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)

RECEIVED

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		
Griffin	John		City of Hartford		
Mailing Address			City	State	ZIP Code
109 North Main Street			Hartford	WI	53027
Phone # (include area code)	Fax # (include area code)		Email		
(262) 673-8263			jgriffin@hartford.wi.gov		

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:

Representative of the owner (City of Hartford)

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

Contact Last Name	First	MI	Organization/ Business Name		
Gross	Erin	N	Stantec Consulting Services Inc.		
Mailing Address			City	State	ZIP Code
12080 Corporate Pkwy, Suite 200			Mequon	WI	53092-2661
Phone # (include area code)	Fax # (include area code)		Email		
(608) 628-6278			erin.gross@Stantec.com		

Environmental Consultant (if applicable)

Contact Last Name	First	MI	Organization/ Business Name		
Gross	Erin	N	Stantec Consulting Services Inc.		
Mailing Address			City	State	ZIP Code
12080 Corporate Pkwy, Suite 200			Mequon	WI	53092-2661
Phone # (include area code)	Fax # (include area code)		Email		
(608) 628-6278			erin.gross@stantec.com		

Section 2. Property Information

Property Name			FID No. (if known)	
Jerrys Dry Cleaning - Former			267170750	
BRRTS No. (if known)		Parcel Identification Number		
0267220908		2103023026		
Street Address		City	State	ZIP Code
24/28 S Main St		Hartford	WI	53027

County	Municipality where the Property is located	Property is composed of:	Property Size Acres
Washington	◉ City ○ Town ○ Village of	◉ Single tax parcel ○ Multiple tax parcels	0.07

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: 12/16/2022

   Reason: We are submitting for a WEDC site assessment grant which requires concurrence from the WDNR. This can be done in an informal manner if a full review is not able to be completed in time.

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

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

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

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

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

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

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

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

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

Post-Closure Modifications - NR 727, [181]

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

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

Section 4. Request for Liability Clarification

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

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

❖ **Include a fee of $700.**

Provide the following documentation:

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

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

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

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

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

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

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

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

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

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

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

❖ **Include a fee of $700.**

Provide the following documentation:

(1) ownership status of the Property;

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

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

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

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

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

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

- ☐ hazardous substances spills - s. 292.11(9)(e), Wis. Stats. [649];
- ☐ Perceived environmental contamination - [649];
- ☐ hazardous waste - s. 292.24 (2), Wis. Stats. [649]; and/or
- ☐ solid waste - s. 292.23 (2), Wis. Stats. [649].

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

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

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

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

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

(5) summary of current uses of the Property;

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

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

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

Section 4. Request for Liability Clarification (cont.)

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

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

(1) a copy of the proposed lease;
(2) the name of the current owner of the Property and the person who will lease the Property;
(3) a description of the lease holder's association with any persons who have possession, control, or caused a discharge of a hazardous substance on the Property;
(4) map(s) showing the Property location and any suspected or known sources of contamination detected on the Property;
(5) a description of the intended use of the Property by the lease holder, with reference to the maps to indicate which areas will be used. Explain how the use will not interfere with any future investigation or cleanup at the Property; and
(6) all reports or investigations (e.g. Phase I and Phase II Environmental Assessments and/or Site Investigation Reports conducted under s. NR 716, Wis. Adm. Code) that identify areas of the Property where a discharge has occurred.

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

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

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

❖ **Include a fee of $700.**

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

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

❖ **Include a fee of $700.**

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

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

Section 5. Request for a Specialized Agreement

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

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

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

(1) Phase I and II Environmental Site Assessment Reports,
(2) a copy of the Property deed with the correct legal description.

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

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

(1) Phase I and II Environmental Site Assessment Reports,
(2) a copy of the Property deed with the correct legal description.

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

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

(1) a draft schedule for remediation; and,
(2) the name, mailing address, phone and email for each party to the agreement.

Section 6. Other Information Submitted

Identify all materials that are included with this request.

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

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

- ☐ Phase I Environmental Site Assessment Report - Date: ____________
- ☐ Phase II Environmental Site Assessment Report - Date: ____________
- ☐ Legal Description of Property (required for all liability requests and specialized agreements)
- ☐ Map of the Property (required for all liability requests and specialized agreements)

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

☐ Groundwater ☐ Soil ☐ Sediment ☐ Other medium - Describe: ____________

Date of Collection: ____________

- ☐ 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: City of Hartford
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.

Erin Gross (signature) — Signature
12/7/2022 — Date Signed

Senior Hydrogeologist — Title
(608) 628-6278 — 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.

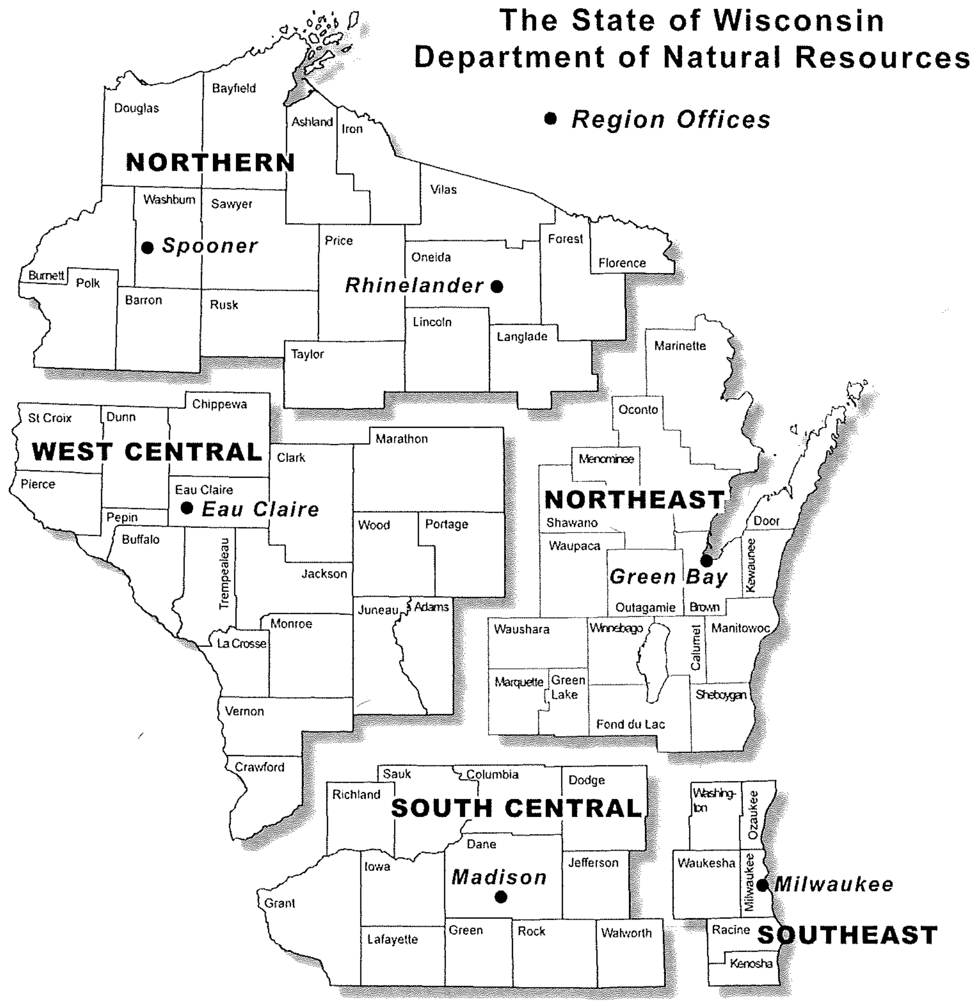
DNR NORTHERN REGION
Attn: RR Program Assistant
Department of Natural Resources
223 E Steinfest Rd Antigo, WI 54409

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		

NR 716.09 Site Investigation Workplan

South Main Street Property
24 South Main Street
Hartford, Wisconsin
BRRTS #02-67-220908

Prepared for:

City of Hartford
109 North Main Street
Hartford, WI 53027

Prepared by:

Stantec Consulting Services Inc.
12080 Corporate Parkway, Suite 200
Mequon, WI 53092-2649

December 7, 2022
Project Number: 193709082

Stantec

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SIGN-OFF SHEET

Author

Rex Key, EIT
Geologic Staff

QUALITY ASSURANCE REVIEW

Technical Reviewer

Erin N. Gross, PG (WI)
Senior Hydrogeologist

Independent Reviewer

Richard J. Binder, PG, CPG
Principal/Project Manager

1.0 INTRODUCTION

1.1 GENERAL

Stantec Consulting Services Inc. (Stantec) prepared this chapter (ch.) NR 716.09 Site Investigation (SI) Workplan on behalf of the City of Hartford (hereinafter referred to as the "City") for field sampling and associated laboratory analyses to be performed to further investigate the extent of contamination identified on and adjacent to the 0.07-acre City-owned property located at 24 South Main Street in Hartford, Wisconsin (hereinafter referred to as the "Site"). The purpose of the SI is to further evaluate the source(s) and extent of identified contaminants detected in soil, groundwater and soil vapor as part of the Stantec Phase II Environmental Site Assessment (ESA) completed in 2020 and Supplemental Site Investigation performed in 2022 (Stantec, 2020 and Stantec, 2022; respectively). The work will be performed in a phased manner and include vapor sampling in surrounding structures and utilities. Groundwater samples will be collected from monitoring wells and piezometers constructed at shallow and intermediate depths as well as within deeper bedrock. Soil samples will also be collected and analyzed. The need and scope of subsequent phases of investigation will be dependent on the results of each phase.

1.2 SITE DESCRIPTION/BACKGROUND

The Site consists of one parcel situated along the eastern boundary of South Main Street in the northwest ¼ of the northwest ¼, Section 21, Township 10 North, Range 18 East in the City of Hartford, Wisconsin. The Site is located at 24 South Main Street (parcel 2103023026). The Site is bordered by commercial properties on all sides with a zoning classification of "General Business District" (Washington County Ascent Land Records Suite, 2022). The general Site location and local topography are illustrated on **Figure 1**.

The Site is currently a paved asphalt parking lot absent of buildings totaling approximately 0.07-acres of land. The Site and surrounding parcels were previously utilized for commercial purposes such as a dry cleaner, auto repair (with at least two gasoline underground storage tanks (USTs) located within South Main Street), a black smith, and a wagon shop. The general layout of the Site, including the approximate property boundary locations, is illustrated on **Figure 2**.

1.3 PROJECT CONTACTS

Key project contacts are summarized below:

<u>Owners and Responsible Party</u>

Owner and Responsible Party (RP):	City of Hartford
Contact Names:	Justin Drew, AICP and John Griffin, PE
Address of the RP:	109 North Main Street Hartford, WI 53027
Phone Number:	262-673-8272 & 715-902-0829
Fax:	262-673-8309
Email:	jdrew@hartford.wi.gov & jgriffin@hartford.wi.gov

Environmental Consultant

Company:	Stantec Consulting Services Inc.
Contact Name:	Erin Gross, PG, Senior Hydrogeologist
Mailing Address:	12080 Corporate Pkwy, Suite 200, Mequon, WI 53092
Phone:	608-628-6278
Email:	erin.gross@stantec.com

1.4 PHYSIOGRAPHIC AND GEOLOGIC CONDITIONS

Following is physiographic and geologic information on the Site, organized in accordance with information specified on ch. NR 716.09 (2)(e).

1.4.1 Topography

The general topography of the Site is shown on the United States Geological Survey (USGS) topographic quadrangle map presented on **Figure 1**. There is approximately seven feet of topographical relief at the Site, sloping from approximately 990 feet above mean sea level (ft amsl) on the east side to 983 ft amsl on the west side.

1.4.2 Hydrology

Based on topography, surface water on the Property that does not infiltrate the ground surface is likely to flow west toward the South Main Street storm drain, which are connected to the City of Hartford storm sewer system. The storm sewers reportedly discharge to the Rubicon River, the nearest section of which is located approximately 750 feet north of the northern property boundary for the Site. There are no mapped wetlands near the Site. The Site lies at least 740 feet outside of the mapped floodway and floodplain bordering the Rubicon River (Federal Emergency Management Agency [FEMA], 2015).

1.4.3 Surface Soils

Based on logs for soil borings sampled as part of the Phase II ESA and Supplemental Site Investigation, non-anthropogenic/imported fill material encountered at the Site consisting of gravel and sand was observed to extend from the ground surface to a maximum depth of 10 feet below ground surface (ft bgs) on the eastern portion of the site (Stantec, 2020 and Stantec, 2022; respectively). Anthropogenic fill material consisting of silty clay with coal and/or asphalt was encountered at the Site to a maximum depth of one ft bgs at various locations. Native soils consisting of silty clay, clay, gravel, and sand was encountered underlying the fill material to approximately 20 ft bgs. Apparent dolomite bedrock was encountered at approximately 20 ft bgs underlying the native soils.

1.4.4 Geology

The Site is in the area covered by the Laurentide Ice Sheet during the Wisconsin Glaciation (Wisconsin Geologic and Natural History Survey [WGNHS], 2011) resulting in topography that is rolling, moderately hilly, and containing numerous drumlins. In general, the area is covered by greater than 50 feet of unconsolidated glacial till (Trotta and Cotter, 1973), although bedrock was encountered on Site at 20 ft bgs (Stantec, 2022). Underlying the till is a series of limestone/dolomite and sandstone bedrock units overlying crystalline rock (Cotter, et. Al., 1969).

1.4.5 Hydrogeology

The shallow water table is often a subdued expression of surface topography. Shallow groundwater generally flows from areas of groundwater recharge, such as hills and broad uplands, to areas of groundwater discharge, such as wetlands, rivers, and lakes. Based on the local surface topography, local shallow groundwater is expected to flow towards the north-northwest (towards the Rubicon River). Groundwater was generally encountered between approximately 6.58 and 7.81 ft bgs in water table wells installed at the Site and as measured to flow in a north-northwest direction (Stantec, 2022). Two piezometers were installed at approximately 25 ft bgs on the northern portion of the Site as part of well nests (PZ-1 and

PZ-2 associated with MW-1 and MW-2, respectively; Stantec, 2022; see **Figure 2** and **Figure 3**). A slight upward gradient was measured at both well nests.

1.4.6 Potential Hazardous Substance Migration Pathways

Stantec evaluated potential contaminant migration pathways at the Site and the findings are summarized below.

Direct Contact: No volatile organic compounds (VOCs) were detected at concentrations exceeding direct contact standards in the soil samples analyzed. Previous soil sampling events detected polycyclic aromatic hydrocarbons (PAHs) in near surface soils exceeding direct contact standards. The areas identified to have PAH concentrations exceeding direct contact standards are capped with asphalt and do not appear to currently pose a risk with respect to direct contact.

Soil Leaching to Groundwater: Tetrachloroethylene (PCE) was the only constituent detected at a concentration exceeding its ch. NR 720 Wisconsin Administrative Code (WAC) Groundwater residual contaminant levels (RCL; GW RCL) in the recent soil samples analyzed. Previous soil sampling events detected various Resource Conservation and Recovery Act (RCRA) metals, PAHs, and VOCs at concentrations exceeding the GW RCL. Asphalt covers the entirety of the known contaminated soil on the Site minimizing the potential for infiltration of contaminants to underlying groundwater. **Groundwater Ingestion:** The Site and the surrounding area is served by City of Hartford community water system, not the groundwater located on Site.

Vapor Intrusion: PCE was the only constituent detected at a concentration exceeding the commercial vapor risk screening level (VRSL) in the sub-slab vapor samples analyzed. Trichloroethylene (TCE) and chloroform were detected at concentrations exceeding their respective residential VRSLs. PCE and TCE were not detected in the indoor air sample exceeding their applicable vapor action levels (VALs); however, chloroform was detected in the indoor air sample at a concentration exceeding the residential VAL, but below the commercial/indoor worker VRSL. Vapor intrusion appears to be a risk and further sub-slab soil vapor and indoor air investigation is recommended.

Off-Site Groundwater Wells / Water Supply: No known water supply wells are present at the Site. Stantec conducted a search for nearby groundwater wells installed using the WDNR Well Construction Information System (WDNR, 2022). No groundwater wells or private or public water supply wells were identified within 1,200 feet of the Site. Due to the distance from the Site, it is unlikely that identified water supply wells will be affected by groundwater contamination at the Site. Based on the above information, the migration potential of contaminants associated with the Site to water supply wells appears to be very low.

Utilities: Based on available records for the area provided by the City of Hartford, a stormwater utility is present along the northern Site boundary and extends toward South Main Street, where other underground utilities are present such as a gas line, water line, and underground electric. The backfill material associated with these, and potentially other utilities, may have created a preferential path for contaminant movement. Further groundwater and vapor investigation offsite is recommended to assess the vertical and lateral extent of the identified contamination.

1.5 PREVIOUS ENVIRONMENTAL STUDIES

Stantec conducted a Phase I ESA of the Site in 2019 which identified several recognized environmental conditions (RECs) including historical dry cleaner, auto repair, black smith, and wagon shop operations on or adjoining the Site (Stantec, 2019). Stantec performed Phase II ESA activities between October 2019 and March 2020 to evaluate if soil and/or groundwater contamination exists in association with the identified RECs (Stantec, 2020). Phase II ESA activities included the completion of 13 soil borings and installation of seven temporary groundwater monitoring wells. Soil and groundwater sample analytical results identified elevated concentrations of chlorinated solvents (PCE, TCE, and cis-1.2-dichloroethene [CIS-1,2-DCE]) exceeding applicable WDNR standards in soil and groundwater on the 24 South Main Street parcel. In addition, PAHs were detected above the WDNR's soil and groundwater standards at the 28 South Main Street parcel, adjoining the Site to the south. The Phase I ESA and Phase II ESA work was performed using hazardous substances and petroleum brownfields funding awarded to Washington County by the United States Environmental Protection Agency (EPA) in 2017 as part of Coalition Community Wide Brownfields Assessment Grant No. BF

00E02304-0. The Site was assigned Assessment, Cleanup and Redevelopment Exchange System (ACRES) Number 239366.

Based on the results of the Phase II ESA, Supplemental Site Investigation activities were performed in 2022 to evaluate the source(s) and extent of release(s) and assess appropriate future actions. The additional work was completed per discussions with John Feeney (WDNR) in early-March 2022. During April and May 2022, Stantec installed three permanent groundwater monitoring wells, two piezometers, two sub-slab soil vapor points, and one indoor air sample. PCE was the only constituent detected in soil at a concentration exceeding applicable WDNR standards. Select chlorinated volatile organic compounds (CVOCs) were detected in the groundwater samples analyzed at concentrations exceeding the ch. NR140 WAC preventive action limit (PAL) and/or enforcement standard (ES). The concentrations of detected constituents appear to increase with depth. A sample from a deep piezometer/well completed at 25 ft bgs had concentrations up to 500 times the ES for PCE. Bedrock/refusal was encountered at approximately 25 ft bgs indicating impacts may be present in the underlying bedrock aquifer. PCE was the only constituent detected at a concentration exceeding the commercial VRSL in the sub-slab vapor samples analyzed. TCE and chloroform were detected at concentrations exceeding their respective residential VRSLs. PCE and TCE were not detected in the indoor air sample exceeding their applicable VALs; however, chloroform was detected in the indoor air sample at a concentration exceeding the residential VAL but below the commercial/indoor worker VRSL.

In general, the identified contamination appears to be related to the historic use of the Site as a drycleaner and the presence of imported fill. The groundwater and vapor impacts appear to be potentially migrating offsite to the north-northwest and may be associated with impacts detected adjacent to Highway 60 as part of other site investigations. Following a discussion with the WDNR, additional investigation was recommended to further assess the extent of CVOC contamination extending offsite.

1.6 INVESTIGATION SCOPING

This section has been organized to match the requirements outlined in ch. NR 716.07 WAC.

1.6.1 Site History – NR 716.07(1)

Downtown Hartford was developed in the mid-1800s. A variety of industries (dry cleaning, auto repair facilities, black smith, wagon shop, service station, printing shop, and tin shop) were located on or around the Property. These industries used a variety of chemicals, including petroleum products. The industries that have existed specifically on Site include: a dry cleaner, auto repair (with at least two gasoline USTs), black smith, and a wagon shop. The historically industrial use of the Property and surrounding properties is an environmental concern. It is likely that the activities in this commercial area may have impacted soil, vapor, and/or groundwater on the Property. Many of the proposed additional borings will focus on further assessing areas associated with former historic use.

1.6.2 Type and Amount of Contamination – NR 716-07(2)

A detailed discussion of the Phase II ESA and Supplemental Site Investigation findings, including the type and amount of contamination, is provided in **Section 1.5**. The key constituents that will determine soil management requirements throughout the Site are PCE, TCE, and CIS-1,2-DCE exceeding applicable WDNR standards in soil and groundwater on the 24 South Main Street parcel. In addition, PAHs were detected above the WDNR's soil and groundwater standards the adjoining parcel to the south, 28 South Main Street. Therefore, the horizontal and vertical extent subject to soil management requirements is dependent primarily on the concentrations of these key constituents.

The volume of impacted soil is undetermined, although it appears that one to five or more feet of impacted soil are present throughout nearly all the Site. A rough initial estimate of the volume can be provided by multiplying the Site area (5,296 square feet) by 2.5 feet (average depth; 13,240 cubic feet or 490 cubic yards [CY]). Groundwater was impacted between 6.58 and 25 ft bgs on site and given elevated concentrations of PCE in groundwater at 25 ft bgs, it's anticipated that impacts may be deeper than 25 ft bgs.

1.6.3 Contaminant Release History – NR 716.07(2)

The presence of contamination adjacent to the Site was confirmed during the Site Investigation conducted by Montgomery Watson and reported to the WDNR on November 3, 1998. Subsequent Phase I ESA, Phase II ESA, and Supplemental Site Investigations, conducted between 2019 and 2022, it is assumed that the contamination present in soil, vapor, and groundwater is attributable to anthropogenic fill and former dry cleaner use, prior to acquisition by the current owners. Other contaminants may be associated with long-term exposure to air pollution from the industrial facilities, commercial or residential buildings, and automobiles operating on the adjoining roads. The assumption for this site investigation is that contamination sources may have resulted in widespread impacts and extend vertically. A focus for this investigation will be to try to more precisely identify the vertical stratification of impacted soil, bedrock, and fill materials, in order to have the data necessary to plan for the effective capping, vapor mitigation, and/or management.

1.6.4 Affected Media – NR 716.07(4)

Contaminants are known to have impacted soil, vapor, and groundwater.

1.6.5 Site Location and Proximity of Other Contaminant Sources – NR 716.07(5)

The following individual facilities directly adjoining the Property were identified as the most likely potential sources of impact to the Property (Stantec, 2019):

<u>Hartford Rexall, 52 South Main Street (south-adjoining property)</u>

This upgradient, south-adjoining property is located approximately 75 feet south-southeast of the Property. It is listed in the Solid and Hazardous Waste Information System (SHWIMS) database. The status of the property is “operating” but no additional information was provided.

<u>Hartford Mobil (aka Hartford Shell, Hofmaier Bros), 45 South Main Street (west-adjoining property)</u>

This side-gradient site is located approximately 94 feet west-southwest of the Property. It is listed under three separate sites. The Hofmaier Bros. is listed in the EDR Historic Automotive (Hist Auto) database. Hartford Mobil is listed under the leaking underground storage tank (LUST), Closed Remediation System (CRS), activity use limitation (AUL), and SPILLS databases. Hartford Shell is listed under the UST and Financial Assurance databases. Hofmaier Bros. was in operation from 1974 to sometime before 1991 and no additional information was provided. Petroleum-related contamination was discovered on the Hartford Mobil site in 1999 and was closed in 2004. The last action on the site occurred in 2013 with cleanup of a spill. Hartford Mobil currently has two 8000- and one 10,000-gallon capacity USTs for unleaded gasoline and a 1000-gallon UST for diesel. Several USTs were closed or removed at some point before 2018 including two 1000-, one 2000-, two 3000-, and one 8000-gallon USTs for unknown contents, and a 550-gallon UST for fuel oil.

<u>Former Hartford Cty (aka Nova Building), 23 South Main Street (west-adjoining property)</u>

This downgradient property is located approximately 94 feet west-northwest of the Property. It is listed in the WI environmental repair program (ERP) and SHWIMS databases. Contaminants on the property are chlorinated solvents and petroleum, both of which were determined to be off-site sources (Hartford Shell and Former Jerrys Drycleaner, respectively). The site was classified as closed in 2012.

<u>Jeff Benton, 67A South Street (south-adjoining property)</u>

This upgradient, southeast-adjoining property is located approximately 105 feet southeast of the Property. It is listed in the UST database. The site had a 2000-gallon UST of fuel oil in 2001 and it has since been closed or removed.

<u>Komp Fabian, 59 E Sumner Street (east-adjoining property)</u>

This sidegradient property is located approximately 131 feet north-northeast of the Property. It is listed in the EDR Hist Auto database. Komp Fabian operated as a gasoline service station from 1972-1976. No additional information was provided.

Hartford Savings Bank (Old Location), 55 E Sumner Street (east-adjoining property)

This sidegradient property is located approximately 141 feet north-northeast of the Property. It is listed in the LUST and UST databases. Contamination at the site was discovered in 1998 and is petroleum related. The site was classified as closed in 2002. Two 500-gallon USTs for kerosene and a 1000-gallon UST for leaded gasoline were registered in 1975 and have since been either closed or removed.

The potential for contamination from these sites to have migrated in soil, groundwater, or through soil vapor and impacted the Site was a primary concern evaluated as part of the Phase II ESA (Stantec, 2020). Based upon data collected thus far, off-site sources do not appear to be impacting the Site.

1.6.6 Site Access – NR 716.07(6)

Access agreements were secured from all Site owners as part of the Phase II ESA and Supplemental Site Investigation. Updated agreements may be required for this investigation which will be performed with the City directing activities rather than Washington County, particularly for off-site sampling activities.

1.6.7 Potential or Known Impacts to Receptors – NR 716.07(7)

Stantec review the WGNHS on-line database of historic well construction reports for wells constructed from 1930-1989 (WDNR, 2022). No groundwater wells or private or public water supply wells were identified within 1,200 feet of the Site. Due to the distance from the Site, it is unlikely that identified water supply wells will be affected by groundwater contamination at the Site. Based on the above information, the migration potential of contaminants associated with the Site to water supply wells appears to be very low.

1.6.8 Potential for Other Impacts – NR 716.07(8)

There are no mapped wetlands or sensitive habitats in proximity to the Site, which is in the middle of a highly urbanized area. The Site is in a historic area of the City, but there are no buildings with historic designations located on the Site, nor any buildings with features or historic uses that would warrant such designation. Outstanding resource waters and/or exceptional resource waters as defined in ch. NR 102.10 and 102.11 are not located on or within proximity of the Site.

1.6.9 Potential Interim Measures or Remedial Actions – NR 716.07(9)

Concentrations of VOCs and PAHs were detected in soil on Site are covered with asphalt/concrete, which helps protect humans from direct contact concerns and reduces leachability from soil to groundwater. Additional sampling will be conducted as part of this SI to further define the nature and extent of soil, groundwater, and vapor impacts surrounding these areas. Since these areas are currently covered with an impervious cap, no interim measures are considered warranted. Interim measures could be warranted based on the results from the additional sampling to be conducted as part of this SI.

1.6.10 Immediate of Interim Actions Taken – NR 716.07(10)

No immediate or interim measures have been taken or are in progress.

1.6.11 Other Information – NR 716.07(11)

Other information is not available.

1.6.12 Need for Hydraulic Conductivity Data – NR 716.09(12)

Given the contaminated groundwater observed during the Phase II ESA and Site Investigation, conducted in 2020 and 2022, hydraulic conductivity analysis shall be pursued under this SI (via standard operating procedure [SOP] No. 17, 18, and 19 in **Appendix B**).

2.0 SAMPLING AND ANALYSIS PLAN

2.1 SITE INVESTIGATION OVERVIEW

2.1.1 Problem Statement

Environmental concerns associated with the Site have been identified but not fully investigated or assessed. The main objective for performing additional field sampling and associated laboratory analyses is to further investigate the extent of identified contaminants detected in the Stantec Phase II ESA and Supplemental Site Investigation activities performed in 2020 and 2022 (Stantec, 2020 and Stantec, 2022; respectively). Specifically, the purpose of the assessment is to further assess the presence and extent of CVOC contamination identified to be extending offsite during the site investigation activities completed to date. The work will be performed in a phased manner and include vapor sampling in surrounding structures and utilities. Groundwater samples will be collected from monitoring wells and piezometers constructed at shallow and intermediate depths as well as within deeper bedrock. Soil samples will also be collected and analyzed. The need and scope of subsequent phases of investigation will be dependent on the results of each phase.

2.1.2 Conceptual Site Model

The "Triad approach" for characterization and remediation of contaminated sites was developed by the U.S. EPA and others with a goal of increasing confidence that project decisions about contaminant presence or absence, location, fate, exposure, and risk reduction choices are made correctly and cost effectively. The foundation for site-related decisions that are both correct and optimized (from a cost-benefit standpoint) is the "Conceptual Site Model" (CSM) (Crumbling, 2004). CSM uses all available historical and current information to estimate:

- The types of contaminants that are most likely to be present at concentrations that exceed regulatory limits, or which could impact redevelopment.
- The locations where contamination is most likely to be present.
- The mechanisms through which contamination was likely or potentially released and the associated zones or depth intervals that are most likely to have been impacted.
- The characteristics of geologic materials underlying the property (in particular, their permeability).
- The depth to the water table and flow direction for shallow and deep groundwater.
- The known or potential presence of natural or manmade features in the subsurface that could affect migration patterns for contaminants or impede sample collection.
- Future plans for use of the property, in particular, if redevelopment activities will be performed.

The current CSM builds on the RECs described in the Stantec Phase I ESA (Stantec, 2019), results of the Phase II ESA (Stantec, 2020), Supplemental Site Investigation (Stantec, 2022), and acknowledges the following attributes of the Site that are relevant to defining the nature and extent of impacts:

- The historic use of the Site as a drycleaner between 1966 and 1992. The historic operation as a dry cleaner resulted in releases of CVOC contamination to soil and groundwater at the Site.
- PCE was detected at a concentration exceeding the small commercial VRSL in the soil vapor underlying the commercial building adjoining the Site to the north
- CVOC constituents were detected at concentrations exceeding their applicable PAL and/or ES in temporary wells TW-2 TW-4, TW-5, and TW-6, monitoring wells MW-1 and MW-2, and piezometers PZ-1 and PZ-2.
- CVOC concentrations were identified to increase with depth in piezometer PZ-2. Bedrock/refusal was encountered at approximately 25 ft bgs indicating impacts may be present in the underlying bedrock aquifer.
- Shallow groundwater was encountered between six and eight feet below ground surface in the well network installed at the Site and was measured to flow in a northwest direction.

Tables 1, **2**, and **3** includes information relevant to the CSM, including the specific concerns targeted for assessment, the associated potential contaminants, and the zones or depth intervals considered most likely to be impacted from the identified concerns.

2.1.3 Assessment Objectives

Stantec will conduct soil, groundwater, and vapor sampling activities to further characterize the identified CVOC impacts extending offsite. In addition, the sampling will determine appropriate future actions, if any, to obtain closure from the WDNR per the ch. NR 700 WAC rule series. Soil quality data will be compared to ch. NR 720 RCLs, groundwater data will be compared to ch. NR 140 WAC groundwater standards, and vapor quality data will be compared to WDNR VRSLs.

SOPs for tasks associated with this work plan are provided in **Appendix B**. SOPs applicable to the activities outlined in this SI Workplan are listed in the table below:

SOP No.	Associated SI Workplan Section Number	Description
1	2.3.2	Volatile Organic Compound Field Screening for Soil and Sediment
2	2.3.1 and 2.3.3	Soil Sample Collection
4	2.4	Groundwater Sample Collection
7	2.3.3 and 2.7	Chain of Custody, Sample Control and Field Documentation Procedures
8	2.4 and 2.9	Equipment Decontamination
9	2.3.2	Calibration, Maintenance, and Operation of Field Equipment
10	2.10	Management of Investigative Wastes
11	2.5	Vapor Sample Collection
15	2.6	Geodetic Surveys
16	2.4	Screening for Petroleum Light Non-Aqueous Phase Liquid with a Low-Voltage Ultraviolet Light
17	1.6.12	Aquifer Pumping Tests
18	1.6.12	Slug Tests
19	1.6.12	Pressure Transducers

2.2 PRE-SUBSURFACE ASSESSMENT ACTIVITIES

2.2.1 Health and Safety

A Site-Specific Health and Safety Plan to be utilized by Stantec personnel during the assessment activities is presented in the Stantec Risk Management Strategy form RMS1 included in **Appendix A**.

2.2.2 Utility Clearance and Coordination and Site Owners

Diggers Hotline will be contacted to locate and mark the locations of registered utilities in the project area. A private locating contractor will also be retained to locate on-site and/or private underground utilities.

2.3 SOIL ASSESSMENT

2.3.1 Hydraulic Probe Sampling and Collection of Soil Samples

Soil sampling and field classification will be conducted according to SOP No. 02 (**Appendix B**). Sample collection and laboratory analytical methods for soil samples, as well as the rationale for selecting sample locations and criteria to be used for selection of specific depth intervals for analysis, are presented in **Table 1**. In addition, pertinent observations noted during installation of the soil borings will be documented on the soil boring logs. Soil samples will be collected continuously with four- to five-foot samplers, dependent on direct-push tooling.

Each soil sample will be assigned a sample identification number (SIN) based on the following format:

Sample Type	Label for Type of Sample	Location Number	Sample Interval (ft bgs)	Sample Round	SIN	Location ID
Soil Boring	SB	1	(0-2)	---	SB-1(0-2)	SB-1
Field Duplicate	FD	---	---	FD-1	---	Field Duplicate
Trip Blank	TB	---	---	Number	TB-1	---

2.3.2 Field Screening

Soil samples will be field screened for the presence of VOCs using a PID as described in SOP No. 01 (**Appendix B**). The PID will be calibrated daily in the field in accordance with the manufacturer's specifications per SOP No. 09 (**Appendix B**).

2.3.3 Soil Sample Preservation and Shipment

Immediately following collection, soil samples will be placed in pre-preserved laboratory supplied containers and stored on ice in a cooler as detailed in SOP No. 02 (**Appendix B**). Any visual evidence of contamination will be noted on the field log. Soil samples will be submitted in accordance with SOP No. 02 (**Appendix B**).

The exact quantity of soil samples collected will be determined in the field and will target soils indicative of a suspected release. As summarized on **Table 1**, a minimum of one unsaturated soil sample (i.e. within 8 ft bgs) will be collected from each well nest location. Samples will be submitted for VOC analysis from the depth of apparent impact (i.e. based upon designated field observations noted in **Table 1**) and/or directly above the water table.

All soil samples will be collected and preserved in accordance with SOP No. 02 (**Appendix B**). Soil samples will be placed in laboratory-supplied containers, preserved as directed by the laboratory, stored on wet ice, and submitted under chain-of-custody procedures to Eurofins TestAmerica (University Park, Illinois) or CT Laboratories (Baraboo, Wisconsin), both State of Wisconsin certified laboratories for VOCs per EPA method 8260D. The laboratory will supply the appropriate containers. Samples will be submitted to the laboratory as soon as possible after collection (i.e., on a daily basis).

Chain-of-custody procedures will be utilized to track possession and handling of individual samples from the time of collection in the field through the time of delivery to the analytical laboratory. The chain-of-custody program will include use of sample labels, custody seals, field logbooks, chain-of-custody forms, and laboratory logbooks. All chain-of-custody procedures will be performed in accordance with SOP No. 07 (**Appendix B**).

2.3.4 Soil Borehole Decomissioning

Soil borings not completed as wells will be sealed in accordance with ch. NR 141.25 WAC by backfilling with bentonite after completion of drilling and soil sampling

2.4 GROUNDWATER ASSESSMENT

As illustrated on **Figure 2** and **Figure 3**, the groundwater assessment will include sampling up to three existing monitoring wells and two existing piezometers, the installation/sampling of up to seven permanent groundwater monitoring wells, seven piezometers, and four bedrock piezometers. Groundwater was encountered between six and eight ft bgs in the existing monitoring well network installed at the Site. The permanent groundwater monitoring wells will be constructed using 2-inch diameter polyvinyl chloride casing with 10-foot long 0.010-inch slotted-screens placed to intersect the water table surface. The piezometers will be constructed using 2-inch diameter polyvinyl chloride casing with 5-foot long 0.010-inch slotted-screens placed to be beneath the water table and above the bedrock surface. The bedrock piezometers will be constructed using 2-inch diameter polyvinyl chloride casing with 5-foot long 0.010-inch slotted-screens placed to be at least five feet below the top of bedrock. The bedrock wells will be installed within six-inch diameter dedicated steel casing and will be grouted in place to 25 ft bgs to prevent vertical smearing between mid-depth piezometers and bedrock piezometers. Bedrock wells will be installed in a phased manner, starting at well nests MW-1/PZ-1 and MW-2/PZ-2. The VOC samples from these bedrock wells will be sent to the lab for 24-hour turnaround to inform if the remaining proposed bedrock wells are warranted.

The wells and piezometers may be protected with a flush mounted steel protective cover. The depth for the wells and piezometers will depend on the actual depth at which groundwater and bedrock are encountered beneath the Site. The actual borehole locations may be adjusted based on accessibility, the location of underground utilities, and results of the private utility locate.

Each groundwater sample will be assigned a SIN based on the following format:

Sample Type	Label for Type of Sample	Location Number	Sample Round	SIN	Location ID
Monitoring Well	MW	1	01	MW-1 (01)	MW-1
Piezometer	PZ	1	01	PZ-1 (01)	PZ-1
Bedrock Piezometer	PZD	1	01	PZD-1 (01)	PZD-1
Field Duplicate	FD	---	---	FD-1	---
Equipment Blank	EB	---	---	EB-1	---
Trip Blank	TB	---	---	TB-1	---

Following installation and recovery and prior to purging and collection of groundwater samples, the elevation of the groundwater table and potentiometric surfaces will be measured, and the volume of water present within each well will be calculated. Decontamination procedures for any non-dedicated or non-disposable equipment used for collection of groundwater samples will also be performed using the procedures set forth in SOP No. 08 (**Appendix B**). Although not anticipated at this Site, the depth and thickness of floating (light) and/or sinking (dense) non-aqueous phase liquids, if present, will be measured using an interface probe (per SOP No..16 in **Appendix B**).

Each well will be purged prior to sampling in accordance with SOP No. 04 (**Appendix B**). If the geologic materials surrounding the well are low yielding, then the wells will be completely evacuated, and groundwater samples will be collected after the water level recovers sufficiently to provide the volume of water needed to fill sample containers for the desired analyses.

The well may be purged using any of the following methods: a peristaltic pump, a low-flow Micro-Purge Sampling System (or equivalent), a Voss disposable polyethylene bailer (or equivalent), or a Waterra hand pump (or equivalent) or similar equipment. Non-disposable purging equipment will be decontaminated in accordance with SOP No. 08 (**Appendix B**).

After purging, groundwater samples will be collected from the permanent groundwater monitoring wells and piezometers. Groundwater samples will be laboratory analyzed for VOCs, perfluoroalkyl and polyfluoroalkyl substances (PFAS), and/or 1,4-dioxane. The samples will be placed in laboratory-supplied containers, preserved as appropriate, stored on ice, and submitted under chain-of-custody procedures to Eurofins TestAmerica (University Park, Illinois) or CT Laboratories (Baraboo, Wisconsin), both State of Wisconsin certified laboratories, for analysis per EPA method 8260D, 537 Modified, and/or SW3510, respectively. Anticipated sample collection and laboratory analytical methods for groundwater samples are summarized in **Table 2.**

2.5 VAPOR ASSESSMENT

As illustrated on **Figure 2**, the vapor assessment will include the sampling of two existing sub-slab vapor points (located at 20/22 South Main Street), installation/sampling of up to three sub-slab vapor points (11, 16/18, & 23 South Main Street), sampling of three underground utilities on Site, and five indoor air samples. The actual sub-slap vapor point locations may be adjusted based on accessibility, the location of underground utilities, and results of the private utility locate. Vapor assessment will be conducted per SOP No. 11 (**Appendix B**).

2.5.1 Sub-Slab Vapor Assessment

The three sub-slab soil vapor points will be installed using a hammer drill. A 5/8-inch diameter drill bit will be used to fully penetrate the concrete floor and allow for VaporPin® installation. The VaporPin® will be fitted with a stainless-steel sealable hose barb to allow for sample collection. After vapor point installation and prior to sampling, two leak tests will be performed. The leak testing will consist of a “shut-in test” to measure if a leak exists between the connections of the sample probe and the sample container and a “water dam” to measure if a leak exists between the seal of the vapor point and concrete. The “shut-in” and “water dam” tests are discussed in further detail in below.

<u>Step One – Shut-In Test</u>
The shut-in test will measure the airtightness of the fittings between the sample probe and the sample container. This process will include the following steps:

1. A vacuum gage was connected to the sampling line between the soil vapor point and sample container (laboratory-supplied Summa canister).
2. Valves to the soil vapor point and Summa canister were shut and air was removed from the sampling line using a hand-pump inducing a vacuum in the line of greater than 50 inches of water (or, approximately 4 inches of mercury).
3. The vacuum reading was monitored for at least one minute to determine if vacuum remained steady. If the vacuum did not remain steady after one minute the connections were tightened and the shut-in test was repeated until a steady vacuum reading was observed.

<u>Step Two – Water Dam Test</u>
The water dam test is used to determine if the soil vapor point seal is preventing outside air from entering the soil vapor point. This process included the following steps:

1. A small enclosure (a short section of a 2-inch PVC pipe, for instance) was sealed to the floor around the sub-slab vapor probe and filled with water.
2. If the water placed in the casing maintains a constant level, the test confirms that no leaks are present in the vapor sample probe.

After successfully completing the two quality control checks, sub-slab soil vapor samples will be collected using 6-liter Summa canisters provided by the analytical laboratory, each equipped with a 30-minute air flow controller (200 milliliters per minute [mL/min]). Each sub-slab sample will be assigned a SIN based on the following format:

Sample Type	Label for Type of Sample	Location Number	Sample Round	SIN	Location ID
Sub-Slab Vapor Point	VP	1	01	VP-1 (01)	VP-1
Field Duplicate	FD	---	---	FD-1	---

The soil vapor samples will be shipped to TestAmerica in Knoxville, Tennessee (Wisconsin State Program certified, identification number 998044300) under chain-of-custody protocol to be analyzed for VOCs using EPA Method TO-15. After completion of sample collection, the hose barb will be removed from each vapor point and replaced with a flush mounted cap, allowing all installed vapor points to remain in place flush with the concrete floor surface. Anticipated sample collection and laboratory analytical methods for vapor samples are summarized in **Table 3**.

2.5.2 Indoor Air Sampling

Stantec will collect indoor air samples surrounding the Site. Stantec will collect five indoor air samples from the basement of the neighboring commercial buildings at 22 South Main Street currently operating as The Pour House, 23 South Main Street currently operating as a chiropractic/optician service, and 11 South Main Street currently operating as Hank's Restaurant & Drinkery. Each indoor air sample collection device (6-liter Summa canister with 8-hour flow controller) will be positioned at a height considered to represent the normal breathing zone (approximately 3 to 5 feet above the lowest floor of the building) in the area of its subsequent sub-slab sampling point. Summa canisters may be placed on a desk, table, shelf, cabinet, etc. so that the sampling location is at the correct height. Collection of indoor air samples near windows or sources of outdoor air leakage will be avoided.

Stantec will use a placard labeled “Do Not Disturb – Active Air Sampling”. Stantec assumes Site occupants will not tamper with the Summa canisters during the 8-hour sample collection time, as Stantec personnel will not be continuously monitoring each canister. Each indoor air sample will be assigned a SIN based on the following format:

Sample Type	Label for Type of Sample	Location Number	Sample Round	SIN	Location ID
Indoor Air	IA	1	01	IA-1 (01)	IA-1
Field Duplicate	FD	---	---	FD-1	---

After approximately 8-hours, the canisters will be sealed and collected for shipment to the project laboratory. Following sample collection, the indoor air samples will be shipped to TestAmerica in Knoxville, Tennessee (Wisconsin State Program certified, identification number 998044300) under chain-of-custody protocol to be analyzed for VOCs using EPA Method TO-15. Anticipated sample collection and laboratory analytical methods for vapor samples are summarized in **Table 3**.

2.5.3 Utility Vapor Assessment

Vapor samples will be collected from the utility corridors on the Site by accessing the manholes adjoining the public rights-of-way. Prior to sampling, the manhole covers will be shifted open slightly to allow enough room from the sample collection tubing to be lowered into the sewer to a depth of approximately one foot above the bottom of the sewer. Since the opening of the manhole is anticipated to be small, sealing the opening around the tubing is not required. If the manhole is opened a significant amount, the space around the tubing will be sealed. The sample collection tubing will be connected to an evacuated 6-liter Summa canisters provided by the analytical laboratory, each equipped with a 30-minute air flow controller (200 mL/min).

Each utility corridor vapor sample will be assigned a SIN based on the following format:

Sample Type	Label for Type of Sample	Location Number	Sample Round	SIN	Location ID
Utility Corridor Vapor	UV	1	01	UV-1 (01)	UV-1
Field Duplicate	FD	---	---	FD1	---

Following sample collection, the utility corridor vapor samples will be shipped to TestAmerica in Knoxville, Tennessee (Wisconsin State Program certified, identification number 998044300) under chain-of-custody protocol to be analyzed for VOCs using EPA Method TO-15. The sample collection tubing will be removed and the manholes re-sealed. Anticipated sample collection and laboratory analytical methods for vapor samples are summarized in **Table 3**.

2.6 SURVEYING

The location for each soil boring will be documented using global positioning satellite (GPS) survey equipment per SOP No. 15 (**Appendix B**).

2.7 FIELD DATA DOCUMENTATION

An up-to-date field logbook will be maintained by each sampling team to document daily activities (if more than one group of individuals is sampling). The logbook will include a general list of tasks performed, additional data, or observations not listed on field data sheets, and document communications with on-site personnel or visitors as these apply to the project (per SOP No. 07 in **Appendix B**).

2.8 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance/quality control (QA/QC) samples to be collected and analyzed will include trip blanks, equipment blanks (for any non-disposable equipment used and/or PFAS sampling), and field replicate/duplicate samples. Trip blanks prepared by the analytical laboratory will accompany the sample bottles from the time of shipment from the laboratory through the time the samples are returned for analysis. Trip blanks will be used to document any contamination detected in samples that may be attributable to shipping and field handling procedures, or contaminated sample containers.

Trip transportation procedures as the investigative samples. At least one trip blank sample will accompany each shipping container that contains samples for VOC analysis.

If non-disposable sampling equipment is used, equipment blanks will be prepared by: (a) filling the decontaminated sampling device with laboratory-supplied reagent-grade water; (b) transferring the water to appropriate sample containers; and (c) submitting the sample for analysis. If contaminants are found in the equipment or trip blanks, the source for the contamination will be assessed and corrective action measures taken (such as modifying the sampling procedures and/or resampling as appropriate). The estimated number of equipment blank samples to be analyzed for each constituent is shown in **Tables 1** through **3**. Please note that it is anticipated that only disposable sampling equipment will be used and that equipment blanks will, therefore, not be required.

2.9 CROSS CONTAMINATION PREVENTION MEASURES

Soil sampling equipment such as drilling tools will be decontaminated prior to arrival on-site and between each sampling location (see SOP No. 08 in **Appendix B**).

2.10 MANAGEMENT OF INVESTIGATIVE WASTES

Any investigative waste (i.e. soil cuttings and fluids) will be placed into labeled containers. Appropriate disposal of the waste will be determined based on the results of laboratory analyses.

Investigative wastes generated will be managed per SOP No. 10 (**Appendix B**). In general, waste soil cuttings, purged groundwater, or core samples will be collected in Department of Transportation (DOT)-approved 55-gallon drums or other appropriate containers, sealed, labeled, and stored on-site pending the completion of laboratory analysis and determination of disposal restrictions, if any. As appropriate, waste soil will be handled, transported, and disposed of by a licensed waste hauler per federal and state requirements. The generator of the waste will be the property owner at the time of the investigation.

3.0 REPORT

The additional site investigation will enable refinement of the conceptual model of the physical subsurface conditions and contaminant sources at the Site. The results of field activities will be documented in a report. The report will include:

- Laboratory analytical reports and chain-of-custody documentation;
- Water level measurement data;
- Tables summarizing analytical results for groundwater samples and comparing the measured concentrations to applicable WAC standards;
- A copy of the laboratory's current certification;
- Maps of well locations and utilities; and
- Narratives summarizing background information, methods of investigation, findings, and conclusions.

Recommendations for future actions, if any, will be provided in the report.

4.0 REFERENCES

Cotter, R.D., R.D. Hutchinson, E.L. Skinner, Hydraulic Investigations, Water Resources of Wisconsin, Rock-Fox River Basin, Atlas HA-360, 1969.

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Trotta, L.C., and R.D. Cotter, USGS, Depth to Bedrock in Wisconsin, 1973.

WDNR, (WDNR, 2022), Wisconsin Department of Natural Resources, Well Construction Information System, accessed August 24, 2022. https://dnr.wi.gov/WellConstructionSearch/#!/PublicSearch/Index

Wisconsin Geological and Natural History Survey (WGNHS), "Lexicon of Pleistocene Stratigraphic Units of Wisconsin," Technical Report 1, 2011.

5.0 DISCLAIMER AND LIMITATIONS

The conclusions in the Work Plan are Stantec's professional opinion, as of the time of the Work Plan, and concerning the scope described in the Work Plan. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. The Work Plan relates solely to the specific project for which Stantec was retained and the stated purpose for which the Work Plan was prepared. The Work Plan is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk. Stantec has assumed all information received from the City of Hartford, and third parties in the preparation of the Work Plan to be correct. While Stantec has exercised a customary level of judgment or due diligence in the use of such information, Stantec assumes no responsibility for the consequences of any error or omission contained therein. This Work Plan is intended solely for use by the City of Hartford in accordance with Stantec's contract with the City of Hartford. While the Work Plan may be provided to applicable authorities having jurisdiction and others for whom the City of Hartford is responsible, Stantec does not warrant the services to any third party. The Report may not be relied upon by any other party without the express written consent of Stantec, which may be withheld at Stantec's discretion.

TABLES

TABLE 1: PROPOSED LABORATORY ANALYSES FOR SOIL
South Main Street Property
Hartford, Wisconsin

Soil Boring ID	Estimated Soil Boring Depth (ft bgs)	Rationale	Soil Sample Depth (ft bgs)	VOCs (8260)[1]
PZ-4	25	PZ-4 will evaluate soil quality upgradient from the identified CVOC plume on the Site. Soil sample depth may be altered based upon field screening (highest PID reading above the water table).	0-6	1
PZ-5	25	PZ-5 will evaluate soil quality sidegradient/upgradient from the identified CVOC plume on the Site. Soil sample depth may be altered based upon field screening (highest PID reading above the water table).	0-6	1
MW-6	15	PZ-6 will evaluate soil quality within the identified CVOC plume in the area of former monitoring well HP07. Soil sample depth may be altered based upon field screening (highest PID reading above the water table).	0-6	1
PZ-7	25	PZ-7 will evaluate soil quality downgradient from the identified CVOC plume offsite to the north. Soil sample depth may be altered based upon field screening (highest PID reading above the water table).	0-6	1
MW-8	15	PZ-8 will evaluate soil quality downgradient offsite to the northwest nearby former monitoring well HP11. Soil sample depth may be altered based upon field screening (highest PID reading above the water table).	0-6	1
PZ-9	25	PZ-9 will evaluate soil quality downgradient offsite to the northwest nearby former monitoring well HP09. Soil sample depth may be altered based upon field screening (highest PID reading above the water table).	0-6	1
MW-10	15	PZ-10 will evaluate soil quality downgradient offsite to the northwest nearby former monitoring well HP13. Soil sample depth may be altered based upon field screening (highest PID reading above the water table).	0-6	1
Estimated number of investigative samples to be analyzed				**7**
Trip Blank		Field and laboratory QA/QC sample.		1
Field Duplicates		Assess the quality of the data and sample collection techniques.		1
Estimated number of QA/QC samples to be analyzed				**2**
Estimated total number of samples to be analyzed				**9**

Notes:

Actual depths for various laboratory analysis may change based on field observations

[1] = Collect VOC samples where photoionization detector (PID) readings are elevated compared to other samples, odors are observed, and/or a sheen is observed.
ft bgs = feet below ground surface
QA/QC = quality assurance/quality control
VOC = volatile organic compound
(8260) = laboratory analytical method

TABLE 2
PROPOSED LABORATORY ANALYSES FOR GROUNDWATER
South Main Street Property
Hartford, Wisconsin

Well ID	Estimated Well Depth (ft bgs)	Rationale	VOCs (8260)
MW-1	N/A	Sample existing well	1
PZ-1	N/A	Sample existing well	1
PZD-1	50 Feet	PZD-1 will evaluate groundwater quality in bedrock nearby MW-1 and PZ-1.	1
MW-2	N/A	Sample existing well	1
PZ-2	N/A	Sample existing well	1
PZD-2	50 Feet	PZD-2 will evaluate groundwater quality in bedrock nearby MW-2 and PZ-2.	1
MW-3	N/A	Sample existing well	1
MW-4	15 Feet	MW-4 will evaluate shallow groundwater quality upgradient from the identified CVOC plume on the Site.	1
PZ-4	25 Feet	PZ-4 will evaluate groundwater quality at depth upgradient from the identified CVOC plume on the Site.	1
MW-5	15 Feet	MW-5 will evaluate shallow groundwater quality sidegradient/upgradient from the identified CVOC plume offsite to the east.	1
PZ-5	25 Feet	PZ-5 will evaluate groundwater quality at depth sidegradient/upgradient from the identified CVOC plume offsite to the east.	1
MW-6	15 Feet	MW-6 will evaluate shallow groundwater quality within the identified CVOC plume in the area of former monitoring well HP07.	1
PZ-6	25 Feet	PZ-6 will evaluate groundwater quality at depth within the identified CVOC plume in the area of former monitoring well HP07.	1
PZD-6	50 Feet	PZD-6 will evaluate groundwater quality in bedrock within the identified CVOC plume in the area of former monitoring well HP07.	1
MW-7	15 Feet	MW-7 will evaluate groundwater quality downgradient from the identified CVOC plume offsite to the north.	1
PZ-7	25 Feet	PZ-7 will evaluate groundwater quality at depth downgradient from the identified CVOC plume offsite to the north.	1
MW-8	15 Feet	MW-8 will evaluate shallow groundwater quality downgradient offsite to the northwest nearby former monitoring well HP11.	1
PZ-8	25 Feet	MW-8 will evaluate groundwater quality at depth downgradient offsite to the northwest nearby former monitoring well HP11.	1
MW-9	15 Feet	MW-9 will evaluate shallow groundwater quality downgradient offsite to the northwest nearby former monitoring well HP09.	1
PZ-9	25 Feet	PZ-9 will evaluate groundwater quality at depth downgradient offsite to the northwest nearby former monitoring well HP09.	1
PZD-9	50 Feet	PZD-9 will evaluate groundwater quality in bedrock downgradient offsite to the northwest nearby former monitoring well HP09.	1
MW-10	15 Feet	MW-10 will evaluate shallow groundwater quality downgradient offsite to the northwest nearby former monitoring well HP13.	1
PZ-10	25 Feet	PZ-10 will evaluate groundwater quality at depth downgradient offsite to the northwest nearby former monitoring well HP13.	0
Estimated number of investigative samples to be analyzed			**15**
Trip Blank		Field and Laboratory QA/QC Sample	1
Equipment Blank		Assess the quality of the sampling procedure	-
Field Duplicate		Assess the quality of the data and collection techniques.	1
Estimated number of QA/QC samples to be analyzed			**2**
Estimated number of samples to be analyzed			**17**

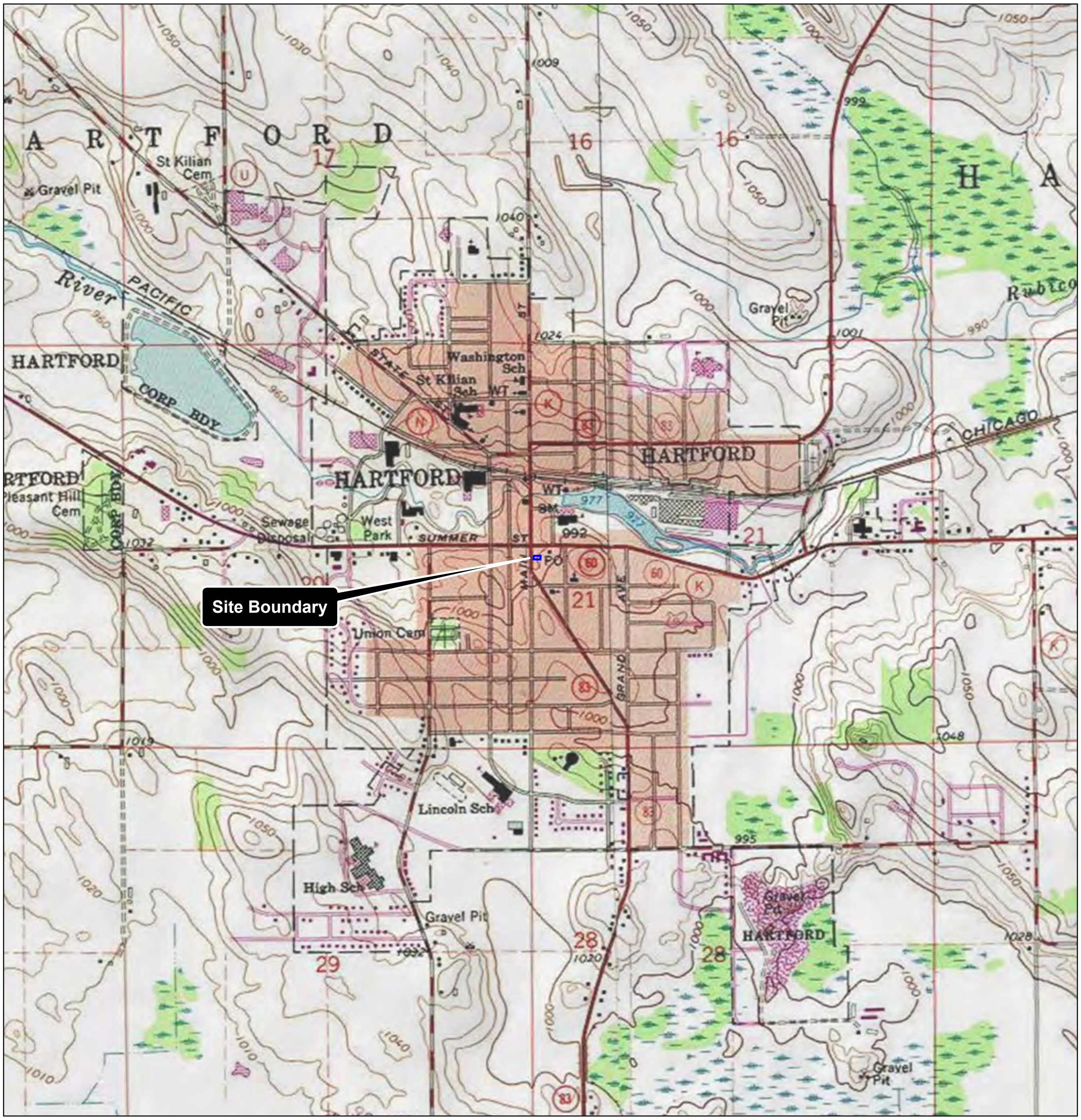
Notes:
MW = Permanent Monitoring Well
PZ = Piezometer
PZD = Bedrock Piezometer
QA/QC = Quality Assurance Quality Control
CVOC = Chlorinated Volatile Organic Compounds
VOC = Volatile Organic Compounds
PFAS = Perfluoroalkyl and Polyfluoroalkyl Substances
(8260) = Laboratory analytical method (SW-846)
ft bgs = feet below ground surface

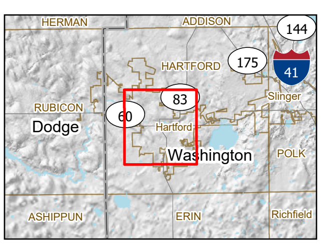
TABLE 2
PROPOSED LABORATORY ANALYSES FOR VAPOR
South Main Street Property
Hartford, Wisconsin

Vapor Sample ID	Sample Type	Rationale	VOCs (TO-15)
VP-1 & VP-2	Sub-Slab	VP-1 & VP-2 will evaluate sub-slab vapor quality offsite to the north downgradient of the identified CVOC plume beneath the building located at 20/22 South Main Street	2
IA-1 & IA-2	Indoor Air	IA-1 and IA-2 will evaluate indoor air quality offsite to the northwest downgradient of the identified CVOC plume in the basement of the building located at 20/22 South Main Street	2
VP-3	Sub-Slab	VP-3 will evaluate sub-slab vapor quality offsite to the north sidegradient of the identified CVOC plume beneath the building located at 16/18 South Main Street	1
IA-3	Indoor Air	IA-3 will evaluate indoor air quality offsite to the north sidegradient of the identified CVOC plume in the basement of the building located at 16/18 South Main Street	1
VP-4	Sub-Slab	VP-4 will evaluate sub-slab vapor quality offsite to the northwest downgradient of the identified CVOC plume beneath the building located at 23 South Main Street	1
IA-4	Indoor Air	IA-4 will evaluate indoor air quality offsite to the northwest downgradient of the identified CVOC plume in the basement of the building located at 23 South Main Street	1
VP-5	Sub-Slab	VP-5 will evaluate sub-slab vapor quality offsite to the northwest downgradient of the identified CVOC plume beneath the building located at 11 South Main Street	1
IA-5	Indoor Air	IA-5 will evaluate indoor air quality offsite to the northwest downgradient of the identified CVOC plume in the basement of the building located at 11 South Main Street	1
UV-1	Utility Corridor	UV-1 will evaluate vapor conditions in the utility corridor by accessing a manhole adjoining the South Main Street right-of-way	1
UV-2	Utility Corridor	UV-2 will evaluate vapor conditions in the utility corridor by accessing a manhole adjoining the South Main Street right-of-way	1
UV-3	Utility Corridor	UV-3 will evaluate vapor conditions in the utility corridor by accessing a manhole adjoining the South Main Street right-of-way	1
Estimated number of investigative samples to be analyzed			**13**
Trip Blank		Field and Laboratory QA/QC Sample	0
Field Duplicate		Assess the quality of the data and collection techniques.	1
Estimated number of QA/QC samples to be analyzed			**1**
Estimated number of samples to be analyzed			**14**

Notes:
VP = Vapor Point
UV = Utility Corridor Vapor Point
IA = Ambient Air Sample
QA/QC = Quality Assurance Quality Control
VOC = Volatile Organic Compounds

FIGURES





Legend

Site Boundary

0 1,000 2,000 Feet

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Stantec

Project Location
T10N, R18E, S21
C. of Hartford, Washington Co., WI

Prepared by AJS on 2022-05-11
TR by JS on 2022-05-11
IR by ENG on 2022-05-18

Client/Project
193708879
Washington County
South Main Street Property
SSSAP

Figure No.
1

Title
Site Location and Topography

Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources: Stantec, WDNR, WisDOT
3. Background: USGS 7.5' Topographic Quadrangles

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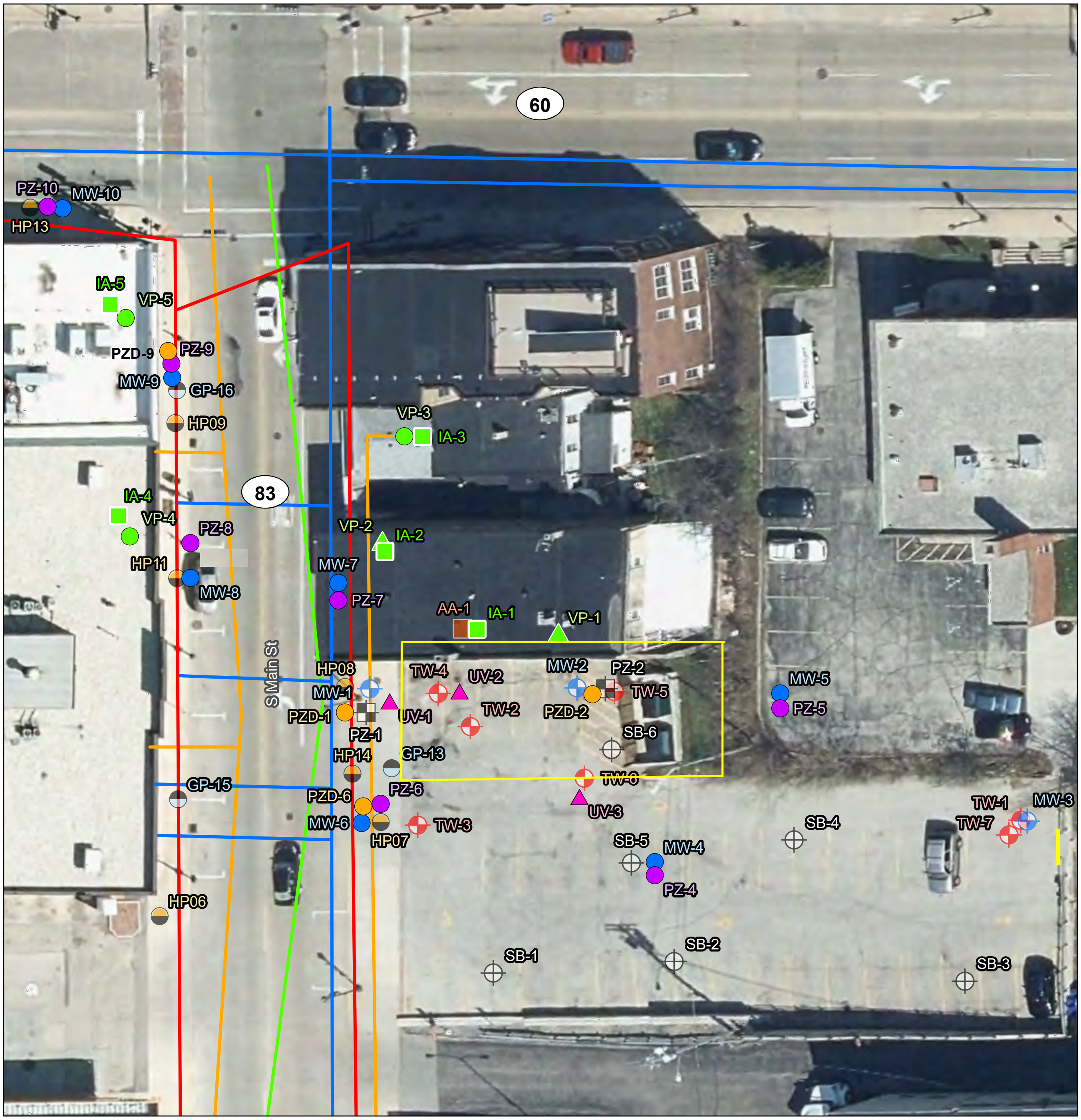

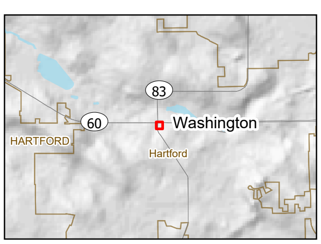

Notes

1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources: Stantec, SCO, WDNR, WisDOT
3. Orthophotography: WDNR WROC 2020

Legend

- Site Boundary
- Proposed Sub-Slab Soil Vapor Sample Location
- Proposed Permanent_Monitoring Well Location
- Proposed Permanent Piezometer Location
- Proposed Bedrock Piezometer Location
- Proposed Utility Corridor Vapor Sample
- Proposed Indoor Air Sampling Location
- Electric
- Water
- Gas
- Storm Sewer
- Monitoring Well Location
- Piezometer Location
- Borehole Location (Former August 2020 Phase II ESA)
- Temporary Well (Former August 2020 Phase II ESA)
- Borehole Location (Former 2014-2015 TRC Soil Investigation)
- Former 1998 Montgomery Watson Soil and Groundwater Investigation
- Indoor Air Sample Location (Former Stantec, 2022)
- Sub-Slab Soil Vapor Sample Location (Former Stantec, 2022)

0 20 40 Feet

(At original document size of 8.5x11)
1:480

N

Stantec

Project Location
T10N, R18E, S21
C. of Hartford, Washington Co., WI

Prepared by DBB on 2022-06-09
TR by JS on 2022-06-10
IR by RK on 2022-08-12

Client/Project
193708879
Washington County
South Main Street Property
SSSAP

Figure No.
2

Title
Prior and Proposed Sample Locations

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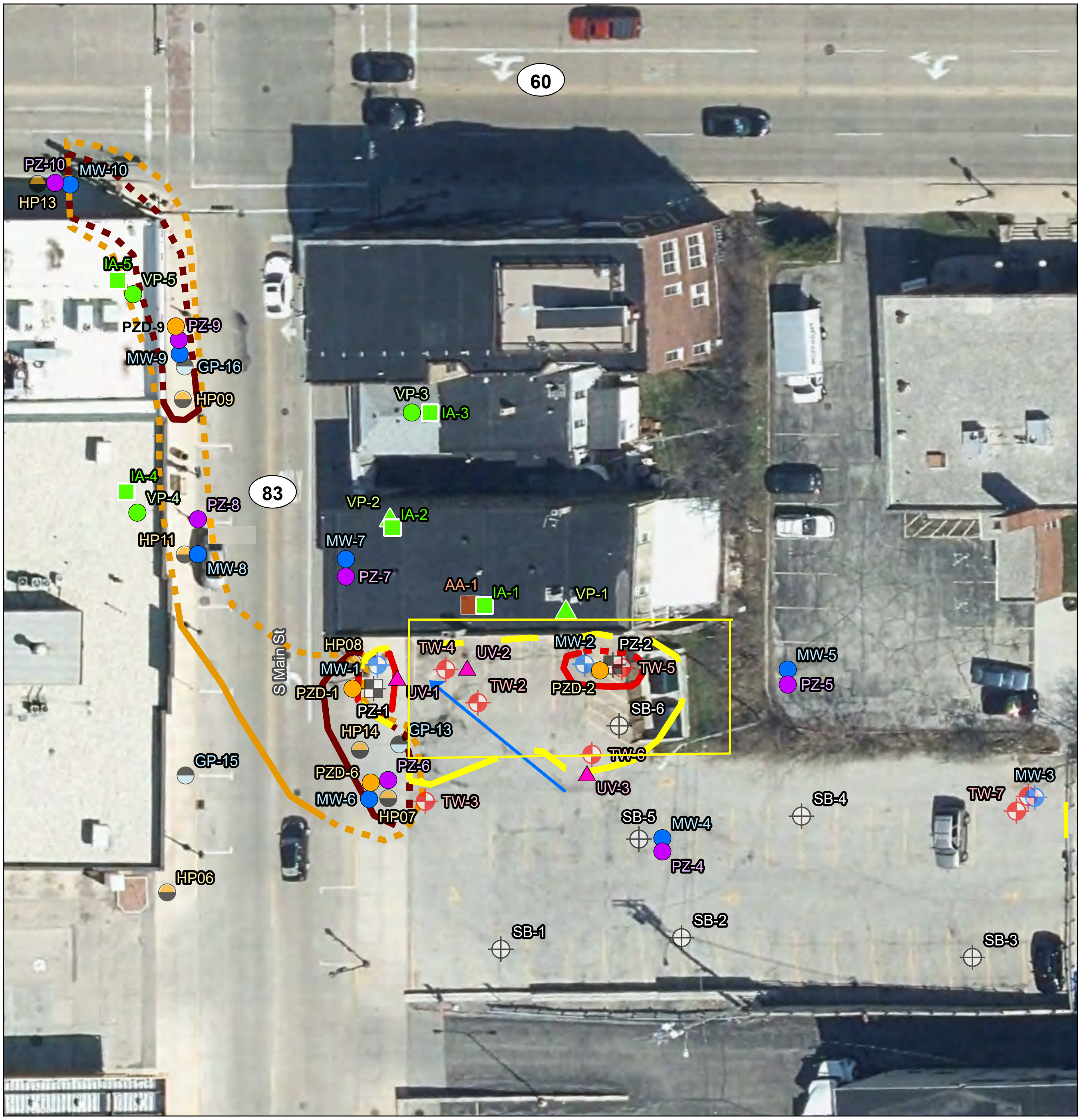

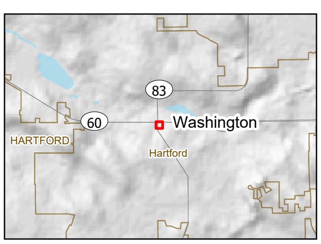

Legend

- Site Boundary
- Proposed Sub-Slab Soil Vapor Sample Location
- Proposed Permanent Monitoring Well Location
- Proposed Permanent Piezometer Location
- Proposed Bedrock Piezometer Location
- Proposed Utility Corridor Vapor Sample
- Proposed Indoor Air Sampling Location
- Groundwater Flow Direction
- Monitoring Well Location
- Pizometer Location
- Borehole Location (Former August 2020 Phase II ESA)
- Temporary Well (Former August 2020 Phase II ESA)
- Borehole Location (Former 2014-2015 TRC Soil Investigation)
- Former 1998 Montgomery Watson Soil and Groundwater Investigation
- Indoor Air Sample Location (Former Stantec, 2022)
- Sub-Slab Soil Vapor Sample Location (Former Stantec, 2022)
- General Extent of Groundwater Contamination Exceeding the NR140 PAL
- General Extent of Groundwater Contamination Exceeding the NR140 ES
- Former General Extent of Groundwater Contamination Exceeding the NR140 PAL (1998)
- Former General Extent of Groundwater Contamination Exceeding the NR140 ES (1998)

Dashed lines indicate inferred extent

0 20 40 Feet
(At original document size of 8.5x11)
1:480

N

Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources: Stantec, SCO, WDNR, WisDOT
3. Orthophotography: WDNR WROC 2020

PAL: Preventive Action Limit
ES: Enforcement Standard

Stantec

Project Location
T10N, R18E, S21
C. of Hartford, Washington Co., WI

Prepared by DBB on 2022-06-09
TR by JS on 2022-05-11
IR by ENG on 2022-05-18

193708879

Client/Project
Washington County
South Main Street Property
SSSAP

Figure No.
3

Title
General Extent of Groundwater Contamination

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APPENDIX A – SITE-SPECIFIC HEALTH AND SAFETY PLAN (RMS1)

Risk Management Strategy (RMS1)

- **If the project requires fieldwork, a HASP or RMS1 must be completed.**
- **If the scope of work for a project that originally did not involve field work changes to include field work, an RMS1 form must be completed and reviewed with employees before field work begins.**
- **Although the RMS1 is intended to be part of the desktop planning process for a project, please be aware that the RMS1 must be carried as a field resource as well, to complement use of the Field Level Risk Assessment (RMS2).**

Date: October 4, 2022	This form expires 1 year from the date of creation
Project / proposal number: 193709082	**Project name:** South Main Street Property
Location: 24 South Main Street, Hartford, WI	
Project description (Companies involved, what, where, when) Supplemenal Site Investigaiton to further delineate the extent of offsite groundater and vapor CVOC contamination.	
Does this project involve fieldwork?	**Yes** - continue with this form
Is this project remote work?	**No**
What method of communication will be used?	☒ Cell Phone ☐ Satellite Phone ☐ Spot Messenger ☐ Other:
Is there a call in – call out system?	**No**
Are there any unique security concerns?	**No**
Will workers on this project be crossing into different states/provinces or countries?	**No**
Is Stantec the Constructor/Prime Contractor?	**Yes -** please contact the HSSE Advisor or Manager for the province, state or country that your staff are working in for guidance on HSSE regulations.
Is Stantec hiring subcontractors?	**Yes -** please confirm that your subcontractor is prequalified. If you have any questions, please email mailto:sub.prequal@stantec.com.
Will Stantec staff or subcontractors be working alone?	**Yes -** provide guidance from SWP 118
Client/Constructor HSSE training required?	**No**
Is there a Client/Constructor HSSE program that the project is required to follow?	**No**
Will this project require international travel outside of North America?	**No**
List the major tasks associated with this project. 1. Mobilize to Site	
2. Monitoring well and piezometer installation with drilling subcontractor	
3. Sub-slab and ambient air vapor sampling	
4. Utility vapor sampling	
5. Well and piezometer development	
6. Sample groundwater and piezometers	
7. Survey monitoring well and piezometer locations	
8. Mobilize back to office	
9. Click here to enter text	
10. Click here to enter text	

Identify critical risk(s) that staff may encounter on this project. For each critical risk identified, review the flatsheet using the In Case of Crisis app or a printed copy.					
Driving	Working at Heights	Traffic Control	Wildlife, Insects, and Vegetation	Mobile and Heavy Equipment	Environments with Water or Ice
Yes	No	Yes	Yes	Yes	No
Ground Disturbance	Ergonomic Hazards and Manual Handling	Hazardous Materials and Environments	Control of Hazardous Energy	Hot Work	Confined Spaces
Yes	Yes	Yes	No	No	No

When assessing energy sources please consider task and site hazards including activities, time of day, time of year and project stages. If an SWP for a task below is not available, please perform a Quantified Hazard Assessment (RMS7) for the task and include below.

Please identify SWPs below that apply to your project:

☒ SWP 107 – First Aid
☐ SWP 103 – WHMIS (CA)
☒ SWP 111 – Medical Surveillance
☒ SWP 104 – HAZCOM (US)
☒ SWP 105 – PPE
☒ SWP 118 – Working Alone In the Field

	Hazards	Applicable SWPs, forms, SOPS, RMS7s	Specialized training beyond the SWPs	Specific Site Controls
Thermal				
	☒ Cold stress ☐ Cold surfaces ☒ Heat stress ☐ Hot surfaces ☐ Hot work ☒ Weather conditions ☐ Other:	☐ SWP 514 - Working on or Near Ice ☒ SWP 114 - Working in Cold Environments ☒ SWP 113 - Heat Stress ☐ SWP 414, 414a – Hot Work Enter additional SWPs, SOPs	Enter specialized training	Wear weather appropriate clothing for conditions. Take breaks as needed. Stay hydrated
Chemical				
	☐ Oxygen deficient atmosphere ☐ H_2S (Hydrogen sulfide) ☐ Asbestos ☐ Silica ☒ Acids ☒ Caustics ☒ Petroleum hydrocarbons ☒ Solvents/Flammables ☒ Volatile organic compounds ☒ Heavy metals ☐ Benzene ☐ Lead ☐ Arsenic ☒ Polycyclic Aromatic Hydrocarbons (PAH) ☐ PCBs ☐ Pesticides	☐ SWP 409 - Respiratory Protection ☐ SWP 411, 411a, 411b, 411c – Confined Space Entry ☐ SWP 304 - Asbestos Safety ☐ SWP 309 - Silica Awareness ☒ SWP 312 - Fueling Gasoline Engines ☐ SWP 305 - Benzene Safety ☐ SWP 314 – Working Around Hazardous Waste and Wastewater ☐ SWP 315 - Arsenic Safety ☐ SWP 319 - Hydrogen Fluoride / Hydrofluoric Acid Safety ☐ SWP 519 - Post-Disaster Building Entry	Enter specialized training	Wear appropriate PPE. Nitrile gloves, glasses, hard hat, high-vis vest, steel toed boots, and covered clothing

	☐ Herbicides	Enter additional SWPs, SOPs		
	☐ Hydrogen fluoride / Hydrofluoric acid			
	☐ Other:			
Biological				
	☒ Wildlife	☐ SWP 409 - Respiratory Protection ☐ SWP 314 - Working Around Hazardous Waste and Waste Water ☐ SWP 108 - Bloodborne Pathogens ☒ SWP 508 - Wildlife Encounters ☐ SWP 102 - Workplace Violence ☐ SWP 510 - Working in Abandoned Buildings ☒ SWP 511 – Ticks and Tickborne Diseases ☐ SWP 519 - Post-Disaster Building Entry Enter additional SWPs, SOPs	Enter specialized training	Stay aware of surroundings during site work. Protect against potential wildlife and nearby pedestrians. Stay in communication with crew and surrounding Site work. Wear bug spray and sun screen as needed. Follow current COVID-19 protocol and complete fit for duty form prior to work.
	☒ Domestic animals (dogs, cattle)			
	☒ Bees / wasps / hornets			
	☒ Ticks			
	☒ Black flies			
	☒ Other stinging or biting insects			
	☒ Pedestrians / onlookers			
	☐ Protesters			
	☐ Poison ivy			
	☐ Poison oak			
	☐ Giant hogweed			
	☐ Wild parsnip			
	☐ Sewage			
	☐ Wastewater			
	☐ Domestic waste			
	☐ Medical waste			
	☐ Bloodborne pathogens			
	☐ Bacterial cultures			
	☒ Other:COVID-19			
	☐ Other:			
	☐ Other:			
	☐ Other:			
Radiation				
	☒ Solar (UVA/UVB)	☐ SWP 502, 502a-q (CA) - Radiation Safety Program Field Manual for Portable Gauges (Canada) ☐ SWP 516, 516a-e (US) - Radiation Safety (US) Enter additional SWPs, SOPs	Enter specialized training	Wear sunscreen and cover up as appropriate to protect selves from the sun
	☐ Welding			
	☐ Nuclear densometers			
	☐ NORMs			
	☐ Microwave			
	☐ Other:			
Noise				
	☒ Mobile equipment	☒ SWP 106 – Noise Control and Hearing Conservation Program Enter additional SWPs, SOPs	Enter specialized training	Wear ear plugs and stay a safe distance from drill rig (about 10-foot buffer).
	☐ Stationary equipment			
	☒ Manual equipment			
	☒ Impact			
	☒ Vibration			
	☐ Impact on communications			
	☐ Other:			

Gravity			
☒ Slip / Trip / Fall ☐ Work from heights ☒ Falling objects ☐ Other:	☐ SWP 201 - Fall Protection / Working at Heights ☐ SWP 202 - Ladder Safety ☐ SWP 203 - Aerial Work Platform ☐ SWP 205 - Scaffold Safety ☒ SWP 208 - Hoisting and Lifting ☐ SWP 510 - Working in Abandoned Buildings Enter additional SWPs, SOPs	Enter specialized training	If icy, wear YakTracks or slip-prevention on footwear and stay a safe distance from the drill rig (about 10-foot buffer). Wear steel toe boots in case of falling objects near feet. Watch your step during work.
Motion			
☒ Working near traffic ☒ Automobile/truck/trailer ☒ Construction equipment ☐ Elevated work platform ☒ Pedestrians ☒ Cyclists ☐ Rail ☐ ATV ☐ ARGO ☐ Watercraft / water ☐ Snowmobile ☐ Aircraft (fixed wing or rotary) ☐ UAVs/Drones ☒ Walking/Hiking ☒ Lifting ☒ Pushing/Pulling ☒ Bending ☒ Posture/position ☐ Climbing ☒ Twisting ☐ Other:	☐ SWP 507 - Aircraft Safety ☒ SWP 124, 124a, 124b – Safe Driving ☒ SWP 216 - Working Near Mobile Equipment ☐ SWP 217, 217a – Forklift Operation ☒ SWP 407, 407a – Traffic Control and Protection Planning ☐ SWP 505, 505a, 505b, 505c, 505d - Off Road Vehicles ☐ SWP 506 - Rail Safety ☒ SWP 115 - Material Handling and Safe Lifting ☒ SWP 125 - Workstation Ergonomics ☐ SWP 513 - Water and Boat Safety Enter additional SWPs, SOPs	Enter specialized training	Be aware of body position during site work to reduce motion injury. Operate the vehicle safely and maintain knowledge of surroundings. Heavy equipment buffer minimum of 10 feet and wear high-vis vest
Mechanical			
☒ Cutting edges ☒ Blades ☒ Rotating parts (e.g., drill/auger) ☒ Wrap points ☒ Shear points ☒ Pinch points ☐ Freewheeling point ☐ Chains ☐ Cables ☐ Other:	☒ SWP 416 - Supervision of Contracted Drilling Activities ☐ SWP 518, 518a – Using a Chainsaw ☒ SWP 206 - Hand and Portable Power Tools ☐ SWP 517 - Safe Machete Use ☐ SWP 408, 408a, 408b, 408c – Lock, Tag & Try ☒ SWP 216 - Working Near Mobile Equipment Enter additional SWPs, SOPs	Enter specialized training	PPE, heavy equipment buffer of 10-feet, use tools appropriately and be conscientious of surroundings

Electrical

☒ Power and communication lines ☒ Static charge and lightning ☒ Wiring ☒ Batteries ☒ Lighting levels ☒ Wet environment ☒ GFCI cords/plugs ☐ Double insulated tools ☐ Exposed circuits ☐ Other:	☒ SWP 213, 213a, 213b, 213c – Utility Clearance ☒ SWP 406, 406a, 406b – Electrical Safety Program ☐ SWP 408, 408a, 408b, 408c – Lock, Tag & Try ☐ SWP 504 - Backpack and Boat Mounted Electro-Fishing ☐ SWP 519 - Post-Disaster Building Entry Enter additional SWPs, SOPs	Enter specialized training	Prior to drilling, look for utilities below and above the drill rig. Private utility locate. If lightning seen or heard, stop work and wait 30 min. If no lightining detected, then may proceed. Repeat as necessary.

Pressure

☒ Excavations and spoil piles ☐ Hydraulic systems ☐ Pneumatic systems ☐ Steam ☐ Vacuum ☐ Cylinders ☐ Other:	☐ SWP 215 - Supervision of Hydro-Excavation Activities ☐ SWP 310 - Compressed Gas Cylinders ☐ SWP 214 - Entering Excavations and Trenches Enter additional SWPs, SOPs	Enter specialized training	Heavy equipment buffer of at least 10 feet. Mind utility locations prior to drilling

PPE	REQ'd	If you need assistance to answer these questions, please contact an HSSE advisor or HSSE manager.
Head (CSA/ANSI)	☒	**Choose a Type and Class:** ☒ Type 1 (no side impact) ☐ Type 2 (side impact) ☐ Other ☐ Class E (rated for 20000 volts) ☐ Class G (rated for 2200 volts) ☐ Class C (no electrical rating)
Eye/face (CSA/ANSI)	☒	☒ Safety glasses with rigid side shields ☐ Polarized safety glasses with rigid side shields ☐ Goggles ☐ Spoggles ☐ Safety glasses and face shield ☐ Goggles and face shield ☐ UV glasses, UV shield
Hand	☒	**Hazard Protection** ☐ Abrasion ☐ Cut ☒ Vibration ☐ Puncture ☐ FR (flame resistant) ☐ Arc Flash ☒ Chemical ☒ Impact ☐ Cold ☐ Heat ☐ Other: **Glove Type** ☒ Nitrile ☐ Leather ☐ Cotton ☐ High Performance Polyethylene ☐ Polyurethane ☐ Kevlar ☐ Latex ☐ PVC ☐ Neoprene ☐ Viton ☒ Other: Gloves for using the hammer drill
Foot (6” minimum ankle support)	☒	☒ CSA Green triangle and orange omega boots (CA) / ASTM / ANSI boots (US) ☐ CSA Green triangle and orange omega rubber boots (CA) / ASTM / ANSI rubber boots (US) ☐ CSA Green triangle and orange omega waders (CA) / ASTM / ANSI waders boots (US) ☐ Traction Aids
High visibility clothing	☒	Class 1 - not used ☒ Class 2 (under 80km/h / 50 mph and daylight) ☐ Class 3 (over 80km/h / 50 mph and/or twilight/dark)

Hearing	☒	☒ Ear plugs ☐ Ear muffs ☐ Ear plugs and muffs
Coveralls	☐	☐ Standard ☐ Tyvek (disposable) ☐ FR (Flame Resistant) – Type: ☐ Chemical resistant
Respiratory	☐	☐ N95 (dust mask) ☐ 1/2 mask - Cartridge type: - Filter type: ☐ Full face - Cartridge type: - Filter type: ☐ PAPR - Cartridge type: - Filter type:
Fall arrest/limit	☐	**Fall arrest harness (verify capacity)** ☐ Class A (fall arrest) ☐ Class D (controlled descent) ☐ Class E (evacuation) ☐ Class L (ladder) ☐ Class P (positioning) **Lanyard** ☐ 6' with shock absorber (verify capacity) ☐ 4' with shock absorber (verify capacity) ☐ 6' Y with shock absorber (verify capacity) ☐ 6' with NO shock absorber (verify capacity) for use on aerial lifts ☐ 4' with NO shock absorber (verify capacity) for use on aerial lifts ☐ Other: **Additional equipment** ☐ Rope Grab ☐ Rope ☐ Self-retracting lifeline – ☐ SRL ☐ SRL-R (integral rescue capability) ☐ SRL-LE (leading edge capability) ☐ Tripod ☐ Retrieval winch ☐ Anchorage connector ☐ Beam anchor ☐ Vertical or horizontal lifeline ☐ Carabiner ☐ Suspension trauma straps
Flotation device	☐	☐ Lifejacket ☐ Floater Jacket ☐ PFD - Type: ☐ PFD inflatable ☐ Survival Suit
Other	☒	Be cognizant of COVID-19 protocol and monitor if any symptoms develop

EMERGENCY RESOURCES

(NOTE: This plan is not adequate for working at heights or confined space activities. A separate plan is required, please contact your Regional HSSE Manager or Advisor.)

Site emergency number:	911	**Fire Department:**	911
Ambulance:	911	**Spill Response:**	911
Police:	911	**Regional HR:**	US North Central & South - Andrea Anderson - (941) 225-6173

Workers' Compensation Claim Coordinator:	US - Melissa Helton - cell 513-720-3706
OSEC:	Kurt Rubsam, (262) 241-4466
Public Relations:	US Northeast, US Central - Maggie Meluzio (781) 221-1002
HSSE Manager:	US North Central – Wes Cline (916) 281-7459
First aid facilities are located:	In truck
First aiders on site:	Erin Gross
Fire extinguisher are located:	In truck
SDS are located:	N/A
Eyewash station is located:	N/A
Spill response equipment is located:	N/A
Muster point is located	Southeast corner of Hwy 60 and South Main Street intersection on the sidewalk

Incident reporting protocol based on work location (Select USA and / or Canada and / or International)

Incident Reporting Protocol Canada

IMMEDIATE ACTIONS

1. Keeping safety in mind, care for injured people (if applicable) and stabilize the scene.
2. For life threatening injuries, **immediately contact 911.** Accompany the injured employee to the medical facility whenever possible.
3. Call **WorkCare (24-hour service): 1-888-449-7787** for work-related symptoms or injuries, and speak to a medical professional for guidance and treatment options.
4. Make voice contact with your supervisor within 1 hour or less of the incident occurring. Leaving a voicemail does not count. If you cannot contact your supervisor, contact the HSSE Manager or HSSE Advisor for your region.
5. Supervisors must immediately contact their HSSE Manager or HSSE Advisor by phone to discuss incident severity and determine if further notifications (internal or external) are required.
6. For incidents involving an injury, regardless of severity, inform the workers' compensation claims coordinator.
7. Additional notifications may be required based on the client requirements.

Incident Reporting Protocol US

IMMEDIATE ACTIONS

1. Keeping safety in mind, care for injured people (if applicable) and stabilize the scene.
2. For life threatening injuries, **immediately contact 911**. Accompany the injured employee to the medical facility whenever possible.
3. Call **WorkCare (24-hour service): 1-888-449-7787** for work-related symptoms or injuries, and speak to a medical professional for guidance and treatment options.
4. Make voice contact with your supervisor within 1 hour or less of the incident occurring. Leaving a voicemail does not count. If you cannot contact your supervisor, contact the HSSE Manager or HSSE Advisor for your region.
5. Supervisors must immediately contact their HSSE Manager or HSSE Advisor by phone to discuss incident severity and determine if further notifications (internal or external) are required.
6. When an employee is guided by WorkCare to obtain medical assistance, or the employee requests medical attention for a non-life-threatening injury, and after alerting the supervisor; the employee must **immediately call Melissa Helton, Stantec's US WC Claims Coordinator at 513-720-3706** for assistance.
7. In most cases WorkCare will provide guidance about which clinic is available and provide directions. Here is a link accessing additional clinic locations: Clinic Search link.
8. Additional notifications may be required based on the client requirements.

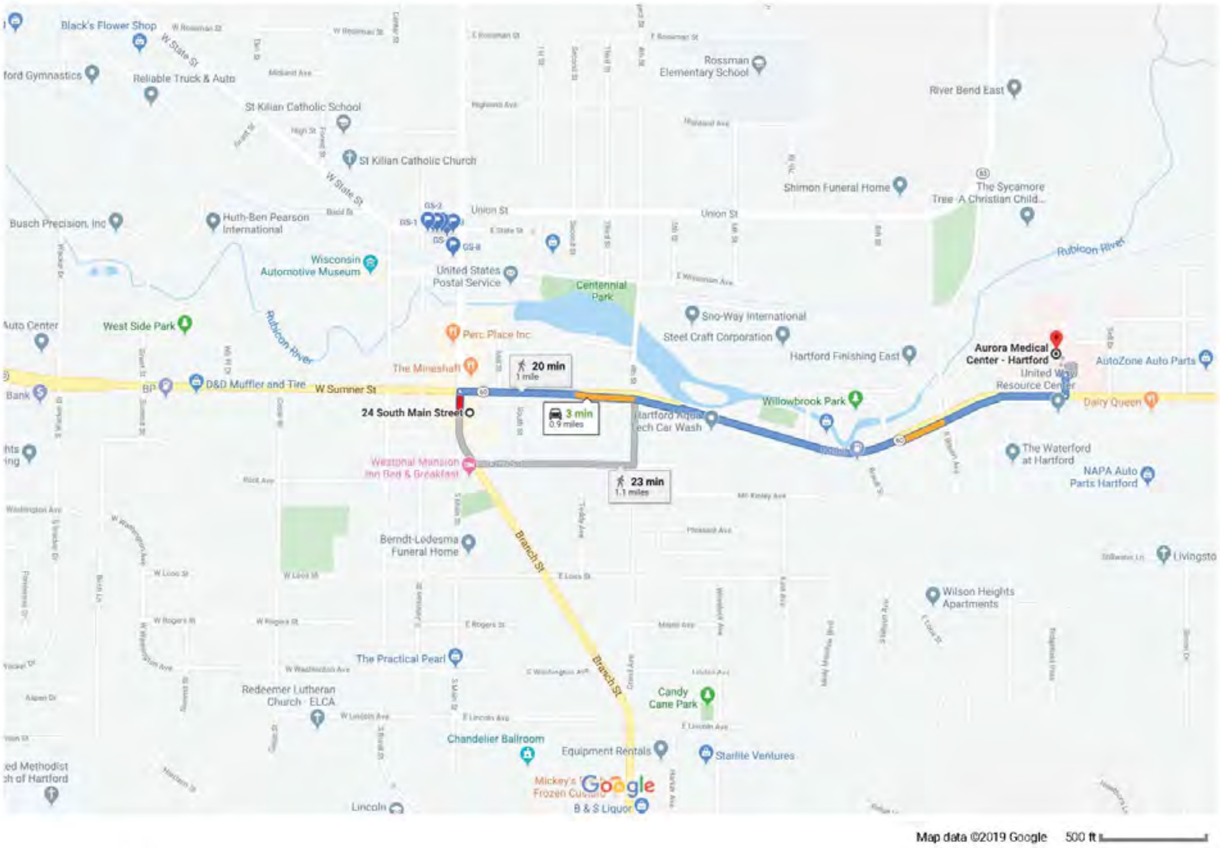
Maps are provided to the nearest medical clinic or hospital

10/22/2019 24 S Main St, Hartford, WI to closest hospital to 24 s main st hartford wi - Google Maps

Google Maps 24 S Main St, Hartford, WI to closest hospital to 24 s main st hartford wi

Property to Hospital

Drive 0.9 mile, 3 min



24 S Main St

Hartford, WI 53027

1. Head north on S Main St toward E Sumner St — 157 ft
2. Turn right at the 1st cross street onto E Sumner St — 0.9 mi
3. Turn left — 164 ft
4. Turn left
   Destination will be on the right — 36 ft

Aurora Medical Center - Hartford

1032 E Sumner St, Hartford, WI 53027

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

https://www.google.com/maps/dir/24+S+Main+St,+Hartford,+WI/closest+hospital+to+24+s+main+st+hartford+wi/@43.3173445,-88.3746853,16z/am=t/... 1/1

PROJECT CONTACT INFORMATION

Title	Name	Company	Phone Number
Stantec Office	Mequon	Stantec	262-241-3133
Project Manager	Rick Binder	Stantec	262-643-9010, cell 262-422-0764
Project Site Safety	Erin Gross	Stantec	608-628-6278
Client or Owner	John Griffin	City of Hartford	715-902-0829
Stantec After-Hours Number	Rick Binder	Stantec	262-422-0764
Other: Washington County	Hannah Keckeisen	Washington County	262-808-7423
Other: Pour House	Brian Morey	The Pour House	414-587-6362

Approvals

By signing this approval, the Project Manager is acknowledging that (s)he has communicated the hazards, controls, required PPE and applicable SWPs to the employees working on this project. It also indicates that the Project Manager has communicated to employees that they must have the equipment required to work safely, they must verify the equipment is in working order, and that they have the knowledge required to operate/use the equipment.

	Print Name	Signature	Date
Prepared by:	Rex Key	Rex Key	9/15/2022
Reviewed by: *(not author)*	Erin Gross	Erin Gross	10/4/2022
Approved by PM:	Richard J. Binder	Richard J Binder	12/7/2022

Employee Review

All employees conducting field work on this project will review the Risk Management Strategy (RMS1) and sign below acknowledging that they have been advised of the hazards, controls, PPE, and other safety equipment required, and have reviewed the applicable SWPs. Employees in the field who identify additional hazards not listed above will notify the project manager of the hazard, and prior to proceeding, will confirm the controls that will be used. Document any on-site changes and communications using the RMS2 as appropriate; see section 4.5 of the HSSE Program Manual on Management of Change.

Please designate Team Lead for field activities below.

	Print Name	Signature	Date
Reviewed by:	Erin Gross (Team Lead Field)	Erin Gross	10/4/2022
	Click here to enter text.		Click here to enter a date.
	Click here to enter text.		Click here to enter a date.
	Click here to enter text.		Click here to enter a date.
	Click here to enter text.		Click here to enter a date.

APPENDIX B – STANTEC STANDARD OPERATING PROCEDURES (SOPs)

Appendix B
Table of Contents
Stantec Field SOPs

Identifier: SOP-01	Revision: 0	Effective Date: 10/31/2012	Stantec
Author: Stu Gross			

Standard Operating Procedure

for:

VOLATILE ORGANIC COMPOUND FIELD SCREENING FOR SOIL AND SEDIMENT

Responsible QA Manager: Richard J. Binder, P.G.	

SOP-01
Volatile Organic Compound Field Screening for Soil and Sediment

Revision Log

Revision No.	***Effective Date***	***Prepared By***	***Description of Revisions***	***Affected Pages***
0	10/31/2012	Stu Gross	New Procedure	All

Table of Contents

Section **Page**

List of Acronyms and Abbreviations

eV	electronvolt
FID	flame ionization detector
IWD	integrated work document
PPE	personal protective equipment
ppm	part per million
PID	photoionization detector
FID	Flame ionization detector
SOP	standard operating procedure
SSHASP	site-specific health and safety plan
uV	ultraviolet
VOC	volatile organic compound

SOP-01
VOLATILE ORGANIC COMPOUND FIELD SCREENING FOR SOIL AND SEDIMENT

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to ensure qualitative field screening of soil and sediment samples is performed consistently.

2.0 SCOPE

All Stantec project participants shall implement this procedure when performing headspace vapor screening on soil or sediment samples using a photoionization detector (PID). A PID is capable of detecting and measuring real-time concentrations of many organic vapors in air. This screening technique is used primarily to identify and soil samples (if any) that may contain volatile organic compounds (VOCs) and to select samples for possible subsequent laboratory analysis. This vapor screening SOP is not for screening to be performed as part of health and safely monitoring.

3.0 TRAINING

3.1 Stantec project participants shall train (e.g., by reading and/or completing on-the-job or classroom training) to and use the current version of this procedure.

3.2 The responsible Stantec project leader shall monitor the proper implementation of this procedure.

3.3 The responsible field leader shall ensure that Stantec project participants complete all training assignments applicable to this procedure.

4.0 DEFINITIONS

4.1 Integrated work document (IWD) - Hazard control documentation that integrates work definition, hazards, and controls for work authorization and user-friendly communication to the workers. The IWD may be a subset of a larger "work package," such as the field readiness review package, that includes other documents and information relating to an activity, but not addressing hazard controls.

4.2 Photoionization detector (PID) - The PID is a portable, nonspecific, vapor/gas detector employing the principle of photoionization to detect and measure real-time concentrations of a variety of chemical compounds, both organic and inorganic, in air.

4.3 Stantec project participant - An inclusive term for any Stantec employee, deployed worker, or subcontractor, inclusive of project leaders, team leaders, and project personnel, who participates in activities conducted as part of Stantec projects.

4.4 Site-specific health and safety plan (SSHASP) - Health and safety plan that is specific to a site or related field activity that has been approved by a Stantec health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

5.1 RESPONSIBLE PERSONNEL

The following identifies the personnel responsible for actions in this procedure:

- Field Leader
- Project Leader
- Quality Assurance/Quality Control Officer
- Project Participants

6.0 BACKGROUND AND PRECAUTIONS

6.1 Use this procedure in conjunction with an approved SSHASP.

6.2 Record any deviation from this procedure in the field notebook.

6.3 As with any field instrument, accurate results depend on the operator's complete familiarity with the operator's manual. Follow the instructions in the operating manual explicitly in order to obtain accurate results, while taking care to prevent the PID's exposure to excessive moisture, dirt, or contamination.

6.4 The PID employs the principle of photoionization. The analyzer responds to most vapors that have an ionization potential less than or equal to that supplied by the ionization source, which is an ultraviolet (UV) lamp. Photoionization occurs when an atom or molecule absorbs a photon of sufficient energy to release an electron and form a positive ion. This occurs when the ionization potential of the molecule in electron volts (eV) is less than the energy of the photon. The sensor is housed in a probe and consists of a sealed ultraviolet light source that emits photons with an energy level high enough to ionize many trace organics, but not enough to ionize the major components of air (e.g., nitrogen, oxygen, carbon dioxide). The ionization chamber exposed to the light source contains a pair of electrodes, one a bias electrode, and the second the collector electrode. When a positive potential is applied to the bias electrode, it creates an electro-magnetic field in the chamber. Ions formed by the adsorption of photons are driven to the collector electrode. The current produced is then measured and the corresponding concentration displayed on a meter, directly, in units above background, usually parts per million (ppm). Three probes, each having a different eV lamp and a different ionization potential, are available for use with the PID; the light energies are 9.5, 10.2, and 11.7 eV. All three probes detect various aromatic and large molecular hydrocarbons. In addition, the 10.2 eV and 11.7 eV probes detect some smaller organic molecules and halogenated hydrocarbons. Gases with ionization potentials near to or less than those of the lamp are ionized. These gases are thus detected and measured by the analyzer. Gases with ionization potentials higher than that of the lamp are not detected. The selection of the appropriate probe is essential in obtaining useful field results. Though it can be calibrated to a particular compound, the instrument cannot distinguish between detectable compounds in a mixture of gases and, therefore, indicates an integrated response to the mixture. A PID is similar to a flame ionization detector (FID) in application. However, the PID is unable to respond to certain low molecular weight hydrocarbons, such as methane and ethane that are readily detected by FID instruments.

6.5 In all instances, document and associate the ultimate procedures employed with the final report.

6.6 PID Instrument Limitations

- The PID is a nonspecific total vapor detector. Do not use to identify unknown substances; it only roughly quantifies them.
- The PID is calibrated to the concentration of a specific compound.
- The PID does not respond to certain low molecular weight hydrocarbons, such as methane and ethane.
- The PID does not detect a compound if the probe has a lower energy than the compound's ionization.
- The PID does not detect certain toxic gases and vapors, such as carbon tetrachloride and hydrogen cyanide, which possess high ionization potentials.
- Certain models of PID instruments are not intrinsically safe; use in conjunction with a combustible gas indicator.
- Electrical power lines or power transformers may cause interference with the instrument and thus cause measurement errors. Static voltage sources such a power lines, radio transmissions, or transformers may also interfere with measurements.
- High winds and high humidity affects measurement readings. The PID may become unusable under foggy or humid conditions. An indication of this is a slow constant climb on the read-out dial.
- Periodically clean the lamp window to ensure ionization of the new compounds by the probe (i.e., new air contaminants).
- The PID measures concentrations from about 1-2,000 ppm, although the response is not linear over this entire range. For example, if calibrated to benzene, the response is linear from about 0-600 units (ppm) above background. This means the PID reads a true concentration of benzene only between 0 and 600 ppm. Greater concentrations are detected at a lower level than the true value.
- Do not expose this instrument to precipitation (e.g., rain). The units are not designed for operation under wet conditions.
- Do not use this instrument for headspace analysis where liquids are inadvertently drawn into the probe.

7.1 EQUIPMENT

- Photoionization Detector (PID)
- Ziploc® bags or similar locking-type bags
- Glass mason jars

- Aluminum foil
- Permanent Marker (i.e., Sharpie®)
- Field book

8.0 PROCEDURE

Field screening of potential soil or sediment contamination is accomplished by performing a headspace analysis on air in contact with a soil or sediment sample enclosed within a new Ziploc® bag or clean glass jar. Samples used for field screening shall not be used for other analyses for chemical constituents.

8.1 Perform Field Calibration

Calibrate PID in accordance with the manufacturer's specifications. The PID is calibrated using zero air and 254 ppm isobutylene gas. Refer to SOP-09 for the instructions on daily calibration of the PID prior to use.

8.2 Headspace Field Screening

(a) Label new Ziploc® bag with the sample identification number.

(b) Place representative soil or sediment sample in Ziploc® or similar "locking-type" bag until bag is approximately one-half full. Capture approximately 1 quart of air in the bag. Seal Ziploc® bag and homogenize sample (i.e., shake well).

(c) Place bag on a stationary surface preferably in a warm environment to allow the headspace to come to equilibrium with the soil or sediment sample. The length of time the headspace is allowed to equilibrate will depend on the ambient temperature and humidity conditions. The following are general guidelines for minimum equilibration times in different ambient air conditions:

Ambient Temperature (°F)	Minimum equilibration times
> 90°	2 minutes
> 70° but ≤ 90°	5 minutes
> 50° but ≤ 70°	10 minutes
≤ 50°	15 minutes

It should be noted that in very hot conditions, a buildup of water vapor in the bag may occur if the bag and sample are heated for too long that may interfere with the operation of the PID.

(d) Insert the tip of the PID probe into the headspace of the Ziploc® bag by piercing it with the probe. Avoid making contact with the soil or sediment sample with the instrument tip to prevent the sample from being drawn into the instrument.

(e) Move soil or sediment around in the bag while the instrument is reading. Record the highest sustained reading in the field book.

(f) A clean glass jar (1 pint size or larger "mason" type jar with screw on metal cap) can be substituted for the Ziploc® bag in the procedure described above.

8.3 Visual and Olfactory Screening

Visual and olfactory screening consists of inspecting the soil and sediment for the presence of stains and odor indicative of residual petroleum hydrocarbons.

(a) Visually inspect and smell soil or sediment sample. Indications of the presence of petroleum hydrocarbons typically include a mottled appearance or dark discoloration of the soil or sediment.

(b) Record observations in the field book. Visual observations do not definitely indicate the presence of petroleum hydrocarbons.

8.4 Quality Assurance Blanks

Blank samples will be measured to determine if any contamination is being introduced as part of the measurement procedure. One PID blank sample will be performed for each 10 samples measured. The measurement procedure for field PID blanks is given below:

The headspace measurement procedure outlined in Section 8.2 should be followed, but no sample should be placed in the Ziploc® bag or glass jar, as no universal soil blank has been accepted. A headspace reading of the Ziploc® bag or glass jar should be taken after the Ziploc® bag or glass jar has been opened, resealed, and allowed to sit until it reaches ambient temperature as noted above.

9.1 RECORDS

The project leader shall submit the following records to central filing.

- Completed field notebook
- Completed field forms, where appropriate

10.0 ATTACHMENTS

Attachment A – Stantec Field PID Data Recording Form (1 page)

SOP-01
Attachment A - PID Field Form

Boring Number	Sample Number	Sample Depth (feet)	Sample Odor	Sample Description	PID Measurement Data				Comments
					Date Collected	Time Collected	Time Analyzed	PID Response (IUI)	

Key:
PID = Photoionization Detector
iui = Instruments units as isobutylene
* = Submitted for laboratory analysis
--- = Not Analyzed or Unknown

Identifier: SOP-02	Revision: 4	Effective Date: 04/01/2016
Author: Stu Gross		

Standard Operating Procedure

for:

SOIL SAMPLE COLLECTION

Responsible QA Manager: Richard J. Binder, P.G.	

SOP-02
Soil Sample Collection

Revision Log

Revision No.	***Effective Date***	***Prepared By***	***Description of Revisions***	***Affected Pages***
0	10/31/12	Stu Gross	New Procedure	All
1	04/15/13	Michael Nied	QAPP revisions per request	9 & 10
2	04/23/15	Dave Constant	Removed Subcontractor Reference from Section 2	5
3	08/10/15	Hiedi Waller	Removed field screening reference in Section 8.0 m. Field Screening remains in Section 8.0 j.	10
4	4/1/16	Harris Byers	Revise for Illinois VOC sampling protocols	All
5	2/14/17	Rachelle Noble	Define 5 gram / 10 gram sample for VOCs	10

Table of Contents

List of Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
C	Centigrade
DRO	Diesel range organics
FL	field leader
G	Gram
GRO	Gasoline range organics
LCD	Liquid crystal display
PAHs	Polynuclear aromatic hydrocarbon
PCBs	Polychlorinated biphenyls
PID	Photoionization detector
PPE	personal protective equipment
PL	Project Leader
QAPP	quality assurance project plan
QP	quality procedure
QA/QC	quality assurance/quality control
SAP	Sampling and analysis plan
SOP	standard operating procedure
SSHASP	site-specific health and safety plan
SSWP	Site-specific work plan
SVOCs	Semi-volatile organic compounds
TOC	Total organic carbon
VOC	volatile organic compound

SOP-02
SOIL SAMPLE COLLECTION

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the procedures for the collection of representative soil samples. Sampling locations and depths are assumed to be those that can be reached with the use of direct-push or conventional hollow-stem drilling methods (i.e., Geoprobe® or hand operated hydraulic push-probe system).

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the actual procedures used should be documented and described in an appropriate site report.

2.0 SCOPE

2.1 All project participants shall implement this mandatory SOP.

3.0 TRAINING

3.1 Stantec project participants shall train to and use the current version of this SOP; contact the author if the SOP text is unclear.

3.2 The responsible Project Leader (PL) shall monitor the proper implementation of this procedure and ensure that the appropriate personnel complete all applicable training assignments.

4.0 DEFINITIONS

4.1 Shelby tube - A single-piece metal tube, of thin gauge, which is forcefully driven into the soil or sediment at the bottom of a borehole to collect an undisturbed subsurface soil or sediment sample.

4.2 Split-spoon sampler - A multi-piece sampler which is threaded onto the end of a drill rod or hand auger and forcefully driven into the soil or sediment at the bottom of a borehole to collect an undisturbed subsurface soil or sediment sample.

4.3 Site-specific health and safety plan (SSHASP) - Health and safety plan that is specific to a site or related field activity that has been approved by the project health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

5.1 RESPONSIBLE PERSONNEL

The following personnel are responsible for activities identified in this procedure:

- Data Steward
- Field Leader
- Field Member
- Geologist
- Project Leader
- QA/QC Officer
- Project Participants

6.0 BACKGROUND AND PRECAUTIONS

6.1 Project participants shall use this SOP in conjunction with an approved SSHASP.

6.2 Background

6.2.1 Split-Spoon Sampler

6.2.1.1 A split-spoon sampler is used to take subsurface soil or sediment samples by forcefully driving the sampler into the soil or sediment at the bottom of a borehole. Samples may be retrieved along the entire length of the borehole to obtain an unbroken record of the subsurface layers, or samples may be retrieved at selected intervals.

6.2.1.2 The split spoon is threaded onto the end of the drill rod and lowered to the bottom of the boring by a heavy steel cable connected to the drilling mast. The sampler is forced into the soil by a drive weight that is dropped repeatedly onto the drive head located at the top of the drill rod. In some designs, the split-spoon sampler is threaded onto a drill stem and placed inside a hollow stem auger. As the auger is rotated and lowered, the split-spoon sampler is advanced along with the drill bit, using the drill rig's drive weight.

6.2.1.3 The sampler is driven into the soil to a depth about six inches shorter than the length of the sampler itself. Split-spoon samplers are available in a variety of lengths and diameters for use in a variety of applications. Occasionally, bedrock or extremely compacted sediments are encountered which make further advance of the sampler extremely difficult or impossible without damage to the sample. This condition is known as “refusal” and is defined as a “penetration of less than one foot for 100 blows” (a blow is the act of striking a drive rod with a drive weight). Six inches for 50 blows is also commonly recognized as “refusal.” Upon “refusal,” either abandon the borehole or remove and replace the sampler with a drill bit.

6.2.1.4 A hand auger may also perform split-spoon sampling. The split spoon is threaded onto the end of a hand-driven drill rod, in place of the auger/bit. The split spoon is advanced into the borehole by manually turning the hand auger. In all other respects, hand-augured, split-spoon sampling is identical to hydraulically-driven, split-spoon sampling.

6.2.2 Shelby-Tube Sampler

The Shelby tube is a similar type of sampling apparatus. The split spoon is a multi-piece sampler; the Shelby tube is a single-piece metal tube of thinner gauge. Like the split spoon, soil is forced into the Shelby tube and stored inside. However, because the Shelby tube is typically advanced hydraulically, it allows the capture of a relatively undisturbed sample. Due to the Shelby tube’s thinner walls and sharp cutting edge, the Shelby tube requires much less effort to push into the soil. Take care not to compress the soil sample by forcing the tube in deeper than its own length.

6.2.3 GeoProbe® Soil Sampling

Geoprobe® is a brand name for hydraulically-powered, direct push machines that use both static force and percussion to advance sampling and logging tools into the subsurface. The first Geoprobe® brand machine was built for the Environmental Protection Agency in 1988. A Geoprobe® direct push machine is a common method for obtaining continuous soil cores or discrete soil samples.

6.3 Precautions

This procedure is limited to the activities of collecting soil and sediment samples for (1) field monitoring and laboratory analysis of concentrations of hazardous constituents, (2) soil/sediment physical characteristics, or (3) geologic logging. This SOP does not address drilling activities, removal of time-sensitive geologic analytical samples, core documentation, lithologic description, packaging of core material, or temporary storage of borehole materials.

7.0 EQUIPMENT

A checklist of suggested equipment and supplies needed to implement this procedure is provided below.

EQUIPMENT AND SUPPLIES CHECKLIST FOR SOIL SAMPLE COLLECTION

√	Quantity	Description
		Sampling and Analysis Plan (SAP)
		Site Specific Health and Safety Plan (SSHASP)
		SOP-1
		SOP-8
		Field book
		Waterproof ink pen and permanent marker
		Camera
		Plastic Sheeting
		Auger rig, Geoprobe®, or hand operated direct push sampling system (i.e., KV sampling system)
		Plastic sampling sleeves
		Utility knife
		Wrenches
		55-gallon steel drums
		Bentonite
		Assorted geology supplies (e.g., hand lens, grain size card, scales, etc.)
		Field boring log forms
		Munsell soil color chart
		Photoionization Detector (PID)
		Ziploc® bags or similar “locking” standard quart-sized plastic bags
		Sample containers
		Sample labels
		Stainless steel or plastic spoon
		Stainless steel, plastic, or other appropriate homogenization bucket, bowl or pan
		Appropriate soil sample containers
		Power-Stop® handle and plastic syringes, if sampling for GRO, DRO, and/or VOCs
		Portable standard balance
		AA Batteries
		Sample labels
		Appropriate PPE (i.e., disposable gloves, steel toe boots, hard hat)
		Insulated cooler, ice and chain-of-custody seals
		Decontamination equipment (SOP-8)
		Other -
		Other -

8.0 PROCEDURE

Field team members shall follow the procedures outlined below for collecting soil samples:

(a) Review proposed sample locations and mark with stakes or flags. If required, the proposed locations may be adjusted based on site access, property boundaries, underground utilities, or subsurface obstructions.

(b) Confirm that all utilities have been cleared before beginning work.

(c) Complete sample container labels with the sample identification number, the analysis type, sampler's initials, and date on appropriate sample containers.

(d) Set up soil sample log table in field book as follows:

Sample ID	Depth	T/T (Time Taken)	T/A (Time Analyzed)	PID Reading	Odor	Sample Description

(e) Operate Geoprobe® or KV system in accordance with manufacturer's instructions. Drill to first sampling depth as described in the SAP.

(f) If probe is refused, up to two additional attempts should be made, slightly varying the position of the sampling device. If it becomes obvious that major subsurface impediment is precluding sampling, an alternate sampling location must be selected, if necessary.

(g) Photograph sample location.

(h) Once the sleeve with the soil sample is retrieved from the direct-push system, place the soil sleeve on a sheet of plastic and cautiously slice the top of the sleeve open with a clean utility knife or sleeve knife so as not to disturb the soil.

(i) Calibrate standard portable balance in accordance with manufacturer's instructions.

(j) Collect the VOC and field screening samples first followed by gasoline range organics (GRO) portion of the soil samples next, if specified in the SAP, using the same procedure. However, if approved by the laboratory, GRO analysis may be performed on the same jars as the VOC analysis. Place remaining soil in a Ziploc® bag for field screening analysis and follow the soil field screening procedures in SOP-1.

The VOC soil sample will be collected using a pre-cleaned, disposable, small-diameter core sampler (i.e., Terra Core, Easy-Draw Syringe, or Power-Stop Handle). The small-diameter core sampler must be able to deliver a minimum of a 5-gram sample into a 40-mL VOA vial.

VOCs are to be collected as quickly as possible after the soil is removed from the ground, from as undisturbed portion of the soil as possible or from a freshly exposed part of the sample. Once the soil sample is collected, remove any excess material that extends beyond the end of the syringe and cap. Remove the syringe from the handle and extrude the required number of soil “plugs” needed to place 10 grams of soil into each laboratory provided pre-tared glass containers containing: 5 ml laboratory supplied VOC water (two vials); 5 ml methanol (one vial); and 5 ml sodium bisulfate solution (one vial). After the addition of the soil to the vials, the vials will be gently swirled to totally immerse the soil in the preservatives. Five (5) gram samples will be collected for the low level VOC samples. A 10 gram sample may be collected and preserved with 10 ml methanol (MeOH) for high level VOCs.

For each sample collected, fill an additional empty container without preservative for dry weight analysis.

The small-diameter core samplers cannot be used for storage or shipment to the laboratory. The soil samples must be transferred into appropriate sample containers immediately upon sample collection for proper preservation.

(k) Collect the diesel range organics (DRO) portion of the soil samples, if specified in the SAP. Place 2 or 4 ounce glass sample jar on the balance’s platform and press the “ZERO” button until the LCD display reads “0 g”. Using a stainless steel or plastic spoon place soil in jar until the LCD display reads “25 g”. Remove the sample jar from the balance platform and immediately cap the jar tightly.

(l) Describe soil in accordance with American Society Testing Materials (ASTM) Method D2488: *Practice for Description and Identification of Soils* on a field boring log form.

(m) Place the remainder of the soil from the sleeve into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly with a stainless steel or plastic spoon to obtain a homogenous sample representative of the entire sampling interval. Then place a level amount of soil into appropriate sample containers and secure the caps tightly. Fill sample containers in the order of most volatile to least volatile, in accordance with the SAP: semi-volatile organic compounds (SVOCs), polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, herbicides, metals, total organic carbon (TOC), and percent solids.

(n) Finish labeling sample containers with the time of collection. Place the samples in bubble-wrap bags. Then place the bubble wrapped samples in a Ziploc® bag. Label Ziploc® bag with the sample identification and project number. Place soil samples in an insulated cooler and chill to </= 6° Centigrade (C).

(o) Complete sample log table in the field book.

(p) Dispose of used sample sleeve in a plastic bag and decontaminate soil sampling equipment (i.e., sample tube, stainless steel spoons and homogenizing bowls) in accordance with SOP-8 and change sampling gloves. Discard gloves in a plastic bag for disposal. Containerize any remaining unused soil from the sample sleeve and from the PID bag in a 55-gallon drum.

(q) Continue drilling to the next sampling interval and collect samples as outlined in Steps G through O.

(r) Upon reaching the final depth of the borehole and the completion of soil sample collection, abandon the borehole with bentonite.

(s) Move to next proposed sample/borehole location and repeat above procedure.

9.1 RECORDS

The Field Leader shall supervise all data entry activities and submit the following records to central filing:

- Complete field notebook
- Field boring logs for each soil boring location

10.1 REFERENCES

To properly implement this SOP, project participants should become familiar with the contents of the following documents:

- ASTM Method D2488: Practice for Description and Identification of Soils
- SOP-01, Volatile Organic Compound Field Screening for Soil and Sediment
- SOP-08, Equipment Decontamination

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Author: Stu Gross			

Standard Operating Procedure

for:

GROUNDWATER SAMPLE COLLECTION

Responsible QA Manager: Richard J. Binder, P.G.	[signature]

SOP-04
Groundwater Sample Collection

Revision Log

Revision No.	***Effective Date***	***Prepared By***	***Description of Revisions***	***Affected Pages***
0	10/31/2012	Stu Gross	New Procedure	All
1	04/17/2013	Michael Nied	QAPP revisions per request	7, 10
2	04/23/2015	Dave Constant	Removed Subcontractor Reference from Section 2. Removed field preservation of groundwater samples in Section 8.3.7	5, 19

SOP-04
Groundwater Sample Collection

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List of Acronyms and Abbreviations

CO_2	Carbon dioxide
DO	Dissolved oxygen
DTB	Depth to bottom
DTW	Depth to water
FL	Field leader
Ft	feet
ms/cm	Millisiemens per centimeter
mV	Millivolt
NTU	Nephelometric turbidity unit
ORP	Oxygen reduction potential
PPE	personal protective equipment
QAPP	Quality assurance project plan
QA/QC	Quality Assurance/Quality Control
SAP	Sampling and analysis plan
s/cm	Siemens per centimeter
SOP	standard operating procedure
SSHASP	site-specific health and safety plan
µmhos/cm	Micromhos per centimeter
VOCs	Volatile organic compounds

SOP-04
GROUNDWATER SAMPLE COLLECTION

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the procedures for the collection of representative groundwater samples.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the actual procedures used should be documented and described in an appropriated site report.

2.0 SCOPE

2.1 This SOP is a mandatory document and shall be implemented by all Stantec project participants when performing purging and sampling of single completion wells.

3.0 TRAINING

3.1 Stantec project personnel using this SOP are trained by reading the procedure, and receiving the appropriate training.

3.2 The Field Leader (FL) shall monitor the proper implementation of this procedure and ensures that relevant team members have completed all applicable training assignments.

4.0 DEFINITIONS

4.1 Hydrogen-ion activity (pH) - The effective negative log base 10 of hydrogen ion [H+] activity. A measure of how acidic or a basic solution is (numerically equal to 7 for neutral solutions and increasingly basic above and acidic below that value).

4.2 Redox potential (Eh in millivolts [mV]) - Chemical reactions whereby a participating element changes its oxidation state by losing or gaining valence electrons. This may be referred to as oxidation-reduction potential (ORP), which is corrected to Eh.

4.3 Single completion well - A well constructed with a single well screen across a zone of groundwater saturation.

4.4 Site-Specific Health and Safety Plan (SSHASP) - A health and safety plan that is specific to a site or related field activity that has been approved by a Stantec health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

4.5 Conductance, or conductivity - A measure of the ease with which an electrical current flows through a substance under the influence of an applied electrical field. It is dependent upon the presence of dissolved ions (total and relative concentrations, valence, and mobility) and temperature. It is the reciprocal (inverse) of resistivity.

4.6 Specific conductance - Defined as the electrical conductance that would occur between the faces of a 1-cm cube of water. It is generally measured in Siemens per centimeter (S/cm), which was previously called micromhos per centimeter (μmhos/cm), or milliSiemens per centimeter (mS/cm). Since specific conductance is temperature sensitive, it is commonly corrected to its equivalent value at 25°C for data comparison. Some equipment makes this conversion automatically, in which case these readings should be noted as "at 25°C." Otherwise, the water temperature at the time of the conductance reading should be recorded along with the conductance measurement so that the reading can later be corrected to 25°C.

4.7 Turbidity - Refers to inorganic solids, gas bubbles and organic matter suspended in water. Turbidity, in nephelometric turbidity units (NTU), is measured as the intensity of light scattered by the suspended particulates in a water sample relative to a standard reference suspension. The goal of well purging for water sampling is to minimize turbidity to a level as low as reasonably achievable.

4.8 Volatile Organic Compounds (VOCs) - A class of chemical compounds, predominantly hydrocarbons and halogenated hydrocarbons, with low molecular weights and low boiling points that are insoluble or slightly soluble in water.

4.9 Well casing volume (bore volume) - The volume of water standing in a well. One casing volume, in gallons, is computed as the measured length (feet [ft]) of the water column times the cross-sectional area (ft^2) of the well casing times the constant 7.48 gal/ft^3.

5.0 BACKGROUND AND PRECAUTIONS

This SOP shall be used in conjunction with an approved SSHASP. Also, consult the SSHASP for information on and use of all PPE.

5.1 Background

5.1.1 Groundwater that is stagnant in the well bore is subject to chemical reactions that may significantly alter the composition of the formation water. This stagnant water may no longer be representative of the groundwater surrounding the well.

5.1.2 Prior to collecting a representative ground water sample for laboratory analysis, ground water must be purged from the well according to the following guidelines:

- Under optimum conditions, four well casing volumes should be removed from the well (see Section 8.1 for method of calculation) before sampling.

- Preferably, turbidity values prior to sampling should be less than 5 NTU. A value of less than 5 NTU is not always obtainable under some circumstances such as excess biogenic carbon dioxide (CO_2) poorly developed wells and invasive sampling techniques that agitate the water in the well casing (variable pumping rates and bailing). Under these circumstances a sample may still be collected.

- Allow readings to stabilize for pH (±0.1 pH unit) and conductivity (±3%). Record stabilized measurements and time collected in the field books. Wait until you have collected at least three stable readings to record the final measurements.

- Occasionally select wells are developed in aquifers that have poor recharge characteristics due to low hydraulic conductivity, shallow hydraulic gradients or a combination of both. Removal of three well casing volumes under these conditions may not be possible due to time constraints, site accessibility, sample volume requirements and prohibitive costs. When these circumstances are encountered, purge a minimum of one well casing volume and sample after specific conductance and pH have stabilized to within (±0.1 pH unit) for pH, and within (±3%) for conductivity for at least three consecutive stable readings.

- The choice of equipment for well purging depends on the well yield, depth to groundwater, casing diameter, the required analysis, and the requirements in the appropriate work plan. The decision to use any well-purging system should be based solely on what is appropriate for that particular situation.

5.2 Precautions

All waste generated from well development must be handled in accordance with SOP-10.

6.0 RESPONSIBLE PERSONNEL

The following personnel are responsible for activities identified in this procedure.

6.1 Stantec project personnel

6.2 FL

6.3 QA/QC Officer

6.4 Subcontractors

7.0 EQUIPMENT

A checklist of suggested equipment and supplies needed to implement this procedure is provided in Attachment A. A brief description of commonly used pieces of equipment, their advantages, and their limitations are listed below.

7.1 Bailer - A hollow tube or pipe fitted with a valve that is lowered into a well and retrieved to purge groundwater from a well.

7.1.1 Bailers may be constructed of stainless steel, polyethylene, or Teflon. When lowered into well, water enters the tube, the valve closes, and the filled bailer is retrieved with a rope or cable. Bailing purges the well casing and screen of standing water. Between bailing cycles, groundwater recovers in the well from the screen interval.

7.1.2 For shallow, small-diameter wells with low yields, well purging by the bailer method is feasible in the absence of a dedicated low-flow pump. Bailers are mechanically simple, lightweight and highly portable, constructed in many sizes, and require no external power source. Disposable bailers are easily operated and inexpensive. If disposable bailers are not used, considerable time and cost savings are possible by using dedicated bailers to reduce the decontamination task and to limit the possibility of cross-contamination (EPA, 1991).

7.1.3 The primary limitations of bailers are:

- Limited-volume purging capability; especially in deep wells where purging is labor intensive and time consuming.
- Tendency to disturb the water by the pressure changes created by purging.
- Sampling personnel are directly exposed to any contaminants present.
- Care must taken to prevent dropping or catching the bailer in the well, and not let the bailer line or bailer come in contact with the ground.

7.2 Electric submersible pump - An electric-motor-operated submersible pump that uses an internal rotating turbine to intake well water and force it to the surface.

7.2.1 The pump assembly is suspended by the discharge tubing and submerged in the well. The turbine in the pump bowl creates sufficient pressure to force water up the discharge pipe.

7.2.2 The submersible pump may be used for purging shallow, small-diameter wells and deep, large-diameter wells that require large rates of discharge. Manufacturers offer small-diameter pumps constructed of stainless steel and Teflon that are capable of efficient purging at significant depths. The pump may be portable and self-contained.

Disadvantages of the submersible pump are that:

- the pump can be difficult to decontaminate and transport along with auxiliary equipment
- the pump motor may be damaged by dry pumping

- the gears may be damaged by water that contains high levels of suspended sediment
- large-capacity pumps are expensive
- with negative displacement, pumps can significantly aerate the sample, thus changing the in situ chemistry and stripping dissolved VOCs.

Careful monitoring during operation is needed to obtain optimum pump performance and to preclude the possibility of equipment damage.

A checklist of suggested equipment and supplies needed to implement this procedure is provided in Attachment A.

8.0 PROCEDURE

8.1Field Preparation

(a) Start at the least contaminated well, if known.

(b) Lay plastic sheeting, or other suitable material, around the well to minimize the likelihood of contamination of equipment from soil adjacent to the well.

(c) Remove protective well cap (i.e., flush mount or Pro-top cover).

(d) Remove locking well casing cap.

(e) Lower electronic water level indicator into well until water surface is encountered.

(f) Measure distance from water surface to reference measure point (north side) on well casing and record the depth to water (DTW) to the nearest ± 0.01 foot in the field book. Record the time the measurement was collected.

(g) Measure total depth of well (depth to bottom [DTB]) and record in the field book. Decontaminate water level indicator in accordance with SOP-8 prior to inserting into the next well.

(h) Determine the well casing volume as defined by the following relationship:

$$V = ((d^2 \pi)/4) \times (h_2 - h_1) \times 7.48$$

Where:

- V = well casing volume, in gallons
- π = 3.1416
- d = well diameter, in feet
- h_1 = depth to water, in feet
- h_2 = well total depth, in feet
- 7.48 = gallons per cubic foot

Determine the height of the water column standing in the well by subtracting depth to water, in feet, from the total well depth. Measure the well diameter, in feet. Calculate the volume in gallons and enter these data on the Well Development Sampling Worksheet (Attachment B).

A minimum of four casing volumes should be purged before collecting a sample. If a sample must be collected before three casing volumes have been purged due to poor recharge, this activity will be documented in the field notebook or appropriate field form.

(i) Select appropriate purging and sampling equipment.

(j) Fill sample containers in the following order:

1) Unfiltered samples for in-field quality measurements (not necessary if down well or flow-through-cell measurements are taken)
2) VOCs
3) Non-filtered, non-preserved (e.g., sulfate, chromium VI, semi- and non-volatiles, pesticides, polychlorinated biphenyls)
4) Non-filtered, preserved (e.g., nitrogen series [ammonia, nitrates, nitrites, etc.], phenolics, total phosphorous, total metals, cyanide, total organic carbon)
5) Filtered, non-preserved (e.g., dissolved chromium VI)
6) Filtered, preserved immediately (e.g., dissolved metals)
7) Miscellaneous parameters

8.2 Special Considerations for VOC Sampling

The following procedures should be followed when filling VOC containers:

(a) Allow readings to stabilize for pH (±0.1 pH unit) and conductivity (±3%). Record stabilized measurements and time collected in the field books. Wait until you have collected at least three stable readings to record the final measurements.

(b) Once pH and conductivity are stabilized, open one vial at a time, set cap in a clean place, and begin collecting the sample.

(c) When filling a VOC vial, tip it at a slight angle and allow a steady stream of water run down its inner wall.

(d) Fill the vial until it appears that it is ready to overflow and a positive meniscus forms on the top of the vial.

(e) Check that the cap has not been contaminated (splashed) and carefully cap the vial. Place the cap directly over the top and screw down firmly. Do not over tighten and break the cap.

(f) Invert the sample vial and tap gently to check for air bubbles. If an air bubble appears, discard the sample and fill another VOC vial. It is imperative that no entrapped air is in the sample vial. If it is not possible to collect a sample vial without air bubbles, make a note in the field book and on the chain of custody form, and submit sample vial to the lab.

(g) Immediately place the sample vial in a protective bubble-wrap bag and place into the cooler.

8.3 Purging and Sampling Methods

8.3.1 Disposable Bailer

This method describes purging and sampling with a disposable bailer. The quality of the samples collected with a bailer highly depends on the skill and care of the operator using it. Take great care when lowering a bailer in and out of the water column. Carefully lift the bailer up and out of the well without allowing it to bang against the casing and use a bottom emptying device to dispense samples.

(a) Equipment needed includes a disposable bailer, nylon rope, scissors, and plastic sheeting.

(b) Determine the volume of water to be purged as described in Section 8.1, Field Preparation.

(c) Attach the nylon rope to the bailer and slowly lower until the bailer is completely submerged, being careful not to drop the bailer to the water, causing turbulence and the possible loss of volatile organic contaminants.

(d) Pull bailer out ensuring that the rope either falls onto a clean area of the plastic sheeting, or is wound on a reel or hand, and never touches the ground.

(e) Empty the bailer into a graduated vessel or container of known volume in order to determine the number of bails necessary to achieve the required purge volume.

(f) Periodically, collect samples of the purge water in two clean 2 ounce plastic sample cups for pH, temperature, and electrical conductivity measurements. Insert pH/temperature probe into one cup and the conductivity probe into the second cup. Allow readings to stabilize for pH (±0.1 pH unit) and conductivity (±3%). Record stabilized measurements and time collected in the field books. Wait until you have collected at least three stable readings to record the final measurements.

(g) Thereafter, pour the purge water into a 55-gallon drum that is temporarily stored on-site pending proper disposal arrangements.

(h) Upon the completion of removing the appropriate purge volume from the well, allow monitoring well to recharge. Assemble and label appropriate sample containers. Change into new clean gloves.

(i) Attach the nylon rope to a clean disposable bailer

(j) Lower the bailer slowly and gently into the well, taking care not to shake the casing side or to splash the bailer into the water. Stop lowering at a point adjacent to the screen.

(k) Allow bailer to fill and then slowly and gently retrieve bailer from the well avoiding contact with the casing.

(l) Remove cap from sample container, insert appropriate sampling tip (i.e., bottom emptying device) into bottom of the bailer and begin to slowly fill the pre-labeled sample container or filtering device. Fill VOC sample containers first.

(m) Filter and preserve samples if required by Sampling and Analysis Plan (SAP). Filter samples in accordance with Section 8.3.6. Preserve samples in accordance with Section 8.3.7.

(n) Cap the sample container tightly and place pre-labeled sample container in a bubble-wrap bag. Then place the bubble wrapped sample in a Ziploc® bag. Label Ziploc® bag with the sample identification and project number. Place groundwater sample in an insulated cooler with ice and chill to </= 6° C.

(o) Replace the well casing cap and well protective cover.

(p) Log all samples in the field book.

(q) Discard bailers in a plastic garbage bag for proper disposal

8.3.2 Submersible Pump and Bailer

This method describes purging with a submersible pump and sampling with a disposable bailer. This method may be appropriate when low-flow pumping equipment is not available by sensitive samples will be collected.

(a) Determine the volume of water to be purged as described in Section 8.1, Field Preparation.

(b) Assemble pump and tubing, and slowly lower the pump into the middle of the water column of the well. Place discharge tube in a graduated vessel or container of known volume in order to measure the amount of water removed from the well to achieve the required purge volume.

(c) Connect pump’s alligator clips to 12-volt battery and begin pumping. Turn on YSI-556 Multi-meter and allow probes to equalize approximately 15 minutes in preparation of collecting field water quality measurements. Periodically, collect field water quality measurements (i.e., temperature, conductivity, pH, dissolved oxygen (DO) and/or oxidation reduction potential (ORP)) by lowering YSI-556 Multi-meter probe into well to a depth at which the well water is flowing past the probe during measuring. Allow readings of to stabilize. Record stabilized measurements and time collected in the field book.

(d) During purging of the well, slowly lower the pump so that, after four well volumes are purged, the pump’s inlet is within approximately 1 foot of the bottom of the well in order to remove stagnant water before collecting samples with a bailer.

(e) Purge well until specified volume of water has been removed and/or until field parameters, such as temperature, pH, conductivity, etc., have stabilized.

Stabilization is achieved after all parameters have stabilized for three successive readings. Three successive readings should be within plus or minus .1 for pH, 3% for conductivity, 10 mV for ORP, and 10% for DO. Three successive readings for temperature are not required. *Note: If you are collecting sensitive samples (i.e., VOCs or trace metals), keep the purging rate as low as possible.*

(f) Thereafter, pour the purge water into a 55-gallon drum that is temporarily stored on-site pending proper disposal arrangements.

(g) Upon the completion of removing the appropriate purge volume from the well, to recharge. Assemble and label appropriate sample containers.

(h) Attach the nylon rope to a clean disposable bailer.

(i) Lower the bailer slowly and gently into the well, taking care not to shake the casing side or to splash the bailer into the water. Stop lowering at a point adjacent to the screen.

(j) Allow bailer to fill and then slowly and gently retrieve bailer from the well avoiding contact with the casing.

(k) Remove cap from sample container, insert appropriate sampling tip (i.e., bottom emptying device) into bottom of the bailer and begin to slowly fill the pre-labeled sample container or filtering device.

(l) Filter and preserve samples if required by SAP.

(m) Cap the sample container tightly and place pre-labeled sample container in a bubble-wrap bag. Then place the bubble wrapped sample in a Ziploc® bag. Label Ziploc® bag with the sample identification and project number. Place groundwater sample in an insulated cooler with ice and chill to </= 6° C.

(n) Remove pump and assembly and fully decontaminate pump in accordance with SOP-8 prior to setting into the next sample well. Discard tubing in a plastic garbage bag for proper disposal.

(o) Replace the well casing cap and well protective cover.

(p) Log all samples in the field book.

<u>8.3.3 Submersible Pump</u>

This method describes purging and sampling with a submersible pump. This method may be appropriate when low-flow pumping equipment is not available and sensitive samples will be collected.

(a) Determine the volume of water to be purged as described in Section 8.1, Field Preparation.

(b) Assemble pump and tubing, and slowly lower the pump into the middle of the water column of the well. Place discharge tube in a graduated vessel or container of known volume in order to measure the amount of water removed from the well to achieve the required purge volume.

(c) Connect pump's alligator clips to 12-volt battery and begin pumping. Turn on YSI-556 Multi-meter and allow probes to equalize approximately 15 minutes in preparation of collecting field water quality measurements. Periodically, collect field water quality measurements (i.e., temperature, conductivity, pH, DO, and/or ORP) by lowering YSI-556 Multi-meter probe into well to a depth at which the well water is flowing past the probe during measuring. Allow readings of to stabilize. Record stabilized measurements and time collected in the field book.

(d) During purging of the well, slowly lower the pump so that, after four well volumes are purged, the pump's inlet is within approximately 1 foot of the bottom of the well in order to remove stagnant water before collecting samples with a bailer.

(e) Purge well until specified volume of water has been removed and/or until field parameters, such as temperature, pH, conductivity, etc., have stabilized. Stabilization is achieved after all parameters have stabilized for three successive readings. Three successive readings should be within plus or minus .1 for pH, 3% for conductivity, 10 mV for ORP, and 10% for DO. Three successive readings for temperature are not required. *Note: If you are collecting sensitive samples (i.e., VOCs or trace metals), keep the purging rate as low as possible*

(f) Thereafter, pour the purge water into a 55-gallon drum that is temporarily stored on-site pending proper disposal arrangements.

(g) Upon the completion of removing the appropriate purge volume from the well, allow monitoring well to recharge. Assemble and label appropriate sample containers.

(h) Carefully move pump to just above the screened section.

(i) Attach gate valve (or other flow control device) to hose (if not already fitted), and reduce flow of water to a manageable sampling rate (several hundred milliliters per minute is preferred).

(j) If no gate valve or other flow-control device is available, run the water down the side of a clean jar and fill the sample containers from a jar.

(k) Remove cap from sample container and slowly fill the pre-labeled sample container or filtering device.

(l) Filter and preserve samples if required by SAP.

(m) Cap the sample container tightly and place pre-labeled sample container in a bubble-wrap bag. Then place the bubble wrapped sample in a Ziploc® bag. Label Ziploc® bag with the sample identification and project number. Place groundwater sample in an insulated cooler with ice and chill to </= 6° C.

(n) Remove pump and assembly and fully decontaminate pump in accordance with SOP-8 prior to setting into the next sample well. Discard tubing in a plastic bag for proper disposal.

(o) Replace the well casing cap and well protective cover.

(p) Log all samples in the field book.

8.3.4 Peristaltic Pump and Disposable Bailer

This method describes purging with a peristaltic pump and sampling with a disposable 1-inch bailer. This method may be appropriate on 1-inch in diameter wells when low-flow pumping equipment is not available and sensitive samples will be collected.

(a) Determine the volume of water to be purged as described in Section 8.1, Field Preparation.

(b) Assemble pump and tubing, and slowly lower the tubing into the middle of the water column of the well. Place discharge tube in a graduated vessel or container of known volume in order to measure the amount of water removed from the well to achieve the required purge volume.

(c) Plug pump into power source, turn “ON” pump and begin pumping. Periodically, collect samples of the purge water in two clean 2 ounce plastic sample cup for pH, temperature, and electrical conductivity measurements. Insert pH/temperature probe into one cup and the conductivity probe into the second cup. Allow readings to stabilize. Record stabilized measurements and time collected in the field books. Wait until you have collected at least three stable readings to record the final measurements.

(d) During purging of the well, slowly lower the tubing so that, after four well volumes are purged, the tubing is within approximately 1 foot of the bottom of the well in order to remove stagnant water before collecting samples with a bailer.

(e) Purge well until specified volume of water has been removed and/or until field parameters, such as temperature, pH, conductivity, etc., have stabilized. Stabilization is achieved after all parameters have stabilized for three successive readings. Three successive readings should be within plus or minus .1 for pH, 3% for conductivity, 10 mV for ORP, and 10% for DO. Three successive readings for temperature are not required. *Note: If you are collecting sensitive samples (i.e., VOCs or trace metals), keep the purging rate as low as possible.*

(f) Thereafter, pour the purge water into a 55-gallon drum that is temporarily stored on-site pending proper disposal arrangements.

(g) Upon the completion of removing the appropriate purge volume from the well, to recharge. Assemble and label appropriate sample containers.

(h) Attach the nylon rope to a clean disposable 1-inch bailer.

(i) Lower the bailer slowly and gently into the well, taking care not to shake the casing side or to splash the bailer into the water. Stop lowering at a point adjacent to the screen.

(j) Allow bailer to fill and then slowly and gently retrieve bailer from the well avoiding contact with the casing.

(k) Remove cap from sample container, insert appropriate sampling tip (i.e., bottom emptying device) into bottom of the bailer and begin to slowly fill the pre-labeled sample container or filtering device.

(l) Filter and preserve samples if required by SAP.

(m) Cap the sample container tightly and place pre-labeled sample container in a bubble-wrap bag. Then place the bubble wrapped sample in a Ziploc® bag. Label Ziploc® bag with the sample identification and project number. Place groundwater sample in an insulated cooler with ice and chill to </= 6° C.

(n) Remove tubing and assembly and fully decontaminate pump in accordance with SOP-8 prior to setting into the next sample well. Discard tubing in a plastic bag for proper disposal.

(o) Replace the well casing cap and well protective cover.

(p) Log all samples in the field book.

8.3.5 Low Flow Purging and Sampling

This method describes purging and sampling with a peristaltic pump. Low flow purging and sampling results in collection of groundwater samples from monitoring wells that representative of groundwater conditions in the geological formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that limits drawdown inside the well casing. The low flow purging and sampling method is fully described in American Society for Testing and Materials (ASTM) Standard Practice D 6771, in which the benefits are described as including:

- Improved sample quality, accuracy, precision and variability through reduced disturbance to the well and formation, reduced mixing, analyte dilution, aeration and degassing.

- Reduced purge water volume (90-95%), leads to savings in disposal costs, and reduced time for purging and sampling may reduce field labor costs.

- Minimization of the aeration of the groundwater sample during collection, improving the sample quality for VOC analysis.

- Improved detection and resolution of contaminant distribution through sampling a smaller section of the formation.

- Improved ability to quantify total mobile contaminant load, without need for filtration.

- Increased well life, through reduced pumping stress.

Peristaltic pumps and other suction lift devices are not suitable for use in wells containing contaminants and/or measurable parameters that may be affected by the vacuum and degassing that occurs when these devices are used. Grab samplers, such as bailers and inertia-lift pumps are also unsuitable as they create too much disturbance to the water column.

Problems that may be encountered using this technique include; difficulty in sampling wells with insufficient yield, failure of one or more key indicator parameters to stabilize, and the cascading of water or the formation of air bubbles in the tubing.

The low flow purging and sampling technique is described as follows:

(a) Measure DTW and DTB in each well as described in Section 8.1.

(b) Review well construction diagram in the field book to determine the screen length of each well. Calculate the depth of mid-screen of the well as the pumping level will need to be at the middle of the well screen.

(c) Assemble tubing to pump, and slowly lower the tubing into the water column of the well. Once the tubing is placed within the well and fixed (rubber strap) set up the pump, water quality multi-meter probe and flow through cell. Assemble and label appropriate sample containers.

(d) Set the pumping rate with control device so it is between 0.1 to 0.5 liters per minute. The goal is to achieve minimal drawdown (< 0.1 m) during purging.

(e) Once the equipment is in place begin purging the well. (Note: After the pump is turned on set the flow rate and do not alter it throughout the development process.) Note your start time as soon as the pump is turned on and containerize purge water in a graduated container so the flow rate can be calculated following completion of development. Make sure the time that the indicator parameters are taken is documented.

(f) Record indicator parameters for temperature, pH, dissolved oxygen, specific conductivity, and ORP, time, and turbidity, if applicable, while purging by placing multi-meter probe in the purge water that has been captured in the flow through cell. Set up the following table in the site's field book to record all necessary information:

Well ID:		**Pumping Rate:**		**Pump Start Time:**		
Time	Temperature	Specific Conductivity	DO	pH	ORP	Turbidity
Total Volume Pumped:				Sample Collection Time:		

Note: Total Volume Pumped is the volume removed upon collection of third consecutive reading (i.e. last measurement).

(g) Measurements should be taken every three to five minutes and stabilization is achieved after all parameters have stabilized for three successive readings.

(h) In general, the order of stabilization is pH, and specific conductivity, followed by ORP, DO, and turbidity. Three successive readings should be within plus or minus .1 for pH, 3% for conductivity, 10 mV for ORP, and 10% for turbidity and DO. Three successive readings for temperature are not required. *Note: DO and turbidity usually require the longest time for stabilization*.

(i) Once parameters have stabilized disconnect the flow through cell and begin collecting samples in the order as specified in Section 8.1. The flow can be decreased if needed to allow attachment of any filtering devices and to minimize aeration of the samples. Record the pumping rate so you have a reference for the next sampling event.

(j) Remove cap from sample container and slowly fill the pre-labeled sample container or filtering device.

(k) Filter and preserve samples if required by SAP.

(l) Cap the sample container tightly and place pre-labeled sample container in a bubble-wrap bag. Then place the bubble wrapped sample in a Ziploc® bag. Label Ziploc® bag with the sample identification and project number. Place groundwater sample in an insulated cooler with ice and chill to </= 6° C.

(m) Remove pump and assembly and fully decontaminate pump in accordance with SOP-8 prior to setting into the next sample well. Discard tubing in a plastic garbage bag for proper disposal.

(n) Replace the well casing cap and well protective cover.

(o) For a low flow purging and sampling event the following data should be recorded, as described in ASTM Practice D 6771:

- Equipment Calibration
- Equipment Decontamination
- Equipment Configuration for Purging and Sampling
- Pump Placement
- Initial Static Water Level
- Initial Pump Rate
- Drawdown Measurements
- Stabilized Pumping Water Level
- Final Pump Rate
- Water Quality and Turbidity Measurements, with Times
- Final Sampling Flow Rate

8.3.6Field Filtering of Groundwater Samples

If filtering of samples is required, a disposable in-line filter should be used to minimize contact with air to avoid precipitation of metals. The typical filter media size used is 0.45 µm because this is commonly accepted as the demarcation between dissolved and non-dissolved species.

The first 500 to 1000 milliliters of a ground-water sample (depending on sample turbidity) taken through the in-line filter will not be collected for a sample in order to ensure that the filter media has equilibrated to the sample (manufacturer's recommendations also should be consulted).

8.3.7 Field Preservation of Groundwater Samples

Please note that except as approved the QA/QC Officer, groundwater samples requiring preservation should be collected only in bottles supplied by the laboratory with the preservative in appropriate quantities pre-added to the bottles by the laboratory. Care must be taken when filling the bottles to avoid spillage of any preservative, both to ensure that samples are properly preserved and to avoid potential health and safety hazards associated with contact with the preservatives.

9.1 REFERENCES

Project personnel using this procedure should become familiar with the contents of the following documents to properly implement this SOP, as applicable and appropriate.

- ASTM, Standard Practice D 6771, *Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground Water Quality Investigations*
- EPA, 1991 *Handbook of Suggested Practices for the Design and Installation of Ground-Water Wells.* EPA-600-4-88-034, March, 1991.
- SOP-8, Equipment Decontamination.
- SOP-10, Management of Investigative Wastes

10.0 RECORDS

The FL is responsible for data entry and submitting the following records to central filing, where applicable:

10.1 Completed field notebook

10.2 Well Development Sampling Worksheet (Attachment B)

11.0 ATTACHMENTS

Attachment A: Equipment and Supplies Checklist for Purging and Sampling of Wells

Attachment B: Well Development Sampling Worksheet

Attachment A

Equipment and Supplies Checklist for Purging and Sampling of Wells

√	Quantity	Description
		SAP
		SSHASP
		SOP-8
		Field book
		Waterproof ink pen and permanent marker
		Camera
		Tool Box (includes at a minimum socket wrench, screwdriver, pliers, hammer, scissors, flashlight)
		Keys for well cap locks
		Electronic water-level indicator
		Calculator
		Appropriate pre-preserved laboratory sample containers
		Sample labels
		Adjustable rate peristaltic or submersible pump and appropriate tubing
		Flow measurement supplies
		Flow cell
		Water quality multi-meter (e.g., YSI 556 multi meter) for measuring temperature, specific conductance, pH, DO and ORP. Separate individual meters may also be used.
		Single check valve disposable bailers
		Sampling tips
		Nylon rope
		Appropriate PPE
		5-gallon plastic pails
		55-gallon steel drums
		Insulated cooler
		Chain-of-custody seals,
		Ziploc® bags
		Ice
		Decontamination equipment (SOP-8)
		Garbage bags

ATTACHMENT B
WELL DEVELOPMENT SAMPLING WORKSHEET

PROJECT ID #_________________________________ **WELL #** __________________

$V_1 + V_2$ = Well Volume
V_1 = Volume of Water in Casing
V_2 = Volume of Water in Filter Pack
D_1 = Inside Diameter of Well Casing = 0.17 feet (2.0-inch diameter)
D_2 = Outside Diameter of Well Casing = 0.20 feet (2.3-inch diameter)
D_3 = Diameter of Borehole - 8.25 inches = 0.69 feet (8.75 inches use 0.72 feet)
H_1 = Depth of Well (A) in feet minus Depth to Water (B) in feet (from surface)
H_2 = Height of Sandpack from Water Level to Bottom of Borehole
N = Percent Porosity of Sandpack is Constant = 35% = 0.35

$$V_1 = 3.14 \frac{D_1^2 H_1}{2}$$

$$V_1 = 3.14 \frac{0.17^2 H_1}{2}$$

V_1 = 3.14 x .01 x __________________
(H1)

V_1 =______cubic ft

$$V_2 = N \times 3.14 \times H_2 \quad \frac{D_3^2}{2} - \frac{D_2^2}{2}$$

$$V_2 = 0.35 \times 3.14 \times H_2 \quad \frac{0.69^2}{2} - \frac{0.20^2}{2}$$

V_2 = 0.35 x 3.14 x________ x (0.119 - .01)
(H2)

V2 =______cubic ft

$V_1 + V_2$ =_____cubic ft +______cubic ft

=___________________cubic feet

_______cubic ft x 7.48 gal/cubic ft =

____________________gal/well volume

If well cannot be purged dry:
Three consistent readings of pH, temperature, and conductivity, and try to obtain sediment free water and ten well volumes if practical

10 x gal/well volume
=____________gallons (or when sediment free)

If well can be purged dry:
Three consistent readings of pH, temperature, and conductivity, and try to obtain sediment free water and three well volumes if practical.
3 x___________gal/well volume
=_____________gallons (or when sediment free)

Identifier: SOP-07	Revision: 3	Effective Date: 08/10/2015	Stantec
Author: Stu Gross			

Standard Operating Procedure

for:

CHAIN OF CUSTODY, SAMPLE CONTROL AND FIELD DOCUMENTATION PROCEDURES

Responsible QA Manager: Richard J. Binder, P.G.	[signature]

SOP-07
Chain-of-Custody, Sample Control and Field Documentation Procedures

Revision Log

Revision No.	***Effective Date***	***Prepared By***	***Description of Revisions***	***Affected Pages***
0	10/31/2012	Stu Gross	New Procedure	All
1	04/17/2013	Michael Nied	QAPP revisions per request	11
2	04/23/2015	Dave Constant	Removed Subcontractor Reference from Section 2	5
3	8/10/15	Hiedi Waller	QAPP format update	All

SOP-07
Chain-of-Custody, Sample Control and Field Documentation Procedures

Table of Contents

List of Acronyms and Abbreviations

COC	chain of custody
ECR	environmental characterization and/or remediation
FL	Field Leader
HAZWOPER	Hazardous Waste Operations & Emergency Response Training for General Site Workers
ID	identification
N/A	not applicable
POC	point of contact
PPE	personal protective equipment
PL	Project Leader
QA/QC	quality assurance/quality control
QC	quality control
SOP	standard operating procedure
SSHASP	site-specific health and safety plan

SOP-07
CHAIN-OF-CUSTODY, SAMPLE CONTROL AND FIELD DOCUMENTATION PROCEDURES

1.1 PURPOSE

This standard operating procedure (SOP) states the responsibilities and describes the process for documenting the traceability of samples collected for environmental characterization and/or remediation projects performed by Stantec using sample control and field documentation, specifically, container labels, Sample Collection Logs, Chain of Custody (COC) forms, and Daily Activity Log forms or field notebooks.

COC procedures are established to provide sample integrity. This custody is in two parts: sample collection and laboratory analysis. A sample is under a person's custody if it meets the following requirements:

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

All samples submitted to a laboratory shall be accompanied by a properly completed COC form. Field documentation shall be performed in accordance with this SOP.

2.0 SCOPE

Participants shall implement this procedure when collecting samples for Stantec projects.

2.1 All participants shall implement this mandatory SOP when documenting the traceability of samples collected for Stantec projects.

3.0 TRAINING

3.1 Participants shall train to (e.g., read and/or attend a class) and use the current version of this SOP; contact the author of this SOP of the QA/QC Officer if the text is unclear.

3.1.1 Participants who provide oversight for sampling activities shall read and/or complete training on this SOP.

3.1.2 Participants who collect samples and complete and sign sample collection logs shall read and/or complete training on this SOP.

3.2 The responsible project leader (PL) shall monitor the proper implementation of this procedure.

3.3 The responsible team leader shall ensure that the appropriate personnel complete all applicable training assignments.

4.0 DEFINITIONS

4.1 Site-specific health and safety plan (SSHASP) - Health and safety plan that is specific to a site or related field activity approved by a Stantec health and safety representative. This document contains information specific to the project, including the scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

4.2 Standard operating procedure (SOP) – A document that describes work processes to be used by Stantec in performing work on environmental characterization and/or remediation (ECR) projects.

4.3 COC – The procedural steps to ensure the traceability of a sample from its initial collection to its final disposition. A sample is in one's custody when one or more of the criteria listed below are satisfied:

- The sample is in one or more of the field team members' physical possession,
- The sample is in one's view after being in one's physical possession, or,
- The sample is in a locked or secured area (accessible only to authorized personnel) and maintained in a manner that would make any tampering evident.
- Documentation of these criteria provides evidence that the COC was maintained. The Field COC form documents the traceability of the sample and the sample location.

4.4 Technical team members – The individuals working on the project.

4.5 Field team members – Those authorized individuals present at a sampling site during sample collection. Their presence at the site must be documented. This is done with site access lists or sign-in sheets that are kept outside the exclusion zone. The documentation is required through Hazardous Waste Operations & Emergency Response Training for General Site Workers (HAZWOPER). In the case of an emergency the Field Leader (FL) must know who is on site.

5.1 RESPONSIBLE PERSONNEL

The following identifies the personnel responsible for actions in this procedure:

- Data Management Staff
- project participants (hereinafter referred to as “participants” or “users”)
- Field Leader or designee
- Project leader

- Team leader
- Users

6.0 BACKGROUND AND PRECAUTIONS

6.1 Use this procedure in conjunction with an approved SSHASP.

6.2 All work performed for Stantec projects must be thoroughly and accurately documented. Sample control and field documentation are necessary to document the work performed in the field, to ensure traceability and defensibility of resulting data, and to be legally defensible. Lack of complete documentation may render the fieldwork invalid.

7.0 EQUIPMENT

A checklist of suggested equipment and supplies needed to implement this procedure is provided below.

CHECKLIST FOR FIELD DOCUMENTATION AND CHAIN-OF-CUSTODY PROCEDURES

√	**Quantity**	**Description**	**Comments**
		Sample containers	
		Sample labels	
		Waterproof ink pen	
		Bubble-wrap packaging	
		Chain-of-custody form	
		Strapping tape	
		Chain-of-custody seal	
		Shipment container (i.e., cooler, box, or envelope)	
		Field notebook	
		Field Activity Log forms	

8.0 PROCEDURE

8.1 Sample Labels

The FL or designee shall ensure that sample labels (Attachment A) that provide information regarding the samples are affixed to the sample containers before or immediately following the sampling activity. Each label may include the following information:

- Location: A unique number that allows the entry of location information into the analytical laboratory database.
- Special Instructions: Special instructions requested of the laboratory.
- Date, Time: Date and time of sample collection.
- Sample ID: Sample identification number and container number for each sample in a shipment.
- Analysis: Analytical method requested for type of contaminant for which the sample is analyzed.
- Preservative: Type of preservative needed for a particular analysis (e.g., ice, $HN0_3$, none).
- Field POC Initials: Printed name and initials of point of contact (POC).

Note: The Date/Time and Field POC Initials must be completed in the field; all other fields are pre-populated based on information provided by the laboratory.

8.2 Field Notebooks and Recording of Sample Collection and Field Screening Data

The FL or designee shall record all information pertinent to the collection of sample media, and additional relevant information, in the field notebook. The FL or designee shall complete the field notebook by signing the bottom of each page to document the collection of the sample and recording of activities.

If collecting field screening data, record results in the field notebook with the following entry fields:

- Sample ID: A unique identification number assigned to each sample. The samples IDs are unique and are assigned prior to field activities.
- Event ID and Event Name: The unique identification number and name assigned to the sampling event during its generation.
- Date and Time Collected: Date and time of sample collection.
- Location ID: This unique identifier allows the entry of location information into the appropriate database and ties the exact location with the analytical results.
- Location Type: A general location description based on the sampling event, planning document, and site knowledge.
- Top and Bottom Depth: Sample beginning and end depths in inches or feet, including the unit (e.g., depth of sample in feet, distance on the transect in feet).
- Field Matrix: Description of the sample's matrix as perceived by the field person collecting the sample.
- Field Quality Control (QC) Type: The type of quality assurance/quality control (QA/QC) sample, if not a regular sample. These include field duplicates and

triplicates, field rinsates, field prepared blanks, field splits, and collocated and performance-evaluation samples.

- Composite Type: If composite samples are collected, identify the type of composite sample.
- Field Prep: The appropriate field-preparation method applied, in the field, on the sample collected.
- Special Instructions: Any comments or special instructions for the sample may be preplanned or completed in the field.
- Sample Description: A description of the sample material collected.
- Sample Location Description: General description of the sampling location (e.g., borehole HDH-1 by TA-16-03, outfall samples in Root River, etc.).
- Field Screening/Measurement Results: The results of field screening conducted on a given sample (for example, photoionization detector or flame ionization detector readings in ppm). List the field-screening method, calibration values, and the sample measurements.
- Collected by Printed Name, Signature and Date: Printed name and signature of the person who collected the sample and the date the COC was completed.

8.3 Field Specific Custody Procedures

The sample packaging and shipment procedures summarized below will assure that the samples will arrive at the laboratory with the COC intact.

8.3.1 Field procedures are as follows:

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

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

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

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

8.3.2 Transfer of Custody and Shipment Procedures are as follows:

(a) Samples should be accompanied by a properly completed COC form as detailed in Section 8.4. The sample numbers, locations, media, time of collection, preservatives and required analyses will be listed on the COC form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the COC form. This COC form documents transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, to the freight shipper, or to/from a secure storage area.

(b) Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis with a separate signed COC form enclosed in each sample cooler, box, or envelope. Samples will be packaged and transported in a manner that maintains the integrity of the samples and permits the analysis to be performed with the prescribed holding time. Samples in glass containers will be packaged in coolers with bubble-wrap packaging materials to prevent breakage during shipping. Shipping containers (i.e., coolers, boxes, and envelopes) will be locked and/or secured with one COC seal and strapping tape in at least two locations for shipment to the laboratory. The COC seal must be signed by the sampler (i.e., relinquisher) and dated.

(c) All shipments will be accompanied by the COC record identifying the contents. The original record (white) and laboratory copy (yellow) will be sealed in a plastic Ziploc bag and accompany the samples in the shipping container. The field copy (pink) will be retained by the sampler for filing in the project file.

(d) If samples are sent by common carrier, a bill of lading should be used. Receipts of bills of lading will be retained as part of the permanent documentation. If sent by mail, the package will be registered with a return receipt requested or with a tracking number. Commercial carriers are not required to sign off on the custody form as long as the custody forms are sealed in the shipping container (i.e., sample cooler, box or envelope).

The COC records will be kept with the analytical laboratory reports in the project file.

8.4 Field COC Forms

The FL or designee shall ensure the use of the Field COC forms (Attachment B) to document the integrity of all samples and to maintain a record of sample collection and transfer between personnel. The FL or designee shall ensure that information is supplied in all blank spaces on the Field COC form; if the space is not applicable, enter "N/A."

The Field COC form contains the following information:

- Event Name: The name assigned to the sampling event during the generation of the field-sampling paperwork.
- COC ID: A unique number assigned to the individual form.
- Sample ID: A unique identification number assigned to each sample. Do not fill in by hand or modify the Sample IDs. The sample IDs are unique and not field assigned.
- Sample Order Matrix: Sample matrix description provided to analytical laboratory.
- Team Leader: Team Leader, or designee, as appropriate.
- FL: The FL responsible for collection of the sample.
- Destination: The analytical laboratory where samples are sent.
- Destination POC: The analytical laboratory point of contact.
- Container ID: The container number for each container that makes up the sample.

- Order: The analytical method requested for the type of contaminant for which sample is analyzed.
- Container Description: Volume and type of container used.
- Preservative: Type of preservation needed for the particular analysis (e.g., ice, $HN0_3$, none).
- Collected Y/N: Indicate whether the container was collected by filling in "Y" or "N."
- Reason: Fill in the reason for not collecting a container. This is required if a container is not collected.
- Special Instructions: Additional relevant information pertaining to the samples (e.g., condition on receipt).
- Relinquished by and Date/Time: Printed name and signature of field team member transferring the possession of samples to the mobile analytical laboratory(s) or fixed base laboratory, or to any other authorized person and the date and time the samples are relinquished.
- Received by and Date/Time: Printed name and signature of the individual receiving the samples and the date and time the samples are received.

Note: The individual accepting custody of a sample or set of samples must verify that all containers identified on the Field COC Form are contained in the package(s) requiring acceptance. The signature on the form acknowledges receipt of all the sample containers.

8.5 Use of Custody Seals

The FL or designee shall ensure the use of custody seals (Attachment C) in order to ensure that samples are not tampered with during transport to the analytical laboratory. The FL or designee shall ensure delivery of the sealed sample containers to the analytical laboratory.

Note: Seals are not required on each sample bottle, nor should they ever be placed on the soil VOC vials. Document in field notebooks if custody seals are not used and the reason that they are not used.

8.6 Complete Field Investigation Summaries

8.6.1 Field personnel shall use bound field notebooks or Daily Activity Log forms (for use in loose-leaf notebooks), in addition to the sample control and field documentation, to record all pertinent field data; this includes detailed summaries of information pertaining to the field investigation and additional field data (e.g., unusual events such as storms).

Note: If Daily Activity Log Forms are used, paginate each sheet of the Daily Activity Log for each day (e.g., 1 of 4, 2 of 4, etc.). Entries in the Field Notebooks or Daily Activity Log forms include the following:

- Date: Month, day, and year at the start of each day and at the top of each page.
- Time: The time of each activity.
- Site Specific Work Plan: If applicable, include the Site Specific Work Plan number and/or name.
- Signature: Preparer must sign the entries at the end of each day.

- Comments: Comments may include, but are not limited to the following:
  - a general description of work performed;
  - deviations from approved plans or procedures;
  - names and affiliations of all participants on site (field team members and/or visitors);
  - a description of general field conditions (such as weather) encountered;
  - problems encountered/ resolutions implemented;
  - sketches and calculations pertaining to the job;
  - supplies and equipment used;
  - when photographs are taken in the field, the time, date, location, roll identification number, frame number, general compass direction, a description of the subject matter, and the photographer's name must be recorded;
  - decontamination practices, such as the time at which decontamination is performed;
  - a description of waste generated as a result of the field investigation; and/or
  - any additional field observations pertinent to the investigation.

9.0 RECORDS

The FL shall maintain the following records, and ensure records are submitted to Central Filing as appropriate:

- Field Notebooks.
- Electronic files on the "Touchpad" computer or equivalent, if used.
- Daily Activity Logs (if used).
- Sample collection information.
- Any other pertinent information.

10.0 ATTACHMENTS

Example Sample Labels and Custody Seals

Example Blank Chain-of-Custody Form

Example Sample Labels and Custody Seals

CUSTODY SEAL
DATE ____________________
SIGNATURE ____________________

QEC
Quality Environmental Containers
800-255-3950 • 304-255-3900

P O Box 1160
Beaver, WV 25813
800-255-3950 • 304-255-3900

Quality Environmental Containers

PROJECT NAME

SAMPLE ID	SAMPLE DATE
SAMPLED BY	SAMPLE TIME
PRESERVATIVE	______GRAB COMPOSITE
ANALYSIS REQUESTED	

ae Analytical"

Pace Analytical Services, Inc.
1241 Bellevue Street, Ste.9
Green Bay, WI 54302
(920) 469-2436

www.pacelabs.com

Client____________________
Client Sample ID:____________________
Date Collected:__________ Time:__________
_ Collected by:____________________
Analysis:____________________

Preservatives: ONone OHN03 ONaOH OHCI
0Na2S203 0MeOH OZnAcetate OOther:__________

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Pace Analytical www.pacelabs.com

Page: of

Section A
Required Client Information:

Company:
Address:
Email To:
Phone: Fax:
Requested Due Date/TAT:

Section B
Required Project Information:

Report To:
Copy To:
Purchase Order No.:
Project Name:
Project Number:

Section C
Invoice Information:

Attention:
Company Name:
Address:
Pace Quote Reference:
Pace Project Manager:
Pace Profile #:

REGULATORY AGENCY

☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER
☐ UST ☐ RCRA ☐ OTHER________

SITE LOCATION: ☐ GA ☐ IL ☐ IN ☐ MI ☐ NC ☐ OH ☐ SC ☐ WI ☐ OTHER____

Filtered (Y/N)

Requested Analysis:

Section D **Required** Client Information

SAMPLE ID
One Character per box.
(A-Z, 0-9 / ,-)
Sample IDs MUST BE UNIQUE

Valid Matrix Codes

MATRIX	CODE
DRINKING WATER	DW
WATER	WT
WASTE WATER	WW
PRODUCT	P
SOIL/SOLID	SL
OIL	OL
WIPE	WP
AIR	AR
OTHER	OT
TISSUE	TS

ITEM #	SAMPLE ID	MATRIX CODE	SAMPLE TYPE G=GRAB C=COMP	COLLECTED: COMPOSITE START DATE	COMPOSITE START TIME	COMPOSITE END/GRAB DATE	COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Preservatives: Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Requested Analysis	Residual Chlorine (Y/N)	Pace Project No. Lab I.D.
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				
9																				
10																				
11																				
12																				

Additional Comments:

RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS			
							Y/N	Y/N	Y/N
							Y/N	Y/N	Y/N
							Y/N	Y/N	Y/N
							Y/N	Y/N	Y/N
						Temp in °C	Received on Ice	Custody Sealed Cooler	Samples Intact

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER:

SIGNATURE of SAMPLER: DATE Signed (MM / DD / YY)

Identifier: SOP-08	Revision: 2	Effective Date: 08/10/2015	Stantec
Author: Stu Gross			

Standard Operating Procedure

for:

EQUIPMENT DECONTAMINATION

Responsible QA Manager: Richard J. Binder, P.G.	[signature]

SOP-08
Equipment Decontamination

Revision Log

Revision No.	***Effective Date***	***Prepared By***	***Description of Revisions***	***Affected Pages***
0	10/31/12	Stu Gross	New Procedure	All
1	04/28/15	Dave Constant	Removed Reference to Subcontractor from Section 2	5
2	8/10/15	Hiedi Waller	Addressed Formatting Issues	All

Table of Contents

List of Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
FL	field leader
HASP	health and safety plan
PPE	personal protective equipment
PL	project leader
QA/QC	quality assurance/quality control
SSHASP	Site-Specific Health and Safety Plan
SOP	standard operating procedure
SSO	site safety officer

SOP-08
EQUIPMENT DECONTAMINATION

1.0 PURPOSE

This standard operating procedure (SOP) states the responsibilities and describes the process to ensure that sampling equipment, drilling equipment and other tools that could come in contact with contaminated media are properly decontaminated. Personnel performing the decontamination procedures will wear the appropriate protective personal equipment (PPE) as specified in Stantec's Corporate Health and Safety Plan (HASP).

2.0 SCOPE

This SOP is a mandatory document and will be implemented by all Stantec personnel when performing decontamination of drilling and sampling equipment.

3.0 TRAINING

3.1 Participants shall train to (e.g., read and/or classroom) and use the current version of this SOP; contact the author of this SOP or the project QA/QC Officer if the text is unclear.

3.2 The Field Leader (FL) will ensure that field team members who are engaged in the collection of samples for Stantec projects are familiar with sampling equipment field decontamination objectives and procedures. This would include personnel who are collecting environmental media samples using hand tools, mechanical drilling and sampling equipment, or excavation equipment.

3.3 The responsible project leader (PL) shall monitor the proper implementation of this procedure.

3.4 The FL shall monitor the proper implementation of this procedure and ensure that relevant team members have completed all applicable training assignments.

4.0 DEFINITIONS

Note: Definitions are specific to this procedure.

4.1 Container - A portable device in which a material is stored, transported, treated, disposed of, or otherwise handled.

4.2 Cross contamination - The inadvertent introduction of contaminated materials from one location to another.

4.3 Site-Specific Health and Safety Plan (SSHASP) - A health and safety plan that is specific to a site or related field activity that has been approved by a Stantec health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., PPE) and hazard mitigation.

5.0 RESPONSIBLE PERSONNEL

The following identifies the personnel responsible for actions in this procedure:

5.1 Field Leader (FL)

5.2 Site Workers

5.3 Project Leader (PL)

5.4 Site Safety Officer (SSO)

6.0 BACKGROUND AND PRECAUTIONS

Note: This SOP is to be used in conjunction with an approved SSHASP. Also, consult the SSHASP for information on use of all PPE.

6.1 To help ensure that samples collected for the purpose of characterizing a potentially contaminated site are representative of the point place where they are collected, the equipment used to collect those samples should be decontaminated between each sampling event. Decontamination helps minimize the potential for cross contamination between sampling locations and helps protect site and community personnel by requiring that equipment not be removed from the site without proper decontamination. The decontamination process should be tailored to the types of contaminants anticipated. The volume of decontamination wastes generated should be kept to a minimum.

6.2 This procedure addresses decontamination for hazardous chemical constituents. A dry decontamination process is used first for the primary purpose of removing soil that may be contaminated by hazardous constituents, followed by a wet decontamination process intended to remove the remaining constituents. Dry decontamination is essentially the mechanical and/or chemical cleaning of the equipment without the excessive use of liquids. Dry decontamination is used first to minimize liquid waste production, especially the production of liquid mixed wastes. The solid waste produced by the dry decontamination process, however, may contain hazardous chemical constituents and become a mixed waste. Wet decontamination is essentially a washing process to remove constituents that are not removed by the dry decontamination process.

6.3 Wastes generated from drilling operations should be managed according to SOP-10.

6.4 Decontamination procedures shall be conducted in accordance with the applicable SSHASP to help ensure that personnel performing the decontamination are protected from equipment-related accidents and from exposures to hazardous and/or mixed wastes. Implementation of these procedures may involve steam cleaning of drilling, excavation, and sampling equipment.

7.0 EQUIPMENT

A checklist of suggested equipment and supplies needed to implement this procedure is provided below.

EQUIPMENT AND SUPPLIES CHECKLIST FOR EQUIPMENT DECONTAMINATION

√	Quantity	Description	Comments
		SOP-07	
		SOP-10	
		Plastic sheeting	
		Pressure washer and collection basin (if required)	
		55-gallon steel drums (if required)	
		Non-phosphate detergent (e.g., Alconox® or Liquinox®)	
		Acid Rinses (inorganic desorbing agent) made from reagent grade diluted nitric or hydrochloric acid and deionized water (if required)	
		Solvent Rinses (organic desorbing agent) shall be pesticide grade methanol, hexane, isopropanol or acetone (if required)	
		Deionized water, organic-free reagent grade received from laboratory	
		Control water (i.e., tap water rinse from a local water system)	
		5-gallon buckets	
		Scrub brushes	
		Gloves (e.g., nitrile or polyethylene)	
		Personal protective clothing	

Participants shall use only the equipment and supplies authorized by the responsible PL and included on the equipment and supply checklist for this procedure. Participants shall report to the PL any equipment or supply item listed on the checklist that is not available for use and the need for equipment or supply items in addition to or different from the equipment and supplies listed on the checklist.

8.0 PROCEDURE

Field equipment used during the sampling activities will be decontaminated prior to sample collection to minimize the potential for cross-contamination. Whenever possible, disposable sampling equipment will be used to minimize the need for decontaminating equipment.

8.1 Hand-held Sample Contact Equipment

Hand-held equipment may include split spoons, barrel or electric hand auger, spoons, knives, mixing bowls and pans, pumps, bailers, water level probe, and other devices.

(a) Minimum decontamination procedures are:

1. Wash all sample contact equipment with a non-phosphate detergent solution (e.g., Alconox® or Liquinox®).

2. Thoroughly rinse the equipment with control water.

(b) More rigorous decontamination procedures are:

1. Wash equipment with a non-phosphate detergent solution (e.g., Alconox® or Liquinox®) and scrub with an inert brush. For internal mechanisms and tubing, circulate the detergent solution through the equipment.

2. Thoroughly rinse the equipment with control water.

3. Rinse with an inorganic desorbing agent (i.e., acid rinse). This step may be deleted if samples will not undergo inorganic chemical analyses.

4. Rinse equipment with control water.

5. Rinse with organic desorbing agent (i.e., solvent rinse). This step may be deleted if samples will not undergo organic chemical analyses.

6. Rinse equipment with deionized water.

7. Allow equipment to air dry prior to next use.

8. Place equipment in an inert container or wrap with clean plastic or aluminum foil for storage or transport to prevent direct contact with potentially contaminated material.

(c) Decontaminate sampling equipment before use, between samples and locations, and upon completion of sampling operations.

(d) Depending on site conditions, it may be appropriate to contain spent decontamination rinse fluids. If appropriate, the rinse fluids shall be placed in a 55-gallon steel drum and secured. The drum shall be stored on-site until pending proper disposal arrangements.

(e) All equipment decontamination shall be performed at a centralized location on-site away from the location the equipment is expected to be used. Care must be taken to transport the equipment to the decontamination area so that the spread of potential contaminants is minimized.

8.2 Large Sample and Non-contact Sample Equipment

Large sample contact equipment may include larger pieces of equipment such as casings, auger flights, pipe, rods, and those portions of a drill rig and Geoprobe® that may stand directly over a boring or well location or that come into contact with casing, auger flights pipe, or rods. Non-contact equipment is described as portions of the equipment that assist in sample collection but does not come in contact with the sample.

The following procedure shall be used to decontaminate the equipment:

(a) Wash external surfaces of the equipment with high-pressure hot water and a non-phosphate detergent solution (e.g., Alconox® or Liquinox®). Alternatively, scrub the equipment with inert brush until all visible dirt, grime, grease, oil, loose paint, rust flakes, etc.

(b) Wash the inside surfaces of casings, drill rods, and auger flights with high-pressure hot water and a non-phosphate detergent solution (e.g., Alconox® or Liquinox®). Alternatively, scrub the equipment with inert brush until all visible dirt, grime, grease, oil, loose paint, rust flakes, etc. are removed.

(c) Rinse equipment with control water.

(d) Decontaminate sampling equipment before use, between samples and locations, and upon completion of sampling operations.

(e) Depending on site conditions, it may be appropriate to contain spent decontamination rinse fluids. If appropriate, ultimately the rinse fluids shall be placed in a 55-gallon steel drum and secured. The drum shall be stored on-site until pending proper disposal arrangements.

(f) Depending on site conditions, spent decontamination rinse water can be allowed to drain directly on the ground surface on a location of the site away from the sampling locations.

(g) All equipment decontamination shall be performed at a centralized location on-site away from the location the equipment is expected to be used. Care must be taken to transport the equipment to the decontamination area so that the spread of potential contaminants is minimized.

(h) In addition, the contractor shall take care to prevent the sample from coming into contact with potentially contaminating substances, such as tape, oil, engine exhaust, corroded surfaces and dirt.

8.3 Decontamination Documentation

Decontamination documentation shall include at a minimum the following:

(a) The location where decontamination occurred.

(b) The individuals performing the decontamination.

(c) The decontamination procedures, including the wash solution and rinse water used (e.g., tap water or reagent grade water).

(d) Equipment storage and transportation procedures.

(e) The handling and disposal of decontamination wastewater.

If this information has already been included in a site sampling plan, re-documentation shall not be necessary.

9.0 RECORDS

The FL is responsible for maintaining the following records.

9.1 Training documentation checklist

9.2 Field notebook

Note: General decontamination activities shall be documented in the field notebook. Should deviations in conditions or problems occur, they should be noted in the field notebook per SOP-07.

10.0 REFERENCES

To implement this procedure properly, participants should become familiar with the contents of the following documents:

- SOP-07, Chain-of-Custody, Sample Control and Field Documentation Procedures
- SOP-10, Management of Investigative Wastes
- American Society for Testing and Materials (ASTM), “Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites, ASTM D 5088”, American Society for Testing and Materials, 2002, revised 2008.
- U.S. Department of Energy, 1987, “Appendix G: Decontamination Guidance,” in The Environmental Survey Manual, Report DOE/EH-0053. Washington, D.C.
- U.S. Environmental Protection Agency, 1994, Sampling Equipment Decontamination, EPA SOP No. 2006, Rev. 0.0, August 11, 1994.

11.1 ATTACHMENTS

Attachment A: U.S. Environmental Protection Agency, 1994, Sampling Equipment Decontamination, EPA SOP No. 2006, Rev. 0.0, August 11, 1994.

SAMPLING EQUIPMENT DECONTAMINATION

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during hazardous waste operations as per 29 Code of Federal Regulations (CFR) 1910.120. This SOP does not address personnel decontamination.

These are standard (i.e. typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitation, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Removing or neutralizing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high and low pressure water cleaning.

The first step, a soap and water wash, removes all visible particulate matter and residual oils and grease. This may be preceded by a steam or high pressure water wash to facilitate residuals removal. The second step involves a tap water rinse and a distilled/deionized water rinse to remove the detergent. An acid rinse provides a low pH media for trace metals removal and is included in the decontamination process if metal samples are to be collected. It is followed by another distilled/deionized water rinse. If sample analysis does not include metals, the acid rinse step can be omitted. Next, a high purity solvent rinse is performed for trace organics removal if organics are a concern at the site. Typical solvents used for removal of organic contaminants include acetone, hexane, or water. Acetone is typically chosen because it is an excellent solvent, miscible in water, and not a target analyte on the Priority Pollutant List. If acetone is known to be a contaminant of concern at a given site or if Target Compound List analysis (which includes acetone) is to be performed, another solvent may be substituted. The solvent must be allowed to evaporate completely and then a final distilled/deionized water rinse is performed. This rinse removes any residual traces of the solvent.

The decontamination procedure described above may be summarized as follows:

1. Physical removal
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse
5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Air dry
9. Distilled/deionized water rinse

If a particular contaminant fraction is not present at the site, the nine (9) step decontamination procedure specified above may be modified for site specificity. For example, the nitric acid rinse may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse may be eliminated if organics are not of concern at a site. Modifications to the standard procedure should be documented in the site specific work plan or subsequent report.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest.

More specifically, sample collection and analysis of decontamination waste may be required before beginning proper disposal of decontamination liquids and solids generated at a site. This should be determined prior to initiation of site activities.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

1. The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte free (specifically for the contaminants of concern).

2. The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal or industrial water treatment system.

3. If acids or solvents are utilized in decontamination they raise health and safety, and waste disposal concerns.

4. Damage can be incurred by acid and solvent washing of complex and sophisticate d sampling equipment.

5.1 EQUIPMENT/APPARATUS

Decontamination equipment, materials, and supplies are generally selected based on availability. Other considerations include the ease of decontaminating or disposing of the equipment. Most equipment and supplies can be easily procured. For example, soft-bristle scrub brushes or long-handled bottle brushes can be used to remove contaminants. Large galvanized wash tubs, stock tanks, or buckets can hold wash and rinse solutions. Children's wading pools can also be used. Large plastic garbage cans or other similar containers lined with plastic bags can help segregate contaminated equipment. Contaminate d liquid can be stored temporarily in metal or plastic cans or drums.

The following standard materials and equipment are recommended for decontamination activities:

5.2 Decontamination Solutions

1. Non-phosphate detergent
2. Selected solvents (acetone, hexane, nitric acid, etc.)
3. Tap water
4. Distilled or deionized water

5.3 Decontamination Tools/Supplies

1. Long and short handled brushes
2. Bottle brushes
3. Drop cloth/plastic sheeting
4. Paper towels
5. Plastic or galvanized tubs or buckets
6. Pressurized sprayers (H_2O)
7. Solvent sprayers
8. Aluminum foil

5.4 Health and Safety Equipment

Appropriate personal protective equipment (i.e., safety glasses or splash shield, appropriate gloves, aprons or coveralls, respirator, emergency eye wash)

5.5 Waste Disposal

1. Trash bags
2. Trash containers
3. 55-gallon drums
4. Metal/plastic buckets/containers for storage and disposal of decontamination solutions

6.0 REAGENTS

There are no reagents used in this procedure aside from the actual decontamination solutions. Table 1 (Appendix A) lists solvent rinses which may be required for elimination of particular chemicals. In general, the following solvents are typically utilized for decontamination purposes:

- 10% nitric acid is typically used for inorganic compounds such as metals. An rinse may not be required if inorganics are not a contaminant of concern.
- Acetone (pesticide grade)[1]
- Hexane (pesticide grade)[1]
- Methanol[1]

[1] - Only if sample is to be analyzed for organics.

7.0 PROCEDURES

As part of the health and safety plan, a decontamination plan should be developed and reviewed. The decontamination line should be set up before any personnel or equipment enter the areas of potential exposure. The equipment decontamination plan should include:

- The number, location, and layout of decontamination stations.
- Decontamination equipment needed.
- Appropriate decontamination methods.
- Methods for disposal of contaminated clothing, equipment, and solutions.
- Procedures can be established to minimize the potential for contamination. This may include: (1) work practices that minimize contact with potential contaminants; (2) using remote sampling techniques; (3) covering monitoring and sampling equipment with plastic, aluminum foil, or other protective material; (4) watering down dusty areas; (5) avoiding laying down equipment in areas of obvious contamination; and (6) use of disposable sampling equipment.

7.1 Decontamination Methods

All samples and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to equipment. Various decontamination methods will remove contaminants by: (1) flushing or other physical action, or (2) chemical complexing to inactivate contaminants by neutralization, chemical reaction, disinfection, or sterilization.

Physical decontamination techniques can be grouped into two categories: abrasive methods and acid non-abrasive methods, as follows:

7.1.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The mechanical abrasive cleaning methods are most commonly used at hazardous waste sites. The following abrasive methods are available:

Mechanical

Mechanical methods of decontamination include using metal or nylon brushes. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushed, degree of brush contact, degree of contamination, nature of the surface being cleaned, and degree of contaminant adherence to the surface.

Air Blasting

Air blasting equipment uses compressed air to force abrasive material through a nozzle at high velocities. The distance between nozzle and surface cleaned, air pressure, time of application, and angle at which the abrasive strikes the surface will dictate cleaning efficiency. Disadvantages of this method are the inability to control the amount of material removed and the large amount of waste generated.

Wet Blasting

Wet blast cleaning involves use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using a very fine abrasive, the amount of materials removed can be carefully controlled.

7.1.2 Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off a surface with pressure. In general, the equipment surface is not removed using non-abrasive methods.

Low-Pressure Water

This method consists of a container which is filled with water. The user pumps air out of the container to create a vacuum. A slender nozzle and hose allow the user to spray in hard-to-reach places.

High-Pressure Water

This method consists of a high-pressure pump, an operator controlled directional nozzle, and a high-pressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) and flow rates usually range from 20 to 140 liters per minute.

Ultra-High-Pressure Water

This system produces a water jet that is pressured from 1,000 to 4,000 atmospheres. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 meters/second (m/s) (1,000 atm) to 900 m/s (4,000 atm). Additives can be used to enhance the cleaning action.

Rinsing

Contaminants are removed by rinsing through dilution, physical attraction, and solubilization.

Damp Cloth Removal

In some instances, due to sensitive, non-waterproof equipment or due to the unlikelihood of equipment being contaminated, it is not necessary to conduct an extensive decontamination procedure. For example, air sampling pumps hooked on a fence, placed on a drum, or wrapped in plastic bags are not likely to become heavily contaminated. A damp cloth should be used to wipe off contaminants which may have adhered to equipment through airborne contaminants or from surfaces upon which the equipment was set.

Disinfection/Sterilization

Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment. This method of decontamination is typically performed off-site.

7.2 Field Sampling Equipment Decontamination Procedures

The decontamination line is setup so that the first station is used to clean the most contaminated item. It progresses to the last station where the least contaminated item is cleaned. The spread of contaminants is further reduced by separating each decontamination station by a minimum of three (3) feet. Ideally, the contamination should decrease as the equipment progresses from one station to another farther along in the line.

A site is typically divided up into the following boundaries: Hot Zone or Exclusion Zone (EZ), the Contamination Reduction Zone (CRZ), and the Support or Safe Zone (SZ). The decontamination line should be setup in the Contamination Reduction Corridor (CRC) which is in the CRZ. Figure 1 (Appendix B) shows a typical contaminant reduction zone layout. The CRC controls access into and out of the exclusion zone and confines decontamination activities to a limited area. The CRC boundaries should be conspicuously marked. The far end is the hotline, the boundary between the exclusion zone and the contamination reduction zone. The size of the decontamination corridor depends on the number of stations in the decontamination process, overall dimensions of the work zones, and amount of space available at the site. Whenever possible, it should be a straight line.

Anyone in the CRC should be wearing the level of protection designated for the decontamination crew. Another corridor may be required for the entry and exit of heavy equipment. Sampling and monitoring equipment and sampling supplies are all maintained outside of the CRC. Personnel don their equipment away from the CRC and enter the exclusion zone through a separate access control point at the hotline. One person (or more) dedicated to decontaminating equipment is recommended.

7.2.1 Decontamination Setup

Starting with the most contaminated station, the decontamination setup should be as follows:

Station 1: Segregate Equipment Drop

Place plastic sheeting on the ground (Figure 2, Appendix B). Size will depend on amount of equipment to be decontaminated. Provide containers lined with plastic if equipment is to be segregated. Segregation may be required if sensitive equipment or mildly contaminated equipment is used at the same time as equipment which is likely to be heavily contaminated.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

As indicated in 7.1.2, a high-pressure wash may be required for compounds which are difficult to remove washing with brushes. The elevated temperature of water from the high-pressure washers is excellent at removing greasy/oily compounds. High pressure washers require water and electricity.

A decontamination pad may be required for the high-pressure wash area. An example of a wash pad may of an approximately 1 1/2 foot-deep basin lined with plastic sheeting and sloped to a sump at one layer of sand can be placed over the plastic and the basin is filled with gravel or shell. The sump is also lined with visqueen and a barrel is placed in the hole to prevent collapse. A sump pump is used to remove the water from the sump for transfer into a drum.

Typically heavy machinery is decontaminated at the end of the day unless site sampling requires that the machinery be decontaminated frequently. A separate decontamination pad may be required for heavy equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Prior to setting up Station 3, place plastic sheeting on the ground to cover areas under Station 3 through Station 10.
Fill a wash basin, a large bucket, or child's swimming pool with non-phosphate detergent and tap water. Several bottle and bristle brushes to physically remove contamination should be dedicated to this station . Approximately 10 - 50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 4: Water Basin

Fill a wash basin, a large bucket, or child's swimming pool with tap water. Several bottle and bristle brushes should be dedicated to this station. Approximately 10-50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 5: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to contain the water during the rinsing process. Approximately 10-20 gallons of water may be required initially by depending upon the amount of equipment to the decontaminate and the amount of gross contamination.

Station 6: Nitric Acid Sprayers

Fill a spray bottle with 10% nitric acid. An acid rinse may not be required if inorganics are not a consist contaminant of concern. The amount of acid will depend on the amount of equipment to be corner. A decontaminated. Provide a 5-gallon bucket or basin to collect acid during the rinsing process.

Station 7: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 8: Organic Solvent Sprayers

Fill a spray bottle with an organic solvent. After each solvent rinse, the equipment should be rinsed with distilled/deionized water and air dried. Amount of solvent will depend on the amount of equipment to decontaminate. Provide a 5-gallon bucket or basin to collect the solvent during the rinsing process.

Solvent rinses may not be required unless organics are a contaminant of concern, and may be eliminated from the station sequence.

Station 9: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 10: Clean Equipment Drop

Lay a clean piece of plastic sheeting over the bottom plastic layer. This will allow easy removal of the plastic in the event that it becomes dirty. Provide aluminum foil, plastic, or other protective material to wrap clean equipment.

7.2.2 Decontamination Procedures

Station 1: Segregate Equipment Drop

Deposit equipment used on-site (i.e., tools, sampling devices and containers, monitoring instruments radios, clipboards, etc.) on the plastic drop cloth/sheet or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross contamination. Loose leaf sampling data sheets or maps can be placed in plastic zip lock bags if contamination is evident.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

Use high pressure wash on grossly contaminated equipment. Do not use high- pressure wash on sensitive or non-waterproof equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Scrub equipment with soap and water using bottle and bristle brushes. Only sensitive equipment (i.e., radios, air monitoring and sampling equipment) which is waterproof should be washed. Equipment which is not waterproof should have plastic bags removed and wiped down with a damp cloth. Acids and organic rinses may also ruin sensitive equipment. Consult the manufacturers for recommended decontamination solutions.

Station 4: Equipment Rinse

Wash soap off of equipment with water by immersing the equipment in the water while brushing. Repeat as many times as necessary.

Station 5: Low-Pressure Rinse

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 6: Nitric Acid Sprayers (required only if metals are a contaminant of concern)

Using a spray bottle rinse sampling equipment with nitric acid. Begin spraying (inside and outside) at one end of the equipment allowing the acid to drip to the other end into a 5-gallon bucket. A rinsate blank may be required at this station. Refer to Section 9.

Station 7: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 8: Organic Solvent Sprayers

Rinse sampling equipment with a solvent. Begin spraying (inside and outside) at one end of the equipment allowing the solvent to drip to the other end into a 5-gallon bucket. Allow the solvent to evaporate from the equipment before going to the next station. A QC rinsate sample may be required at this station.

Station 9: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure washer.

Station 10 : Clean Equipment Drop

Lay clean equipment on plastic sheeting. Once air dried, wrap sampling equipment with aluminum foil, plastic, or other protective material.

7.2.3 Post Decontamination Procedures

1. Collect high-pressure pad and heavy equipment decontamination area liquid and waste and store in appropriate drum or container. A sump pump can aid in the collection process. Refer to the Department of Transportation (DOT) requirements for appropriate containers based on the contaminant of concern.

2. Collect high-pressure pad and heavy equipment decontamination area solid waste and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

3. Empty soap and water liquid wastes from basins and buckets and store in appropriate

drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

4. Empty acid rinse waste and place in appropriate container or neutralize with a base and place in appropriate drum. pH paper or an equivalent pH test is required for neutralization. Consult DOT requirements for appropriate drum for acid rinse waste.

5. Empty solvent rinse sprayer and solvent waste into an appropriate container. Consult DOT requirements for appropriate drum for solvent rinse waste.

6. Using low-pressure sprayers, rinse basins, and brushes. Place liquid generated from this process into the wash water rinse container.

7. Empty low-pressure sprayer water onto the ground.

8. Place all solid waste materials generated from the decontamination area (i.e., gloves and plastic sheeting, etc.) in an approved DOT drum. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

9. Write appropriate labels for waste and make arrangements for disposal. Consult DOT regulations for the appropriate label for each drum generated from the decontamination process.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITYASSURANCE / QUALITY CONTROL

A rinsate blank is one specific type of quality control sample associated with the field decontamination process. This sample will provide information on the effectiveness of the decontamination process employed in the field.

Rinsate blanks are samples obtained by running analyte free water over decontaminated sampling equipment to test for residual contamination. The blank water is collected in sample containers for handling, shipment, and analysis. These samples are treated identical to samples collected that day. A rinsate blank is used to assess cross contamination brought about by improper decontamination procedures. Where dedicated sampling equipment is not utilized, collect one rinsate blank per day per type of sampling device samples to meet QA2 and QA3 objectives.

If sampling equipment requires the use of plastic tubing it should be disposed of as contaminated and replaced with clean tubing before additional sampling occurs.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results in accordance with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow OSHA, U.S. EPA, corporate, and other applicable health and safety procedures.

Decontamination can pose hazards under certain circumstances. Hazardous substances may be incompatible with decontamination materials. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Also, vapors from decontamination solutions may pose a direct health hazard to workers by inhalation, contact, fire, or explosion.

The decontamination solutions must be determined to be acceptable before use. Decontamination materials may degrade protective clothing or equipment; some solvents can permeate protective clothing. If decontamination materials do pose a health hazard, measures should be taken to protect personnel or substitutions should be made to eliminate the hazard. The choice of respiratory protection based on contaminants of concern from the site may not be appropriate for solvents used in the decontamination process.

Safety considerations should be addressed when using abrasive and non-abrasive decontamination equipment. Maximum air pressure produced by abrasive equipment could cause physical injury. Displaced material requires control mechanisms.

Material generated from decontamination activities requires proper handling, storage, and disposal. Personal Protective Equipment may be required for these activities.

Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard (i.e., acetone , alcohol, and trisodiumphosphate).

In some jurisdictions, phosphate containing detergents (i.e., TSP) are banned.

12.0 REFERENCES

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, February, 1988.

A Compendium of Superfund Field Operations Methods, EPA 540/p-87/001.

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, USEPA Region IV, April 1, 1986.

Guidelines for the Selection of Chemical Protective Clothing, Volume 1, Third Edition, American Conference of Governmental Industrial Hygienists, Inc., February, 1987.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October, 1985.

APPENDIX A

Table

Table 1. Soluble Contaminants and Recommended Solvent Rinse

TABLE 1
Soluble Contaminants and Recommended Solvent Rinse

SOLVENT [1]	EXAMPLES OF SOLVENTS	SOLUBLE CONTAMINANTS
Water	Deionized water Tap water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Nitric acid Acetic acid Boric acid	Basic (caustic) compounds (e.g., amines and hydrazines)
Dilute Bases	Sodium bicarbonate (e.g., soap detergent)	Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents [2]	Alcohols Ethers Ketones Aromatics Straight chain alkalines (e.g., hexane) Common petroleum products (e.g., fuel, oil, kerosene)	Nonpolar compounds (e.g., some organic compounds)
Organic Solvent [2]	Hexane	PCBs

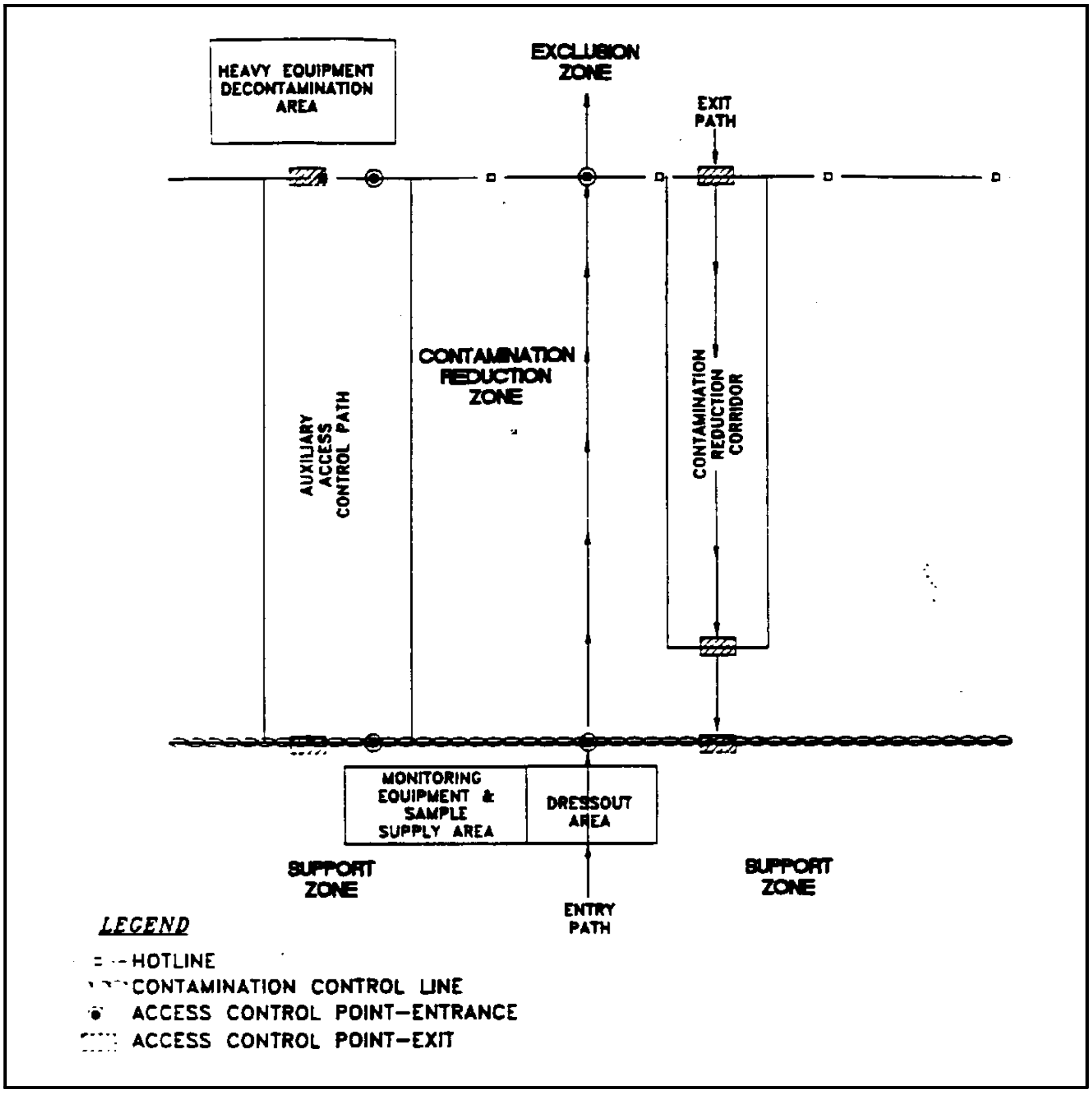
[1] - Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard

[2] - WARNING: Some organic solvents can permeate and/or degrade the protective clothing

APPENDIX B

Figures

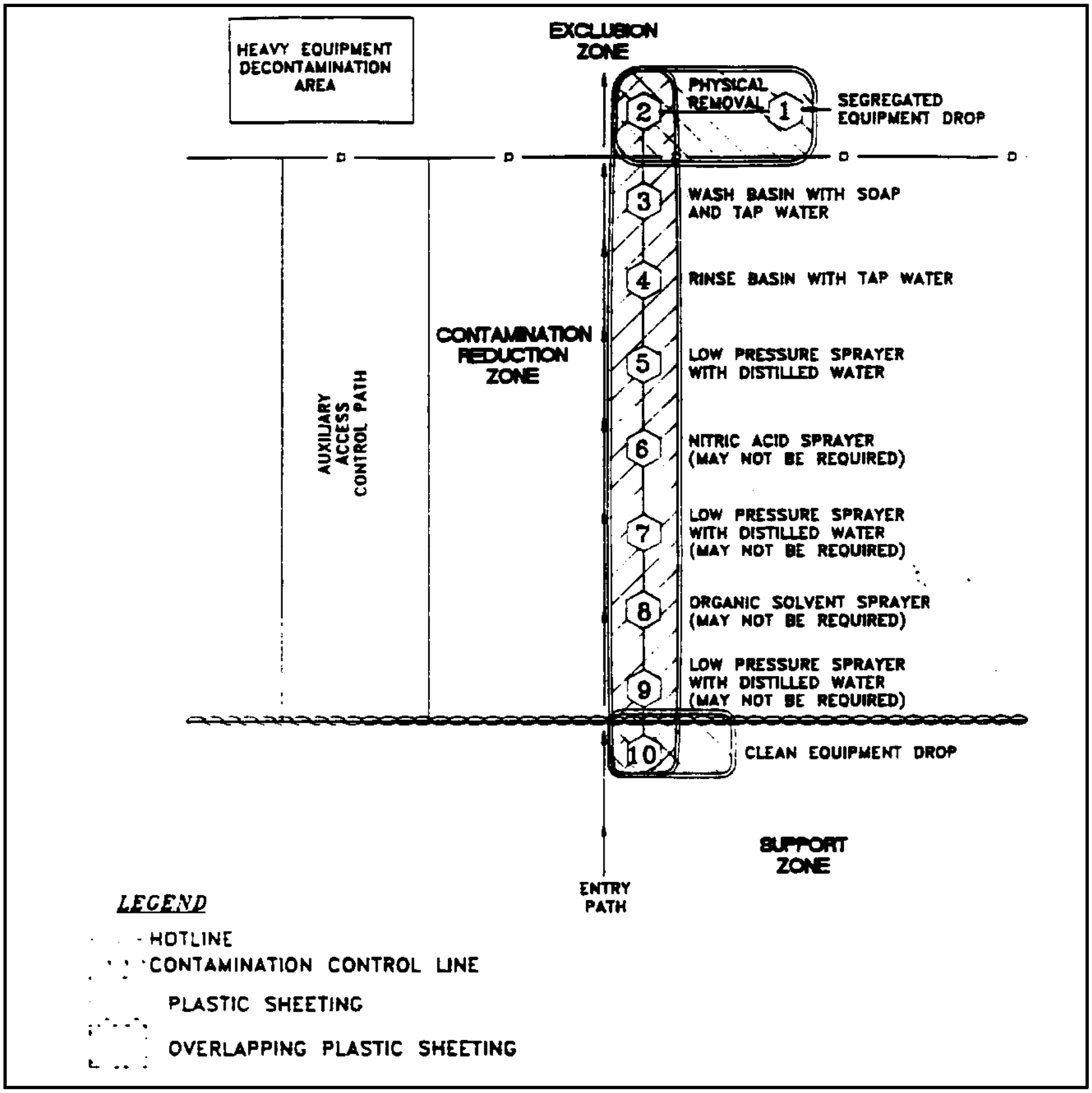
Figure 1. Contamination Reduction Zone Layout



APPENDIX B (Cont'd.)

Figures

Figure 2. Decontamination Layout



Identifier: SOP-09	Revision: 1	Effective Date: 04/17/2013	Stantec
Author: Stu Gross			

Standard Operating Procedure

for:

CALIBRATION, MAINTENANCE, AND OPERATION OF FIELD EQUIPMENT

Responsible QA Manager: Richard J. Binder, P.G.	Richard J. Binder

SOP-09
Calibration, Maintenance, and Operation of Field Equipment

Revision Log

Revision No.	***Effective Date***	***Prepared By***	***Description of Revisions***	***Affected Pages***
0	10/31/12	Stu Gross	New Procedure	All
1	04/17/2013	Michael Nied	QAPP revisions per request	13
2	1/13/14	Lynelle Caine	Changed stabilization criteria	11
3	2/14/2017	Rachelle Noble	Add calibration check language per request	5

Table of Contents

<u>Section</u> **<u>Page</u>**

List of Acronyms and Abbreviations

C	centigrade
DO	Dissolved oxygen
DTW	depth to water
ECR	environmental characterization and/or remediation
F	Fahrenheit
FL	Field Leader
HAZWOPER	Hazardous Waste Operations & Emergency Response Training for General Site Workers
LCD	liquid crystal display
Mg/L	milligrams per liter
ORP	oxygen release potential
PID	photoionization detector
PL	Project Leader
PPE	personal protective equipment
Ppm	parts per million
QA/QC	quality assurance/quality control
SOP	standard operating procedure
SSHASP	site-specific health and safety plan

SOP-09
CALIBRATION, MAINTENANCE, AND OPERATION OF FIELD EQUIPMENT

1.0 PURPOSE

This standard operating procedure (SOP) describes the procedures for calibration, operation, and maintenance of field measurement and testing equipment commonly utilized by Stantec on environmental assessment and other environmental projects. The purpose for this SOP is to ensure accurate and consistent field chemistry, water level, and organic vapor measurements using measuring and testing equipment such as:

(1) Photoionization Detector (PID)
(2) Portable Standard Balance
(3) Electronic water level indicator
(4) YSI 55 Dissolved Oxygen (DO)/temperature meter
(5) YSI 556 Multi-meter
(6) pH/Temperature/Conductivity meter
(7) Oxidation Reduction Potential (ORP) pen

2.0 SCOPE

Participants shall implement this procedure when collecting samples for Stantec projects.

2.1 All participants shall implement this mandatory SOP when performing operation, maintenance, or calibration of field instruments used on Stantec environmental projects.

2.2 If field measurement instruments not included in this SOP are utilized on a project, Section 8.0 of this SOP should be modified to include procedures specific to that instrument.

2.3 Field equipment will be within 10% of the calibration check prior to field operations. If calibration check is not within specified criteria, calibration shall be conducted on the equipment per operations manual or returned to manufacturer for calibration.

3.0 TRAINING

3.1 Participants shall train to (e.g., read and/or attend a class) and use the current version of this SOP; contact the author of this SOP or the Project QA/QC Officer if the text is unclear.

3.1.1 Participants who provide oversight for field sampling activities that utilize one or more field instruments shall complete training on this SOP.

3.1.2 Participants who calibrate, maintain, or operate field instruments shall complete training on this SOP, as well as review equipment manufacturers manuals for each field instrument utilized.

3.2 The responsible project leader (PL) shall monitor the proper implementation of this procedure.

3.3 The responsible team leader shall ensure that the appropriate personnel complete all applicable training assignments.

4.0 DEFINITIONS

4.1 Site-specific health and safety plan (SSHASP) - Health and safety plan that is specific to a site or related field activity approved by a Stantec health and safety representative. This document contains information specific to the project, including the scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

4.2 Standard operating procedure (SOP) – A document that describes work processes to be used by Bonestroo in performing work on environmental characterization and/or remediation (ECR) projects.

4.3 Technical team members – The individuals working on the project.

4.4 Field team members – Those authorized individuals present at a sampling site during sample collection. Their presence at the site must be documented. This is done with site access lists or sign-in sheets that are kept outside the exclusion zone. The documentation is required through Hazardous Waste Operations & Emergency Response Training for General Site Workers (HAZWOPER). In the case of an emergency the Field Leader (FL) must know who is on site.

5.0 RESPONSIBLE PERSONNEL

The following identifies the personnel responsible for actions in this procedure:

- Data Management Staff
- project participants (hereinafter referred to as “participants” or “users”)
- Field Leader or designee
- Project leader
- Team leader
- Users

6.0 BACKGROUND AND PRECAUTIONS

6.1 Handle all gas canisters in accordance with an approved SSHASP.

6.2 Field measurements form a critical component of data collection as part of site assessments or other environmental projects. Making certain that field equipment is properly maintained, calibrated, and operated is critical to the reliably of the decision process and/or evaluations made based on the field measurement data. As such, equipment maintenance, calibration should be carefully documented as part of the project record keeping ensuring defensibility of resulting data.

7.0 EQUIPMENT

A checklist of suggested equipment and supplies needed to implement this procedure is provided below.

CHECKLIST FOR FIELD EQUIPMENT CALIBRATION, MAINTENANCE, AND OPERATION

√	Quantity	Description	Comments
		Thermo Environmental Instruments, Inc. PID	
		PID calibration gases (i.e., Zero air and 254 parts per million [ppm] isobutylene)	
		CS2000 Portable Standard Balance	
		Weight Set or 1-1,000 gram test mass	
		pH/temperature/Conductivity meter	
		Buffer solutions of pH 4, 7 and 10	
		ORP pen	
		Electronic water level indicator	
		YSI-556 Multi-meter	
		YSI-55 DO meter	
		SOP-8	

8.0 PROCEDURE

Field personnel are responsible for the calibration, calibration verification and maintenance of the measuring and testing equipment in accordance with this procedure and documented maintenance and calibration schedules.

8.1 PID

8.1.1 Calibration Frequency:

PIDs require calibration at the beginning of each day and as necessary during use.

8.1.2 Calibration Standards and Procedure:

Calibrate PID in accordance with the manufacturer's specifications. The PID is calibrated using zero air and 254 ppm isobutylene gas.

8.1.3 Maintenance:

Maintain the instrument as follows:

1) Calibrate at the beginning and end of each day, and as necessary during use.

2) Recharge battery at the end of each day.

3) Clean lamp and dust filter as necessary.

4) Replace water traps if they become wet.

8.1.4 Operation:

Operate the instrument as follows:

1) Label new quart-size Ziploc® bag (or similar "locking" plastic bag, or glass mason jar) with the sample identification number.

2) Place representative soil or sediment sample in Ziploc® bag until bag is approximately one-half full. Capture approximately 1 quart of air in the bag. Seal Ziploc® bag (or glass jar with aluminum foil seal and screw cap ring) and homogenize sample (i.e., shake gently).

3) Place bag on a stationary surface, to allow the headspace to come to equilibrium with the soil or sediment sample. The following are general guidelines for minimum equilibration times in different ambient air conditions:

Ambient Temperature (°F)	**Minimum equilibration times**
> 90°	2 minutes
> 70° but ≤ 90°	5 minutes
> 50° but ≤ 70°	10 minutes
≤ 50°	15 minutes

It should be noted that in very hot conditions, a buildup of water vapor in the bag may occur if the bag and sample are heated for too long that may interfere with the operation of the PID.

4) Turn on PID. Calibrate PID prior to first measurement each day. After instrument is calibrated and warmed up, insert the tip of the PID probe into the headspace of: (a) the Ziploc® bag by piercing it with the probe, or (b) the glass jar by piercing the aluminum foil seal with the probe tip. Avoid making contact with the soil or sediment sample with the instrument tip to prevent the sample from being sucked into the instrument.

5) Move soil or sediment around in the bag while the instrument is reading. Record the highest sustained reading in the field book. Turn off PID if no other samples are ready for testing.

8.2 Portable Standard Balance

8.2.1 Calibration Frequency:

At the beginning of each day and as needed during use.

8.2.2 Calibration Standards and Procedure:

Calibrate balance in accordance with the manufacturer's specifications using a 10 - gram test mass or weight.

8.2.3 Maintenance:

Maintain the instrument as follows:

1) Calibrate at the beginning of each day, and as necessary during use.

2) Clean platform at the end of each day, and as necessary during use.

3) Replace batteries as needed.

8.2.4 Operation:

Operate the instrument as follows:

1) Turn on balance by pressing the "ON/OFF/ZERO" button. "0" should read on the LCD display. If not, the "ON/OFF/ZERO" button until the scale reads "0".

2) Press the "CAL/UNIT" button briefly to change the weighing unit. The following weighing units may be selected: grams (g) or pounds-ounces (lb- oz). Use grams as the default weighing unit. Measure in pounds and ounces only if specifically required by a particular laboratory or field method.

3) Place glass sample jar on balance platform. Press "ON/OFF/ZERO" button until the scale reads "0". Slowly fill sample jar with soil until your specified mass in grams is achieved and stable on the liquid crystal display (LCD) unit. A down arrow will appear in the lower left corner of the display when a stable reading has been achieved. Be careful to not spill loose soil onto top of balance platform, as this will cause the weight of the sample jar to be incorrect.

4) Remove sample jar from balance platform, add appropriate preservative (if necessary), and cap jar tightly.

5) Wipe off balance platform before next use, if necessary, to remove any stray soil particles. Turn balance off by pressing the "ON/OFF/ZERO" button.

8.3 <u>Electronic Water Level Indicator</u>

8.3.1 Calibration Frequency:

Calibration is not required.

8.3.2 Maintenance:

Maintain the instrument as follows:

1) Decontaminate at the beginning and end of each day, and in between measurement locations.

2) Replace batteries as needed.

8.3.3 Operation:

Operate the instrument as follows:

1) Turn on indicator. Lower electronic water level indicator probe and tape into the monitoring well until water surface is encountered. An alarm will sound indicating that the probe has reached the top of the water surface.

2) Measure the distance from water surface to the reference measure point marked on the north side of well casing and record the depth to water (DTW) measurement on the tape to the nearest ± 0.01 foot in the field book. Record the time the measurement was collected.

3) Reel the water level indicator tape up and remove from the well. Turn off the indicator and decontaminate the water level indicator in accordance with SOP-8.

8.4 YSI-556 Multi-meter (DO/pH/temperature/Conductivity/ORP)

8.4.1 Calibration Frequency:

Calibrate at the beginning and end of each day in accordance with manufacturer's specifications.

1) DO calibration in mg/L is performed in a water sample which has a known concentration of dissolved oxygen (usually determined by a Winkler titration).

2) The 3-point option will be selected to calibrate the pH sensor using three calibration standard solutions of 4, 7 and 11 pH. In this procedure, the pH sensor is first calibrated with a pH buffer and two additional buffers (pH 4 and 11). The 3-point calibration method assures maximum accuracy when the pH of the media to be monitored cannot be anticipated.

3) For maximum accuracy, the conductivity chosen should be within the same conductivity range as the samples being prepared to measure. Using standards less than 1 mS/cm are not recommended. The following conductivity standards are recommended:

- For fresh water use a 1 mS/cm conductivity standard.
- For brackish water use a 10 mS/cm conductivity standard.
- For seawater use a 50 mS/cm conductivity standard.

4) ORP calibration will be completed to the sample temperature using the Zorbell solution as per the table below:

Temperature ºC	Zorbell Solution Value, mV
-5	270.0
0	263.5
5	257.0
10	250.5
15	244.0
20	237.5
25	231.0
30	224.5
35	218.0
40	211.5
45	205.0
50	198.5

8.4.2 Maintenance:

Maintain the instrument as follows:

1) Decontaminate at the beginning and end of each day, and in between measurement locations.

2) Replace batteries as needed.

3) Replace DO membrane cap prior to each use.

8.4.3 Operation:

Operate the instrument as follows:

1) Turn on multi-meter and allow probes to equalize approximately 15 minutes prior to taking first readings. Lower the multi-meter probe into the monitoring well to approximately the middle of the water column.

2) Allow readings to stabilize. Readings are considered to be stabilized when 3 consecutive measurements taken 3 to 5 minutes apart until the following stabilization criteria are met.

   Temperature: ± 0.2° Centigrade (C).
   pH: ± 0.1 unit
   D.O.: ± 0.3 milligrams per liter (mg/L)
   Conductivity: > 100 ± 5% or < 100 ± 3%

   It should be noted that readings typically stabilize in the following order (1) pH, (2) temperature, (3) conductivity, (4) ORP and (5) DO.

3) Record stabilized measurements and time collected in the field book.

4) Remove probe from well and decontaminate in accordance with SOP-8.

8.5 YSI-55 DO/Temperature meter

8.5.1 Calibration Frequency:

Calibrate at the beginning and end of each day in accordance with manufacturer's specifications.

8.5.2 Maintenance:

Maintain the instrument as follows:

1) Decontaminate at the beginning and end of each day, and in between measurement locations.

2) Replace batteries as needed

3) Replace DO membrane paper prior to each use.

8.5.3 Operation:

Operate the instrument as follows:

1) Turn on DO/Temperature meter and allow probe to equalize approximately 15 minutes prior to taking first readings. Lower the DO/Temperature probe into the monitoring well to approximately the middle of the water column.

2) Allow readings to stabilize.

3) Record stabilized measurements and time collected in the field book.

4) Remove probe from well and decontaminate in accordance with SOP-8.

8.6 ORP Pen

8.6.1 Calibration Frequency:

ORP pens are factory calibrated.

8.6.2 Maintenance:

Maintain the instrument as follows:

1) Decontaminate at the beginning and end of each day, and in between measurement locations.

2) Replace batteries as needed

3) Clean probe glass with cotton swab and methanol when needed.

8.6.3 Operation:

Operate the instrument as follows:

1) Place sample in a clean 2 ounce plastic sample cup. Insert ORP pen into sample.

2) Allow readings to stabilize.

3) Record stabilized measurements and time collected in the field book.

4) Remove probe from well decontaminate in accordance with SOP-8.

8.7 pH/Temperature/Conductivity Meter

8.7.1 Calibration Frequency:

The pH probe is calibrated at the beginning and end of each day in accordance with manufacturer's specifications. This calls for using standards with a pH value of 4.0, 7.0, and 10.0 in the calibration process. The conductivity meter is also calibrated at the beginning and end of each day in accordance with manufacturer's specifications using a potassium chloride standard solution that has a conductivity of 1413 µS at 25° C.

8.7.2 Maintenance:

Maintain the instrument as follows:

1) Decontaminate at the beginning and end of each day, and in between measurement locations.

2) Replace batteries as needed.

3) Clean pH probe glass with cotton swab and methanol when needed.

8.7.3 Operation:

Operate the instrument as follows:

1) Place sample in two clean 2 ounce plastic sample cups. Insert pH and temperature probes into one sample cup and the conductivity probe into the other sample cup and allow readings to stabilize.

2) Record stabilized measurements and time collected in the field book.

3) Remove probe from well. Decontaminate in accordance with SOP-8.

9.0 RECORDS

The FL shall maintain the following records, and ensure records are submitted to Central Filing as appropriate:

- Field Notebooks.
- Equipment calibration logs, if used.
- Daily Activity Logs (if used).

Identifier: SOP-10	Revision: 0	Effective Date: 10/31/2012	Stantec
Author: Stu Gross			

Standard Operating Procedure

for:

MANAGEMENT OF INVESTIGATIVE WASTES

Responsible QA Manager: Richard J. Binder, P.G.	[signature]

SOP-10
Management of Investigative Wastes

Revision Log

Revision No.	*Effective Date*	*Prepared By*	*Description of Revisions*	*Affected Pages*
0	10/31/12	Stu Gross	New Procedure	All

SOP-10
Management of Investigative Wastes

Table of Contents

Section **Page**

SOP-10
Management of Investigative Wastes

List of Acronyms and Abbreviations

AK	Acceptable knowledge
AOC	Area of contamination
CH	Closed head
DOT	Department of Transportation
ECR	Environmental characterization and/or remediation
EPA	Environmental Protection Agency
FL	Field leader
IDW	Investigative-derived waste
Lbs	pounds
OH	Open head
PCB	Polychlorinated biphenyl
PL	Project leader
PPE	Personal protection equipment
Ppm	Part per million
QA/QC	Quality assurance/quality control
SSHASP	Site-specific health and safety plan
SSSAP	Site-specific sampling and analysis plan
SOP	Standard operating procedure
SSA	Satellite Accumulation Area
US	United States
WMC	Waste Management Coordinator
WMP	Waste management plan
40 CFR	Title 40, Code of Federal Regulations

SOP-10
MANAGEMENT OF INVESTIGATIVE WASTES

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the process for managing investigative-derived waste (IDW) generated during environmental characterization and/or remediation (ECR) projects performed by Stantec. IDW include drill cuttings, unused core samples, monitoring well development/purge water, discarded soil and groundwater sampling equipment, discarded personal protective equipment (PPE), and other waste generated during environmental investigation projects. The purpose for this SOP is to assure that these waste materials are properly disposed in a manner consistent with the protection of human health and the environment.

2.0 SCOPE

2.1 This SOP is a mandatory document and shall be implemented by all Stantec project personnel when they anticipate the generation of ECR project wastes.

2.2 The process described herein includes planning and implementation/management requirements associated with ECR project waste management activities.

2.3 This procedure outlines the preparation, approval, and retention of all required documents associated with waste generation.

3.0 TRAINING

3.1 Stantec project personnel using this SOP are trained by reading the procedure.

3.2 The Field Leader (FL) shall monitor the proper implementation of this procedure and ensure that relevant team members have completed all applicable training assignments.

4.0 DEFINITIONS

Acceptable knowledge (AK): A waste stream characterization method that can be used to meet all or part of the waste analysis requirements appropriate for the waste media. The method may include documented process knowledge, supplemental waste analysis data, and/or facility records of analysis.

Accumulation date: The date a hazardous waste is first generated, or the date that hazardous waste collected in a satellite accumulation area exceeds 55 gallons of hazardous waste or 1 kilogram of acute hazardous waste or 100 kilograms of any residue or contaminated soil, waste, or other debris resulting from the cleanup of a spill, into or on any land or water of any acute hazardous waste.

Acute hazardous waste: Environmental Protection Agency (EPA) hazardous waste number designated with an (H) in the "hazard code" column of Title 40, Code of Federal Regulations (40 CFR) § 261.31-33.

Area of contamination (AOC): Existing area of continuous contamination of varying amounts and types that are identified on a case-by-case basis.

Construction and demolition debris: Materials generally considered to be not water soluble and non-hazardous in nature, including, but not limited to, steel, glass, brick, concrete, asphalt roofing materials, pipe, gypsum wallboard, lumber, and other materials discarded during the construction or destruction of a structure or project. It also includes rocks, soil, tree remains, trees, and other vegetative matter that normally results from land clearing.

Environmental Media: Borehole cuttings and core, soil, rock, sediments, surface water, and groundwater that are displaced during corrective action.

Hazardous waste: A solid waste that is not excluded from regulation as a hazardous waste and

- exhibits any of the defined characteristics of hazardous waste (ignitability, corrosively, reactivity, or toxicity), or
- is a listed hazardous waste, or
- is a mixture of solid waste and hazardous waste, or
- is derived from a listed hazardous waste.

Investigation-derived waste (IDW): Solid or hazardous waste that was generated as a result of investigation/characterization corrective action activities.

> Note: IDW includes, but is not limited to sample media, personal protective equipment, contaminated sampling supplies, plastic, and decontamination fluids.

Polychlorinated biphenyl (PCB): Any chemical substance that is limited to the biphenyl molecule that has been chlorinated to varying degrees or any combination of substances which contains such substance. {40 CFR §761.3}

PCB remediation waste: Waste containing PCBs as a result of a spill, release, or other unauthorized disposal, at the following concentrations:

- materials disposed of prior to April 18, 1978, that are currently at concentrations greater than or equal to 50 part per million (ppm) PCBs, regardless of the concentration of the original spill;
- materials that are currently at any volume or concentration where the original source was greater than or equal to 500 ppm PCBs beginning on April 18, 1978, or greater than or equal to 50 ppm beginning on July 2, 1979; and
- materials that are currently at any concentration if the PCBs are spilled or released from a source not authorized for use under 40 CFR Part 761. {40 CFR § 761.3}

Note: PCB remediation waste means soil, rags, and other debris generated as a result of any PCB spill cleanup, including, but not limited to:

- Environmental media containing PCBs, such as soil and gravel; dredged materials (e.g., sediments); settled sediment fines; and aqueous decantate from sediment.
- Sewage sludge containing less than 50 ppm PCBs and not in use according to 40 CFR § 761.20(a)(4); PCB sewage sludge; commercial or industrial sludge contaminated as the result of a spill of PCBs including sludges located in or removed from any pollution control device; or aqueous decantate from an industrial sludge.
- Building and other man-made structures (such as concrete floors, wood floors, or walls contaminated with a leaking PCB or PCB-contaminated transformer), porous surfaces, and non-porous surfaces.

Recycled: A material that is used, reused, or reclaimed.

Reclaimed: A material that is processed to recover usable products or is regenerated.

Satellite accumulation area: A designated space for accumulating hazardous where the volume of waste shall not exceed 55 gallons or the volume of acutely hazardous/mixed waste shall not exceed 1 kilogram. {40 CFR § 262.34, 20.4.1.300}.

Segregate: To separate wastes that can be managed together based on similar characteristics and ultimate handling approach.

Site-Specific Health and Safety Plan (SSHASP): A health and safety plan that is specific to a site or related field activity that has been approved by a Stantec health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., PPE) and hazard mitigation.

Solid waste: Any garbage; refuse; sludge from a waste treatment plant, water-supply treatment plant, or air-pollution-control facility; and other discarded material including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations and from community activities.

Special waste: Solid waste identified in State regulations as requiring unique handling, transportation, or disposal to assure protection of the environment and the public health, welfare, and safety.

> Note: Special waste includes: treated formerly characteristic hazardous waste, asbestos waste, ash, infectious waste, sludge, industrial solid waste, spill of a commercial chemical product, dry chemicals that become characteristic hazardous waste when wetted, and petroleum-contaminated soil.

Use or reuse: A material that is either employed as an ingredient in an industrial process to make a product or employed in a particular function or application as an effective substitute for a commercial product.

<u>Waste generator</u>: ECR Project person, by site, whose act or process produces hazardous waste or whose act first causes a hazardous waste to become subject to regulation. {40 CFR §260.10}

Note: The definition above is specific to hazardous waste because it is defined in the hazardous waste management regulations.

<u>Waste Management Coordinator (WMC)</u>: The person responsible for coordinating waste-management activities on behalf of waste generators, line managers, facility managers.

<u>Waste management record</u>: A complete package of documents constituting the written record for a waste stream.

<u>Waste stream</u>: A group of wastes from one site than can be managed together because of the similar characteristics and ultimate handling approach.

5.0 BACKGROUND AND PRECAUTIONS

5.1 This SOP shall be used in conjunction with an approved SSHASP. Consult the SSHASP for information on and use of all PPE.

Note: Potential waste management hazards (i.e., chemical, physical, or other) at each waste-generating site are documented in the SSHASP. Hazards that are not addressed in the SSHASP (i.e., pinch points, drum and container lifting and moving, etc.) are addressed and documented at daily tailgate safety meetings.

5.2 The waste generator or the waste management coordinator shall verify the most recent documentation requirements and facility waste acceptance criteria prior to waste characterization or waste profile form submittal to avoid redundant or unnecessary activities.

5.3 Conflicting requirements between this document and other regulations or criteria shall be resolved by implementing the requirements that are regulatory drivers.

Note: Identified discrepancies shall be noted to the author of this procedure so that they can be included in subsequent revisions of this SOP.

5.5 This SOP does not address all conceivable situations. For waste management assistance, contact a waste management coordinator or Stantec regulatory specialist.

6.0 RESPONSIBLE PERSONNEL

The following personnel are responsible for activities identified in this procedure.

- Author
- Stantec project personnel

- Project leader (PL)
- Project Quality Assurance/Quality Control (QA/QC) Officer
- Subcontractors
- Team leader
- Waste generator
- Waste hauler
- Field Leader

7.0 EQUIPMENT

A checklist of suggested equipment and supplies needed to implement this procedure is provided below.

EQUIPMENT AND SUPPLIES CHECKLIST FOR MANAGEMENT OF INVESTIGATIVE WASTES

√	General Description	Description
	Waste management area signage, as appropriate	"Satellite Accumulation Area (SAA)"
		"Less-than-90-day Accumulation Area"
		"Universal Waste Storage Area"
		Other -
		Other -
	Labels, as appropriate	"Analysis Pending"
		"Hazardous Waste"
		"Asbestos"
		Department of Transportation (DOT) labels
		Other -
	Health & Safety/Decontamination Equipment	Eye wash
		Field shower station (or water supply source of adequate volume and pressure to accommodate decontamination of personnel)
	Spill control equipment, as appropriate	Regular or non-sparking shovels
		Absorbent
		Broom
		Container
		Secondary containment pallets
		Plastic sheeting

	Fire extinguishers, as appropriate	Fire extinguishers are required for less-than-90-day accumulation areas that store ignitable waste. The type of extinguisher shall be appropriate for the waste being stored.
√	**General Description**	**Description**
	Tools, as needed	Bung wrench
		Hammer
		Socket wrench and sockets
		Wire brush
		Screwdriver
		Pliers
		Non-sparking tools
	Barricade tape/rope and stands (to cordon off/delineate storage area).	
	Waste containers that meet DOT shipping requirements for the waste	
	Pallets for drummed waste to prevent deterioration of containers and provide for stable storage	
	PPE, as appropriate. (Specific PPE will be identified in the SSHASP).	Gloves
		Eye protection
		Protective coveralls
		Respirator
	Decontamination equipment, as appropriate	Spray washers
		Brushes
		Water
		Wipes
		Tub/bucket

8.0 PROCEDURE

Note: It is each person's responsibility to ensure that they use and are trained to the current version of this procedure. The author or Project QA/QC Officer may be contacted if text is unclear.

8.1 Waste Identification and Characterization

8.1.1 Waste characterization shall be adequate enough to enable compliance with on-site or off-site waste acceptance criteria.

8.1.2 Characterization of Stantec ECR project wastes shall be completed through a specified process.

8.1.3 Where appropriate, project-specific waste management procedures should be developed as a standalone waste management plan (WMP) or incorporated into a site-specific sampling and analysis plan (SSSAP) prior to the start of field activities that would generate waste. Development of the procedures should include the following steps:

- Review historical site documentation;
- Where existing chemical data are lacking, development of a waste analysis suite and identification of test methods to be used to identify and quantify potential contaminants;
- Specification of the type of sample(s) to be collected;
- Listing of the anticipated amount of waste, per type expected to be generated as part of the Stantec ECR project activity;
- Listing of packaging requirements;
- Identification of preliminary classifications of wastes to be generated.

8.1.4 The WMP or waste management procedures in the SSSAP shall be updated when

- A new waste type or classification not previously identified is generated,
- A strategy changes, or
- A field activity changes.

8.1.5 Appropriate project personnel shall complete the WMP.

8.2 Waste Generation and Storage

8.2.1 Means to store, control, and transport each potential waste type and classification shall be determined prior to the start of field operations that generate waste.

8.2.2 A waste storage area shall be established prior to generating waste. Requirements may differ for each waste type and classification; therefore, Stantec project personnel shall plan to manage all waste types/classifications specified in the WMP. Vehicle traffic, site drainage, accessibility for container-handling equipment, site egress for emergency access, and fire protection shall be considered for siting a storage area.

8.2.3 The general location of the waste storage area shall be specified in the WMP.

8.2.4 Waste storage areas in publicly accessible locations shall be fenced and locked.

8.2.5 Each container of waste generated shall be individually labeled as to waste classification, and item identification number immediately following containerization.

8.2.6 After a sample has been used for its intended purpose, it no longer enjoys an exclusion under 40 CFR § 261.4(d). Returned contaminated sample material shall be characterized and managed as waste. Management requirements for the returned samples are dependent on the waste classification.

8.2.7 Each storage area or container shall have a posted authorized user list or key control. Absolute control shall be maintained while adding, removing, sampling, labeling, or shipping waste.

8.2.8 At the end of daily field activities, an inspection shall be conducted to confirm that all waste containers are properly closed, and stored on level ground. This inspection shall be documented in a field logbook.

8.2.9 Containerized waste shall meet appropriate DOT requirements.

8.2.10 The waste storage duration for hazardous and mixed waste, special waste, and PCB waste are regulated and shall be adhered to.

8.3 Media Specific Protocols for Management of Investigative Wastes

8.3.1 Drill Cuttings and Unused Core Samples

a) All cuttings and unused core samples generated during drilling (e.g., hollow stem auger, air rotary, Geoprobe®, hand auger methods) shall be placed in a 55-gallon steel drum. The drums should be secured with a sealed cover. The drums shall be tagged with a "Non-hazardous" waste label and characterized as a solid waste. The generator name and phone number, site address, drum contents, and the state's identification number, if applicable, shall be completed on the label with a waterproof pen. The number of drill cutting drums shall be recorded in the field book.

b) The drill cutting drums shall be stored on-site until receipt of laboratory analytical analysis. Upon a receipt of laboratory analysis, a review of the laboratory analysis should be performed and a determination shall be made as to whether the drill cuttings remain characterized as a non-hazardous waste (i.e., solid waste). If it is determined that the cuttings are characterized as a hazardous waste, a "Hazardous" waste label shall be placed over the "Non-hazardous" waste label. The generator name and phone number, site address, drum contents, and the state's identification number, if applicable, shall be completed on the label with a waterproof pen.

c) The drill cutting drums shall be temporarily stored on-site until disposal arrangements are made with a proper waste disposal facility.

8.3.2 Monitoring Well Development/Purge Water and Decontamination Water

a) All water generated during the development and purging of monitoring wells and decontamination of equipment shall be placed in a 55-gallon steel drum. The drums should be secured with a sealed cover. The drums shall be tagged with a "Non-hazardous" waste label and characterized as a solid waste. The generator name and phone number, site address, drum contents, and the state's identification number, if applicable, shall be completed on the label with a waterproof pen. The number of drill cutting drums shall be recorded in the field book.

b) The water drums shall be stored on-site until receipt of laboratory analytical analysis. Upon a receipt of laboratory analysis, a review of the laboratory analysis should be performed and a determination shall be made as to whether the drill cuttings remain characterized as a non-hazardous waste (i.e., solid waste). If it is determined that the cuttings are characterized as a hazardous waste, a "Hazardous" waste label shall be placed over the "Non-hazardous" waste label. The generator name and phone number, site address, drum contents, and the state's identification number, if applicable, shall be completed on the label with a waterproof pen.

c) The water drums shall be temporarily stored on-site until disposal arrangements are made with a proper disposal waste facility.

8.3.3 Discarded Soil and Groundwater Sampling Equipment

Discarded soil and groundwater sampling equipment (e.g., soil sleeves from drilling, disposable bailers) will be placed in plastic bags and disposed as a solid waste material.

8.3.4 Discarded PPE

Discarded PPE (e.g., gloves) will be placed in plastic bags and disposed as a solid waste material.

8.4 Segregation

8.4.1 Proper segregation is essential for appropriate storage, treatment, or disposal of waste. Appropriate segregation eliminates the potential of mixing incompatible wastes.

8.4.2 All waste shall be segregated by classification and compatibility to prevent cross-contamination. Classifications of waste include, but are not limited to:

- Hazardous waste;
- Special waste;
- Mixed waste;
- Solid waste; and
- PCB waste.

8.4.3 Liquid, sludge, and solid physical form wastes shall be segregated.

8.4.4 Adequate space or a physical barrier shall be left between various waste classifications and any incompatible waste streams within a classification.

8.5 Packaging and Transportation

8.5.1 All waste shall be packaged appropriately.

8.5.2 All waste shall be packaged to meet the on-site and/or off-site waste acceptance criteria, as appropriate.

8.5.3 All waste containers shall be labeled as to the chemical hazards in accordance with DOT requirements.

8.5.4 The FL shall take appropriate measures to accurately identify the weight of containers to ensure that the DOT rating for maximum container weight is observed. The FL shall be able to measure or estimate the weight of the container (tare weight of the container plus contents) within +/- 10% of the actual weight. When practical, a calibrated scale shall be utilized to establish container weight. However, when mobilization or use of a scale at a field site is not practical, the following table shall be used as a reference guide to accurately estimated container weights.

Container Type	**Tare Weight**
55 gallon steel open head (OH) drum	55 pounds (lbs)
55 gallon steel closed head (CH) drum	50 lbs
30 gallon steel OH drum	35 lbs
30 gallon steel CH drum	30 lbs
Waste Type	**Average Density**
Soil (typical Midwestern United States)	10-12 lbs/gallon
Aqueous solution (decontamination water	8.3 lbs/gallon
Concrete	20 lbs/gallon
Sampling debris, PPE	0.5 lbs/gallon
Base course	13 lbs/gallon

8.5.5 Used containers can be reused if the container is inspected in accordance with Department of Transportation requirements.

8.5.6 Rusted, dented, or otherwise damaged containers shall not be used for waste packaging.

8.5.7 No more than 1% solid physical form material shall be present in a container containing liquid waste.

8.5.8 No more that 1% free liquid shall be present in a container containing solid physical form waste.

8.5.9 Some commercial disposal facilities require that containers be “sealed” by the generator prior to shipment. The date the container was sealed shall be recorded in a field logbook.

8.5.10 A record of appropriate vehicle placarding and container labeling shall be documented in a field logbook.

8.5.11 Waste transportation can be coordinated directly with the disposal facility by the PL or FL.

8.5.12 Waste containers shall be inspected prior to shipment and the evaluation shall be documented.

8.5.13 All containers shall be secured by the waste hauler prior to transportation.

8.5.14 The generator shall submit copies of the Uniform Hazardous Waste Manifest, special waste manifest, non-hazardous waste manifest, and other shipping papers such as bills of lading, as applicable, to the PL who will store the records in Central Filing.

8.6 Contained in Policy

8.6.1 Environmental media contaminated with hazardous waste shall be managed as hazardous waste until the media no longer "contains" the hazardous waste. Environmental media "contains" hazardous waste when:

- It exhibits a characteristic of a hazardous waste; or
- It is contaminated with concentrations of hazardous constituents from listed hazardous waste that are above health-based levels.

8.6.2 Environmental media is considered to no longer "contain" hazardous waste when:

- It no longer exhibits a characteristic of hazardous waste; or
- Concentrations of hazardous constituents from listed hazardous waste are below health-based levels.

8.6.3 In the case of environmental media that "contains" a characteristic hazardous waste, the determination that the environmental media no longer "contains" the hazardous waste can be made through relatively straightforward analytical testing and requires no formal determination by the regulatory authority. The environmental media shall not be diluted to meet this requirement.

8.6.4 For environmental media contaminated with hazardous constituents from listed hazardous waste, Stantec project personnel shall submit a letter to the regulatory agency along with all applicable data to justify that the hazardous constituents are below health-based levels.

9.0 REFERENCES

Project personnel using this procedure shall become familiar with the contents of the following documents to properly implement this SOP.

- SOP-07, Chain-of-Custody, Sample Control and Field Documentation Procedures.
- SOP-08, Equipment Decontamination
- 40 CFR Parts 260-270
- 40 CFR Part 761, Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions.
- 49 CFR Part 173, Shippers - General Requirements for Shipments and Packaging.
- United States Environmental Protection Agency, "Management of Remediation Waste Under RCRA," (Solid Waste and Emergency Response Division, EPA530-

F-98-062, October 1998).

10.0 RECORDS

10.1 The FL is responsible for submitting the following records to the PL.

10.2 Completed and reviewed notebook.

10.3 Notebook attachments and/or data, applicable

10.4 Completed document signature form.

10.5 A copy of the generator's copies of the Uniform Hazardous Waste Manifest, special waste manifest, non-hazardous waste manifest, and other shipping papers such as bills of lading, as applicable.

Identifier: SOP-11	Revision: 4	Effective Date: 08/10/2015	Stantec
Author: Stu Gross			

Standard Operating Procedure

for:

VAPOR SAMPLE COLLECTION

Responsible QA Manager: Richard J. Binder, P.G.	

SOP-11
Vapor Sample Collection

Revision Log

Revision No.	***Effective Date***	***Prepared By***	***Description of Revisions***	***Affected Pages***
0	01/21/11	Stu Gross	New Procedure	All
1	04/17/2013	Michael Nied	QAPP revisions per request	10,11
2	04/28/2015	Dave Constant	Removed Subcontractor Reference from Section 2. Added Vacuum Canister Sampling to Section 8.2. 3.	5, 12
3	08/10/2015	Hiedi Waller	Format document. Revised Section 8.3.	All
4	04/01/2016	Harris Byers	Revise for Illinois Protocols	All

SOP-11
VAPOR SAMPLE COLLECTION

Table of Contents

List of Acronyms and Abbreviations

CVOC	Chlorinated Volatile Organic Compound
EPA	Environmental Protection Agency
FL	Field leader
HDPE	High density polyethylene
ID	identification
L	liter
NPT	National pipe thread
OSHA	Occupational Safety and Health Administration
PAL	Preventive action limit
PID	photoionization detector
PPE	personal protective equipment
PVC	Polyvinyl chloride
PVF	Polyvinyl fluoride QAPP Quality assurance project plan
QA/QC	Quality Assurance/Quality Control
SAP	Sampling and analysis plan
SOP	standard operating procedure
SSHASP	site-specific health and safety plan
TO	Toxic organic
VOCs	Volatile organic compounds

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the procedures for the collection of representative vapor samples to evaluate the vapor intrusion pathway.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the actual procedures used should be documented and described in an appropriated site report.

2.0 SCOPE

2.1 This SOP is a mandatory document and shall be implemented by all Stantec project participants when collecting vapor samples.

3.0 TRAINING

3.1 Stantec project personnel using this SOP are trained by reading the procedure, and receiving the appropriate training.

3.2 The Field Leader (FL) shall monitor the proper implementation of this procedure and ensures that relevant team members have completed all applicable training assignments.

4.0 DEFINITIONS

4.1 GeoProbe® – a hydraulically-operated sampling device mounted on a truck or four-wheel drive vehicle. The sampling device is deployed from the vehicle and positioned over a sample location. The base of the sampling device is positioned on the ground. The weight of the vehicle is hydraulically raised on the base. As the weight of the vehicle is transferred to the probe, the probe is pushed into the ground. When the probe reaches the sample depth, up to 50 feet under favorable geologic situations, samples can be collected.

4.2 Level D – Defined by Occupational Safety and Health Administration (OSHA) as a work uniform affording minimal protection used for nuisance contamination only. Level D is appropriate when the atmosphere contains no known hazard and work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

4.3 Site-Specific Health and Safety Plan (SSHASP) - A health and safety plan that is specific to a site or related field activity that has been approved by a Stantec health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

4.4 Volatile Organic Compounds (VOCs) - A class of chemical compounds, predominantly hydrocarbons and halogenated hydrocarbons, with low molecular weights and low boiling points that are insoluble or slightly soluble in water. Volatile chemicals are defined as chemicals with a Dimensionless Henry's Law Constant of greater than $1.9x10^{-2}$ or a vapor pressure greater than 0.1 Torr (mmHg) at 25°C.

5.0 BACKGROUND AND PRECAUTIONS

This SOP shall be used in conjunction with an approved SSHASP. Also, consult the SSHASP for information on and use of all PPE.

5.1 Background

Vapor intrusion "pathway screening" is used to determine whether or not the potential for vapor intrusion exists on or off a contaminated property. Vapor intrusion problems most often arise from light end petroleum products and chlorinated VOCs.

5.2 Sampling Restrictions

Soil gas samples should be collected in areas above where volatile chemical contamination in the soil or groundwater has been identified. Soil gas samples must be collected from a depth at least three feet below the ground surface or building foundation, but above the saturated zone. No soil gas sampling should take place within 48 hours after a rainfall event of ½ inch or greater, in standing or ponded water areas and where soil is constantly watered by an irrigation system.

6.0 RESPONSIBLE PERSONNEL

The following personnel are responsible for activities identified in this procedure:

- Data Steward
- Field Leader
- Field Member
- Project Leader
- QA/QC Officer
- Project participants

7.0 EQUIPMENT

A checklist of suggested equipment and supplies needed to implement this procedure is provided in Attachment A. A brief description of commonly used pieces of equipment, their advantages, and their limitations are listed below.

7.1Tedlar® Bag - manufactured from polyvinyl fluoride (PVF; Tedlar®) film. They are generally considered inert and can be used to collect samples containing common solvents, hydrocarbons, chlorinated solvents, and many other classes of compounds. They are commonly used to collect low-level sulfur vapors, but only if the bag fittings are non-metallic (polypropylene, Teflon, or Nylon).

7.1.1 Never reuse a Tedlar® bag.

7.1.2 Sample hold time will vary for different classes of compounds:

- 24 hours sulfur vapors (especially hydrogen sulfide and methyl mercaptan)

- 24 hours chemically active compounds like 1,3-Butadiene
- 72 hours chlorinated solvents and aromatic compounds
- 72 hours atmospheric vapors like oxygen, nitrogen, carbon dioxide, etc.

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7.1.3 Disadvantages of the Tedlar® bags are:

- If the sampling container is somehow crushed or damaged, sample integrity is doubtful
- When samples are shipped to the lab by air carrier, the negative pressures in plane cargo holds can cause the sample to expand – if the Tedlar® bag was filled too full, it can burst
- Photosensitive sample constituents should be shielded from sunlight

7.2 Summa™ Canister – refers to electropolished, passivated stainless steel vacuum sampling devices, such as toxic organic (TO) canisters, SilcoCans, MiniCans, etc, which are cleaned, evacuated, and used to collect whole-air samples for laboratory analysis.

7.2.1 The canister has a hand valve and fixed orifice to regulate flow. A grab sample of ambient air is drawn into a pre-evacuated Summa canister or through a sampling pump.

7.2.2 Disadvantages of the Summa™ canisters are:

- Contamination may occur in the sampling system if canisters are not properly cleaned before use.
- All sampling equipment should be thoroughly cleaned.

A checklist of suggested equipment and supplies needed to implement this procedure is provided in Attachment A.

8.0 PROCEDURE

8.1 Soil Gas Sampling

8.1.1 Utilities should be identified to assess possible man-made pathways.

8.1.2 A direct push method should be used to advance a heavy-gauge decontaminated steel probe, with an expendable tip, to the desired depth.

8.1.3 Once the desired depth (greater than three feet below ground surface or building foundation) is reached, connect the 1/8 to ¼ inch outside diameter post-run tubing of either Teflon® or nylon to the expendable point holder.

8.1.4 Pull the rods up three to six inches to create a cavity to collect the soil gas sample. Seal the rods at the surface with bentonite, clay, or use a water dam to prevent air from entering around the rods.

8.1.5 Purge the tubing of three volumes prior to the collection of the soil gas sample.

8.1.6 A helium tracer gas (or another tracer gas or other leak apparatus detection system approved by the Illinois EPA) must be used during the sampling to confirm there are no leaks around the soil gas sampling train. It may be beneficial to conduct a shut-in test on the sampling train prior to purging or sampling.

8.1.7 If using Tedlar bags or Summa canisters, they must be certified clean by the laboratory prior to sample collection. The holding times for soil gas samples are no more than 30 days for Summa canisters and no more than 48 hours for Tedlar bags. For light sensitive or halogenated volatile chemicals, the sample containers must be opaque or dark-colored. Samples in transparent containers can be protected from light degradation either by placing the containers in a dark receptacle (such as a box) or by wrapping the container with aluminum foil. For example, glass PUF casings may be wrapped with foil.

8.1.8 Soil gas samples can be collected in vacuum gas canisters fitted with a controller to limit vapor flow to no more than 200 ml/min (a 6 L canister will fill in approximately 30 minutes at this flow rate). Vapor samples should be analyzed using Method TO-15 or Method TO-14a for the chemicals of concern identified from soil and groundwater sampling conducted at the site.

8.2 Sub-Slab Sampling Techniques

Sub-slab vapor samples can be collected in vacuum gas canisters fitted with a controller to limit vapor flow to no more than 200 ml/min (a 6 L canister will fill in approximately 30 minutes at this flow rate). Vapor samples should be analyzed using Method TO-15 or Method TO-14a for the chemicals of concern identified from soil and groundwater sampling conducted at the site. The sub- slab screening technique is described as follows:

a) Each sub-slab vapor probe will be installed by drilling a 1/2 inch diameter hole through the slab until it punctures the floor slab and barely enters the underlying sub-slab material. The upper few inches of the hole will be reamed using a 1-inch drill bit. The probe insert (consisting of a brass coupling, nipple and head plug) will be set in the drilled hole and grouted into place using a hydro-cement. The cement would be allowed to set prior to sampling. When the monitoring is to be completed the head plug will be replaced with a brass or stainless steel valve with male national pipe thread (NPT) threads on one side and a 1/4 –inch compression or barb fittings on the other side. These fittings will connect to ¼-inch high-density polyethylene (HDPE) or nylon tubing. All fittings will be sealed using Teflon tape.

b) Prior to each sampling event, vapor points should be purged to eliminate stagnant air trapped within the sub-slab sample point air space. A high-density polyethylene or nylon tubing connected to the vapor point should be connected to a peristaltic pump and Tedlar® bag. Use of a peristaltic pump will ensure that sampled air does not circulate through a pump causing potential cross contamination and leakage. Purge each vapor probe by filling two dedicated 1-liter (L) Tedlar® bags. A purge volume of 2 L is based upon the assumption of a ¼" air space beneath a slab and an affected sample diameter of 2 feet.

c) Prior to sampling, check the vacuum of the canisters prior to use to confirm that they are not leaking. There should not be a difference of 4" Hg or more; if there is then canister should not be used.

d) A shut-in test will be completed prior to sampling to ensure there are no leaks at the compression fittings. The shut-in test will be completed by connecting a vacuum gauge into the sampling line between the sub-slab probe and the Summa canister. Valves to the probe and Summa Canister will be shut and air will be removed from the sampling line, inducing a vacuum in the line of 50 to 100 inches of water. When all the external valves to the sampling line are shut, the vacuum gage should remain steady for at least one minute. If a loss of a vacuum is observed during the time period, it would indicate a leak and the fittings would be adjusted until the line can hold a vacuum.

e) A tracer gas (helium) will be also used to ensure there are no leaks at the probe seal. Specifically, helium will be introduced to a shroud covering the sub-slab probe to create concentrations in the shroud that are above 40% by volume. The air under the shroud will be screened with a handheld helium detector to confirm the concentrations. Then sub-slab vapor samples will be withdrawn from the probe into a Tedlar® bag and field screened. If the tracer gas is detected in the air sample, adjustments will be made to the fittings and probe seal prior to sampling. A sub-slab sample will not be collected until each probe passes the shut-in and tracer tests.

f) After the helium and shut-in test are performed, a sub-slab vapor sample will be collected from each probe using a 6-liter evacuated stainless steel canister (Summa™ canister) fitted with an air flow control regulator to limit air flow to less than 200 ml/min. Low sample volume and flow rates will decrease breakthrough by ambient air. When sampling is complete, a partial vacuum should be present in the canister and the vacuum reading should be recorded and provided to the laboratory. Vapor samples collected in the Summa™ canisters will be laboratory analyzed for chemicals of concern using the Environmental Protection Agency (EPA) Modified Method TO-15.

g) Three sub-slabs will be completed at buildings with a footprint less than 5,000 square feet. For larger buildings, an additional sub-slab sample will be collected for each additional 2,000 square feet. At the end of sampling, a partial vacuum should be present in the canister; this vacuum should be recorded for the lab.

8.3 Indoor and Outdoor Air Sampling

The goal of indoor air sampling is to determine if there is a complete exposure pathway due to vapor intrusion and determine if mitigation or remediation is necessary to address unacceptable risks. An outdoor air sample will be collected whenever indoor air samples are collected.

Indoor and outdoor gas samples will be collected considering these guidelines:

- Prior to collecting indoor air samples conduct a survey for any items that may contribute VOCs to the indoor air and remove these items from the building at least 24 hours prior to sampling.
- Place vacuum gas canisters away from the direct influence of any forced air

emanating from air conditioning units, central air conditioning vents, furnaces or heaters.

- Indoor air samples should be collected at residences should be collected as 24-hour time-weighted samples using vacuum gas canisters.
- Indoor air samples collected at commercial/industrial buildings should be collected as 8 hour time weighted samples.
- Indoor air samples should be sampled on the lowest occupied level of the building and in commonly occupied spaces with the sampling canister placed approximately 3 to 5 feet above the floor and near the center of the room away from windows.
- One indoor air sample will be collected from every level of a typical residential home and multiple samples will be collected from commercial and industrial facilities.
- Outdoor samples will be collected using the same procedure as indoor samples.

<u>Vacuum Canister Sampling</u>

The soil gas sampling technique is described below. Soil gas samples will be collected using vacuum canisters.

(a) Prior to sampling, check the vacuum of the canisters using an integrated vacuum gauge to confirm that they are not leaking. There should not be a difference of 4" Hg or more; if there is then canister should not be used. The canister vacuum will be measured immediately prior to canister deployment, and recorded in the field log book.

(b) The critical orifice flow controller will be installed, as supplied by the laboratory, on the canister. The canister will be opened fully at the beginning of sample collection period and the start time will be recorded.

(c) The canister valve will be closed fully at the end of the sample period and the end time recorded. Any evidence of canister disturbance during the sample collection will be recorded.

(d) The canister vacuum will be measured and recorded immediately after canister retrieval at the end of the sample period. Any samples where the canister reached atmospheric pressure will be rejected, and the canisters returned for cleaning. Once the vacuum is measured, the safety cap will be securely tightened on the canister inlet.

9.0 REFERENCES

Stantec personnel using this procedure should become familiar with the contents of the following documents to properly implement this SOP, as applicable and appropriate.

- SOP-07, Chain of Custody, Sample Control and Field Documentation Procedures
- SOP-08, Equipment Decontamination
- SOP-09, Calibration, Maintenance, and Operation of Field Equipment

- SOP-10, Management of Investigative Wastes

10.0 RECORDS

The FL is responsible for data entry and submitting the following records to central filing, where applicable:

10.1 Completed field notebook

11.1 ATTACHMENTS

Attachment A: Equipment and Supplies Checklist for Soil Vapor Collection

SOP-11 Vapor Sample Collection

Attachment A

Equipment and Supplies Checklist for Vapor Sample Collection

√	Quantity	Description
		SAP
		SSHASP
		SOP-11
		Field book
		Waterproof ink pen and permanent marker
		Camera
		Tool Box (includes at a minimum socket wrench, screwdriver, pliers, hammer, scissors, flashlight)
		Keys for well cap locks
		PID
		Calculator
		Appropriate pre-preserved laboratory sample containers
		Sample labels
		Adjustable rate air sampling pump and appropriate tubing
		Tedlar® bags, 1.0 L, at least 1 bag per sample
		Summa canisters (plus their shipping cases) for sample, storage and transportation.
		Appropriate PPE
		Insulated cooler
		Chain-of-custody seals,
		Ziploc® bags
		Ice
		Decontamination equipment (SOP-8)
		Garbage bags
		Bentonite
		Filter Sand

SOP-15

ATTACHMENT A

Equipment and Supplies Checklist – Survey Projects		
Check	**Item Description**	**Quantity**
	brush ax	
	concrete or “pk” nails	
	gps unit	
	hammer	
	indelible felt tip pens for marking location ID	
	machete	
	pin flags	
	shovels	
	spare batteries for surveying instruments	
	Surveyor’s tacks	
	tape measure graduated in 0.1 ft	
	total station	
	tripods	
	walkie/talkies or field radios	
	wooden stakes	
	Other	

Identifier: SOP-15	Revision: 0	Effective Date: 8/19/15	Stantec
Author: Harris L. Byers			

Standard Operating Procedure

for:

GEODETIC SURVEYS

Responsible QA Manager: Richard J. Binder, P.G.	[signature]

SOP-15
Geodetic Surveys

Revision Log

Revision No.	***Effective Date***	***Prepared By***	***Description of Revisions***	***Affected Pages***
0	8/19/15	Harris Byers	New Procedure	All

SOP-15
Geodetic Surveys

Table of Contents

Section **Page**

List of Acronyms and Abbreviations

CAD	Computer-Aided Design
GIS	geographic information system
GPS	Global Positioning System
IA	Information Architecture
ID	identification number
PL	project leader
QA	quality assurance
QP	quality procedure
QA/QC	quality assurance/quality control
PPE	personal protective equipment
PL	project leader
RTK	Real-Time Kinematic
SOP	standard operating procedure
SPCS	state plane coordinate system
SSHASP	site-specific health and safety plan
Sub-CM GPS	Sub-Centimeter Global Positioning System
US ft	US survey foot

SOP-15
COORDINATING AND EVALUATING GEODETIC SURVEYS

1.0 PURPOSE

This standard operating procedure (SOP) states the responsibilities and describes the methodology for coordinating and evaluating geodetic surveys and establishing quality assurance (QA) and quality control (QC) for geodetic survey data. This procedure applies to all environmental characterization and/or remediation (ECR) projects performed by Stantec that require geodetic survey.

2.0 SCOPE

2.1 All Stantec project participants shall implement this mandatory SOP.

2.2 Subcontractors performing work on behalf of Stantec shall follow this SOP.

3.0 TRAINING

3.1 Stantec project participants shall be trained to and use the current version of this SOP. If the SOP text is unclear, contact the author.

3.2 The responsible Stantec project leader (PL) shall monitor the proper implementation of this procedure and ensure that the appropriate personnel complete all applicable training assignments.

3.3 The PL shall ensure that field team members who coordinate, conduct, or evaluate geodetic surveys for the Stantec project are familiar with the objectives and requirements of the intended surveying activities and have sufficient relevant experience with sub-centimeter Global Positioning System (GPS) units and/or Total Station surveying instruments to conduct this work.

4.0 DEFINITIONS

4.1 <u>Coordinates</u> – Horizontal locations are to be referenced to the Wisconsin State Plane Coordinate System based on the North American Datum of 1927. Elevations are to be referenced to feet above mean sea level (ft amsl).

4.2 <u>Sub-cm Real-Time Kinematic Global Positioning System (sub-cm RTK GPS)</u> - A system of receivers, computers, antennas, relay stations, and data collectors that uses satellite signals to determine horizontal and vertical positions. Using Real-Time Kinematics to differentially correct satellite data, the error with the GPS is expected to be sub-centimeter. The sub-cm GPS system uses the Wisconsin Department of Transportation differential correction network.

4.3 <u>Site-specific health and safety plan (SSHASP)</u> - A health and safety plan that is specific to a site or Stantec project-related field activity that has been approved by a Stantec health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

4.4 Stakeout survey - A survey, the purpose of which, is to locate in the field a point of interest for which the coordinates have previously been defined.

4.5 Registered Land Surveyor - A person who is professionally licensed to perform control, property, easement, or boundary surveys according to the conditions and qualifications defined by the State in which the project is located.

4.6 Survey personnel - Licensed professional surveyors, earth scientists, or other professionals whose field experience with the use of Total Stations, sub-cm GPS units, or other surveying equipment is sufficient to obtain survey data of acceptable quality for Stantec project requirements.

4.7 Total Station - A surveying instrument that consists of an integrated electronic distance measuring system, an optical horizontal and vertical angle measuring system, an internal or external electronic data recording device, and an internal or external computer.

4.8 Unknown location survey - A survey the purpose of which is to establish the coordinates of a location.

5.0 RESPONSIBLE PERSONNEL

The following personnel are responsible for activities identified in this procedure:

- PL
- QA/QC officer
- Stantec project participants
- Subcontractors
- Survey personnel
- User

6.0 BACKGROUND AND PRECAUTIONS

This SOP is focused on obtaining survey data of acceptable quality for use in Stantec project investigations.

6.1 If a survey requires traversing with a Total Station from control monuments to the survey site, the survey must close by returning either to the place of beginning or to another control monument.

6.2 The PL shall determine the accuracy requirements for survey data and inform survey personnel of those requirements before surveying activities are undertaken.

6.3 Survey data with horizontal accuracy to within 0.1 ft are acceptable for most Stantec project investigations, and data with a lesser degree of horizontal accuracy are occasionally acceptable. Vertical accuracy of 0.05 feet is required for surveys for which elevation data (i.e., vertical coordinates) are required. Many surveys, such as surveys to identify sample locations, may not require elevation data.

7.0 EQUIPMENT

7.1 This SOP is to be used in conjunction with an approved SSHASP. Also, consult the SSHASP for information on and use of all PPE.

7.2 Attachment A provides a checklist of suggested equipment and supplies needed to implement this procedure.

8.0 PROCEDURE

8.1 Evaluate Geodetic Survey Requirements

8.1.1 The PL or a designated Stantec project participant (designee) shall determine the type of survey to be performed, the information that will be required by survey personnel, and the survey information to be reported (e.g., sample points, elevation, historical information, excavation boundaries).

8.1.2 The PL or the designee shall determine whether the survey is for purposes of staking out previously defined locations (a stakeout survey) or to identify unknown locations (an unknown location survey).

8.1.3 For stakeout surveys, the PL or designee shall gather the following information: coordinate values for the stakeout points from Stantec Geographic Information System (GIS) personnel (or documents from which coordinate values can be calculated); instructions for field identification of stakeout points (e.g., stakes, pin flags, whiskers, spray paint, ribbon, sub-meter GPS or Total Station); and the location identification numbers (IDs) to be assigned to the stakeout points.

8.1.4 For unknown location surveys, the PL or designee shall gather information that will assist survey personnel in location identification, for example, a map on which pin flags mark existing sampling locations, documentation of the perimeter of an excavated trench, or an indication of the elevation of a monitoring well.

8.1.2 The PL shall ensure that survey personnel have sufficient experience in the application of survey methods and the use of surveying equipment to obtain data of acceptable quality for use in the Stantec project. See Section 6.0.

8.2 Prepare to Perform a Geodetic Survey

8.2.1 The PL or designee shall provide survey personnel with a statement of the type of survey to be performed, the data and degree of accuracy the survey is required to produce, and the type of equipment necessary to complete tasks.

8.2.2 For stakeout surveys, the PL or designee shall provide survey personnel with the following:

- the coordinates for the survey locations or documentation, such as as-built drawings, aerial photographs, or historical notes, from which the survey coordinates can be calculated
- instructions for the method of marking points in the field (e.g., with stakes, pin flags, whiskers, spray paint, or ribbon)
- the location IDs to be assigned to the staked out points
- acceptable accuracy in sub-cm GPS data collection
- locations and coordinates of control monuments and benchmarks if a total station is to be used.

8.2.3 For unknown location surveys, the PL or designee shall provide survey personnel with the following:

- a clear statement of the locations to be surveyed and scope of work
- a statement of the required accuracy for each point location
- locations and coordinates of control monuments and benchmarks if a total station is to be used.
- acceptable error in backshooting and in sub-cm GPS data collection.

8.3 Perform Geodetic Survey Field Activities

8.3.1 Survey personnel using a total station or level shall chronologically document the survey field activities by maintaining a handwritten field notebook and recording, at a minimum, the names of control monuments used, intermediate traverse points, error in backshooting, the sequence of measurements made, and brief descriptors of the points measured. Survey personnel shall mark and identify survey locations as instructed by the PL and record the marker in the field notebook.

Note: Angles and distances measured do not need to be recorded in the field notebook.

8.3.2 Survey personnel using a sub-cm GPS shall collect all location and quality assurance/quality control data electronically in the Carson Data recorder per manufacturer directions. QA/QC data to be maintained in the data recorder is to include the number of satellites; vertical and horizontal dilution of precision, and vertical and horizontal standard deviation of measurement. A minimum of 10 individual measurements are to be averaged (either manually or within the Carson Data Recorder) to determine the location of points surveyed with a sub-cm GPS.

8.3.3 All surveys should be tied to either local elevation medallions located at section corners or to a site-specific Site benchmark.

8.4 Prepare Geodetic Survey Data for QA Review

8.4.1 After completing field survey activities, survey personnel shall return to the office and either Stantec Computer-Aided Design (CAD) or GIS personnel shall prepare the survey data for QA/QC review.

8.4.2 Either Stantec CAD or GIS personnel shall prepare a plot of the points located by the survey and identify each location point with the surveyor's point label.

8.4.3 For Total Station surveys, survey personnel shall calculate the "error of closure" (i.e., the ratio of the closure error to the distance traversed) and record the calculation result and the locations and derivative coordinate values in a spreadsheet.

8.4.4 For sub-cm GPS surveys, survey personnel shall record the individual point uncertainty value associated with the derivative coordinate value in a spreadsheet. Only data points collected with a "FIXED" RTK signal are to be used. In addition, the vertical and horizontal dilution of precision shall be less than 3.

8.5 Perform QA/QC Review of Geodetic Survey Data

8.5.1 Survey personnel shall submit the survey plot and spreadsheet for survey location points, and the field notebook to the PL and QA/QC manager for review.

8.5.2 The PL shall ensure that all documentation (e.g., plats, coordinate values, and reports) of work performed by registered professional survey personnel for a Stantec project bear the surveyor's seal and signature.

8.5.3 The PL or designee shall assure that survey data are acceptable for use for the Stantec project by verifying that the survey personnel have used the correct State reference coordinates expressed in US ft; have assigned a surveyor's label to each survey point; have completed the field notebook; and have satisfied Stantec project survey requirements for documentation of control monuments, traverse points, etc.

8.5.4 The PL or designee shall assure that the survey plot is both internally consistent (all surveyed points in correct location relative to each other) and that the error of closure or the individual point uncertainty value associated with the derivative coordinate value are sufficiently small.

8.5.5 The PL shall notify survey personnel of any errors in the data that require resolution.

8.6 Submit Geodetic Survey Data

8.6.1 When the survey data are determined to be acceptable, the PL or designee shall sign the survey data spreadsheet and deliver to the Stantec GIS personnel.
Note: The completed spreadsheet will contain the following information for each survey location:

- Point ID
- Northing and Easting Horizontal Locations and Vertical Elevation
- The closure error (for surveys conducted with the Total Station) or the individual point uncertainty values (for surveys conducted with the GPS)

9.0 RECORDS

9.1 The FL shall submit the following records to the PL:

- field notebook
- hardcopy printout of raw measurements (for Total Station surveys)
- survey location map
- a copy of the approved procedure used by a subcontractor (if applicable)

10.0 REFERENCES

To properly implement this SOP, Stantec project participants should become familiar with the contents of the following documents:

- User guides supplied with equipment, as appropriate.
- Wisconsin Administrative Code Ch. NR 141 Groundwater Monitoring Well Requirements

11.0 ATTACHMENTS

Attachment A: Equipment and Supplies Checklist Form (1 page)

Identifier: SOP-16	Revision: 0	Effective Date: 8/19/15	Stantec
Author: Harris Byers			

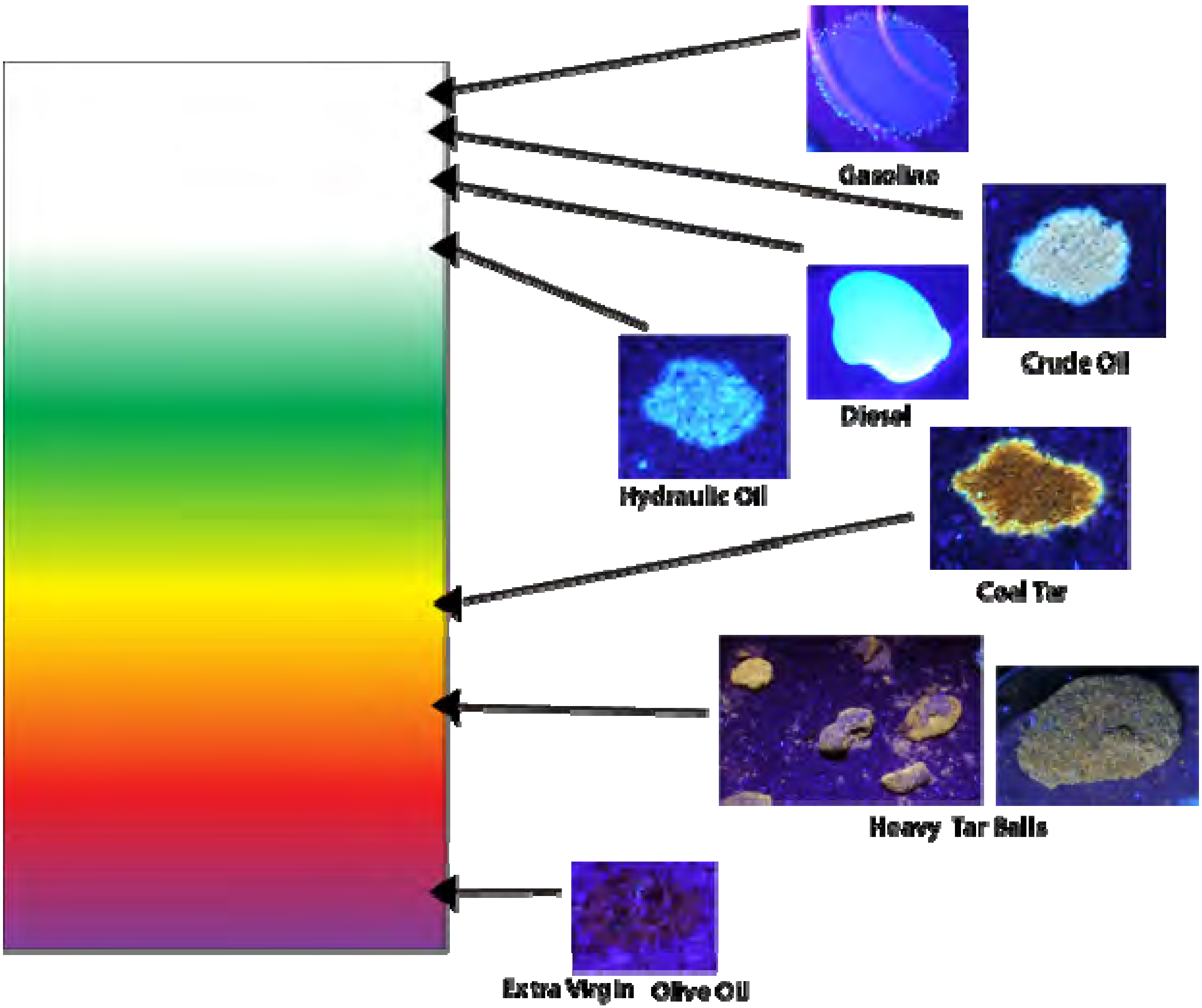
Standard Operating Procedure

for:

SCREENING FOR PETROLEUM LIGHT NON-AQUEOUS PHASE LIQUID WITH A LOW-VOLTAGE ULTRAVIOLET LIGHT

Responsible QA Manager: Richard J. Binder, P.G.	[signature]

Hydrocarbon Contaminant Color Chart



SOP-16
Screening for Petroleum Light Non-Aqueous Phase Liquid with a Low-Voltage Ultraviolet Light

Revision Log

Revision No.	***Effective Date***	***Prepared By***	***Description of Revisions***	***Affected Pages***
0	8/19/15	Harris Byers	New Procedure	All

SOP-16
Screening for Petroleum Light Non-Aqueous Phase Liquid with a Low-Voltage Ultraviolet Light

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Section **Page**

List of Acronyms and Abbreviations

DM	document manager
FL	field leader
FM	field member
MSDS	material safety data sheet
PPE	personal protective equipment
PID	photoionization detector
PL	project leader
QP	quality procedure
SOP	standard operating procedure
SSHASP	site-specific health and safety plan
SSO	site-safety officer
LVUL	Low-Voltage Ultraviolet Light

SOP-16
Screening for Petroleum Light Non-Aqueous Phase Liquid with a Low-Voltage Ultraviolet Light

1.0 PURPOSE

This standard operating procedure (SOP) describes the general process for operating and using a portable hand-held low-voltage ultraviolet light (LVUL) spotlight to screen for petroleum light non-aqueous phase liquid (LNAPL) as part of environmental characterization and/or remediation (ECR) projects performed by Stantec. The use of a LVUL spotlight is extremely valuable to detect petroleum LNAPL in cases where free-phase liquid is not apparent based on visual or olfactory observations, such as in cases involving a release of motor oil or hydraulic oil to soil.

2.0 SCOPE

All Stantec project participants shall implement this procedure when screening hard surfaces or environmental media for petroleum LNAPL using a LVUL spotlight. A LVUL spotlight is capable of inducing visible fluorescence in petroleum LNAPL and therefore is useful in screening samples prior to laboratory analysis.

3.0 TRAINING

3.1 Project participants shall be trained to and use the current version of this SOP. If the text of the SOP is unclear, contact the author if the SOP.

3.2 The responsible project team leader (PL) shall monitor the proper implementation of this procedure and ensure that the appropriate personnel complete all applicable training assignments.

4.0 DEFINITIONS

4.1 <u>Site-specific health and safety plan (SSHASP)</u> - Health and safety plan that is specific to a site or field activity that has been approved by the health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

4.2 <u>Low-Voltage Ultraviolet Light</u> - A portable hand-held spotlight consisting of Light Emitting Diode (LED) lights capable of producing ultraviolet wavelength (365 nm) light using a low-voltage internal battery.

5.0 RESPONSIBLE PERSONNEL

The following personnel are responsible for activities identified in this procedure:

- Author
- Field Leader (FL)
- Operator
- Project Leader (PL)
- Quality Assurance/Quality Control (QA/QC) Officer
- Field Worker
- User

6.0 BACKGROUND AND PRECAUTIONS

6.1 Project participants shall use this SOP in conjunction with an approved SSHASP and site-specific sample and analysis plan.

6.2 Background

6.2.1 The use of ultraviolet light to induce fluorescence in petroleum LNAPL was originally developed for use in subsurface fuel detection using a cone penetrometer (CPT) system. Applied Research Associates, Inc.'s (ARA) Fuel Fluorescence Detector (FFD) for CPT is widely accepted by state and federal regulators (EPA, DoD) for delineation of underground fuel contamination plumes in support of remediation efforts. However, these light arrays were limited to CPT and required high voltage to operate, thus limiting their portability in the field. Recent developments in LEDs have allowed Vertek (a division of ARA) to develop a portable battery powered hand-held spotlight capable of inducing fluorescence in petroleum LNAPL.

6.2.2 Unit batteries should be replaced periodically, per the manufacturer's instructions.

6.3 Precautions

6.3.1 <u>Instrument integrity</u> - Immediately notify the instrument manufacturer of any condition or concern relative to the LED's structural integrity, source shielding, source switching condition, or operability.

6.3.2 <u>Labels and certifications</u> - Do not alter or remove the labels or instructions on the spotlight.

6.3.3 <u>Handling</u> - Do not drop or expose portable LVUL spotlights to conditions that produce excessive shock or vibration. Do not store the instrument at an ambient temperature below -4°F or above 110°F.

6.3.4 <u>Transport</u> - Properly package the LVUL spotlight during transport. The suitcase that accompanies the unit is acceptable. As appropriate, review all DOT shipping/transport requirements and label/placard requirements with the instrument manufacturer prior to transport.

6.3.5 Ultraviolet Light – The LVUL spotlight generates light in the ultraviolet wavelength and therefore ultraviolet protective glasses must be worn while using the spotlight. Operators should not look directly into the spotlight.

6.4 Limitations

6.4.1 The LVUL spotlight is a non-specific screening tool for identifying petroleum LNAPL capable of generating a visual fluorescence when exposed to ultraviolet wavelength light. The spotlight cannot be used to identify specific constituents nor constituent concentrations.

6.4.2 As depicted on Figure 1, the LVUL spotlight responds best to larger weight hydrocarbon LNAPLs; though it can faintly induce fluorescence in gasoline. A LVUL spotlight will not identify potential impacts from straight chain, aliphatic hydrocarbons, including synthetic motor oils, semi-volatile organic compounds (SVOCs), or chlorinated solvents.

7.0 EQUIPMENT

7.1 LVUL spotlights may come with a variety of peripheral equipment. If deviations are made from this SOP, documentation must be made in the field notebook.

7.2 Ultraviolet safety glasses must be worn by the operator while the LVUL spotlight is in use. Appropriate safety glasses are to be stored in the LVUL spotlight storage case.

8.0 PROCEDURE

The operator shall perform the following procedure, making any deviations from this SOP. Figure 1 presents a summary of visual fluorescence to be expected in common petroleum LNAPL.

8.1 Screening Soil

8.1.1 If using direct-push Geoprobe drilling techniques, when a core of soil is collected, break the core into 0.5 to 1.0 foot sections and illuminate the end of each core with the LVUL spotlight. Record the following observations in the field book: presence/absence of fluorescence, color of fluorescence (see Figure 1), and approximate area of soil core cross-section with fluorescence. Collect a soil sample per the site-specific sample and analysis plan.

8.1.2 If using hollow-stem auger drilling techniques (without a Shebly Tube), collect and illuminate soil cuttings with the LVUL spotlight on approximately 0.5 to 1.0 foot depth intervals. Record the following observations in the field book: presence/absence of fluorescence and color of fluorescence (see Figure 1). Collect a soil sample per the site-specific sample and analysis plan.

8.1.3 If using hand-held sampling devices (i.e. push probe, shovel, auger), illuminate soil cuttings on approximately 0.5 foot depth intervals. Record the following observations in the field book: presence/absence of fluorescence and color of fluorescence (see Figure 1). Collect a soil sample per the site-specific sample and analysis plan.

8.2 Screening Hard Surfaces

8.2.1 Hard surfaces (i.e. concrete floors/walls, floor trenches, catch basins, piping, etc.) can be illuminated directly with the LVUL spotlight to screen surfaces for the presence of petroleum LNAPL. Record the following observations in the field book: presence/absence of fluorescence and color of fluorescence (see Figure 1). Collect a soil sample per the site-specific sample and analysis plan.

9.0 RECORDS

The field team leader shall maintain the following records:

- Completed daily activity log or instrument log book

10.0 REFERENCES

To properly implement this SOP, Stantec project participants should become familiar with the contents of the following documents

SOP-07 Chain of Custody, Sample Control and Field Documentation Procedures

11.0 ATTACHMENTS

Figure 1 – Hydrocarbon Contaminant Color Chart

SOP-17

Attachment A
Equipment and Supplies Checklist for Aquifer Pumping Tests

As appropriate, assemble the following equipment and supplies:

_______ Pressure transducer

_______ Electric water-level indicator

_______ Weighted tapes

_______ Electronic data logger (if transducer method is used)

_______ Laptop computer

_______ Tape measure (subdivided into hundredths of feet)

_______ Watch or stopwatch with second hand

_______ Waterproof-ink pen

_______ Appropriate references and calculator

_______ Barometer or recording barograph (for tests conducted in confined aquifers)

_______ Field Notebook

_______ Pumping/Recovery Test Data forms

_______ Groundwater Elevation forms

_______ Any PPE listed or required in the SSHASP

_______ Any additional supplies listed in associated procedures, as needed

SOP-17

Attachment B
Pumping/Recovery Test Data Sheet

Completion Instructions for the Pumping/Recovery Test Data Form

Use an indelible dark-ink pen. Use one form, or series of forms, for each well in which measurements are made. To change an entry, draw a single line through it and amend the entry with the correct information. Date and initial the change. Complete the following information:

Header Information

1. Test Location – Site where the activity is being performed.
2. Pumped Well – Well in which stress is induced. Also test well.
3. Observation Well(s) – Well(s) located at some distance for the test well to be monitored. One or more observation wells may be monitored.
4. Sheet Number–Number all the sheets that are used for this activity.
5. Source of Data Below – specify the well from which the data recorded on the form came (pumped well, observation well 1, 2, etc.).
6. Measured Distance from Test Well to Observation Well (ft) – measure and record this distance to the nearest tenth of a foot.
7. Measuring Point – describe the physical reference mark from which all manual water-level measurements are made (e.g., TOC, top of casing). Also give the distance above ground surface of measuring point (ft).
8. Test Started – Record date, time when pumping began (i.e., time zero), and pre-test static depth to water (DTW) to the nearest hundredth of a foot.
9. Test Ended – Record date, time, and final DTW measurement at the end of the pumping portion of the test (i.e., when the pump was turned off and when the recovery portion of the test begins).
10. Initial and Final Flow Meter Readings (gal) – Record readings in gallons made from the in-line flow meter immediately prior to the time the pump is turned on and after the pump has been turned off.
11. Pump Capacity – Record pump type, model, and capacity in horsepower.
12. Range of Pumping Rates (gpm) – Low and high discharge rates over course of test. Check frequently.
13. Average Pumping Rate (gpm) – Record the average flow rate in gallons per minute over the course of the pumping period. Divide the total gallons pumped by the total elapsed time of pumping.
14. Test Conducted by – Print name and position title, then sign. Weather and Other Comments. Record all other conditions pertinent to the sample collection in this section on the Daily Activity Log form in SOP-01.04.

Pumping Test

1. Date and Time (date:hour:minutes) — Day and time of water-level measurement during the pumping portion of the test using the suggested format: DD-MMM-YY (e.g., 01-JAN-91) and the 24-hr clock time (0837 for 8:37 a.m. and 1912 for 7:12 p.m.).
2. Elapsed Time (min) — Cumulative time of measurement, to the nearest minute, since time zero (i.e., when the pump was turned on).
3. Depth to Water (ft) — DTW to the nearest hundredth of a foot in the well monitored.
4. Pumping Rate (gpm) — Flow rate in gallons per minute measured from the inline flow meter*. This column is applicable only for the form used to record test well data.*

Recovery Test

1. Date and Time (date:hour:minutes) — Day and time of water-level measurement during the recovery portion of the test. Suggested format as above.
2. Elapsed Time (min) — Time of measurement, to the closest minute, since time zero (i.e., when the pump was turned on).
3. Depth to Water (ft) — DTW to the nearest hundredth of a foot corresponding to the water-level measurement in the test or observation well.

Attachment B
Pumping/Recovery Test Data

Pumping/Recovery Test Data

Test Location ________ Pumped Well _________ Observation Wells ____________ Sheet _____ of _____

Source of Data Below _______________ Distance from Pumped Well (ft) _______ Measuring Point _________

Test Started: Date ____________ Time _____________ Pre-test Static Water Level (ft) ______________

Test Ended: Date ____________ Time _____________ Final Water Level (ft) ______________________

Initial Flow Meter Reading (gal) _________________ Final Flow Meter Reading (gal) ____________________

Pump Capacity (type/hp) ______________________ Range of Pumping Rates (gpm) ____________________

Average Pumping Rate (gpm) ______________________

Test Conducted by ____

(Print name and title, then sign)

Pumping Test				Recovery Test		
Date and Time (date - hour:minutes)	**Elapsed Time** (minutes)	**Depth to Water** (feet)	**Pumping Rate** (gpm)	**Date and Time** (date - hour:minutes)	**Elapsed Time** (minutes)	**Depth to Water** (feet)

Identifier: SOP-17	Revision: 0	Effective Date: 8/19/15	Stantec
Author: Harris Byers			

Standard Operating Procedure

for:

AQUIFER PUMPING TESTS

Responsible QA Manager: Richard J. Binder, P.G.	

SOP-17
Aquifer Pumping Tests

Revision Log

Revision No.	***Effective Date***	***Prepared By***	***Description of Revisions***	***Affected Pages***
0	8/19/15	Harris Byers	New Procedure	All

SOP-17
Aquifer Pumping Tests

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Section **Page**

List of Acronyms and Abbreviations

DM	document manager
FL	field leader
FM	field member
PPE	personal protective equipment
PL	project leader
QP	quality procedure
SOP	standard operating procedure
SSHASP	site-specific health and safety plan
SSO	site-safety officer

SOP-17
AQUIFER PUMPING TESTS

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the process for performing pumping tests to determine the hydraulic properties of water-bearing geologic materials as part of environmental characterization and/or remediation (ECR) projects performed by Stantec.

2.0 SCOPE

This SOP is a mandatory document and shall be implemented by all Stantec project participants when performing pumping tests for Stantec projects.

3.0 TRAINING

3.1 All users of this SOP are trained by reading the procedure.

3.2 The Field Leader (FL) shall monitor the proper implementation of this procedure and ensure that relevant team members have completed all applicable training assignments.

4.0 DEFINITIONS

4.1 Aquifer - A geologic material that stores and transmits water at sufficient rates to supply a well; confined - when not open to the atmosphere due to the presence of an impermeable or confining layer; unconfined - when open to the atmosphere through openings in the overlying geologic units. As used below includes saturated zones of any productivity.

4.2 Pumping Test - A test made by pumping a well for a period of time and observing the change in hydraulic head in the aquifer. Data collected are used to determine the capacity of the well and hydraulic characteristics of the aquifer.

4.3 Drawdown - The lowering of the water table in an unconfined aquifer, or potentiometric surface for a confined aquifer, resulting from pumping of wells. Also, the decrease in water level in a well that is being pumped or is in proximity to a pumping well.

4.4 Hydraulic conductivity - The rate of fluid flow in gallons per day through a cross section of one square foot (gpd/ft^2) of a permeable medium under a unit hydraulic gradient at the prevailing temperature or at 16°C. It is a function of both the medium and of the fluid flowing through it. Also known as the coefficient of permeability or Meinzer unit.

4.5 Potentiometric Surface - For a confined aquifer, an imaginary surface that represents the height to which water will rise in a well or series of wells. For an unconfined aquifer, the potentiometric surface is called the water table.

4.6 Recovery - The water-level rise in a well after the pump has been shut off.

4.7 Site-Specific Health and Safety Plan (SSHASP) - A health and safety plan that is specific to a site or related field activity that has been approved by a Stantec health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

4.8 Specific yield - The ratio of the volume of water that a given mass of saturated rock or soil will yield by gravity to the volume of the mass expressed as a percentage (dimensionless). It is sometimes referred to as the unconfined storativity.

4.9 Storage coefficient - The volume of water that a confined aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head (dimensionless).

4.10 Transmissivity - The rate at which water is transmitted through a unit width of the full saturated thickness of an aquifer under a unit hydraulic gradient expressed in gallons per day per foot (gpd/ft). Transmissivity is numerically equal to the product of hydraulic conductivity and saturated thickness of the aquifer.

5.0 BACKGROUND AND PRECAUTIONS

5.1 This SOP shall be used in conjunction with an approved SSHASP. Also, consult the SSHASP for information on and use of all PPE.

5.2 A pumping test is a controlled field procedure to determine the hydraulic properties of water-bearing geologic units. Aquifer characteristics that may be obtained from pumping tests include hydraulic conductivity (K), transmissivity (T), specific yield (Sy) for unconfined aquifers, the storage coefficient (S) for confined aquifers, and the vertical hydraulic conductivity of confining layers. Also, the occurrence and position of recharge or impermeable boundaries can be identified. These parameters can be determined by graphical solutions and computerized programs.

5.3 Pumping tests are generally carried out by monitoring the water level over time in the pumping well and in each observation well (if available) while the pumping well is being discharged at a constant rate. Such tests provide results that are more representative of aquifer characteristics than those obtained by other methods. They can also be used to determine the hydraulics of secondary aquifer flow. However, pumping tests require a greater degree of labor activity and expense than other methods and therefore may not always be justified for all levels of investigation.

5.4 Refer to the site-specific work plan for the duration of the pumping test, the location of the observation well, and the data to be collected. Collection of measurements and documentation of data will be performed as described in Section 8.2

6.0 RESPONSIBLE PERSONNEL

The following personnel are responsible for activities listed in this SOP:

6.1 Field Leader

6.2 Team Leader

6.3 Quality Assurance/Quality Control (QA/QC) Officer

6.4 Author

6.5 Stantec project personnel

7.0 EQUIPMENT

A checklist of suggested equipment and supplies needed to implement this procedure is provided in Attachment A. Descriptions of commonly used equipment items and their capabilities are listed below and in SOP-09.

7.1 Electric Water-level Meter - A spool-mounted, flat graduated tape attached to a stainless-steel electrode that emits an audible and visual signal when contact with water is made.

7.2 Electronic Data Logger - An electronic device that can be programmed to receive electric impulses that are stored as data. Pressure transducers are designed to be used with automatic data-logging instruments and send a current to the data logger. The current is proportional to the pressure and can be converted to meaningful units by the data logger.

7.3 Pressure Transducer - An electronic probe connected to a wire cable that is lowered into the water column of a well to measure pressure, or head. The pressure measured is the total pressure which includes both the hydrostatic pressure of the water column above the transducer and the atmospheric pressure at the water surface. Changes in pressure are proportional to changes in the water-level.

8.0 PROCEDURE

Note: Subcontractors performing work on behalf of Stantec will follow this (SOP) for performing aquifer pumping tests.

8.1 Preoperational Activities

8.1.1 Ensure that permission to discharge is obtained (coverage under a general WPDES/NPDES Permit or a site-specific permit may be required) or that a containment system is available for collecting the water that will be pumped during the test. This is especially important for wells that may produce contaminated water in the event that the site-specific work plan requires containerization of pumped water as waste.

8.1.2 Confirm from the site drilling crew that well installation is complete and that the equipment necessary to conduct the pumping test is deployed. All wells should be properly developed before testing.

8.1.3 Obtain the pumping test equipment, appropriate operating manuals, and information on equipment modifications necessary to conduct a pumping test. Check the equipment for proper functioning where appropriate. The drilling crew is responsible for supplying equipment and completing the following tasks:

8.1.3.1 Installing a submersible or turbine pump.

8.1.3.2 Installing a flow meter in the discharge line of the pumping well to accurately measure and monitor the volume of discharge.

8.1.3.3 Installing sufficient pipe to transport the discharge from the pumping well away from the area to prevent infiltration of extracted water into the pumped zone.

8.1.3.4 Installing a gate valve along with a pressure regulator on the discharge pipe to control the pumping rate.

8.1.3.5 Placing an outlet near the well head, but past the totalizer and flow meters, for water-quality monitoring and sampling.

8.1.4 Ensure that all gauges, transducers, flow meters, and other equipment used in conducting pumping tests are properly calibrated before use. If necessary, perform any on-site zero adjustment or calibration and document those procedures.

8.1.5 It is advisable to monitor and record water levels at the test site for about one week before performing the test using a continuous recording device. These records establish the barometric efficiency of the aquifer. The records also help determine if the aquifer is experiencing an increase or decrease in head over time that may be caused by recharge or pumping in the nearby area or by diurnal variations.

8.2 Pumping and Recovery Test Operations

Pumping tests consist of two phases: (1) an initial pumping phase resulting in water-level drawdown, and (2) a recovery phase after the pump has been turned off. Water-level monitoring is conducted throughout both of these phases.

8.2.1 When all equipment has been deployed, manually measure static water levels in the test well and any observation well(s) using a water-level meter. Read and record the totalizer value from the in-line flow meter prior to turning on the pump. At a predetermined time zero, initiate pumping at a specified discharge rate and immediately begin time-series water-level measurements in the test and observation wells. Measure all depths to water from a designated reference marker point (measuring point).

8.2.2 If measuring water level manually, the frequency of readings will vary with time of pumping. Rapid drawdown in the test well is likely to occur during the first several minutes after the pump has been turned on. This is because the first water to be produced is extracted, not from the formation, but from the well casing and the highly permeable filter-pack around the well screen. Therefore, early measurements are taken frequently while those later in the test are taken less frequently. For example, water-level measurements in the test well may be taken at 15-second intervals for the first 15 minutes after time zero, every 30 seconds for the next half hour, every 1 minute for the next two hours, and so on with decreasing frequency over time until pumping stops. Continue to monitor water levels during the recovery phase of the test. Recommended standard references for guidance on measurement frequency include Kruseman and DeRidder (1970), Saunders (1998), and Walton (1987).

8.2.3 Water-level changes in observation wells will occur after a delayed period of time. Changes will be observed when the effects of drawdown surrounding the pumping well (i.e., the cone of depression) have expanded aerially outward in the formation a sufficient distance to reach the observation well. Depending on the radial distance from the pumping well, water-level measurements in observation wells may be taken every 15 minutes initially, every 30 minutes for several hours, and once each hour thereafter until pumping stops. Continue to monitor water levels during the recovery phase of the test.

8.2.4 To reduce field personnel time during the pumping test, continuous recording of water-level changes in the test and observation wells can be accomplished using electronic pressure transducers and data loggers. Drawdown and recovery changes may be monitored in real time by connecting the pressure transducer to a lap-top computer.

8.2.5 Barometric pressure should be recorded during the test. The barometric data, as well as projected pre-test water-level trends, may be applied as corrections to water-level readings so that the reduced data are representative of the hydraulic response in the aquifer to pumping from the test well.

8.2.6 The duration of the test is determined by the needs of the project and the aquifer properties. In general, longer tests produce more definitive results. A duration of one to several days, followed by a similar period of monitoring the recovery of the water level, is desirable.

8.2.6.1 The pumping test may be discontinued if the water level becomes constant with time. This normally indicates that a hydrogeologic source or leaky aquifer condition has been intercepted and that additional useful information will not be collected by continued pumping.

8.2.6.2 A simple procedure for determining the adequacy of data is to plot the log of time versus drawdown for the most distant observation well. When the plot becomes a straight line on the semi-log graph paper, enough data has been collected. Ideally, the straight line should continue over at least one log cycle.

8.2.7 The time when the pump is shut off marks the beginning of the recovery phase of the test. Perform the following to complete the test:

8.7.1 After the pump has been shut off, water-level monitoring is maintained while water recovers in the test and observation well(s). Continue monitoring for a period of time equal to one-half that of the pumping portion of the test or until the water in these wells has stabilized at levels that approach their pre-test static values.

8.7.2 Read and record the totalizer value from the in-line flow meter after the pump is turned off.

8.7.3 When full recovery has been reached, or nearly so, in the test and observation well(s), monitoring is ceased and the pumping test is complete. Begin post-operational procedures.

8.3 Documentation

8.3.1 When electronic pressure transducers and data loggers are used to monitor the pumping test, store all data internally or on computer diskettes or tape. A laptop computer should be used in the field to view data and assure the equipment is working properly. Transfer the information directly to the main computer to analyze it. Periodically take measurements manually and record in a field notebook to verify the data recorded by the data logger.

8.3.2 All manually collected data should be recorded in a field notebook and appropriate field forms.

8.4 Post-operational Activities

8.4.1 If using an electronic data logger, follow the steps in the data logger software to end the test. These steps include:

- Stop the logging sequence
- Save memory and disconnect battery at the end of the day's activities.

8.4.2 Decontaminate the water-level device, transducer(s) and cable(s).

9.0 REFERENCES

The following documents have been cited within this procedure.

- SOP-07 Chain of Custody, Sample Control and Field Documentation Procedures
- SOP-08 Equipment Decontamination
- SOP-09 Calibration, Maintenance, and Operation of Field Equipment
- Kruseman, G. P., and DeRidder, N. A., 1970, Analysis and evaluation of pumping data: International Institute for Land reclamation and Improvement, Bull. 11, Wageningen, The Netherlands.
- Sanders, L. L., 1998, A manual of field hydrogeology: Prentice Hall, Upper Saddle River, New Jersey.
- Walton, W. C., 1987, Groundwater pumping tests — design and analysis: Lewis Publishers, Chelsea, Michigan.

10.0 RECORDS

10.1 A completed Pumping/Recovery Test Data form (Attachment B).

10.2 A completed Water Level Elevation Data Sheet (Attachment B).

10.3 Field notebook containing deviations, calibration data, and all other pertinent information.

11.0 ATTACHMENTS

The document user may employ documentation formats different from those attached to/named in this procedure—as long as the substituted formats in use provide, as a minimum, the information required in the official forms developed by the procedure.

Attachment A: Equipment and Supplies Checklist for Aquifer Pumping Tests (1 page)

Attachment B: Pumping/Recovery Test Data (form and completion instructions) (3 pages)

SOP-18

Attachment A
Equipment and Supplies Checklist Well Slug Tests

______ Water pressure transducers, if appropriate

______ Electronic Data logger

______ Electric water level indicator if transducer method is not used

______ Manufacturer's operating manuals for equipment selected above

______ Weighted tapes with plopper (plumb bob)

______ Steel tape (graduated in hundredths of a foot)

______ Blue surveyor's chalk

______ Teflon or stainless steel bailer of a known volume

______ Stopwatch or watch with a second hand

______ Tape measure (graduated in tenths of a foot)

______ Semi log graph paper (if required)

______ Straight edge

______ Calculator

______ Appropriate reference material

______ Duct tape

______ Indelible dark-ink pens

______ Daily Activity Logs

______ Groundwater Elevation Forms

______ Slug Test Data forms

______ Any PPE listed or required in the SSHASP

______ Five gallon bucket

______ Any additional supplies listed in associated procedures, as needed

SOP-18

Attachment B
Instructions for Completing a Slug Test Data Sheet

Use an indelible dark-ink pen. Make an entry in each blank. For entry blanks for which no data are obtained (except in Comments section), enter “UNK” for unknown, “N/A” for not applicable, or “ND” for not done, as appropriate. To change an entry, draw a single line through it, add the correct information above it, and date and initial the change. For all forms, complete the following information:

Header Information:

1. Location - well field or other area description, as appropriate.
2. Geologic Unit - Note stratigraphic unit behind screen tested.
3. Well Number - Record the well designation number.
4. Sheet Number - Number all the sheets that are used for this activity, by day or by some practical unit.
5. Field Team Member Identification - Print your name and position title, then sign.

Slug Test Parameters:

1. Test Method - Record whether the slug device is injected or withdrawn (pulled out) from the monitor well.
2. Slug Dimensions - The slug and/or bailer dimensions or water volume must be known in order to perform calculations properly.
3. Well Construction Details - The well screen length (especially of openings), filter pack length, casing diameter and borehole diameter must be known, at a minimum, to perform calculations. Attach diagram of well design.
4. Test Started - Record clock time slug inserted or withdrawn
5. Test Stopped - Record clock time monitoring halted.
6. Test ID - For data logger file if transducer used.
7. Method of Water-Level Measurement - Record the type of instrument used to measure water level.
8. Comments - Record any relevant weather and all other conditions pertinent to the sample collection in this section.

Slug Test Data:

1. Time of Measurement - Record clock time that reading was made in the following formats: DD-MM-YY (e.g., 01-Jan-91) and the 24 hour clock time (0837 for 8:37 a.m. and 1912 for 7:12 p.m.)
2. Elapsed Time (min.) - Record, in minutes, the cumulative time readings from the beginning of the test (time zero) to the end of the test.
3. Depth to Water (ft) - Record the depth to water measured in hundredths of feet.

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Attachment B

Slug Test Data

Location ______________________ Geologic Unit __________ Well Number _________ Sheet _____ of ____

Field Team Member Signature _____________________________________ ____________________________
(Print name and title, then sign)

Test Method: ___ Slug Injection or ___ Slug Withdrawal Slug Dimensions or volume ______________

Well Construction Details (attach diagram): ____

Test Started __________________ Test Stopped _______________ Test ID ____ ________________________

Method of Water-Level Measurement: ____

Comments: ____

____

____

Time of Measurement	**Elapsed Time (minutes)**	**Depth to Water (feet)**	**Time of Measurement**	**Elapsed Time (minutes)**	**Depth to Water (feet)**

□ Check here if continued on the back of this sheet.

Identifier: SOP-18	Revision: 0	Effective Date: 08/19/15	Stantec
Author: Harris Byers			

Standard Operating Procedure

for:

SLUG TESTS

Responsible QA Manager: Richard J. Binder, P.G.	

SOP-18
Slug Tests

Revision Log

Revision No.	*Effective Date*	*Prepared By*	*Description of Revisions*	*Affected Pages*
0	8/19/15	Harris Byers	New Procedure	All

SOP-18
Slug Tests

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SOP-18
SLUG TESTS

List of Acronyms and Abbreviations

DM	document manager
FL	field leader
FM	field member
PPE	personal protective equipment
PL	project leader
QP	quality procedure
SOP	standard operating procedure
SSHASP	site-specific health and safety plan
SSO	site-safety officer

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the process for determining saturated hydraulic conductivity under in situ conditions by the slug test withdrawal method of analysis for environmental characterization and/or remediation (ECR) projects performed by Stantec.

2.0 SCOPE

This SOP is a mandatory document and shall be implemented by all Stantec project participants when performing slug tests.

3.0 TRAINING

3.1 All users of this SOP are trained by reading the procedure.

3.2 The Field Leader (FL) shall monitor the proper implementation of this procedure and ensure that relevant team members have completed all applicable training assignments.

4.0 DEFINITIONS

4.1 <u>Hydraulic conductivity</u> - The rate of fluid flow in gallons per day through a cross section of one square foot (gpd/ft^2) of a permeable medium under a unit hydraulic gradient at the prevailing temperature or at 16°C. It is a function of both the media and of the fluid flowing through it. It is also known as the coefficient of permeability or Meinzer unit.

4.2 <u>Site-Specific Health and Safety Plan (SSHASP)</u> - A health and safety plan that is specific to a site or related field activity that has been approved by a Stantec health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

4.3 <u>Storage coefficient</u> - The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head (dimensionless).

4.4 <u>Transmissivity</u> - The flow rate of water in a cross section of saturated material having the dimensions unit width and total thickness as height, under a unit hydraulic gradient. Also, hydraulic conductivity times thickness of the material.

5.0 BACKGROUND AND PRECAUTIONS

Note: This SOP is to be used in conjunction with an approved SSHASP. Also, consult the SSHASP for information on and use of all PPE.

5.1 The slug test measures the rate of water-level recovery in a well over time in response to the injection or withdrawal of a mass (slug) beneath the groundwater table. The slug can be a quantity of water or a solid of known volume. Hydraulic conductivity in the immediate vicinity of the well can be determined by measuring water-level versus time data after the slug is added or removed. Refer to the site-specific work plan for more information on the scope of work, a description of slug testing activities, and the locations of the wells that are to be tested.

5.2 First, a solid slug is inserted to a level beneath the groundwater surface and the water level is allowed to reach equilibrium. Then the slug is removed and the rise in water level is measured with time. Alternatively, a slug of water is injected or withdrawn and water-level response monitored.

5.3 The primary advantages of using slug tests to estimate conductivities are:

- estimates can be made in situ and the errors incurred in the laboratory testing of disturbed samples can be avoided.
- tests can be performed quickly at relatively low costs because a pumping well and observation wells are not required.
- the hydraulic conductivity of small, discrete portions of a saturated medium can be estimated (e.g., sand layers in a clay).

5.4 Limitations of slug testing include:

- only the hydraulic conductivity of the saturated material immediately surrounding the well is estimated, which may not be representative of it over a larger area.
- certain assumptions are made in the analysis process; if the assumptions are inappropriate for the geologic conditions at the site, the slug test data are invalid.
- the storage coefficient, S, usually cannot be determined
- data sufficient for analysis may not be collected if the hydraulic conductivity is relatively high.

5.5 The time required for a slug test is a function of the volume of the slug, the hydraulic conductivity of the formation, and the type of well completion. The slug volume should be large enough that a sufficient number of water level measurements can be made before the water level returns to equilibrium conditions. The length of the test may range from less than a minute to several hours.

5.6 If the well is to be used for monitoring, take precautions so contamination is not introduced by equipment placed in the well.

5.6.1 If water is added to the monitoring well, it must be obtained from an uncontaminated source and transported in a clean container.

5.6.2 Non-disposable bailers or appropriate measuring equipment must be cleaned before the test.

5.7 Conduct slug tests on relatively undisturbed wells. If a test is conducted on a well that has recently been pumped for water-sampling purposes, the measured water level must be within 0.1 ft of the static water level at the wells.

Note: The exact dimensions of the borehole, casing, and filter must be recorded for accurate analysis of the slug test data.

5.8 Site workers preparing for field operations should read and understand the procedures outlined in the SSHASP for the particular health and safety equipment to be used.

6.0 RESPONSIBLE PERSONNEL

The following personnel are responsible for activities identified in this SOP.

6.1 Field Leader

6.2 Team Leader

6.3 Quality Assurance/Quality Control (QA/QC) Officer

6.4 Stantec project participants involved in the testing

7.0 EQUIPMENT

A checklist of suggested equipment and supplies needed to implement this procedure is provided in Attachment A.

7.1 <u>Pressure Transducer</u> - A device which senses pressure variations and converts it to an electrical signal for transmission to another device (a receiver) for processing or decision making. A number of pressure transducers are available on the market. The operator must consult the manufacturer's specifications on calibration, operation, maintenance and chemical compatibility with the contaminants at the site.

7.2 <u>Electric Water Level Meter</u> - A flat graduated tape is attached to a stainless steel probe containing an electrode, which emits an audible and visible signal when contact with water is made.

8.0 PROCEDURE

Note: Subcontractors performing work under the project's quality program may follow this SOP for collecting slug test data. Subcontractor's own procedures may be used provided that the substitute procedures meet the requirements prescribed by the QAPP, and have been approved by the QA/QC Officer before starting the activities.

8.1 The following general procedures should be used to collect and report slug test data. The procedures required for a particular slug test may vary slightly from those described, depending on site-specific conditions. Modifications to the test procedures will be contained in the site-specific work plan.

8.2 Procedures for conducting the slug test with a pressure transducer and data logger, as well as a water-level probe, are described below. Be sure to complete all data-collection forms.

8.3 Slug Test with Pressure Transducer and Data Logger

8.3.1 Before beginning the slug test, enter the required information into the electronic data logger in accordance with the manufacturer's instructions. It is important to consult the operations manual for the proper data-entry sequence as different models require different data entry procedures.

8.3.2 When using an electronic data logger and pressure transducer to perform the slug test, store all data internally; and also on computer diskettes or on tape. The information should be transferred directly to the appropriate computer for analysis as soon as practical after the test is completed. Maintain a computer printout of the data in the project files as documentation.

8.3.3 Determine the static water level in the well; measure the depth to water periodically for several minutes to several hours, and taking the average of the readings. Record information on the Water Level Elevation Data Sheet or the field notebook.

8.3.4 Install the transducer and cable in the well below the estimated target drawdown depth. Be sure the depth of submergence is within the design range stamped on the transducer. Tape the transducer cable to the well to hold the transducer at a constant depth.

8.3.5 After connecting the transducer cable to the electronic data logger, enter the initial water level and transducer design range into the recording device according to the manufacturer's operating instructions. Record the initial water level on the recording device.

8.3.6 Smoothly lower the slug or bailer into the well. Observe the transducer readout to detect where the slug contacts the water.

8.3.7 Allow the water level to stabilize (within 0.1 ft) and remove the cylinder or bailer. Remove the slug or volume as quickly and smoothly as possible because the analysis assumes that an instantaneous change in volume is created in the well.

8.3.8 Continue measuring and recording depth/time measurements until the water level returns to equilibrium conditions or a sufficient number of readings have been made to clearly show a trend on a plot of water-level recovery versus the logarithm of time.

8.4 Slug Test with Electric Water Level Meter

Note: This method should only be used if an electronic data recorder cannot be obtained. This method cannot be used for saturated zones with high hydraulic conductivities because stabilization of groundwater will occur rapidly. If the slug test data are collected and recorded manually, record observations on the Slug Test Data form (Attachment B) in accordance with the completion instructions.

8.4.1 Determine the static water level in the well. Measure the depth to water periodically for several minutes and take the average of the readings. Record results on the Water-Level Elevation Data Sheet or field notebook.

Note: In order to accurately measure water-level changes, it is important to take the measurements rapidly.

8.4.2 Smoothly lower the slug or bailer into the well. The depth where the top of the slug contacts the water can be estimated by marking the depth to water found in Section 6.4.1 onto the slug line.

8.4.3 Measure and record the depth to water and time of each reading. The moment when the volume is removed is time zero. Depths should be measured to the nearest one hundredth of a foot. The number of depth/time measurements necessary to complete the test varies.

8.4.4 Continue measuring and recording depth/time measurements until the water level returns to equilibrium conditions or a sufficient number of readings have been made to clearly show a trend on a plot of water-level recovery versus the logarithm of time.

8.5 Straddle-Packer/Injection Test with Transducer and Data Logger

Note: This method is used when the well is completed with multiple screens that must be isolated for testing.

8.5.1 Insert straddle packer/injection assembly opposite screen of interest.

8.5.2 Determine the static water level in the well; measure the depth to water periodically for several minutes to several hours, and taking the average of the readings. Record information on the Water Level Elevation Data Sheet or field notebook.

8.5.3 Install the transducer and cable in the well below the estimated target drawdown depth. Be sure the depth of submergence is within the design range stamped on the transducer. Tape the transducer cable to the well to hold the transducer at a constant depth.

8.5.4 After connecting the transducer cable to the electronic data logger, enter the initial water level and transducer design range into the recording device according to the manufacturer's operating instructions. Record the initial water level on the recording device.

8.5.5 Before beginning the slug test, enter the required information into the electronic data logger in accordance with the manufacturer's instructions. It is important to consult the operations manual for the proper data-entry sequence as different models require different data entry procedures.

8.5.6 Fill large open stock tank with potable water.

8.5.7 Connect flow meter on inflow side of pump on drill rig.

8.5.8 Connect hose to open end of flow meter and submerge other end in stock tank.

8.5.9 Connect another hose to the outflow end of pump on drill rig.

8.5.10 With pump on, adjust the flow to reasonable rate before starting the test (direct discharge back into stock tank).

8.5.11 Read and record totalizer on flow meter (gal).

8.5.12 Direct discharge down rod connected to straddle-packer assembly and record the time injection started.

8.5.13 After a short time interval, halt injection by removing hose and placing it in stock tank.

8.5.14 Record time and totalizer on flow meter (gal).

8.5.15 Continue measuring and recording depth/time measurements until the water level returns to equilibrium conditions or a sufficient number of readings have been made to clearly show a trend on a plot of water-level recovery versus the logarithm of time.

8.5.16 Be sure data sheet is filled in completely (Attachment B).

8.6 Post-operation Activities

8.6.1 Decontaminate the downhole equipment. Cut off contaminated portions of rope and dispose of them.

8.6.2 If you used an electronic data logger, proceed as follows:

- stop the logging sequence,
- download the data to a computer, print the data, file them on a floppy disk, and
- save the memory and disconnect the battery at the end of the day's activities.

8.7 Check all data-collection forms for completeness.

9.0 REFERENCES

The following documents have been cited within this procedure.

- SOP 04 Groundwater Sample Collection
- SOP-07 Chain of Custody, Sample Control and Field Documentation Procedures
- SOP-10 Management of Investigative Wastes
- SOP-19 Pressure Transducers

10.0 RECORDS

10.1 A completed Slug Test Data form.

10.2 A completed Water Level Elevation Data Sheet.

10.3 Field notebook that contains any deviations, calibration data, and any additional comments.

11.0 ATTACHMENTS

Project personnel may use documentation formats different from those attached in this SOP—provided the substitute forms include the information required in the official forms.

Attachment A: Equipment and Supplies Checklist for Slug Tests (1 page)

Attachment B: Slug Test Data Form (and completion instructions) (2 pages)

SOP-19

Attachment A
Equipment and Supplies Checklist for Pressure Transducers

Where appropriate, assemble the following equipment and supplies:

_____ Electronic data logger and printer or level head

_____ Keys for gates and well locks

_____ Manufacturer’s operating manual for the data logger in use

_____ Pressure transducer and cable

_____ Manufacturer’s operating manual for the pressure transducer in use

_____ Water-level meter

_____ Tape measure (graduated in tenths of a foot)

_____ Duct tape

_____ Clean water

_____ Decontamination equipment

_____ Waterproof pen

_____ Water-Level Forms

_____ Daily Activity Logs

_____ Any PPE listed or required in the SSHASP

_____ Any additional supplies listed in associated procedures, as needed

Identifier: SOP-19	Revision: 0	Effective Date: 8/19/15	Stantec
Author: Harris Byers			

Standard Operating Procedure

for:

Pressure Transducers

Responsible QA Manager: Richard J. Binder, P.G.	[signature]

SOP-19
Pressure Transducers

Revision Log

Revision No.	***Effective Date***	***Prepared By***	***Description of Revisions***	***Affected Pages***
0	8/19/15	Harris Byers	New Procedure	All

SOP-19
Pressure Transducers

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List of Acronyms and Abbreviations

DM	document manager
FL	field leader
FM	field member
PPE	personal protective equipment
PL	project leader
QP	quality procedure
SOP	standard operating procedure
SSHASP	site-specific health and safety plan
SSO	site-safety officer

SOP-19
Pressure Transducers

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the process for using pressure transducers as part of environmental characterization and/or remediation (ECR) projects performed by Stantec.

2.0 SCOPE

This SOP is a mandatory document and shall be implemented by all Stantec project participants when using pressure transducers.

3.0 TRAINING

3.1 All users of this SOP are trained by reading the procedure.

3.2 The Field Leader (FL) shall monitor the proper implementation of this procedure and ensure that relevant team members have completed all applicable training assignments.

3.3 The FL should ensure that field team members understand the use of pressure transducers and the specific data loggers with which they are to be used. The field team members must document that they have read and understand this procedure.

4.0 DEFINITIONS

4.1 Hydrostatic head - The pressure exerted by a column of fluid.

4.2 Site-Specific Health and Safety Plan (SSHASP) - A health and safety plan that is specific to a site or related field activity that has been approved by a Stantec health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation

5.0 BACKGROUND AND PRECAUTIONS

5.1 This SOP shall be used in conjunction with an approved SSHASP. Also, consult the SSHASP for information on and use of all PPE.

5.2 A pressure transducer measures pressures over a specific range of submergence. Outside this range, measurements will not be accurate. If the transducer is overpressured, permanent damage can occur; therefore, the transducer probe must never be submerged beyond its rated depth.

5.3 Most pressure transducers are self-compensating for changes in atmospheric pressure via a vent to the atmosphere. The vent port is normally located where the cable attaches to the data logger. Thus, where extension cables are being used, the operator should ensure that the connector is not submerged. Also, no sharp bends should be made in the transducer cable.

5.4 A number of pressure transducers are available on the market and the operator must consult the manufacturer's specifications concerning maintenance and chemical compatibility with contaminants which are expected to be present in the medium to be monitored (usually water).

5.5 Under normal conditions it should not be necessary to disassemble the pressure transducer. However, if it does become necessary, follow the manufacturer's instructions carefully and check the accuracy of the reassembled probe as discussed in Section 8.0.

Note: Many data loggers contain lithium batteries, which are classified by the Department of Transportation (DOT) as hazardous material. If shipment is necessary, contact the DOT and all other authorities (i.e., Federal Express, Airport, etc.).

6.0 RESPONSIBLE PERSONNEL

The following personnel are responsible for activities identified in this procedure.

6.1 Field Leader

6.2 Team Leader

6.3 Quality Assurance/Quality Assurance (QA/QC) Officer

6.4 Author

6.5 Stantec project personnel

7.0 EQUIPMENT

A checklist of suggested equipment and supplies needed to implement this procedure is provided in Attachment A. Alphabetized descriptions of commonly used pieces of equipment, their advantages, and their limitations are listed below.

7.1 <u>Electric Data Logger</u> - An electronic device that can be programmed to receive electric impulses, that are stored as data. Pressure transducers are designed to be used with automatic data-logging instruments and send a current to the data logger. The current is proportional to the pressure and can be converted to meaningful units by the data logger.

7.2 Pressure Transducer - An electronic probe connected to a wire cable that is lowered into the water column of a well to measure pressure. The pressure measured is the total pressure, which includes both the hydrostatic pressure of the fluid column above the transducer and the atmospheric pressure at the fluid surface. Changes in head are proportional to changes in the height of the water column or water-level.

8.0 PROCEDURE

Note: Subcontractors performing work under the projects quality program will follow this SOP for pressure transducers.

Note: Deviations from SOPs shall be made in the field notebook.

8.1 Preliminary Activities

Be sure to record the information listed on the manufacturer's data log sheet. Begin by identifying the serial number and model number of the instrument. Record this information on the field notebook.

8.1.1 Assemble the equipment and supplies listed in Attachment A. Consult manufacturer's operating manual(s) to ensure the proper operation of all equipment.

8.1.2 Ensure the proper operation of the electronic data logger and pressure transducer. Review guidelines in the manufacturer's operating manual for the electronic data logger. Consult the operating manual to learn the proper procedure for setting the transducer's depth, reference elevation, scale factor, and test number. Be sure that the data logger or its battery pack is fully charged. Use a 3-to 4-ft column of water in a capped piece of polyvinyl chloride [PVC] casing to test the response of the electronic data logger and pressure transducer.

8.1.3 Conduct the following tests for the proper depth response and drift of readings in the PVC column. To calibrate the data-logging instrumentation, perform this check daily where possible.

8.1.3.1 Depth-Response Test

1. Mark the length of the transducer cable at measured intervals appropriate for the column of water. With the use of a 4-ft column of water, for example, mark the cable with tape at 1-ft intervals, measuring from the transducer tip.
2. Connect the cable to the data logger and put it into display mode so that changes in hydrostatic pressure can be monitored.
3. Fill a capped piece of PVC well casing with water, submerge the transducer probe to the first mark and obtain a reading. Repeat until the last mark has been reached. Start the logging sequence.
4. Wait one minute and raise the transducer a measured length. Wait one more minute.

5. Continue raising the transducer cable by the measured increments and logging the results, continuing to wait for one minute between measurements, until all segments have been measured.
6. Check the depth recorded on the data logger against the actual depths. If the difference is greater than 5% of the measured depth, return the transducer to the manufacturer for calibration.

8.1.3.2 Drift Test

1. Lower the transducer into the water column and temporarily tape the cable to the edge of the pipe.
2. Connect the transducer cable to the electronic data logger and begin a 15-min. logging sequence.
3. Check the results for noticeable drift of the depth measurement.
4. Notify the manufacturer if an unacceptable noticeable drift is occurring.

8.2 Field Operation of Pressure Transducers

8.2.1 Locate the monitoring wells where the pressure transducer will be utilized.

8.2.2 Decontaminate the transducer and cable.

8.2.3 Take an initial water-level measurement from the well to be monitored by using a tape or water-level sounder. Record all pertinent information on the Water-Level Elevation Data Sheet or the field notebook.

8.2.4 Before beginning the monitoring, set up the data logger as outlined in the manufacturer's operating manual. The type of information may vary with the model used. Consult the operating manual for the proper data-entry sequence to be used. To prevent accidental data loss, be sure that the field operator understands what computations must be made and how to save the data.

8.2.5 Cover sharp edges of the well casing with duct tape to protect the transducer cables. Lower the pressure transducer into place; and monitor the hydrostatic pressure during installation. Duct tape the transducer cable into place before commencing the test.

8.2.6 Check the depth of the transducer by using the display mode of the data logger and test transducer response by raising it about a foot.

8.2.7 Commence the water-level measuring task to be performed (for example, the slug test or the pumping test).

8.3 Post-operation activities

8.3.1 Ensure that all equipment is accounted for and decontaminated. If decontamination is required, dispose of all decontamination materials.

8.3.2 Save the data (and print if possible) before you shut down the electronic data logger (see the manufacturer's operating manual).

9.0 REFERENCES

The following documents are cited within this procedure

- SOP-04 Groundwater Sample Collection
- SOP-07 Chain of Custody, Sample Control and Field Documentation Procedures
- SOP-08 Equipment Decontamination
- SOP-10 Management of Investigative Wastes

10.0 RECORDS

The field leader is responsible data entry and for submitting the following records to central filing.

10.1 Completed Water Level Elevation Data Sheet.

10.2 Completed field notebook to record calibration data, any calculations, decontamination procedures, any deviations, data from the electronic data logger, and any additional comments.

11.0 ATTACHMENTS

The document user may employ documentation formats different from those attached in this SOP - as long as the substituted formats include the information required in the official forms developed by the procedure.

Attachment A: Equipment and Supplies Checklist for Pressure Transducers (1 page)

SOP-20

Appendix A
Equipment and Supplies Checklist

As appropriate, assemble the following equipment and supplies.

___ Concrete Coring Drill and Bits

___ Work table surface

___ Knife/blade

___ Decontamination supplies

___ Deionized water

___ Chain of Custody

___ Sample Collection Logs

___ Any SSHASP-required PPE

___ Any additional supplies listed in associated procedures, as needed.

___ Appropriate laboratory supplied sample containers

___ Sample labels

___ Wet Ice

___ Coolers and appropriate packing material

___ Air Bills and directions to Fedex

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Author: Harris L. Byers		

Standard Operating Procedure

for:

Sample Collection of Concrete Cores

Responsible QA Manager: Richard J. Binder, P.G.	