment C: Slug Testing Equipment

Attachment D: In-Situ Inc., Pneumatic Slug Testing Technical Note

Attachment E: Multiple Slug Test Decision Guideline

Attachment F: Slug Test Data Processing and Analysis

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll US Corporation (Ramboll) for conducting in-situ hydraulic conductivity (slug) tests to estimate the hydraulic properties of confined and unconfined aquifers. The hydraulic conductivity of an aquifer is a key parameter used for the evaluation of groundwater flow and contaminant transport. The use of slug tests to estimate aquifer hydraulic conductivity is widely accepted and should be performed under the direction of an experienced hydrogeologist or engineer.

Slug tests are a means to estimate the hydraulic conductivity (K) of an aquifer immediately surrounding a test well/piezometer. Slug tests generally consist of inducing a near instantaneous head change (ΔH) in a well (relative to the water level in the formation surrounding the well) and monitoring the time required for the head (H) within the well to recover to the static water level/equilibrium with the surrounding aquifer. The timing of the head response in the well is a function of the differential head created and the hydraulic conductivity and coefficient of storage of the aquifer.

Analysis of the head data, with an appropriate theoretical model provides an estimate of the saturated hydraulic conductivity of subsurface geologic strata for a limited radius surrounding the tested well. By performing slug tests for a group of wells in the same hydrogeologic unit, the hydraulic conductivity range of the unit may be estimated over a larger area and with a higher degree of certainty. Typical hydraulic conductivity ranges for various soil types are provided in **Attachment A**.

Hydraulic conductivity values calculated from in situ hydraulic conductivity tests are estimates for the material immediately surrounding the open interval of the test well, thereby only providing hydraulic conductivity estimates for a very small portion of the geologic formation of interest. To assess variability in hydraulic conductivity across a site, a typical slug testing program will generally include multiple slug tests in multiple representative wells screened in each geologic unit to provide robust hydraulic conductivity averages or ranges. Near-well conditions such as the filter pack design and condition, quality of well development, skin effects (e.g. borehole smearing), and wellbore storage may affect the representativeness of test results. Slug tests are used when a high degree of accuracy is not needed, provide approximate values of hydraulic conductivity, and do not produce values of storage coefficients. Slug test hydraulic conductivity estimates are generally not considered sufficient to evaluate aquifer behavior to stresses imposed across a large area or over long periods (e.g. for groundwater extraction system design, etc.) and should not be exclusively relied upon for designing a groundwater recovery system or other system. Aquifer pumping tests (refer to **FGD 6.08**, Estimation of Hydraulic Properties-Pumping Tests) and hydraulic pulse tests (refer to **FGD 6.18**, Estimation of Hydraulic Properties-Hydraulic Pulse Tests) are recommended to estimate the bulk hydraulic properties (e.g. hydraulic conductivity, transmissivity, storage/storativity etc.) of an aquifer for applications like groundwater extraction system design or dewatering systems.

The guidelines presented in this FGD cover the initiation of slug tests using physical/solid objects or pneumatic pressure. Tests initiated with an instantaneous rise in head will be referred to as falling head tests while those initiated by an instantaneous drop in head will be referred to as rising head test because of the direction of the head change being monitored.

Although this FGD provides guidelines associated with typical field activities and projects, it should be understood that for certain projects more specific procedures or alternative methods, including site-specific, state-specific, or regulatory program-specific guidelines, requirements or procedures, may be applicable. Specific requirements for each project will be reviewed by the Ramboll Principal-in-Charge / Project Director (PIC) and Project Manager (PM) and any additional requirements will be defined in a project-specific Work Plan, Sampling Plan and/or FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans, but rather provide a reference for developing project-specific requirements.

This FGD does not supersede Ramboll health and safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. Ramboll employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP, followed by approved site-specific procedures, which may include those in this FGD. The Ramboll PIC and/or PM shall ensure that all project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information are maintained in the project file for the duration of the project or as established by applicable Ramboll's document handling and retention policies. The signatures of the PIC and/or PM indicate approval of the methods and precautions outlined in the HASP.

2. EQUIPMENT/MATERIALS

A checklist of equipment generally required for a typical slug test at contaminated sites is provided below. Additional equipment may be specified in the project-specific HASP and/or Work Plan/Field Sampling Plan and the following list should not be considered exhaustive. More specialized sampling equipment may be required depending on project-specific needs. Ramboll oversight personnel should understand and be familiar with the operation and safe handling of the equipment and materials that are required for slug testing.

2.1 General Equipment Checklist:

- Site information (e.g., maps, contact numbers, keys or lock codes for gates or access points);
- Field notebook and all-weather or permanent pens as outlined in **FGD 1.01** (Field Notes and Records).
- Plastic sheeting;
- Measuring tape;
- Trash Bags - used to dispose of gloves and any other non-hazardous waste generated during testing (refer to **FGD 15.01**, Waste Handling);
- 55-gallon steel drums, Department of Transportation-rated (for legal waste hauling), or other appropriate waste container – for disposal of any Investigation Derived Wastes (IDW) and/or decontamination wastes (refer to **FGD 15.01**, Waste Handling);
- Labels for Investigation Derived Waste (IDW) containers as outlined in **FGD 15.01** (Waste Handling) and indelible pen or sharpie;

- Bucket, spray bottle, distilled/deionized water, and Liquinox (or Alconox) – used for the decontamination of equipment (refer to **FGD 14.01**, Sampling Equipment Decontamination); and
- Personal Protective Equipment (PPE) and field screening equipment in accordance with the site-specific HASP, including sterile gloves which must always be worn when handling and utilizing sample equipment.

2.2 Project- or Task-Specific Slug Testing Equipment Checklist:

- Well construction specifications and/or diagrams;
- Cable ties;
- Well keys;
- Electronic water level indicator (refer to **FGD 6.04**, Groundwater and Free Product Level Measurements);
- Electronic data logging, water level/pressure transducer (transducer) (e.g. In-Situ Troll family or equivalent). For longer duration tests consider gauged or vented transducers (i.e., can auto-compensate for barometric pressure); otherwise, in addition to the absolute (or non-vented) transducer, a barometric transducer may also be required;
- Field computer (such as a Rugged Reader or equivalent) and/or field laptop computer with applicable software selected for the appropriate water-level transducer;
- Slug Testing Data Acquisition Form(s) (see **Attachment B**);
- Communication cables for the transducer and computer equipment;
- An initiation device
  - For physical slug test initiation:
    - Solid cylinders of polyvinyl chloride (PVC), stainless steel, or other relatively inert material of appropriate diameter and various lengths are recommended.
    - Disposable suspension line or tether constructed of material that minimizes interactions or alterations when in contact with groundwater or that may cause loss of analytes via sorption (e.g., poly twine, nylon string, stainless-steel, Teflon-coated stainless-steel wire, etc.) for lowering and raising slug.
    - Slug suspension stand - used to control placement of the slug in deep wells or large-diameter wells requiring large slugs (see **Attachment C**).
  - For pneumatic test initiations pneumatic slug testing equipment:
    - A wellhead assembly (well coupler, pressure gauge, regulator and ball valve) and a pressure source (e.g., hand pump [bicycle pump], air compressor, or compressed gas cylinder).
    - Air fittings (e.g., check valves, pressure gauges, ball valves, strain-relief compression fittings) constructed of materials that will not affect groundwater quality (e.g., stainless steel).
- Tool set: socket set, socket wrench, screw driver, multi-tool, safety shears, "turkey baster" and/or cup for water removal from flush-mounted well vaults;

- Spare/replacement parts: gripper plugs/well caps, well lid bolts; and
- Folding work table.

A Slug Testing Data Acquisition Form is provided in **Attachment B** and information on the typical equipment used for Slug Testing and Pneumatic Slug Testing is provided in **Attachments C** and **D**, respectively.

3. PROCEDURES REFERENCED

The following FGDs are related to this FGD and should be reviewed prior to mobilization, as needed:

- **FGD 1.01**, Field Notes and Records;
- **FGD 2.02**, Site Preparation, Inspection and Housekeeping;
- **FGD 4.04**, Field Screening - Water Quality;
- **FGD 4.06**, Equipment Calibration;
- **FGD 6.04**, Groundwater and Free Product Level Measurements
- **FGD 6.07**, Well Development
- **FGD 6.15**, Well Construction Record
- **FGD 14.01**, Sampling Equipment Decontamination; and
- **FGD 15.01**, Waste Handling.

The list above is not intended to be all inclusive. Other FGDs and Standard Practice Instruction (SPI) may need to be referenced based on the specific requirements of the site-specific Work Plan/Sampling Plan (e.g., field screening FGDs, FGDs for sampling of other media, etc.).

4. PROCEDURES

4.1 Planning and Design Considerations

Significant test strategy decisions will be approved by the PIC and/or PM before the initiation of associated field activities and documented in the Work Plan/Field Sampling Plan. The Work Plan/Field Sampling Plan will be designed for the collection of quality data to meet the objectives of the study/monitoring program and will include the well locations and depths, number of tests per well, initiation and data logging methods, as well as quality assurance/quality control requirements. The Work Plan for slug testing will specify whether any extraction wells in the project vicinity require shut-down before the start of testing. The Work Plan/Field Sampling Plan will generally provide some discretion in the field depending on the conditions encountered; however, significant departure from prescribed testing activities should be discussed with and approved by the PIC and/or PM.

When planning the slug testing, the following should be considered:

- *Type of Slug Test* - There are two types of slug test recovery responses: falling-head and rising-head tests. Both tests measure the recovery of heads to pre-test/static conditions in a well after the initiation of a near instantaneous change in head. Falling-head tests are initiated by inserting a slug of known volume into the water column (of a well with a fully saturated well screen / open interval) that should result in a head increase that is proportional to the volume of the slug used. After a falling-head test is initiated, the heads are measured in the well to monitor the fall/decline from the initial maximum displacement (H_o) to pre-test/static conditions. Rising-head tests are initiated by removing a slug of known volume from the water column that should result in a head drop that is proportional to the volume of the slug used. After a rising-head test is initiated, the heads are measured in the well to monitor the rise/increase from the initial maximum displacement (H_o) water to static conditions (i.e. equilibrium with the surrounding aquifer).

  In high hydraulic conductivity aquifers (i.e., where heads in the well recover to pre-test levels within 60 seconds), a pneumatic slug test can be used. Pneumatic slug tests require an air-tight seal between the top of the well and the apparatus that is used to seal, pressurize, and vent the well casing. The well casing is pressurized (with air or an inert gas) to lower the head inside the well to the desired displacement/well casing pressure. Once heads in the well are stable, a valve is opened to release the air pressure within the well casing and start a rising-head test. A pneumatic slug test cannot be performed on a well with a partially saturated screen/open interval (i.e. screened/open interval that crosses the water table). A diagram of a pneumatic slug test is included in **Attachment D**.

  Rising-head slug tests tend to have less noise in the data compared to falling-head tests, because the slug insertion for the latter can create anomalous data points. However, to perform a rising-head slug test the slug must be initially placed in the well (as would be required for a falling-head test), and a duplicate test (i.e., falling-head test followed by a rising-head test) is typically performed. The duplicate test is used to confirm slug test results and is preferred by some regulatory programs (USEPA, 1994).

- *Multiple Slug Tests* – Depending on the duration of each test, consideration should be given to performing multiple rising and falling head slug tests on individual wells to allow accurate test analysis. Repeating slug tests in a well with the same slug will yield information about the accuracy and reproducibility of the hydraulic conductivity obtained from the tests, while repeat slug tests conducted with different size slugs may be used to evaluate whether the observed aquifer responses are dependent upon the initial displacement used for each test. Butler (1998) suggests that a minimum of three tests be completed per well with initial displacements (H_o) that vary from 0.66 to 6 feet (e.g., Test 1 – H_o = 1 ft, Test 2 – H_o = 3 ft, and Test 3 – H_o = 5 ft) and that the directionality of flow for one of the tests be different (e.g. Test 1 – falling head [flow from the well to the formation], Test 2 – rising head [flow from the formation to the well], Test 3 – falling head). A guide for the number of tests to be performed based on the well recovery time is provided in **Attachment E**.

- *Well Construction Details* – Review of well construction details is important for test method selection and as input parameters for analysis of test data. At a minimum, the following information should be gathered prior to planning a slug test event:
  - Aquifer lithology and expected hydraulic characteristics of screened aquifer material;
  - Casing (inside) radius;
  - Well screen (inside) radius;
  - Borehole radius;
  - Screen length;
  - Filter pack material;
  - Depth to top of screen from water table (or depth to water table from top of screen for partially saturated wells);
  - Predicted initial displacement for each slug;
  - Static (pre-test) depth to water in well; and
  - Saturated thickness of aquifer.
- *Slug Properties* – The slug may consist of a variety of materials including plastic, PVC, stainless steel, or air (rental companies typically offer solid slugs). If transducers are being used to monitor head changes in the well, the diameter of the slug should allow room for the transducer cable and the movement of the slug without disrupting the transducer. The size of slug will depend on the well diameter and required minimum volume to be displaced. Initial displacement should produce a reasonable signal to noise ratio. For recommendations on initial displacement refer to Butler (1998). When using solid slugs, at a minimum, the slug radius and length inserted below the water level should be recorded on the Slug Testing Data Acquisition Form (see **Attachment B**). For pneumatic slug initiations, the stabilized well casing pressure should be measured and recorded.
- *Well Condition* - Slug tests should not be performed in newly constructed wells prior to development or existing wells that are otherwise silted due to inactivity. Hydraulic conductivity estimates from undeveloped or poorly developed wells will be lower than the formation hydraulic conductivity due to the impact of drilling debris. The Work Plan should identify whether existing wells require development prior to slug testing.
- *Well Design* - The well installation method, the type and length of well screen, grain size distribution of the well filter pack, and/or nature of the well development can affect the results of a slug test. Slug tests should only be completed in developed wells. If the filter pack grain size is smaller than that of the natural formation, then the results of a slug test will not reflect the hydraulic conductivity of the natural formation.
- *Partially Saturated Screened Interval* - For rising-head slug tests conducted in wells that are screened across the water table with a filter pack that is coarser than the formation, the response data typically displays two distinct linear slopes when normalized head is plotted relative to time. An initial slope reflecting drainage from the filter pack followed by a second distinct slope reflecting the formation response. Prior to testing such wells, an evaluation should be made following procedures described in Butler (2014) to predict the amount of displacement head response that can be attributed to filter-pack drainage

and confirm that the formation head response to the remaining displacement can be separated from the transducer noise.

- *Pre-Test Groundwater Level Monitoring* – The need for and duration of groundwater level monitoring before initiating the slug testing should be defined based on (a) the duration of the slug test compared to the background water level change time period (e.g., where wells are known to recover very quickly [less than 10 seconds], no pre-test groundwater level monitoring may be required); (b) the potential for tidal influence; (c) potential for unknown local groundwater level changes due to extraction or infiltration; (d) water level recovery due to opening a previously air-tight sealed well; and (e) the depth of the aquifer (to allow sufficient time for thermal equilibration of equipment and the cable to stretch). The water level in the well must be static prior to initiating the test. A background changing water level that occurs during the test will affect the test results.

4.2 Pre-Field Work Preparation Procedures

Before initiating field activities, field staff should review and complete pertinent tasks identified in **FGD 2.02**, Site Preparation, Inspection and Housekeeping. Further, for sites with contaminated groundwater any non-dedicated, non-disposable equipment (e.g., water level indicator, transducer) should be decontaminated before use and between wells as described in **FGD 14.01** (Sampling Equipment Decontamination), the project-specific Work Plan/Field Sampling Plan, and/or Quality Assurance Project Plan (QAPP) to minimize potential cross-contamination between wells. Used disposable equipment (e.g., tethers) that is considered IDW should be managed in accordance with **FGD 15.01**, Waste Handling, following the testing event.

At a minimum, the following tasks should be completed to prepare field staff for implementation of the work:

- Review and sign the site-specific HASP.
- Coordinate and obtain permission for site access and extraction well pump shutdowns (as necessary).
- Review the project-specific Work Plan/Field Sampling Plan/QAPP, where applicable.
- Review and discuss with the PIC and/or PM the proposed Work Plan/Field Sampling Plan or sampling/testing strategy.
- Review the standard instruction manual(s) provided by the manufacturer of the specific equipment being used for logging changes in heads during slug testing.
- Document that equipment/materials required to complete the work have been secured and packed prior to travel.

Prior to initiating the slug testing activities, Ramboll oversight personnel should field-verify the well identity and construction against available documentation (site plans, well construction logs, etc.). Prior to testing, it is imperative that a positive well identification be made using measured total well depth, well labels, site plans, and well construction records to document that the correct well is tested (refer to **FGD 6.04**, Groundwater and Free Product Level Measurements). If total well depth is measured on a site with groundwater contamination, proper decontamination of the water level indicator tape must be conducted

before deploying the water level indicator into another well (refer to **FGD 14.01**, Sampling Equipment Decontamination).

Further, prior to the commencement of the field effort, Ramboll oversight personnel should inspect, test, and/or calibrate equipment that may be used to take field measurements (refer to **FGD 4.06**, Equipment Calibration). Pre-measuring the slug suspension line(s) to the individualized targeted depths, in advance of field efforts will increase productivity.

Unless otherwise required by the project-specific Work Plan/Field Sampling Plan, for sites with groundwater contamination, slug testing should begin with wells with the lowest expected groundwater contaminant concentrations and proceed systematically to wells with the highest expected groundwater contaminant concentrations.

4.3 General Slug Testing Guidelines

The guidelines in this section provide the recommended practices for rising- and falling-head slug tests to be performed on properly constructed and developed wells installed in confined or unconfined aquifers at contaminated sites.

4.3.1 Pre-Test Preparation

Before initiating a slug test,

- Where applicable, contact the identified key site personnel upon arrival to the Site and assess proposed work areas.
- Wells to be tested should be inspected for damage, access constraints, and/or vehicle traffic proximate to the well location.
- Although equipment should be decontaminated between uses, to further limit potential cross-contamination between wells, perform measurements from least to most contaminated locations.
- Place polyethylene sheeting around the well for placement of slug testing equipment and to contain any accidental spillage during testing.
- Remove the well cover or equivalent protective casing cover (refer to **FGD 6.04**, Groundwater and Free Product Measurements) and measure head space concentrations in accordance with the applicable manufacturer instructions and field screening FGDs (e.g., **FGD 4.01**, Field Screening - Combustible Gas; **FGD 4.02**, Field Screening - Volatile Gas; **FGD 4.03**, Field Screening - Landfill Gas). Record field screening readings in the field book. The necessity and methodology to conduct field screening should be detailed in the site-specific HASP and sampling/testing plan.
- As detailed in **FGD 6.04**, Groundwater and Free Product Measurements, record the condition of the well, noting any damage to the well, plug, and/or protective casing, and record any evidence of air pressure (positive or negative) when removing the well cap;
- Complete depth-to-water measurements prior to any planned slug testing activities unless otherwise specified in the Work Plan/ Field Sampling Plan (refer to **FGD 6.04**, Groundwater and Free Product Measurements). If the gripper plug sealing the well casing was under pressure or vacuum when removed, manual water level measurements should be collected until the change in water level is less than 0.01 feet over a period of

30 seconds before recording the static water level. If unanticipated free product is detected in a well, consult with the PIC and/or PM before proceeding further.

- Measure the total well depth to the nearest 0.1 foot.
- Measure the inner and outer diameter of the well casing or confirm the existing well construction log information.
- Slowly lower the transducer to a depth below the static water level and as close to the top of the water column but deep enough that the transducer will not be disturbed during insertion and removal of the slug.
- Secure the transducer to the well casing to ensure when the slug is added to the well it will not disturb the transducer.
- Allow the transducer to thermally equilibrate with the water temperature in the well prior to establishing a reference level on the transducer. Record the transducer depth reading.
- Properly program the transducer to fit well conditions and expected slug test response. Record the model and serial number of each data logging transducer and synchronize units with the field computer or mobile device that will be used during the slug tests. As the default, set the Rugged Reader/computer to collect readings every second. The highest measurement frequency (typically 0.25 seconds) is recommended for pneumatic tests or for tests in high-conductivity material such as sand and gravel.
- Record a second depth-to-water measurement to confirm the head is at static conditions.
- Record the initial pressure (height of water column above the transducer), barometric pressure, and temperature (if available) measurements from the transducer and confirm they represent static conditions. Ideally, the transducer should record heads for a sufficient period of time (specified in the Work Plan/ Field Sampling Plan) prior to test initiation to assess whether the aquifer is at static conditions and equipment has stabilized, and whether there are external influences on heads that could affect the response data (refer to Section 4.1).
- The measured head and pressure reading will act as the baseline and be used to confirm the head has recovered (dropped after slug-in or risen after slug-out) to the initial value.

4.3.2 Falling Head Test (Physical Slug-In)

After baseline conditions have been established, the falling-head slug test is performed as follows:

- Lower slug to just above the water (during data analysis an assumption is that water is displaced instantaneously by "quickly" and uniformly lowering the slug into the water to maximize the initial displacement).
- Start the transducer recording and then rapidly lower the slug into the water.
- Record time the test started in the field notebook or Slug Testing Data Acquisition Form (refer to **Attachment B**).
- Secure the slug to the well casing or other secure feature adjacent to the well. Be careful not to move slug up or down in the well or bump the transducer cable during the test.

- Once the slug is secure, record head measurements frequently (every second) during the early stages of the test. The recording interval may be increased over the course of the test as heads begin to stabilize. Record the time interval used to collect readings in the field notebook or Slug Testing Data Acquisition Form (refer to **Attachment B**).
- The test is considered completed when the head has recovered 95% of the initial displacement (5% of the initial displacement above the static head) or if readings change less than 0.01 feet every 10 minutes. For very low conductivity formations, it may not be practical to record the entire recovery period as the time to completion is related to the type of material being tested.
- Once the head has stabilized, prepare to repeat the process for the slug-out (rising head) test. The recovery from the falling head test should be at least 95% of the initial displacement before initiating a rising head test. A repeat test should not be performed if heads have not recovered to pre-test static head (or 95%).
- If a regional water level trend was identified during the pre-test period, continue logging heads during the post-test period to provide additional data for trend correction.

4.3.3 Rising Head Test (Physical Slug-Out)

Typically, a rising head test is initiated by rapidly pulling the slug out of the water after recovery (i.e., at least 95% of the initial displacement) from a falling head test. The rising head test is performed as follows:

- Once the head has stabilized, start the transducer log and then immediately remove the solid slug from the water.
- Record time the test started in the field notebook or Slug Testing Data Acquisition Form (refer to **Attachment B**).
- Once the test has been initiated, record head measurements frequently (every second) during the early stages of the test. The recording interval may be increased over the course of the test as heads begin to stabilize. Record the time interval used to collect readings in the field notebook or Slug Testing Data Acquisition Form (refer to **Attachment B**).
- The test is considered completed when the head is equal to the initial value or if readings change less than 0.01 feet every 10 minutes. For very low conductivity formations, it may not be practical to record the entire recovery period as the time to completion is related to the type of material being tested. If repeated testing is part of the workplan, then 95% recovery to the original head should be achieved prior to conducting an additional test.
- If a regional water level trend was identified during the pre-test period, continue logging water levels during the post-test period to provide additional data for trend correction.

4.3.4 Pneumatic Rising Head Test

A pneumatic slug testing device may be used to perform rising-head tests on wells with water levels that are a minimum of 5 feet above the top of the well screened interval

(refer to **Attachment D**). The pneumatic method is typically used for tests in high hydraulic conductivity formations and after baseline conditions have been established, as follows:

- Install the wellhead assembly on the well casing and secure as recommended by the manufacturer (e.g., with metal bank clamps, Fernco coupler with hose clamps and a ratcheting strap). Position the pneumatic slug test manifold on the well so that there is an air tight seal.
- Insert the transducer through the wellhead assembly and at least 5 feet into the water or to the top of the well screen. Secure transducer cable to well to prevent movement and allow the transducer to thermally equilibrate with the water temperature in the well prior to establishing a reference level on the transducer. Record the transducer depth reading.
- Close the pressure release valve and start the transducer log. Pressurize the well to the desired displacement using a hand pump (e.g., bicycle pump) or compressed air tank. Monitor the applied pressure using the gauge and control it using the regulator to ensure that the head is not depressed below the top of the well screen or below the transducer.
- Once the transducer readings and air pressure readings have stabilized, immediately release the air pressure in the well by releasing the vent valve on the well head assembly.
- Record time the test started in the field notebook or Slug Testing Data Acquisition Form (refer to **Attachment B**).
- The test is considered completed when the transducer head reading is at the pre-test initial value. If repeated testing is part of the workplan, then 95% recovery to the original head should be achieved prior to conducting an additional test. If 95% recovery to the original head is not achieved, consult with the PIC and/or PM before proceeding further.
- If a regional water level trend that could affect water levels during the test period was identified during the pre-test period, continue logging water levels during the post-test period to provide additional data for trend correction.

4.3.5 Slug Test Completion

Following completion of the slug test(s) in each well:

- If possible, use a field computer to download the data from the transducer, confirm the test results, and evaluate whether repeat tests are needed.
- Withdraw the testing equipment from the well, replace the gripper plug and well cap, and secure the well.
- Properly decontaminate non-dedicated, non-disposable equipment prior to use and after use at each well. For non-dedicated equipment that has come in contact with groundwater, remove the equipment from the monitoring well and decontaminate in accordance with **FGD 14.01**, Sampling Equipment Decontamination.
- Record in the field book or Slug Testing Data Acquisition Form (refer to **Attachment B**):
  - Deviations from procedures defined in the project-specific Work Plan, Sampling Plan and/or FGD (i.e., ceasing testing prior to stabilization);

  - The rationale for any modifications or deviations from the procedures; and
  - Abnormal conditions within the well (e.g., evidence of blockage, root growth into the well casing, separated casing sections, etc.).

  Inform the Ramboll PIC and/or PM so necessary maintenance, redevelopment or repairs are conducted before the next planned groundwater sampling or testing event.

- Following completion of the field tests and prior to demobilizing, the parameters necessary for data analysis should be confirmed. These include the well name, test date, test type (rising vs falling head), well construction details, slug used and its dimensions, predicted initial displacement, and pre-test water level measurements. The transducer records from slug tests must also be processed prior to performing analysis. These data will be inspected to identify the test initiation points and static water levels.

General information on data processing and analysis is provided in **Attachment F**.

5. PRECAUTIONS AND OTHER CONSIDERATIONS

Field activities require recording sufficiently detailed information throughout the implementation of field work; however, certain precautions should be taken to ensure safety while conducting slug testing. Additionally, implementation of the work may face some difficulties, including the following:

- It is important to always remain alert and aware of your surroundings. Slug testing could involve the use of generators and associated equipment, and is subject to hazards posed by equipment, vehicle traffic, industrial machinery, hazardous chemicals and contaminants, and/or other physical, mechanical, and chemical hazards.
- Prior to mobilization, identify the location of wells and evaluate the need for security, barricading, and/or traffic control (e.g., when wells are located in driveways or on the right of way).
- At sites with certain contaminants and/or subsurface conditions, potentially toxic and/or explosive gases may accumulate at and around the well as it is being tested. Stay upwind of the well and ensure that air monitoring is conducted, and personal protective equipment is used in accordance in the site-specific HASP.
- Keep any tether, or suspension lines untangled. Use a plastic winder or spool winder to retrieve the slug to keep the line from tangling.
- When working out of sight of the general public or when site employees are in potentially hazardous areas (e.g., wooded habitats), field staff should use the "buddy system" and should ensure that the project-specific HASP includes safety measures and procedures for work in isolated areas.
- Care should be taken when opening well protective covers and removing well caps for the presence of venomous spiders and insect nests, such as wasps or hornets.
- For some wells, well keys may not work with rusted/outdated well locks. Bolt cutters may be used to remove the lock, which should be replaced upon completion of well

testing. Do not use petroleum-based solvent sprays to free seized locks as it may impact water quality in the well. Replace any damaged locks.

- Wells with a water-tight cap may experience a buildup of pressure or may be under vacuum. Keep your face and body away from the top of the well when loosening or removing the cap and allow the water level to stabilize before recording the static depth to water.
- Operate electronic water level meters and transducers in accordance with the manufacturer's instructions and recommendations.
- When multiple transducers are used, recording the model and serial number of each transducer and synchronizing their time encoding with the field computer or mobile device can help identify problems with a specific unit during data processing should they arise.
- Do not delete the data from the transducer until the presence of a copy of the slug test data is confirmed. Practice using the program in the office by taking measurements and downloading data before setting up on the well in the field.
- At sites where the density of water may vary or may be denser than fresh water, the effects of water density should be considered in the slug test design (refer to **FGD 6.22**, Groundwater Sampling - Transducers).
- Any movement of the slug or the transducer once it has been lowered into the well will create erroneous data and may give inaccurate results.
- Confirm each well was properly developed, especially wells within clay units. During well installation, the clay unit can smear, and reduce the effective hydraulic conductivity.
- If the well has not been sampled or developed in a long time, discuss the necessity to redevelop wells prior to commencing the slug test. Allow wells 48 hours to equilibrate prior to slug testing.
- Note any odors, staining, organic matter, or sediment on the slug or other equipment prior to decontaminating equipment. These may cause a change in the measured conductivity.
- Be aware of active wells or pump areas which could influence the measured conductivity.
- Be aware of the local geology when estimating how much time a slug test may take. For example, a test in a clay soil environment may take an entire field day to complete. Alternatively, a test conducted in a well set in a sand and gravel aquifer may be completed in less than one minute.

6. RECORDKEEPING

Document all testing locations in accordance with **FGD 1.04** (Documenting Sampling Locations) and record all information related to slug testing in accordance with **FGD 1.01** (Field Notes and Records) and **FGD 1.03** (Data Management).

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ATTACHMENT A
TYPICAL HYDRAULIC CONDUCTIVITY VALUES

Typical Hydraulic Conductivity Values

Aquifer Material	Extreme Kmin, ft/d	Likely Kmin, ft/d	Likely Kmax, ft/d	Extreme Kmax, ft/d	Rock Type
Gravel	90	300	3000	3000	Unconsolidated Sedimentary Rock
Sand and Gravel Mixes	1	30	300	300	Unconsolidated Sedimentary Rock
Coarse Sand	50	70	300	300	Unconsolidated Sedimentary Rock
Medium Sand	1	20	70	200	Unconsolidated Sedimentary Rock
Fine Sand	0.05	3	20	20	Unconsolidated Sedimentary Rock
Gulf Coast Aquifer Systems (6603 values)	2	30	200	800	Unconsolidated Sedimentary Rock
Stream Terrace Deposit, Fort Worth, Texas (59 values)	0.01	1	100	300	Unconsolidated Sedimentary Rock
Surficial Aquifer, central Florida (fine sand and silt, 55 values)	0.01	0.1	30	50	Unconsolidated Sedimentary Rock
Silt, Loess	0.0003	0.001	0.1	6	Unconsolidated Sedimentary Rock
Till	3E-07	0.003	0.3	0.6	Unconsolidated Sedimentary Rock
Clay soils (surface)	0.01	0.01	1	1	Unconsolidated Sedimentary Rock
Clay	0.000001	0.00001	0.0001	0.001	Unconsolidated Sedimentary Rock
Unweathered Marine Clay	2E-07	2E-07	0.0006	0.0006	Carbonate Rocks
Karst	0.3	10	1000	10000	Carbonate Rocks
Reef Limestone	0.3	10	1000	6000	Carbonate Rocks
Limestone, Dolomite	0.0003	0.004	0.1	2	Carbonate Rocks
Fine-Grained Sandstone	0.0001	0.001	1	6	Indurated Sedimentary Rock
Medium-Grained Sandstone	0.001	1	10	80	Indurated Sedimentary Rock
Siltstone	0.000001	0.00001	0.005	0.04	Indurated Sedimentary Rock
Claystone	3E-09	0.000001	0.00001	0.00003	Indurated Sedimentary Rock
Anhydrite	1E-07	1E-07	0.006	0.006	Indurated Sedimentary Rock
Shale	1E-08	1E-07	0.0001	1	Metamorphic or Volcanic Rock
Permeable Basalt	0.1	1	100	6000	Metamorphic or Volcanic Rock
Fractured Igneous and Metamorphic Rock	0.001	0.05	10	100	Metamorphic or Volcanic Rock
Weathered Granite	0.1	1	10	20	Metamorphic or Volcanic Rock
Weathered Gabbro	0.1	0.1	1	1	Metamorphic or Volcanic Rock
Basalt	0	0.03	0.1	0.1	Metamorphic or Volcanic Rock
Unfractured Igneous and Metamorphic Rock	0	9E-09	0.00006	0.00006	Metamorphic or Volcanic Rock

To convert ft/day to cm/sec divide table value by 2834.65

Source: Halford, K.J. and Kunianksy, E.L., 2002, Documentation of Spreadsheets for the Analysis of Aquifer Pumping and Slug Test Data: USGS OFR 02-197.

ATTACHMENT B
SLUG TESTING DATA ACQUISITION FORM

In-Situ Hydraulic Conductivity Testing (Slug Testing) Log

RAMBOLL

Well ID: _____
Northing: _____
Easting: _____

Site Name: _____ Field Personnel: _____ Start Date: _____
Site Location: _____ End Date: _____
Project #: _____ Weather: _____

Well Information:

Initial Static DTW (ft bmp): _____
Final Static DTW (ft bmp): _____
Reported Depth (ft bmp): _____
Measured Depth (ft bmp): _____
Well Dia. (inches): _____
Borehole Dia. (inches): _____
LWC (ft): _____
Well Condition Notes: _____

Lithology: _____
Screen Int. (ft bmp): _____ - _____
Screen Length (ft): _____
Slot Size (inches): _____
Submerged Screen*: _____
Filter Pack Grade: _____
Annular Seal Desc.: _____

Transducer Information:

Type: _____
Transducer S/N: _____
Model #: _____
Pressure Rating: _____
Transducer Depth†: _____ Ft H_2O
Pressure Rating: _____

Barometric Transducer:

Type: _____
Model #: _____
S/N: _____

Measurment Point (MP)	Slug Information	Data Storage (DS)
MP Type:	Slug Type:	Device Type:
MP Elev. (ft amsl):	Length (ft):	Device S/N:
	Diameter (inches):	Software:
	Disp. (feet H_2O):	

Test 1

☐ Falling Head ☐ Rising Head
Maximum Head Change (ft): _____
Recovery % (95% Optimal): _____
Manual DTW (ft bmp): _____
Transducer DTW (ft bmp): _____
Recording Interval: _____
Time Start: _____
Time End: _____
File Name: _____

Test 2

☐ Falling Head ☐ Rising Head
Maximum Head Change (ft): _____
Recovery % (95% Optimal): _____
Manual DTW (ft bmp): _____
Transducer DTW (ft bmp): _____
Recording Interval: _____
Time Start: _____
Time End: _____
File Name: _____

Test 3

☐ Falling Head ☐ Rising Head
Maximum Head Change (ft): _____
Recovery % (95% Optimal): _____
Manual DTW (ft bmp): _____
Transducer DTW (ft bmp): _____
Recording Interval: _____
Time Start: _____
Time End: _____
File Name: _____

Test 4

☐ Falling Head ☐ Rising Head
Maximum Head Change (ft): _____
Recovery % (95% Optimal): _____
Manual DTW (ft bmp): _____
Transducer DTW (ft bmp): _____
Recording Interval: _____
Time Start: _____
Time End: _____
File Name: _____

* If **no** perform rising head test only.
†1 psi = 2.31 feet of H_2O / 1 inch H_2O = 0.03609 psi

DTW = Depth to Water
LWC = Length of Water Column

ET = Elapsed Time
SN = Serial Number

Notes: _____

ATTACHMENT C
SLUG TESTING EQUIPMENT

Figure 1: Water Level Meter

Source: https://www.solinst.com/

Electronic Water Level Meter

A measuring tape with a conductive probe at the zero mark to detect the depth to water in a well or borehole.

Pressure Transducer/Water Level Transducer

Water level transducers are self-contained units that can store temperature and water level measurements over an extended period of time. The pressure transducer should be submerged to a predetermined depth sufficiently below the top of the water column to avoid interference with the slug. Allow the transducer 15 to 20 minutes to thermally equilibrate before initiating a slug test.

Figure 2: Pressure Transducer/ Water Level Logger

Source: https://www.solinst.com/

Figure 3: Direct Read Cable

Source: https://www.solinst.com/

Direct Read Cable

The direct read cable allows for the real-time retrieval of data from the transducer. It can also be used to download and program the transducer in the field without removing the transducer from the water. The cable may have a USB port to allow communications with a PC or other communications device. Allow the transducer cable 15 to 20 minutes to stretch after deploying the transducer before initiating a slug test.

Figure 4: Slug Suspension Stand

Slug Suspension Stand

Controls the placement of the slug in a well. A stand is helpful for testing wells with high depth to groundwater or large diameter wells requiring large volume slugs.

Slug

Solid slug of polyvinyl chloride (PVC) or other relatively inert material of appropriate diameter and length to produce desired initial water level displacement. Slugs can be custom constructed or rented.

Figure 5: Slug

ATTACHMENT D
IN-SITU INC., PNEUMATIC SLUG TESTING TECHNICAL NOTE

Pneumatic Slug Testing Using the Level TROLL® 700

October 2011

Introduction

Hydraulic Conductivity

Estimating hydraulic conductivity (K) in groundwater is necessary in hydrologic investigations. Accurate hydraulic conductivity values are fundamental for complete site characterization, for planning and designing further test programs, and can be especially important for remediation applications.

Benefits of Slug Testing

Slug testing is one of the most common methods for field determination of hydraulic conductivity. Its conventionality is due to a number of advantages over other methods. Slug testing:

- Uses minimal equipment that is inexpensive to buy or rent, lowering total costs
- Can be performed by a single individual, who can perform multiple tests in a short period of time
- Involves a simple procedure and the equipment is easy to operate
- Does not produce wastewater or disposal problems
- Can be performed where pumping is prohibited
- Is appropriate in "tight" aquifers where pumping would cause the well to go dry
- Is useful in low conductivity environments where it may not be practical to perform a constant-rate pumping test
- Can be implemented in a series of wells so that horizontal and vertical variations in the transmissive and storage properties of a formation can be determined
- Determines hydraulic conductivity for each well tested. The spatial variability of this parameter across the site is useful for numerical modeling and designing subsequent multi-well aquifer pumping tests. *This is especially useful for remediation.*

Slug Test Variations

Conventional Slug Tests

A conventional slug test artificially raises or lowers the water level in a well bore from its normal static water level (SWL) by injecting or removing a known volume. The recovery of the water level to its original state is measured.

Tests employing a sudden rise in water level by injecting a volume are referred to as falling-head, slug, slug-in, and injection tests. Tests employing a sudden drop in water level by removing a volume are referred to as rising-head, bail-down, bailer, slug-out, and withdrawal tests. Both types can be referred as response tests. The accuracy of the collected data is highly dependent upon the slug in/out event being nearly instantaneous. Refer to Figure 1 for a diagram of a slug-in test.

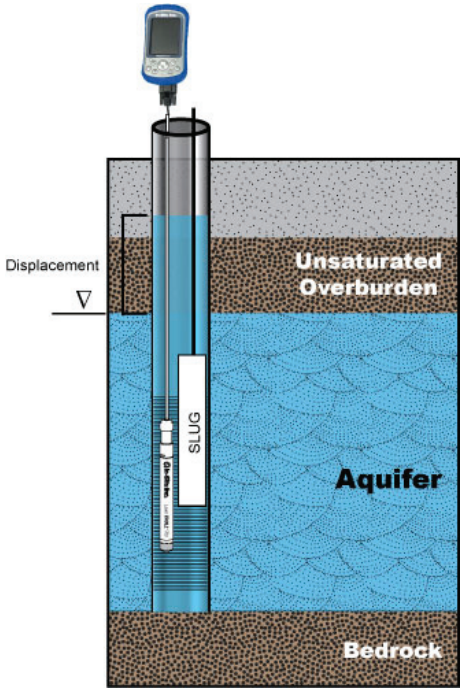

Figure 1. Example of a conventional slug-in test

Problems arise in traditional slug tests due to the physical insertion or removal of a slug. The initial slugging event can cause significant "noise" in early data because of the wave caused by the slug. The amount of displacement can be small, and even this small displacement may require a bulky slug. Slugs may be difficult to maneuver in well casings, can disturb the pressure instrument, and can create false data. Physical slugs can cause cross-contamination of wells, or regulations may prohibit injection slugs. Finally, manual insertion or removal of a slug can be extremely difficult to perform in a nearly instantaneous manner.

Pneumatic Slug Tests

Pneumatic slug testing is an apt solution to these problems. Pneumatic slug tests use pressurized air or nitrogen as the slugging agent. The well is sealed, and the water column is pressurized. As the pressure increases, the water level drops and water is forced out of the column and into the aquifer. The level drops until the pressure of the water head is equal to the increased air pressure in the well. Once equilibrium is attained, the pressure is instantaneously released and the water level begins to return to the SWL. Figure 2 depicts the water level changes of a pneumatic slug test.

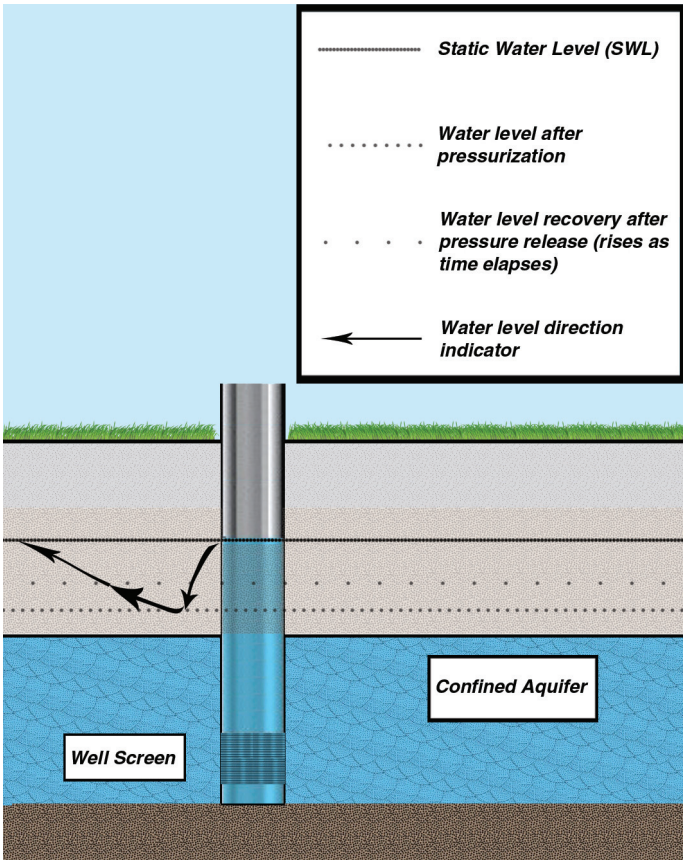

Figure 2. Water level changes during a pneumatic slug test

Benefits of Pneumatic Slug Testing

Pneumatic slug testing does not add noise to the data or disturb equipment in the well. The amount of displacement can be altered *in situ*. A pneumatic slug test eliminates cross-contamination of wells, reduces equipment contact with water that may be hazardous, and allows testing where a traditional slug test may be prohibited. While initial equilibration can take time in a pneumatic test, the slugging event is nearly instantaneous.

Completing a Pneumatic Slug Test

Well-head Assembly

In order to conduct a pneumatic slug test, a special well-head apparatus must be procured. Refer to Figure 3 for a diagram of a pneumatic slug test well-head assembly.

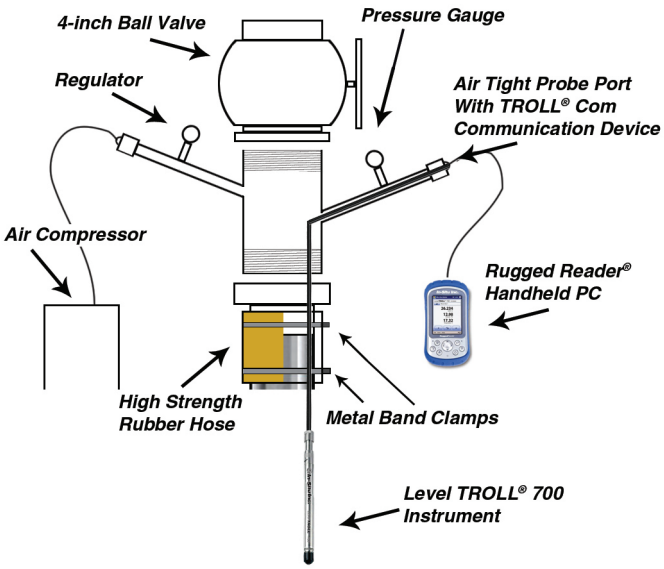

Figure 3. Example well-head assembly schematic

Crucial design elements include:

- A quick-release ball valve at the top of the unit that is of equal or larger diameter to the well head
- A ball valve orientation that, upon opening the valve, allows air to flow straight through the entire unit without encountering corners
- A probe insertion port that does not interfere with air flow and tightly seals around the instrument cable
- A pressure gauge and regulator that monitor and maintain constant air pressure in the column
- A base that can accommodate 2-inch or 4-inch wells, and can be easily installed and sealed
- An air compressor

Conducting a Pneumatic Slug Test

Two measurements must be made prior to conducting a pneumatic slug test. First is the depth of the SWL. You can determine the depth to the SWL by using an In-Situ® Rugged Water Level Tape. The second measurement is the depth from the SWL to the top of the well screen. You should consult the driller's log to determine the depth to the top of the screen.

IMPORTANT: The amount of pressure applied to the water column must not depress the SWL to the top of the screen. If the water level falls below the screen, gas can inadvertently be injected into the formation and cause the hydraulic conductivity value to be much lower than the actual value (Levy et al. 1993). If the SWL is too close to the well screen, a pneumatic slug test may not be practical.

When you have determined the distances and the maximum amount of pressure that can be applied, you can install the well-head assembly.

Once the assembly is installed, you will need to program the monitoring instrument. In-Situ® Inc. recommends the Level TROLL® 700 Instrument, which offers a true logarithmic sampling mode for precise water level measurements. True logarithmic sampling is ideal for pneumatic slug testing. True logarithmic sampling measurements are logged quickly at the beginning of the test, and are gradually taken further apart on a logarithmically decaying schedule until they become linear. In a slug test, the initial slug event causes a rapid change in water level, but as the level equilibrates the change becomes less substantial. You can use Win-Situ® 5 or Win-Situ Mobile Software to set the level reference to zero to accurately measure the change from the initial condition.

Program the data log to start prior to column pressurization in order to capture the original SWL and determine the elapsed time to column pressurization.

With the Level TROLL 700 log running, you can begin pressurizing the well. A pressure equivalent of two to eight feet (0.6 to 2.4 m) of water is recommended, but do not exceed the previously determined maximum to the well screen. Allow the pressure in the well to stabilize as determined by the pressure gauge on the well-head assembly. Once equilibrium is reached, the test may commence. You will need to restart the log in order to resume taking readings at the highest sampling rate. Then release the ball valve and monitor the rise in water level. Once the level has reached the previously determined SWL, the test is complete. The Level TROLL 700 logs test data from which you can create a recovery curve graph. The data can be analyzed to calculate the hydraulic conductivity of the aquifer in that location. See Figure 4 for a sample recovery graph (**NOTE**: Graph is for illustration purposes only).

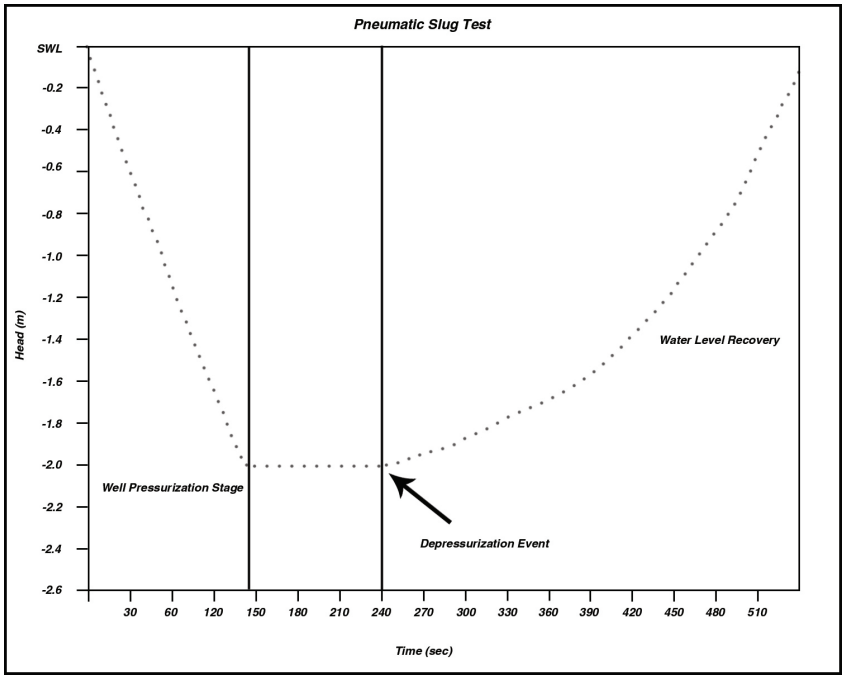

Figure 4. Example data plot of water level recovery

Conclusion

A pneumatic slug test may be the best way to determine hydraulic conductivity. In-Situ® Inc. can provide all of the monitoring equipment necessary for a pneumatic slug test, either as rental equipment or for purchase. The Level TROLL® 700 and Win-Situ® 5 or Win-Situ® Mobile Software provide industry-leading data logging and data management capabilities, and the Rugged Reader® Handheld PC allows for increased mobility in the field.

References

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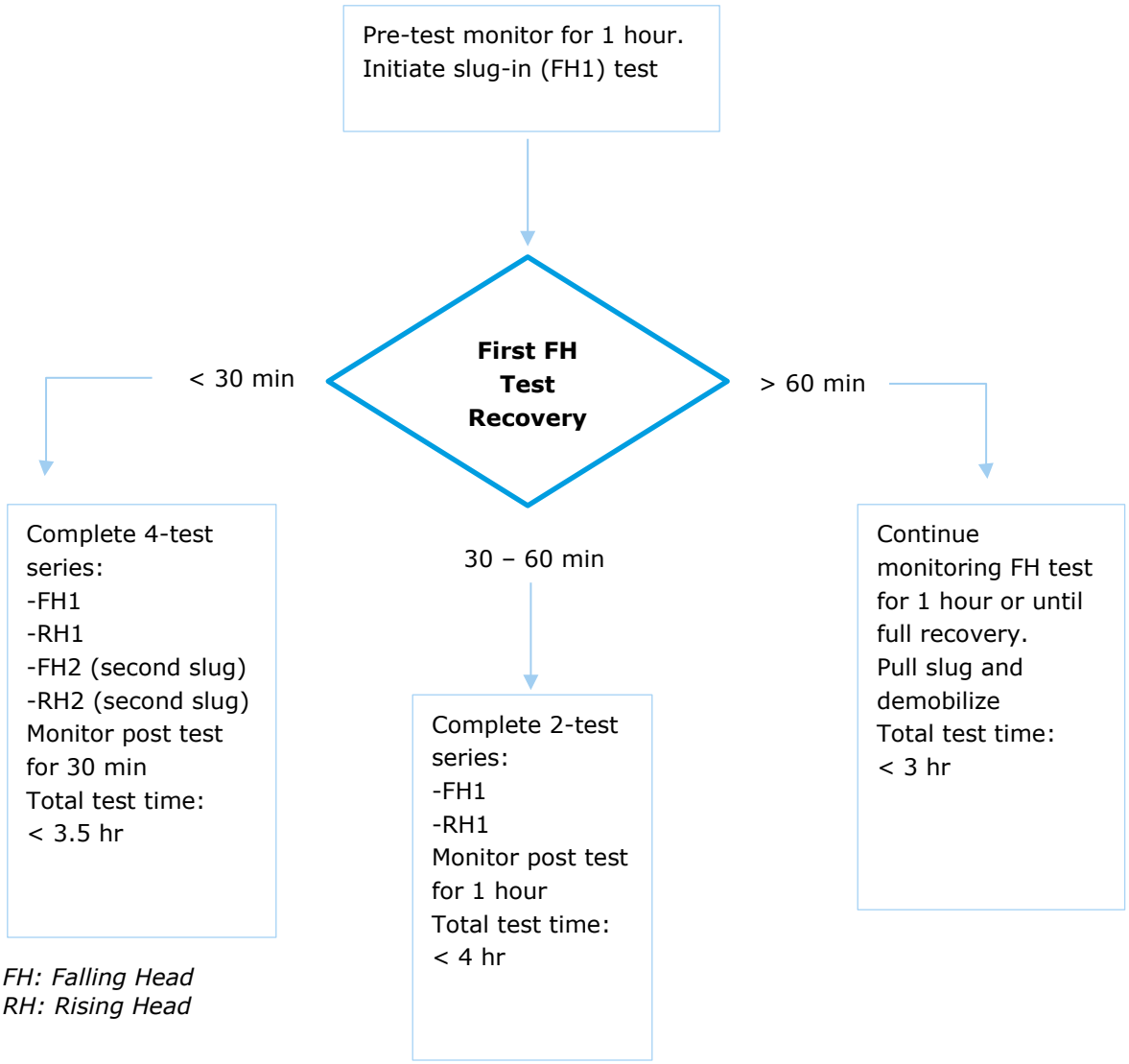
Zemansky, G.M, McElwee, C.D. 2005. High-resolution slug testing. Ground Water. 43: 222-230. DOI: 10.1111/j.1745-6584.2005.0008.x

For more information, contact In-Situ Inc.
221 East Lincoln Avenue, Fort Collins, CO 80524
1-800-446-7488 (toll-free in U.S.A. & Canada)
1-970-498-1500 (international & domestic)
www.in-situ.com

October 2011/rev. 03

ATTACHMENT E
MULTIPLE SLUG TEST DECISION GUIDELINE

Multiple Slug Test Decision Guideline - Physical Slugs



FH: Falling Head
RH: Rising Head

ATTACHMENT F
SLUG TEST DATA PROCESSING AND ANALYSIS

Following completion of the field tests and prior to analyzing the results of slug tests, the parameters necessary for data analysis (well name, test date, test type (rising vs falling head), well construction details, slug used and its dimensions, predicted initial displacement, and pre-test water level measurements) must be tabulated, the transducer records from slug tests must be processed, and the data inspected to identify the test initiation points and static water levels.

F1.1 Data Processing and Analysis

Computer programs, such as AQTESOLV, AquiferTest Pro, AquiferWin32, and the USGS Spreadsheets for the Analysis of Aquifer-Test and Slug-Test Data (Version 1.2) are readily available tools for analyzing slug testing data. These programs utilize numerical solutions to analyze results from slug tests, including Cooper et al (1967), Bouwer and Rice (1976) and Kansas Geological Survey (KGS; Hyder et al 1994) solutions. The analysis procedure involves fitting curves to plots of normalized head (displacement divided by initial displacement) versus elapsed time and should be done by an experienced hydrogeologist or engineer. The decision trees presented below may be used to select an appropriate model for a slug test given the test conditions. The most typical slug tests analyses are described briefly below:

- The *Cooper model* is useful for estimating the hydraulic properties (transmissivity and storage coefficient) of nonleaky confined aquifers or where the screen is below the water table in an unconfined aquifer. Analysis involves matching a type curve to head displacement data from an overdamped slug test.
- The *Bouwer and Rice model* is the most widely used method to analyze tests conducted in wells screened across the water table. To account for filter pack drainage, the model must be modified to use the effective casing radius (effective radius is an empirical factor and is not from measurements in the field), rather than the nominal casing radius (Butler, 2014). A straight line should fit to the formation response portion of the plot in the 0.2 to 0.3 normalized head range (relative to the effective initial displacement of the formation response phase).
- The *KGS model* is often used to estimate hydraulic conductivity for slug tests conducted in fully and partially penetrating wells in confined and unconfined aquifers. The KGS model estimates both hydraulic conductivity and specific storage and can be used to identify whether a well is affected by insufficient development (i.e. presence of a well skin).

If the observed aquifer responses to multiple slug tests on a well with varied initial displacements seem to be dependent upon the magnitude initial displacement used for each test, it suggests mechanisms beyond those considered in the standard linear models (e.g., Bouwer and Rice, KGS) are affecting the response data, and an alternative model should be selected (Butler, 2010) by an experienced hydrogeologist or engineer.

In situ hydraulic conductivity tests interpretations are not unique. Incorrect assumptions of the conditions, which affect the test, will provide results that do not accurately reflect site conditions. Therefore, care must be taken to appropriately identify the conditions of the test, select the analytical model for interpretation, and selection of input parameters.

F1.2 Evaluation Considerations

Well construction information (i.e. well ID, well depth, well and borehole diameter, and screen and filter pack length) can typically be found on well completion diagrams or well construction summary tables. In instances where a well screen or filter pack are partially saturated, the screen or filter pack length should be equivalent to the saturated thickness of each.

The effective radius (Re) for hydraulic conductivity test is typically localized around the test well borehole. Rovey and Cherkauer (1995) summarized differing estimates for the effective radius of slug tests from 1.5 to 3 feet to 25 times the well bore radius. If the water level is below the top of the screen in formations which are finer grained than the sand pack, the well radius used must consider the borehole diameter and the porosity of the sand pack. The Re can be calculated using the following equation:

$$R_e = [r_c^2 \times (1 - n)] + \sqrt{n(r_w^2)}$$

Where:

R_e = effective well radius (length)

r_c = radius of the well casing (length)

r_w = radius of the borehole (length)

n = filter pack porosity (dimensionless)

For generally homogeneous aquifers, the portion of the aquifer influenced during the test is generally limited to the interval immediately adjacent to the filter pack or open portion of the borehole. In this case, the aquifer thickness can be considered equivalent to the saturated filter pack thickness.

For aquifers where the hydraulic conductivity of the materials surrounding a well screen may vary by multiple orders of magnitude, the groundwater flux to or from a well during a hydraulic conductivity test will dominantly occur through the most transmissive materials. For example, in a fractured carbonate/crystalline bedrock or significant layering of fine and coarse-grained soils the hydraulic conductivity of the rock matrix or fine-grained soils will likely be orders of magnitude lower than the fractures or coarse-grained soils. As a result, the hydraulic conductivity of the fractures or coarse-grained soils will be higher than the bulk hydraulic conductivity calculated over the open interval of the well. The following formula should be employed to estimate the hydraulic conductivity of the coarse-grained layers:

$$K_s = \frac{K_b}{s_{\%}}$$

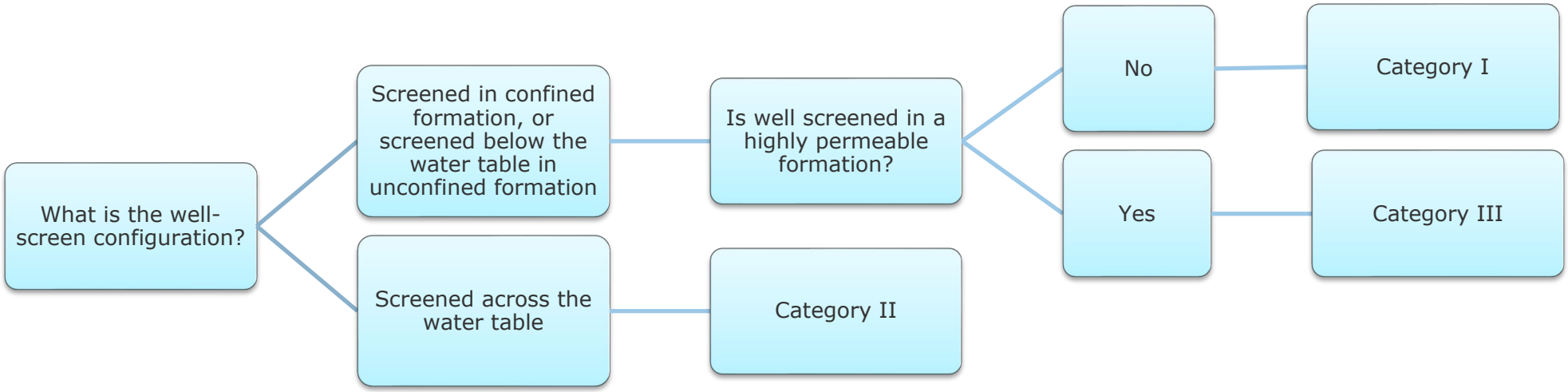
Where:

K_s = hydraulic conductivity of the more permeable materials,

K_b = bulk hydraulic conductivity of the open interval of the well, and

$S_{\%}$ = percent thickness of the more permeable materials within the open interval of the well.

SELECTION OF TEST CATEGORY*



**Does not cover fractured formations. See Butler (1998) or Shapiro & Hsieh (1998) for additional details*

CATEGORY I ANALYSIS

Analyze data with Cooper et al. model for tests in fully penetrating wells

Can a good fit be obtained using a physically plausible storage estimate?

- Yes → The hydraulic conductivity (K) can be estimated from the transmissivity value (T) and aquifer thickness (L_e), using $K = T/L_e$
- No → Is the well fully or partially penetrating?
  - Fully → Test may be affected by insufficient development or double-porosity flow, see Butler (1998) for details
  - Partially → Test may be affected by vertical flow above or below the screened interval → Analyze the data with the KGS model for tests in partially penetrating wells → Can a good fit be obtained using a physically plausible storage estimate?
    - Yes → The hydraulic conductivity estimate should be reasonable
    - No → The test may be affected by insufficient development, see Butler (1998) for details

Example of KGS model analysis for a slug test conducted in an unconfined aquifer

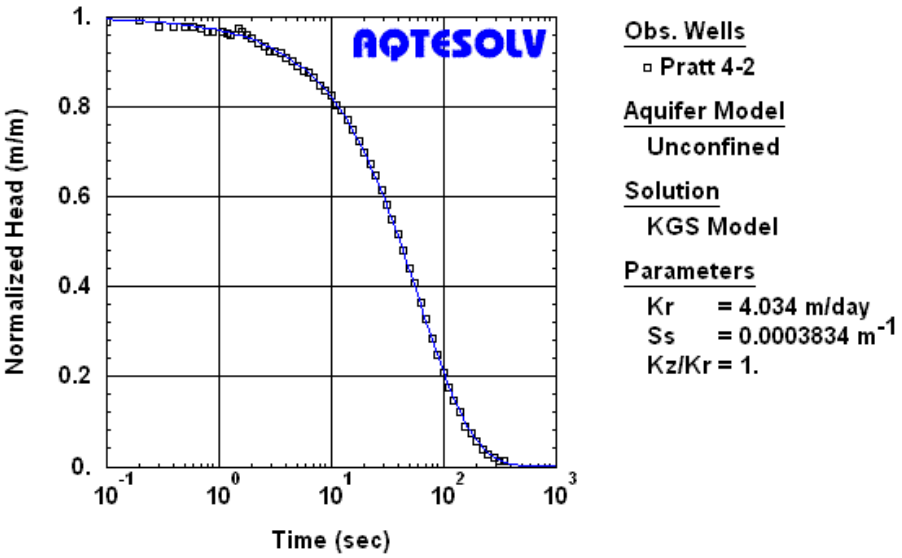
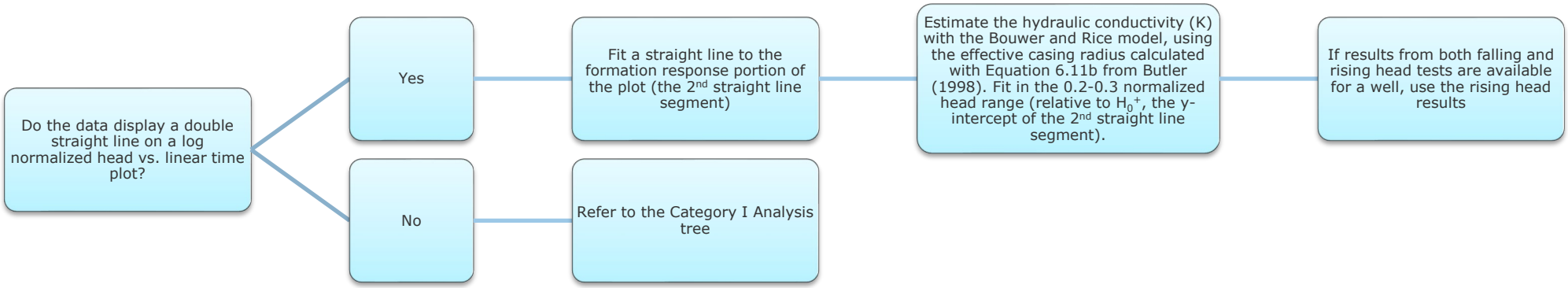


Image from: http://www.aqtesolv.com/slug_test_analysis.htm

CATEGORY II ANALYSIS



Example of Bouwer and Rice model analysis for a slug test conducted in a well screened across the water table

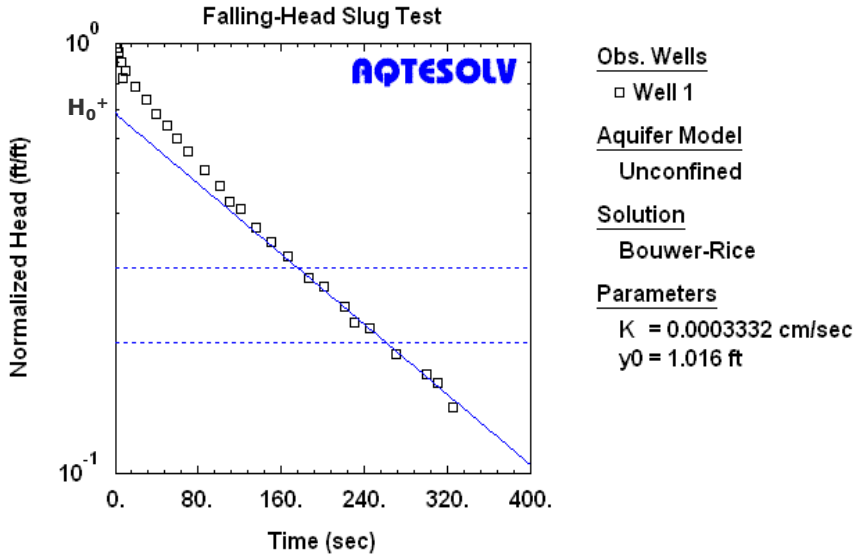
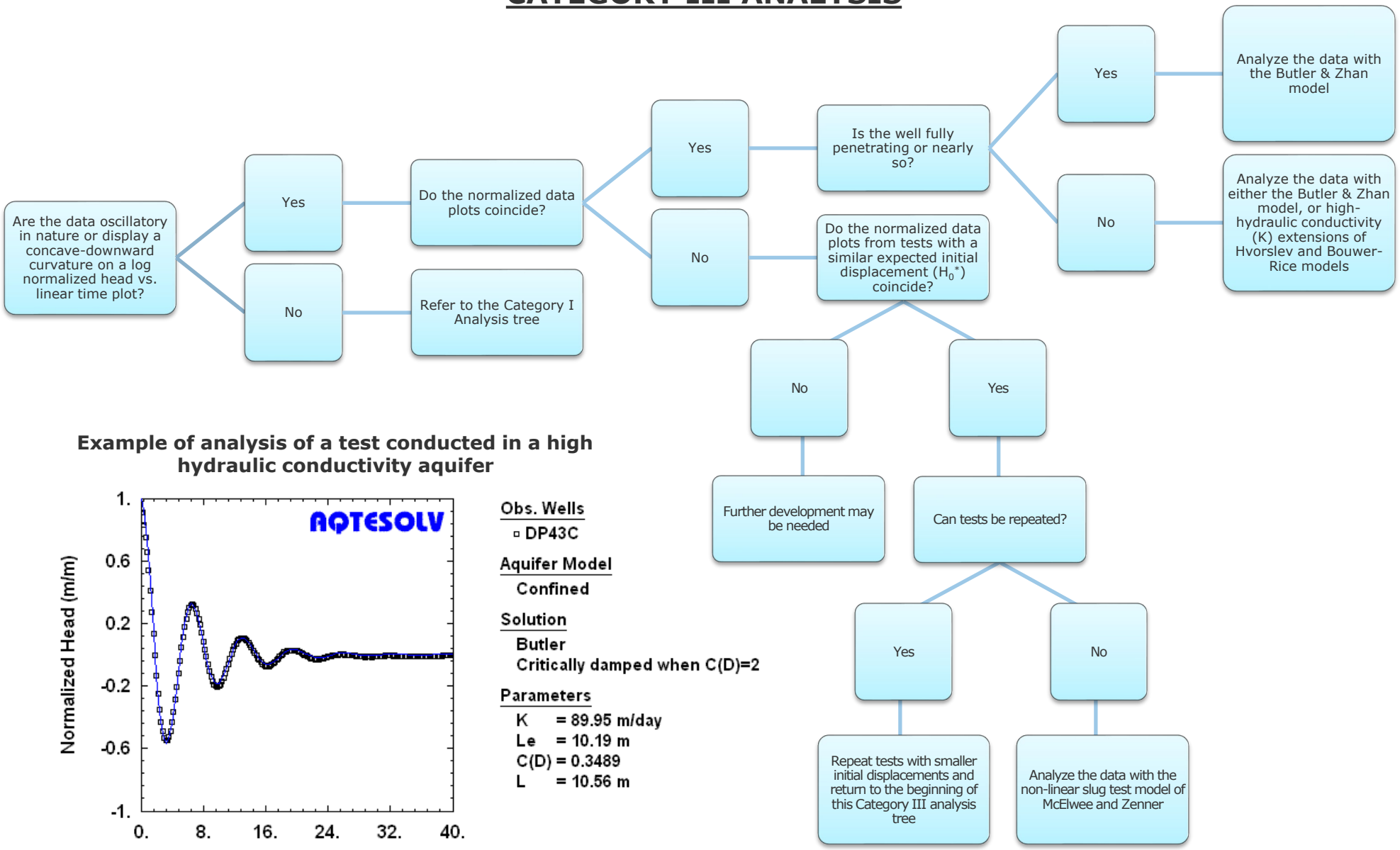


Image from: http://www.aqtesolv.com/slug_test_analysis.htm

CATEGORY III ANALYSIS



Example of analysis of a test conducted in a high hydraulic conductivity aquifer

Obs. Wells
- DP43C

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=2

Parameters
K = 89.95 m/day
Le = 10.19 m
C(D) = 0.3489
L = 10.56 m

Image from: http://www.aqtesolv.com/slug_test_analysis.htm

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- Butler, J. J. 1998. The Design, Performance, and Analysis of Slug Tests.
- Butler, J. J. 2010. Duffield G. F., and Kelleher D. L. Field Guide for Slug Testing and Data Analysis. Midwest Geosciences Group.
- Duffield, G.M., 2007. AQTESOLV for Windows Version 4.5 User's Guide, HydroSOLVE, Inc., Reston, VA

FIELD GUIDANCE DOCUMENT NO. 6.07

WELL DEVELOPMENT

RAMBOLL ENVIRON

FIELD GUIDANCE DOCUMENT NO. 6.07

WELL DEVELOPMENT

Prepared By:	Chris Buzgo Taryn Correll Melanie Charles
Peer Reviewed By:	Jose Sananes Jessica Donovan Michael Wilson Robert Patchett Sarah Stoneking Ryan Keeler John Noble David Heidlauf Amy Caron Nestor Soler Carol Serlin
Approved By:	J. Mark Nielsen
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1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll Environ for the development of newly constructed groundwater wells and existing wells being rehabilitated. Well development is a critical step in the construction of a well and is necessary before the well can be used in environmental and hydrogeologic investigations (e.g., groundwater sampling, water level monitoring, withdrawal tests, and injection tests). Well development is also used in the rehabilitation of wells which may have been in disuse over long periods of time and/or have accumulated silt.

Well development refers to the process of clearing the well and formation around the screen of fine-grained materials such as fine sands, silts, and clays, produced during drilling or naturally occurring in the formation. Well development is conducted to create an effective filter pack, allowing for establishment of a good hydraulic connection between the well and the formation so as to allow water to flow more freely to the well.

Typical well development methods include bailing, overpumping, mechanical surging, air-lift surging, and water jetting. The appropriate well development method is selected on the basis of well design, well depths, lithology, and other project requirements. The simplest method of removing fines from water-bearing formations is by a process of overpumping during which water is removed from the well at a higher rate than used for normal service of the well (e.g., purging prior to sampling). Effective development should cause reversals of flow through the well screen so as to agitate the sediment, remove the finer fraction from the well pack, and to rearrange the well pack. This FGD focuses on the most common well development method- mechanical surging with bailing and pumping to force water into and out of the well screen interval by operating a plunger up and down in the casing, similar to a piston in a cylinder.

Although this FGD provides guidelines for well development using mechanical surging with bailing and pumping, other well development methods may be more appropriate for specific site conditions or types of wells (e.g., bedrock wells, multiple nested wells installed within a single borehole, artesian wells, deep water production wells with more than one screened interval, and wells with the potential presence of a Non-Aqueous Phase Liquid (NAPL)) or may be specified by state-specific or regulatory program-specific guidelines, requirements or procedures. In general, well development procedures that include adding water or other fluids to the well and have the potential to impact groundwater quality are not recommended. Sometimes, depending upon well type depth and lithology, a combination of different methods may be needed.

Site-specific and state/regulatory requirements, for well development should be reviewed by the Ramboll Environ Principal-in-Charge / Project Director (PIC) and Project Manager (PM) and any additional requirements defined in a project-specific Work Plan, and/or sampling plan. It should be emphasized that these guidelines are not meant to be project-specific work plans but rather a general reference for developing project specific requirements.

It should be noted that this FGD does not supersede Ramboll Environ Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP

shall prevail. All Ramboll Environ employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP, followed by procedures recommended in this FGD. The Ramboll Environ PIC and PM shall ensure that all project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information is maintained in the project file for the duration of the project. The signatures of the PIC and PM indicate approval of the methods and precautions outlined in the HASP.

2. EQUIPMENT / MATERIALS

Below is a general checklist of equipment that may be required for well development efforts. This checklist only suggests general equipment that may be necessary for a project or task and should not be considered exhaustive. Where licensed drillers are required to develop wells, the drilling contractor will generally supply the equipment and materials necessary for well development. Additional equipment may be specified in the project-specific HASP.

1. Well Development Equipment Checklist

   - Either a surge block and cable, bailer or Waterra® inertial lift development valve and tubing (or similar). A surge block consists of a plunger made of PVC or rubber attached to a rod or pipe and connected to a cable of sufficient length to reach the bottom of the screen. Bailer (generally, can be supplied by the drilling contractor). Bailers are typically non-dedicated, bottom suction bailers constructed of stainless steel and attached to the cable in the same manner as the surge block;
   - Appropriate pump and associated polyethylene tubing and power source, such as a marine battery or portable generator;
   - Electronic water level indicator or interface probe (refer to **FGD 6.04**, Groundwater and Free Product Level Measurements);
   - Turbidimeter, multi-probe water quality meter, and flow-through cell;
   - Decontamination equipment (refer to **FGD 14.02**, Equipment Decontamination);
   - Trash Bags - used to dispose of gloves and any other non-hazardous waste generated during well development (refer to **FGD 15.01**, Waste Handling);
   - 55-gallon steel drums or other appropriate waste containers supplied by drilling contractor unless specialized containers are required) - used to dispose of any Investigation Derived Wastes (IDW) including well development water and/or decontamination wastes (refer to **FGD 15.01**, Waste Handling);
   - Equipment (i.e., disposable bailer, cooler) and sample containers for collecting IDW characterization sample(s);
   - Plastic sheeting;
   - Well keys;
   - Personal Protective Equipment and field screening equipment in accordance with the site-specific HASP;
   - Site information (maps, contact numbers, previous field logs, etc.);

- Well design and construction information such as well logs, construction specifications, and diagrams.
- Field notebook and all-weather or permanent pens as outlined in **FGD 1.01** (Field Notes and Records);
- Labels for Investigation Derived Waste (IDW) containers as outlined in **FGD 15.01** (Waste Handling); and
- General hand tools for opening and closing protective well covers and 55-gallon drums.

2. Additional Suggested Equipment
   - Road and site maps;
   - Camera and extra batteries;
   - Weighted, calibrated measuring tape;
   - Clipboard/field case; and
   - Calculator.

3. PROCEDURES REFERENCED

The following FGDs are related to this FGD and should be referenced, as needed:

- **FGD 1.01**, Field Notes and Records;
- **FGD 1.03**, Data Management;
- **FGD 4.06**, Equipment Calibration;
- **FGD 6.01**, Permanent Overburden Well Installation;
- **FGD 6.04**, Groundwater and Free Product Level Measurements;
- **FGD 6.05**, Permanent Bedrock Well Installation;
- **FGD 6.06**, Temporary Overburden Well Installation and Sampling;
- **FGD 6.15**, Well Construction Record;
- **FGD 14.01**, Sampling Equipment Decontamination; and
- **FGD 15.01**, Waste Handling.

The list above is not intended to be all inclusive. Other FGDs and Standard Practice Instruction (SPI) may need to be referenced based on the specific requirements of the site-specific Work Plans/sampling plan (e.g., field screening FGDs, FGDs for sampling of media, etc.).

4. PROCEDURES

4.1 Well Development Methods and Planning Considerations

Well development is a critical step in the installation of a well (refer to well installation FGDs) and is also used in the rehabilitation of wells. In certain States, the development or rehabilitation of a well is to be performed by contractors licensed as a water or environmental well driller (as appropriate) in the State where the work is being performed. Therefore, State regulations and guidance governing well development should be consulted prior to conducting the work. In addition, local Ramboll Environ staff should be contacted for any other regional or local requirements.

The method used to develop wells is dependent upon site-specific subsurface conditions, equipment availability, well design and well accessibility. Similarly, the volume of water to be removed for well development can depend on the radius or zone of influence of the well and how the well was constructed (e.g., duration and drilling method). Thus, prior to well development, available well construction details and information on the local geology and hydrogeology should be compiled and reviewed. The complexity of the well construction, the local geology, and the presence and the risk of aquifer contamination are also factors to consider in planning the development of a well. If water or other fluids were added to the well during construction (e.g. rock coring or fluid rotary), at least the amount of water lost to the borehole during drilling shall be removed from the well during development. If the well was installed via mud-rotary drilling methods, well development should occur immediately following well installation if possible, otherwise removal of a mudcake filter pack may be problematic. For other drilling methods, well development should occur at least 48 hours after well installation to allow the grout sufficient time to cure. However, if grout is not used to seal the well (e.g., hydrated bentonite chips), well development could occur within several hours of well installation.

Generally, pumping a well until the water runs clear is not an effective or proper well development method, since the one-directional high-stress flow may cause bridging of formation soils and filter pack materials. Appropriate well development methods include mechanical surging with bailing or pumping, over pumping, air lift pumping, and jetting. Following are general guidelines for the most common well development method, mechanical surging with bailing and pumping.

4.2 Pre-Field Work Preparation Guidelines

Before initiating field activities, field staff should review and complete pertinent tasks identified in **FGD 2.02** (Site Preparation, Inspection and Housekeeping). At a minimum, the following tasks should be completed to prepare field staff for what may be expected during implementation of the work:

- Review and sign the a site-specific HASP;
- Coordinate and obtain necessary access agreements and permits;
- Review project-specific work plan/sampling plan, where applicable;
- Review project-specific Quality Assurance Project Plan (QAPP), where applicable; and

- Review and discuss with the PIC and/or PM the proposed Work Plan/sampling plan or sampling strategy.
- Prior to initiating the well development activities, Ramboll Environ personnel should review the well construction records (refer to **FGD 6.15**, Well Construction Record) and confirm the location and construction details (materials, diameter, depth, etc.).
- Confirm that all non-dedicated (i.e. reusable) equipment and instruments that will come in contact with the well have been decontaminated (refer to **FGD 14.01**, Sampling Equipment Decontamination).
- Prior to opening the well, field screening equipment (refer to field screening equipment FGDs) should be calibrated (refer to **FGD 4.06**, Equipment Calibration) and background levels recorded in the field notebook in accordance with **FGD 1.01** (Field Notes and Records).

4.3 Well Development Using Mechanical Surging with Bailing and Pumping

- During the well development process Ramboll Environ personnel should record all equipment and materials used including times and quantities. Observations and field data should be recorded in the field notebook in accordance with **FGD 1.01** (Field Notes and Records). Ramboll Environ personnel should record any problems encountered and communicate with the PM or PIC. Initial records should include:
  - Well designation;
  - Date of well installation;
  - Well diameter, well depth, screen depth and length, and height of well casing above or below ground surface;
  - Date of development and start and end times of development;
  - Calculation of the well volume (see equation below), including source of well construction information (e.g., well record, field measurement);
  - Details in the equipment used for well development (i.e., type and size/capacity of pump, description of surge equipment, such as surge block, bailer, Waterra® or pump); and
  - Name of well developer and drilling company (if applicable).
- Verify the correct well has been located based on well tag/identifier on the outer casing.
- Unlock and open the protective steel casing or well box.
- Unlock and remove the inner casing cap (or water-tight locking cap on the well casing in the case of a flush mounted well) and, when required, use the field screening equipment (refer to field screening equipment FGDs) to measure organic vapor/gas concentrations in the well box. Record all field measurements in the field notebook in accordance with **FGD 1.01** (Field Notes and Records).
- If appropriate based on surface conditions, polyethylene plastic sheeting should be placed around the well casing.
- Measure and record in the field notebook the depth to water and total well depth before development using an electronic water level indicator or interface probe (if NAPL is

expected to be present) (refer to **FGD 6.04**, Groundwater and Free Product Level Measurements) and calculate the well volume in gallons (V_w) using the following equation:

$$V_w = 7.48(\pi \frac{d_w^2}{4} h_w)$$

Where:

d_w is the well diameter (feet)
h_w is the height of water in the well (feet)

In general, the volume of a 2-inch diameter well is 0.16 gallons per foot and the volume of a 4-inch diameter well is 0.65 gal/ft.

- Well development should begin by assembling the equipment for well development and withdrawing at least two well volumes of water from the well and storing it into 55-gallon steel drums or other appropriate waste containers (refer to **FGD 15.01**, Waste Handling). During the initial water withdrawal, water level drawdown in the well and purge/water removal rate should be measured and recorded in the project field book. However, if the well runs dry during the initial well volume removal, if initial water level monitoring indicates that the well will run dry, or existing nearby wells in the same formation have been identified as running dry during development or purging, the well development activities should be temporarily halted and the Ramboll Environ oversight personnel should contact the PIC and/or PM to discuss alternate well development procedures.
- The entire screened interval should be developed from the top of the well screen down, dividing the screened interval into sections (typically 3 to 5 feet) as necessary. This will prevent the buildup of fines grained materials on the surge block, which in turn could bind the surge block to the well casing.
- Following initial water withdrawal, the well should then be surged by lowering the surge block or other surge device (Waterra®) to the top of the well screen and manually pumping the surge block with a stroke of less than 3 feet. The pulling and pushing action on the surge block will force water into and out of the well screen, thereby removing any drilling or formation fine grained materials from the well screen and suspending them in the development water. After surging, the surge block should be removed and development water removed using the pump and tubing. A bailer may be used prior to pumping to remove water with high turbidity in order to avoid damage to pumping equipment. Turbidity and other water quality parameters (e.g., conductivity, temperature, and pH) should be measured during removal of the development water to evaluate the geochemical characteristics of the purge water. Alternatively, if allowed by the well configuration, a low-capacity pump can be installed above the surge block to simultaneously surge and discharge, thereby ensuring a gradient is maintained towards the well.
- The above surging and removal action is performed at depths corresponding to the entire screened interval until drilling or formation fine grained materials are no longer produced or until turbidity has decreased and other water quality parameters (e.g., conductivity, temperature, and pH) have stabilized. Typically, well development should proceed until

monitored parameters (especially turbidity) have stabilized or a total of five well volumes of water have been removed. The stabilization metrics should be defined in the Work Plan/sampling plan. The surging and removal action sequence may be repeated at higher extraction rates to achieve the desired well development. Some wells may be incapable of achieving non-turbid water quality and well development should be suspended after a reasonable well development effort has been undertaken and results have been communicated to the PIC and/or PM.

- Ramboll Environ personnel should describe in the field notebook the details of the well surging process (e.g., equipment used, depths surged, surge depth increments, and speed, length and frequency rates.) Ramboll Environ personnel should record the drawdown in the well, the purge rate during each pumping cycle, and the water quality parameters per well volume removed. In addition, Ramboll Environ personnel should provide descriptions of the physical character of removed water, including changes in clarity, color, particulate matter, and odor.
- The following guidelines improve the effectiveness of well surging:
  - The manual surging rate should initially be gentle, with gradual increases during the development process (i.e., increases in rate with depth of surging). The manual surging rate is controlled by the speed, length and frequency of the pushing and pulling action.
  - The energy of surging is gradually increased at each depth of surging until drilling or formation fine grained materials are no longer produced from surging at that depth.
  - The depth of surging is incrementally increased from top to bottom of the well screen.
- Measure and record in the field notebook the depth to water, drawdown and total well depth after each removal of development water and at the completion of development using an electronic water level indicator (refer to **FGD 6.04**, Groundwater and Free Product Level Measurements).
- Measure the purge rates during each cycle and record in the field notebook.
- If the well runs dry during development or if it is suspected that the well will run dry, the well development activities should be temporarily halted and Ramboll Environ oversight personnel should contact the PIC and/or PM to discuss alternate well development procedures. In some cases, well recharge may span from hours to more than a day.
- Record in the field notebook the total amount of water removed during well development and the rationale for terminating the development of the well (e.g., water quality parameters stabilized, five well volumes removed, well ran dry).
- All equipment shall be decontaminated upon completion of well development (refer to **FGD 14.01**, Sampling Equipment Decontamination) and dedicated equipment (e.g., non-reusable tubing) should be removed and managed as investigation-derived waste (refer to **FGD 15.01**, Waste Handling).

4.4 Management of Investigation-Derived Waste

All IDW, including well development and decontamination fluids, generated during well development will be containerized pending analytical results and determination of disposal options as outlined in **FGD 15.01** (Waste Handling), unless project-specific requirements specify otherwise.

5. PRECAUTIONS AND OTHER CONSIDERATIONS

Certain precautions should be taken to ensure safety while conducting well development activities. Additionally, implementation of the work may face some difficulties and may require compliance with state-specific or regulatory program-specific requirements.

- Some States may have specific licensing requirements for installing monitoring wells. Where required, only drillers licensed in the State where the work is being performed should be subcontracted to perform the work.
- If the State requires that the well be developed by the drilling contractor, the drilling contractor should be informed of the well construction design as part of the contracting process so they can ensure that the appropriate equipment, personnel and materials are mobilized. The driller should define the specific equipment that will be used for well development, so field personnel can prepare accordingly.
- It is important to always remain alert and aware of your surroundings. Sites may be subject to hazards posed by heavy equipment, vehicle traffic, industrial machinery, hazardous chemicals and contaminants, and other physical, mechanical, and chemical hazards.
- Prior to mobilization, determine the location of wells and evaluate the need for security, barricading, and/or traffic control (e.g., when wells are located on the right of way).
- At sites with certain contaminants and/or subsurface conditions, potentially toxic and/or explosive gases may accumulate at and around the well as it is being developed. Stay upwind of well development activities and ensure that air monitoring is conducted and personal protective equipment is used in accordance in the site-specific HASP.
- Water shall not be added to the well to aid in development, unless previously approved by the PIC and PM and/or regulatory agency.
- For existing wells being rehabilitated through development, well keys may not work with rusted/outdated well locks. Bolt cutters may be used to remove the lock, which should be replaced upon completion of well rehabilitation. Do not use petroleum based solvent sprays to free seized locks as it may impact water quality in the well.
- Wells with a water-tight cap may experience a buildup of pressure. Keep your face and body away from the top of the well when loosening or removing the cap.

6. RECORDKEEPING

Record all information related to well development in accordance with **FGD 1.01,** Field Notes and Records and **FGD 1.03**, Data Management.

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