Illinois Environmental Protection Agency

Bureau of Land • 1021 North Grand Avenue East • P.O. Box 19276 • Springfield • Illinois • 62794-9276

ILLINOIS EPA RCRA CORRECTIVE ACTION CERTIFICATION

This certification must accompany any document submitted to Illinois EPA in accordance with the corrective action requirements set forth in a facility's RCRA permit. The original and two copies of all documents submitted must be provided.

1.0 Facility Identification

Name: Equilon Enterprises LLC d/b/a Shell Oil Products US
County: Madison
Street Address: 900 South Central Avenue
Site No. (IEPA): 1191150002
City: Roxana
Site No. (USEPA): ILD080012305

2.0 Owner Information

Name: *NOT APPLICABLE*
Mail Address:
City:
State: Zip Code:
Contact Name:
Contact Title:
Phone:

3.0 Operator Information

Name: Equilon Enterprises LLC d/b/a SOPUS
Mail Address: 128 East Center Street
City: Nazareth
State: PA Zip Code: 18064
Contact Name: Leroy Bealer
Contact Title: Principal Program Manager
Phone: 484-632-7955

4.0 Type of Submission (check applicable item and provide requested information, as applicable)

☐ RFI Phase I Workplan/Report
☐ RFI Phase II Workplan/Report
☐ CMP Report;
☒ Other (describe): Standard Operating Procedures Update

IEPA Permit Log No. B-43R
Date of Last IEPA Letter on Project October 30, 2020
Log No. of Last IEPA Letter on Project B-43R2
Does this submittal include groundwater information: ☒ Yes ☐ No

Date of Submittal 3/22/21

5.0 Description of Submittal: (briefly describe what is being submitted and its purpose)

Routine Updates to Standard Operating Procedures Previously Submitted

6.0 Documents Submitted (identify all documents in submittal, including cover letter; give dates of all documents)

RCRA Corrective Action Form, Cover Letter, Revised SOPs

7.0 Certification Statement

(This statement is part of the overall certification being provided by the owner/operator, professional and laboratory in Items 7.1, 7.2 and 7.3 below). The activities described in the subject submittals have been carried out in accordance with procedures approved by Illinois EPA. I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

7.1 Owner/Operator Certification

(Must be completed for all submittals. Certification and signature requirements are set forth in 35 IAC 702.126.) All submittals pertaining to the corrective action requirements set forth in a RCRA Permit must be signed by the person designated below (or by a duly authorized representative of that person):

1. For a Corporation, by a principal executive officer of at least the level of vice president.
2. For a Partnership or Sole Proprietorship, by a general partner or the proprietor, respectively.
3. For a Governmental Entity, by either a principal executive officer or a ranking elected official.

A person is a duly authorized representative only if:

1. the authorization is made in writing by a person described above; and
2. the written authorization is provided with this submittal (a copy of a previously submitted authorization can be used).

Owner Signature: ____________________ Date: ____________

Title: *NOT APPLICABLE*

Operator Signature: ____________________ Date: 3/18/21

Title: Principal Program Manager

7.2 Professional Certification (if necessary)

Work carried out in this submittal or the regulations may also be subject to other laws governing professional services, such as the Illinois Professional Land Surveyor Act of 1989, the Professional Engineering Practice Act of 1989, the Professional Geologist Licensing Act, and the Structural Engineering Licensing Act of 1989. No one is relieved from compliance with these laws and the regulations adopted pursuant to these laws. All work that falls within the scope and definitions of these laws must be performed in compliance with them. The Illinois EPA may refer any discovered violation of these laws to the appropriate regulating authority.

Any person who knowingly makes a false, fictitious, or fraudulent material statement, orally or in writing, to the Illinois EPA commits a Class 4 felony. A second or subsequent offense after conviction is a Class 3 felony. (415 ILCS 5/44 (h))

Professional's Signature: ____________________ Date: ____________

Professional's Name *NOT APPLICABLE*

Address ____________________

Professional's Seal:

City ____________________

State _____ Zip Code ____________

Phone ____________________

7.3 Laboratory Certification (if necessary)

The sample collection, handling, preservation, preparation and analysis efforts for which this laboratory was responsible were carried out in accordance with procedures approved by Illinois EPA.

Name of Laboratory *NOT APPLICABLE*

____________________ Date: ____________

Signature of Laboratory Responsible Officer

Mailing Address of Laboratory

Address ____________________

City ____________________

State _____ Zip Code ____________

____

Name and Title of Laboratory Responsible Officer

AECOM
AECOM
100 North Broadway
20th Floor
St. Louis, MO 63110
USA
aecom.com

March 22, 2021

Mr. Kenneth E. Smith, PE
Manager, Permit Section
Illinois Environmental Protection Agency
Division of Land Pollution Control
Bureau of Land
1021 North Grand Avenue East
Springfield, Illinois 62794

Updates to Standard Operating Procedures - 2021
Equilon Enterprises LLC dba Shell Oil Products US
Roxana, Illinois
1191150002 - Madison County
ILD080012305
Log B-43R

Dear Mr. Smith:

As part of AECOM Technical Services, Inc.'s (AECOM's) quality improvement process, we recently performed a review of Standard Operating Procedures (SOPs) used by field staff performing activities at the Investigation Site in Roxana, Illinois. Previously revised SOPs have been submitted to the Illinois Environmental Protection Agency (IEPA), most recently on June 18, 2020. These SOPs were originally submitted, as requested by IEPA, within various reports and work plans related to the Investigation Site in Roxana, Illinois. We are submitting the enclosed updated SOPs for your reference and in accordance with revisions to Sections C.7.5 and C.8.4 of the RCRA Post-Closure Permit Application[1] for the Equilon Enterprises LLC d/b/a Shell Oil Products US (SOPUS) facility at the WRB Refining LP Wood River Refinery.

The SOPs included with this submittal and corresponding revisions are listed below.

SOP No	SOP Title	Purpose of Revision
3	Calibration & Maintenance of Field Instruments	Editorial and formatting related to equipment unable to be calibrated and visual inspection of water level/interface probes.
4	Decontamination	Editorial and formatting related decontamination equipment used.
8	Field Reporting & Documentation	Editorial and formatting; update references to and discussion about field computers.
10	Well Gauging Measurements	Editorial and formatting; update references to field computers.

[1] Class 1* Permit Modification – Section C Revision for SOP Reference (Log No. B-43R-CA-82, CA-88, CA-94 and CA-97) was submitted to IEPA on January 29, 2018. This modification was approved by an IEPA letter with modified Permit dated December 20, 2019.

AECOM

SOP No	SOP Title	Purpose of Revision
11	Groundwater Sampling & Well Wizard Operation	Editorial and formatting; update references to field computers; update sample bottle inspection and handling.
18	Low Flow Groundwater Purging & Sampling	Editorial and formatting; update references to field computers; update equipment list.
20	Well Development or Redevelopment	Editorial and formatting; update equipment list; update actuator pump stabilization.
23	Quality Assurance Samples	Editorial and formatting.
24	Sample Classification, Packaging & Shipping	Editorial and formatting related to frequency of sample shipping.
25	Sample Containers, Preservation & Holding Times	Editorial and formatting related to sample temperature information.
26	Sample Control & Custody Procedures	Editorial and formatting.
44R	Soil Vapor Purging & Sampling	Editorial and formatting; update references to field computers.
48	SVE Well Data Collection & Sampling	Editorial and formatting; update equipment list; discuss “fullness” of Tedlar® bags collected; update discussion of 6-minute sample interval.
49	SVE Effectiveness Monitoring	Editorial and formatting; update discussion about use of sample splitter when collecting duplicate samples.
51	Vapor Sample Classification, Packaging & Shipping	Editorial and formatting.
52	Soil Vapor Field Laboratory Screening	Editorial and formatting; update instrument accuracy target compared to calibration standard; provide clarification about field lab equipment.
53	Dwyer Digital Manometer	Editorial and formatting related to readings out of range and reading fluctuations
56	LNAPL Recovery	Editorial and formatting; update equipment list; add recovery thresholds typically followed.

AECOM

As previously requested by IEPA, below is an SOP summary table, which indicates the most recent revision date for each SOP for your reference.

SOP No.	SOP Title	Last Updated
3	Calibration & Maintenance of Field Instruments	3/12/2021
4	Decontamination	3/12/2021
5	Utility Clearance Procedures	12/9/19
8	Field Reporting and Documentation	3/12/2021
10	Well Gauging Measurements	3/12/2021
11	Groundwater Sampling & Well Wizard Operation	3/12/2021
12	Grouting Procedures	12/9/19
14	Headspace Soil Screening	12/9/19
17	Logging	12/9/19
18	Low Flow Groundwater Purging & Sampling	3/12/2021
20	Well Development	3/12/2021
21	Monitoring Well Installation	7/24/2015
23	Quality Assurance Samples	3/12/2021
24	Soil and Groundwater Sample Identification, Packaging & Shipping	3/12/2021
25	Sample Containers, Preservation & Holding Times	3/12/2021
26	Sample Control & Custody Procedures	3/12/2021
28	Soil Sampling	12/9/19
29	Soil Probe Operation	12/9/19
42	Groundwater Profiling	12/9/19
44R	Soil Vapor Purging & Sampling	3/12/2021
46	Indoor Air Sampling with Canisters	7/23/2015
47	Sub-slab Soil Gas Installation & Sampling with Canisters	4/4/2017
48	SVE Well Data Collection and Sampling	3/12/2021
49	SVE Effectiveness Monitoring at VMPs	3/12/2021
51	Vapor Sample Classification, Packaging & Shipping	3/12/2021
52	Soil Vapor Field Laboratory Screening	3/12/2021
53	Dwyer Digital Manometer	3/12/2021
56	LNAPL Recovery	3/12/2021

Copies of this submittal are being sent separately directly to Amy Butler (IEPA, Springfield) and Gina Search (IEPA, Collinsville).

If you have any questions, please contact Wendy Pennington at wendy.pennington@aecom.com (314-802-1196).

Sincerely,

Wendy Pennington,PE
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encl: Revised SOPs 3, 4, 8, 10, 11, 18, 20, 23, 24, 25, 26, 44R, 48, 49, 51, 52, 53, and 56
RCRA Corrective Action Certification Form

cc: Amy Butler (IEPA - Springfield, IL)
Gina Search (IEPA - Collinsville, IL)
Leroy Bealer (SOPUS)
Erika Reynolds (Greensfelder Hemker)
Project File
Repositories (Roxana Public L brary, website)

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to define the procedure for calibration and maintenance of field instruments frequently used during environmental field activities for the Shell projects in Hartford and Roxana, Illinois. This SOP gives descriptions of the most commonly used of these instruments and field procedures to calibrate and maintain these field instruments. Calibration and maintenance records are maintained with the project file. This SOP serves as a supplement to information which might be in a project Work Plan or scope of work and is intended to be used together with other SOPs.

2. Other SOPs referenced in this SOP

- SOP No. 4 – Decontamination

3. Equipment

The following equipment is typically required during field instrument calibration and maintenance activities.

- Nitrile gloves
- Safety glasses
- Site logbook
- Field data sheets
- Equipment Calibration Record forms
- Distilled or deionized water
- Decontamination equipment
- Health and Safety Equipment
- Field Instrument Operations Manual
- Calibration gases for Air Monitoring Equipment
- Calibration solutions for Water Monitoring Equipment.

4. Types of Field Instruments Commonly used during Environmental Investigations

The following are some of the more commonly used instruments during environmental investigations.

- Photoionization Detector (PID)

- Flame Ionization Detector (FID)
- Multi-gas Meter [4-gas meter] (usually includes Explosimeter, Hydrogen Sulfide detector, Oxygen sensor, and Carbon Monoxide meter)
- Single-gas Meter (usually Benzene or Hydrogen Sulfide meters)
- Groundwater Level Indicator
- Petroleum/Groundwater Interface Probe
- Groundwater pH, Temperature, Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential and/or Turbidity Meter(s).

5. Maintenance

Each instrument has specific maintenance requirements, which are described in the instrument's manufacturer's manual. These maintenance requirements shall be followed. General maintenance such as regular cleaning of the instrument, battery checks and replacement, dust filter checks and replacement, and ensuring the instrument is handled and stored properly can be performed by AECOM employees. Other maintenance items such as sensor repair, annual calibrations and repair of a malfunctioning piece of equipment shall be performed by the instrument manufacturer or licensed dealer and shall NOT be performed by AECOM employees, unless specifically directed by the equipment supplier. Contact the manufacturer or licensed dealer to determine where the instrument shall be submitted for maintenance tasks, if necessary.

6. Calibration

Due to the wide variety of field instruments available, various parameters potentially monitored, and the wide range of functions potentially performed by each instrument, a description of the calibration of every type of instrument available is not feasible. However, a generalized SOP for general types of field equipment calibration is presented here. Refer to the manufacturer's manual for specific calibration instructions for the instrument being used.

The appropriate calibration field form for the equipment being calibrated shall be completed in its entirety, including the rental company, equipment model and serial/ID number. If something on the calibration field form does not apply, fill in the space on the form with "NA".

Air Monitoring Instruments (PID, FID, Multi-gas Meters, Single-gas meters, etc.)

1. Turn the instrument on. The on/off switch may be a toggle switch, knob, or button to be depressed depending on the type and brand of instrument being used.

2. Allow the instrument to "warm up" and progress through the startup diagnostic routine.
3. Perform a "fresh air" calibration, if possible, for the air meter. This fresh air calibration shall be performed using a zero-air filter, if provided with the air monitor, or using a zero-air calibration gas.
4. Record the initial reading on the proper equipment calibration field form. Also record the fresh air calibration standard on the field form.
5. Apply the proper calibration gas and proceed with calibration as directed in the manufacturer's manual.
6. Record the final calibrated reading on the field equipment calibration forms.
7. Verify a moisture and dust filter is in place on the air meter intake nozzle, when applicable.
8. If directed in the manufacturer's manual, at periodic intervals throughout the day, the calibration of the instrument shall be checked and re-evaluated as directed in the manufacturer's manual.

a. If the instrument is out of calibration range, verify proper calibration gas(es) is used and re-attempt calibration.

Groundwater Parameter Instruments (YSI ProDSS, pH-Con 10, turbidimeters, etc.)

Frequently one instrument will have multiple sensors for measuring various parameters in water. With the exception of temperature, each of these parameters can generally be field calibrated.

1. Turn the instrument on. The on/off switch may be a toggle switch, knob, or button to be depressed depending on the type and brand of instrument being used.
2. Allow the instrument to "warm up" and progress through the startup diagnostic routine.
3. Apply calibration solution(s) as instructed by the instrument prompts and/or the manufacturer's manual. Reseal calibration solution containers for future use.
4. Adjust the reading of the instrument, if necessary, to correlate to the corresponding calibration solution being applied.
5. Record calibration reading(s) on the proper field calibration form(s).
6. If proper calibration cannot be achieved, contact the rental company to troubleshoot and/or obtain a new unit.

7. Dispose of used calibration solution.

Water Level Indicator and Petroleum/Water Interface Probe

Field calibration of this instrument is not required. Rather a series of field checks to ensure the instrument is in proper working order are described.

1. Visually inspect the tape for cuts or exposed metal/wire.
2. Turn the instrument on. The on/off switch is usually a knob located on the side of the reel which the measuring tape is rolled onto.
3. Push the "test" button to ensure that the batteries are in working order. If the batteries are working, an audible tone will be heard, and a visible light located on the side of the reel will illuminate.
4. Immerse the sensor probe in potable water in a shaded environment[1] to ensure the audible tone is heard and visible light illuminates when the probe enters the water and make an observation of where the water level is at on the probe. Repeat this step several times to familiarize yourself with this contact point. If sensor probe does not react when immersed, contact the manufacturer or licensed dealer for troubleshooting or replacement.
5. Immerse the sensor probe (for interface probes only) in pure phase product (such as vegetable oil) to ensure the audible tone is heard and visible light illuminates when the probe enters the product. Make an observation of where the product level is at on the probe. Perform decontamination on the probe as outlined in SOP No. 4 Decontamination after this step. If sensor probe does not react when immersed, contact the manufacturer or licensed dealer for troubleshooting or replacement

7. Decontamination

Small instruments and equipment that comes into contact with environmental media shall be cleaned according to SOP No. 4 – Decontamination between each use and shall be stored in such a way as to prevent contamination.

[1] Distilled or deionized water typically do not trigger a tone. Sunlight may also interfere with the production of a tone.

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to define the standard procedures for decontamination of field equipment and personnel for Shell projects in Hartford and Roxana, Illinois. This SOP serves as a supplement to information which might be in a project Work Plan or scope of work and is intended to be used together with other SOPs.

The overall objective of multimedia sampling programs is to obtain samples that accurately depict the chemical, physical, and/or biological conditions at the sampling site. Extraneous contaminants can be brought onto the sampling location and/or introduced into the medium of interest during the sampling program (e.g. using sampling equipment that is not properly or fully decontaminated). Trace quantities of contaminants can consequently be captured in a sample and lead to false positive analytical results and an incorrect assessment of the contaminant conditions associated with the site. Decontamination of drilling, sampling and other equipment (e.g., all non-disposable equipment that will come in direct contact with samples) is, therefore, required prior to, between, and after uses to ensure that sampling cross-contamination is prevented, and that on-site contaminants are not carried off-site.

2. Other SOPs referenced in this SOP:

- SOP No. 8 - Field Reporting and Documentation

3. Equipment

The following is a list of equipment that may be needed to perform decontamination:

- Brushes
- Wash tubs
- Buckets
- Scrapers, flat bladed
- Hot or cold water - high-pressure sprayer
- Sponges or paper towels
- Liquinox detergent (or equivalent)
- Isopropyl alcohol
- Potable or distilled water
- Deionized or distilled water

- Garden-type water sprayers
- Plastic sheeting or trash bags
- GAST® high-flow pump (or equivalent)
- Appropriate PPE (i.e., Tyvek, face shield, goggles, safety glasses, nitrile gloves, etc.)

4. Decontamination Procedures

Proper mixing instructions for Liquinox detergent: use 2.5 tablespoons Liquinox detergent per gallon of water. If another detergent is being used, verify the proper mixing instructions prior to use.

New 5-gallon buckets will be used for detergent and rinse water at the start of each quarterly task. Detergent water and rinse water shall be mixed fresh each morning and shall be replaced with new solutions at least at mid-day. More frequent replacement of solutions may be necessary if gross contamination (i.e., light non-aqueous phase liquid [LNAPL], sheen, or suspended particles) is observed.

4.1 Personnel

Personnel shall be provided space to wash and rinse gloves, and any other non-disposable personal protective equipment (PPE). A container shall be available to dispose of used disposable items such as gloves, or Tyvek (if used).

The decontamination procedure for field personnel shall include:

1. Glove wash in a Liquinox (or similar) solution
2. Glove rinse in distilled water
3. Outer glove removal, if present
4. Coverall removal, if present
5. Inner glove removal

Refer to the project Health and Safety Plan (HASP) for additional information. If conditions change and/or upgrade of PPE is required, refer to the task or project specific HASP for more specific information.

4.2 Groundwater Parameter Equipment (e.g., YSI ProDSS or similar)

Equipment used to measure groundwater parameters, which does not come into contact with the analytical sample, may be decontaminated between wells if necessary (i.e., gross contamination observed on the sonde probes, history of elevated benzene results at a particular well[1], etc.) (Steps 1 through 6 below). This equipment will, at a minimum, be decontaminated at the end of each sampling day (Step 7 below). The following steps shall be used when decontaminating groundwater parameter measuring equipment:

1. Personnel shall dress in appropriate PPE to reduce the potential of personal exposure as required by the HASP and THA.
2. Spray or wash sensors with a soap and water solution (Liquinox or similar and potable or distilled water).
3. Spray or rinse sensors with distilled water.
4. Wash flow cell in a wash tub or bucket containing soap and water solution (Liquinox or similar along with potable or distilled water) and scrubbed with a bristle brush or similar utensil.
5. Rinse flow cell with distilled water in a second tub or bucket.
6. New 5-gallon buckets will be used for detergent and rinse water at the start of each quarterly task. Detergent water and rinse water shall be mixed fresh each morning and shall be replaced with new solutions at least at mid-day. More frequent replacement of solutions may be necessary if gross contamination (i.e., LNAPL, sheen, or suspended particles) is observed.
7. At the end of each sampling day,
    a. Soak the optical dissolved oxygen (DO) cap in distilled white vinegar for 10 to 15 minutes.
    b. Rinse the optical DO cap in distilled water.
    c. Wash the flow cell in a wash tub or bucket containing soap and water solution (Liquinox or similar along with potable or distilled water and scrubbed with a bristle brush or similar utensil.
    d. Rinse flow cell with distilled water in a second tub or bucket.
    e. If flow cell is still odorous, soak in a wash tub or bucket containing soap and water solution (Liquinox or similar along with potable or distilled water) for 10 to 15 minutes. Also consider performing decontamination activities more often during the next sampling day/event.

[1] Elevated levels of benzene may cause accelerated deterioration of the optical dissolved oxygen lens, which in turn will require more frequent lens replacement.

Following decontamination, equipment shall be placed in a clean area (i.e., in the truck, in a dedicated container, etc.) or on clean plastic sheeting in the work zone to prevent contact with contaminated media. If the equipment is not used immediately after decontamination, the equipment shall be stored in a manner which minimizes potential contact with contaminants. Overnight, the equipment will be stored with the sonde sensors submerged in potable water.

4.3 Groundwater Sampling Pumps

Submersible, non-dedicated, reusable groundwater sampling pumps shall be decontaminated between each sampling location. The following steps shall be used to decontaminate groundwater sampling pumps:

1. Personnel shall dress in appropriate PPE to reduce the potential of personal exposure as required by the HASP.
2. Exterior of the sampling pump, including the electrical cord, shall be sprayed and/or wiped off with isopropyl alcohol to remove gross contamination. The outer sampling pump casing may be removed, if necessary, to remove gross contamination on sampling pump motor module.
3. Sampling pump, including electrical cord, shall be placed in a wash tub or bucket containing a soap and water solution (Liquinox or similar along with potable or distilled water). Sampling pump shall be turned on to circulate the soapy water for a minimum of 5 minutes.
    a. Sampling pump may be scrubbed with a bristle brush, sponge or similar utensil.
    b. If the electrical cord will not fit into the wash tub or bucket, it can be wiped down with a paper towel saturated with a detergent water solution.
4. Sampling pump, including electrical cord, shall be placed in a second tub or bucket containing distilled water. Sampling pump shall be turned on to circulate rinse water for a minimum of 5 minutes and until water coming out of the pump no longer contains soapy solution.
    a. If the electrical cord will not fit into the tub or bucket, it can be wiped down with a paper towel saturated with distilled water.
5. New 5-gallon buckets will be used for detergent and rinse water at the start of each quarterly task. Detergent water and rinse water shall be mixed fresh each morning and shall be replaced with new solutions at least at mid-day. More frequent replacement

of solutions may be necessary if gross contamination (i.e., LNAPL, sheen, or suspended particles) is observed.

Following decontamination, equipment shall be placed in a clean area (i.e., in the truck, in a dedicated container, etc.) or on clean plastic sheeting in the work zone to prevent potential contact with contaminants. If the equipment is not used immediately after decontamination, the equipment shall be stored in a manner which minimizes potential contact with contaminants.

4.4 Water Level / Interface Probes

The following steps shall be used to decontaminate water level meters and oil/water interface probes:

1. Personnel shall dress in appropriate PPE to reduce the potential of personal exposure as required by the HASP and THA.
2. A paper towel or other disposable media shall be saturated with isopropyl alcohol.
3. A portion of a second paper towel or other disposable media shall be saturated with a detergent water solution and the remaining portion of the same paper towel or other disposable media shall be saturated with distilled water.
4. The measuring tape shall be wiped clean as it is removed from the monitoring well by passing through the saturated disposable media. The tape must pass through the isopropyl alcohol first, the detergent water solution second, and the distilled water last.
5. Care shall be taken to replace saturated paper towels if gross contamination is observed or to replace paper towels which become dry during the process.
6. Probe tip shall also be sprayed off with Liquinox (or similar) detergent water solution and distilled water after wiping.
    a. Solinst and Heron brand probe tips will NOT be cleaned with isopropyl alcohol.
    b. If another brand interface probe is being used, check the equipment manual to verify proper decontamination procedures and solutions.

Following decontamination, equipment shall be placed in a clean area (i.e., in the truck, in a dedicated container, etc.) or on clean plastic sheeting in the work zone to prevent potential contact with contaminants. If the equipment is not used immediately after decontamination, the equipment shall be stored in a manner which minimizes potential contact with contaminants.

4.5 Other Sampling Equipment

The following steps shall be used to decontaminate other sampling equipment:

1. Personnel shall dress in appropriate PPE to reduce the potential of personal exposure as required by the HASP.
2. Gross contamination on equipment shall be scraped/wiped off at the sampling or construction site.
3. Equipment shall be sprayed and/or wiped off with isopropyl alcohol.
4. Equipment that cannot be damaged by liquid or water shall be placed in a wash tub or bucket containing soap and water solution (Liquinox or similar along with potable or distilled water) and scrubbed with a bristle brush or similar utensil.
5. Equipment that cannot be damaged by liquid or water shall then be rinsed with distilled water in a second tub or bucket.
6. Equipment that may be damaged by liquid/water shall be carefully wiped clean using a sponge/paper towel with isopropyl alcohol, followed by a sponge/paper towel with detergent water and a sponge/paper towel with deionized or distilled water. Care shall be taken to prevent equipment damage.
7. New 5-gallon buckets will be used for detergent and rinse water at the start of each quarterly task. Detergent water and rinse water shall be mixed fresh each morning and shall be replaced with new solutions at least at mid-day. More frequent replacement of solutions may be necessary if gross contamination (i.e., LNAPL, sheen, or suspended particles) is observed.

Following decontamination, equipment shall be placed in a clean area (i.e., in the truck, in a dedicated container, etc.) or on clean plastic sheeting in the work zone to prevent contact with contaminated media. If the equipment is not used immediately after decontamination, the equipment shall be stored in a manner which minimizes potential contact with contaminants.

4.6 Drilling and Heavy Equipment

Drilling rigs and other equipment shall be decontaminated at a decontamination station located near a central staging area. The decontamination station may consist of a temporary or permanent structure capable of collecting all decontamination fluids. Mobile decontamination trailers may be used to decontaminate heavy equipment at each site. The following steps shall be used to decontaminate drilling and heavy equipment:

1. Review THA for drilling and heavy equipment decontamination.

2. Personnel shall dress in appropriate PPE to reduce personal exposure as required by the HASP and THA.
3. Equipment showing gross contamination or having caked-on drill cuttings shall be scraped with a flat-bladed scraper at the sampling or construction site.
4. Equipment that cannot be damaged by water, such as drill rigs, augers, drill bits, and shovels, shall be washed with a high-pressure water sprayer then rinsed with potable water. Care shall be taken to adequately clean the insides of the hollow-stem augers, backhoe buckets, etc.[2]

Following decontamination, drilling equipment shall be placed on the clean drill rig and moved to a clean area. If the equipment is not used immediately, it shall be stored in a designated clean area.

4.7 Equipment Leaving the Site

Vehicles used for site activities shall be cleaned on an as-needed basis, as determined by the Site Safety Officer, using soap and water on the outside and vacuuming the inside. On-site cleaning shall be required for dirty vehicles (i.e., muddy tires) leaving the site. Construction equipment, such as hollow stem augers, other drilling equipment, etc., shall be pressure washed before the equipment is removed from the site to limit exposure of off-site personnel to potential contaminants.

4.8 Wastewater

Liquid wastewater from decontamination activities shall be containerized and left at the site where it originated, unless otherwise specified. Check with the Project IDW Coordinator for additional information/guidance.

4.9 Tedlar® Bags

The following steps shall be used to decontaminate used Tedlar® bags for reuse:

1. Personnel shall dress in appropriate PPE to reduce the potential of personal exposure as required by the HASP and THA
2. Tedlar® bags shall be pre-sorted into the following purge categories based on the concentrations of the most recent sample in the Tedlar® bag:

[2] Use of hot water and/or steam cleaning during decontamination warrants a Hot Work Permit, which must be evaluated and approved prior to use.

Oxygen (%)	Minimum Number of Purges Required
20.9	none
16 – 20.9	1
0 – 16	2

Total Hydrocarbon Concentration (ppm)	Minimum Number of Purges Required
0.0	none
0.1 - 10	1
10 - 100	2
100 – 1,000	3
1,000 – 10,000	4
>10,000	5

If the oxygen and total hydrocarbon concentration (THC) values in the previous Tedlar® bag concentration do not line up on the table above, the more conservative approach (i.e., the greatest number of purges) shall be chosen.

3. In a well-ventilated area, begin the purge process by introducing ambient air into the Tedlar® bag through a GAST® sampling pump (or equivalent). Fill the Tedlar® bag approximately 80% full and then expel the ambient air from the Tedlar® bag using the intake hose on the GAST® sampling pump (or equivalent). Repeat until the required number of purges outlined in Step 2 above has been performed, or until ambient conditions are present in the Tedlar® bag.
4. After the final purge is complete, introduce ambient air into the Tedlar® bag through the pump and screen the Tedlar® bag to ensure that Oxygen is 20.9% and THC is 0.0 ppm (ambient conditions). If ambient conditions are not present in the Tedlar® bag after purging is complete, continue purging and screening the Tedlar® bag. If ambient conditions are not present after 10 purges, discard the Tedlar® bag.
5. Once ambient conditions are verified and the Tedlar® bag is examined to ensure that it is structurally intact, expel the remaining air and affix a new sampling label. Place the Tedlar® bag in the designated storage location for future use.

5. Documentation

Sampling personnel shall be responsible for documenting the decontamination of sampling equipment, drilling equipment and/or personnel. The documentation shall be recorded with waterproof ink in the sampler's field logbook with consecutively numbered pages. The information entered in the field book concerning decontamination shall include the following:

- Decontamination personnel
- Date and start and end times
- Decontamination observations
- Weather conditions.

Refer to SOP No. 8 Field Reporting and Documentation for further information regarding logbook entries and logbook management.

6. Quality Assurance Requirements

Equipment rinsate samples of the decontaminated sampling equipment may be taken to verify the effectiveness of the decontamination procedures. The rinsate sampling procedure shall include passing distilled water through or over a decontaminated sampling tool (such as a split spoon) and collecting the rinsate water into the appropriate sample bottles. The rinsate sampling procedure, including the sample number, shall be recorded in the field notebook.

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to define the standard procedure for field reporting and documentation for Shell projects in Hartford and Roxana, Illinois. This SOP provides descriptions of equipment and field procedures necessary to properly document field activities. This SOP serves as a supplement to information which might be in a project Work Plan or scope of work and is intended to be used together with other SOPs.

2. Other SOPs referenced in this SOP

- None

3. Equipment

Equipment used during field reporting and documentation may include, but is not limited to:

- Calculator
- Bound field logbook
- Waterproof pen and/or permanent marker
- Field forms, if applicable, for the task(s) being performed
- Field computer
- Camera

4. Field Reporting and Documentation

Documentation of observations, activities and data acquired in the field shall provide information on the acquisition of samples and provide a permanent record of field activities. The observations and data shall be recorded using one or more of the following:

- Pens with permanent waterproof ink in a permanently bound weatherproof field logbook;
- Field forms; and/or
- Field computer.

Field activities vary depending on the work to be performed. No set of general rules can anticipate all information that must be collected for a particular project or task. Below is a list of things to do or consider during field reporting.

- The logbooks, field forms/paperwork and field computer shall be kept in the field team's possession or in a secure place during performance of work.
- Language shall be objective and factual.

- Changes or deletions in the field logbook or on field forms will be lined out with a single strike mark, initialed, dated, and remain legible.
- Information will be recorded to allow for the sampling event or task to be reconstructed without relying on the sampler's memory.
- At the end of each day and/or task, a scanned copy of all field forms used and/or logbook entries made will be emailed to the task manager and project administrator (GDS) for review and filing.
- The task manager will review these scanned copies in a timely manner to verify the quality of the information.

Obtain further direction regarding documents to be provided and at what frequency from the task/project manager.

5. *Field Logbook*

Each project or task shall have a dedicated logbook. The following information shall be recorded on the front cover of each logbook:

- Project name/location (i.e., Rand, Roxana, WRR, etc.);
- Date range or year of activities included within; and
- Task the logbook is for (i.e., Quarterly Groundwater; Drilling and Well Installations, System O&M, etc.).

The information in the field logbook shall typically include the following as applicable to the task being performed, even if this information is also recorded on field forms and/or a field computer:

- Date;
- Names of field team members performing work;
- Change in field team members throughout the day, if any;
- Any PPE upgrades/downgrades (i.e., Tyvek, respirator, etc.);
- Weather conditions;
- Asset/Serial number of any equipment used;
- Names and company of subcontractors (if applicable);

- Names and title/organization of any site visitors (i.e., client, property owner, Agency representative, etc.);
- Time of each observation/entry;
- Time calibration of field equipment is performed (if applicable);
- Time of mobilizing to work location;
- Time work permit was obtained (if applicable);
- Work location (i.e., Property, Process Area, Location ID, etc.);
- Work to be performed at location (i.e., water level gauging, drilling/sampling, etc.);
- Location of sample (i.e., monitoring well ID, borehole location and depth, etc.);
- Description of samples (matrix sampled – i.e., water, soil vapor, soil, etc.);
- Time of sample collection;
- Sample ID;
- QA/QC samples collected (if applicable);
- Sample analysis planned (i.e., VOC, SVOC, BTEX, etc.);
- Odor observations during field activities, if any (i.e., hydrocarbon- or petroleum-like, etc.);
- Information concerning sampling changes, schedule modifications, and change orders;
- Time and details of any delay (i.e. operator unavailable, car parked over location, drill rig delays, equipment malfunction, etc.);
- Field observations and/or summary of daily tasks;
- Sketch (i.e. well construction details, utility locate markings, etc.);
- Signature/Initials and date by personnel responsible for observations at the end of the page/entry/day;
- If decontamination is performed and on what equipment.

Each page in the logbook shall be numbered and dated. The entries shall be legible and contain accurate and inclusive documentation of the project/task activities. Lines and pages shall not be skipped within a logbook. If a page is inadvertently skipped, a diagonal line shall be drawn across the page and "Page inadvertently skipped" recorded. The bottom of each page in the field books shall be signed or initialed by the person making the entry at the end of the day.

6. *Field Forms/Paperwork*

Data may also be recorded on field forms for different tasks performed. If filling out a field form, verify that **every line** contains an entry. If something on the field form does not apply, enter "**NA**" on the line.

7. *Field Computers*

The AECOM employees working on the Shell project may also use a field computer to collect field data. Currently, field computers have a Microsoft Windows 10 operating system and Microsoft Office software. For data management purposes, each computer has an unique number (LTP-1, LTP-2, etc.).

When completing an entry in a field computer, verify that **every line/box** contains an entry with the appropriate information. If something in the electronic data entry device does not apply, enter "**NA**".

Dedicated electronic data entry devices are typically used for dedicated locations and routine activities; however, this may change over time or as tasks warrant.

8. *Document Control*

Document control refers to the maintenance of inspection and investigation project files. All information below shall be kept in project files. Investigators may keep copies of reports in their personal files, however, all official and original documents relating to inspections and investigations shall be placed in the official project files. Information recorded in electronic format shall be saved in the project directory. The following documents shall be placed in the project file:

- Chain-of-Custody Records and bound field logbooks
- Records obtained during the investigation
- Complete copy of the analytical data and memoranda transmitting analytical data
- Official correspondence received or transmitted, including records of telephone calls
- Photographs and/or digital files associated with the project
- One copy of the final report and transmittal memorandum

- Relevant documents related to the original investigation/inspection or follow-up activities related to the investigation/inspection.

Personal observations and irrelevant information shall not be placed in the official project files. Throughout the performance of field work as well as at the conclusion of the task/project, the Task Manager will review the file to ensure that it is complete or follow up with the field team member(s), if necessary.

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to define the standard procedure for measuring water level, non-aqueous phase liquid (NAPL) level, and/or bottom depth in monitoring wells for Shell projects in Hartford and Roxana, Illinois. This SOP serves as a supplement to information which might be in a project Work Plan or scope of work and is intended to be used together with other SOPs.

2. Other SOPs referenced in this SOP

- SOP No. 4 – Decontamination
- SOP No. 8 – Field Reporting and Documentation

3. Equipment

The following equipment is typically needed:

- Water Level or Product/Water Interface probe with 0.01-foot increments;
- Well keys;
- Assorted tools (safety knife, drill, screwdriver, etc.)
- Photoionization Detector (PID) (e.g., RAE Instruments MiniRAE 3000 or equivalent);
- Nitrile gloves;
- Site logbook;
- Field data sheets;
- Field computer;
- Appropriate decontamination equipment; and
- Appropriate personal protective equipment (PPE).

4. Fluid Level Measurement Procedures

Observations made during the fluid (water and/or NAPL) level measurement shall be recorded in the field logbook, on appropriate field forms, and/or in the appropriate program in the field computer in accordance with the procedures defined in SOP No. 8 Field Reporting and Documentation.

Appropriate PPE, as described in the Health and Safety Plan (HASP) shall be worn during well opening, fluid level measurement, and decontamination. The following procedures shall be completed when measuring fluid levels:

1. Decontaminate the water level probe prior to use in each monitoring well according to SOP No. 4 Decontamination.
2. Observations regarding the condition of the well, including the well pad, surface completion or protective casing, working padlock, etc. shall be documented in the field logbook, on appropriate field forms and/or in the field computer.
3. Put on a new, unused pair of disposable nitrile gloves.
4. Approach the well from upwind.
5. Unlock and remove the well cap.
6. Monitor the air quality at the top of the casing and in the breathing zone with a PID. Record the air quality readings on appropriate field forms and/or in the field computer.
    a. If the well appears to be under vacuum or pressure conditions, allow adequate time after removing the well cap to reach equilibrium. Vacuum or pressure conditions may cause the water and/or NAPL level within the well to rise or fall once the well cap is removed and the well is exposed to atmospheric conditions.
7. After the well has reached equilibrium, measure the depth to water from the top-of-casing reference point with a water level or NAPL/water interface probe. Check for NAPLs in the water column, where applicable.
    a. If no reference point is marked on the well casing, measurements shall be made from the north side of the well casing.
    b. If a special well wizard dedicated pump cap is present, the cap shall be removed from the riser pipe and depth to water measured from the top of well casing reference point. If the well wizard dedicated pump cap is unable to be removed, gauge the fluid level through the opening in the cap.
8. Measurements will be made to the nearest 0.01 feet. Record the measured reading(s) on appropriate field forms and/or in the field computer.
9. Regauge and check the recorded measurement(s) before the probe is removed from the well in order to confirm the measurement and verify that the water level is static.
    a. If the regauged depth to water and/or NAPL is the same or comparable to the initial measurement (i.e., ± 0.02 feet), the fluid level is considered static.

   b. If the regauged depth to water and/or NAPL is not comparable to the initial measurement, the water level is still equilibrating to atmospheric conditions. Periodically regauge the depth to water and/or NAPL until two consecutive measurements are comparable, indicating a static fluid level.

10. If NAPL is detected within a well, confirm the presence of NAPL by visual observations on the interface probe, a clear plastic bailer (disposable or dedicated), or similar. Record the measurement and the confirmation method on appropriate field forms and/or in the field computer.

   a. If NAPL presence is not confirmed by visual observations, decontaminate the water level or water/product interface probe and regauge to check the measurement. Contact the task manager to discuss.

11. Measure the total depth of the well, if required. A measuring tape, with a weight attached to the end if necessary, can be used in place of the water level or interface probe to measure the total well depth. Measurements will be made to the nearest 0.01 feet. Record the measured reading on appropriate field forms and/or in the field computer.

   a. If a special well wizard dedicated pump is present, remove the pump completely from the well prior to measuring the total well depth.

12. All columns/entries of field data sheets and/or field computer shall be completed, including date and time of measurements. An example water level data sheet with instructions is attached to this SOP. Verify that every line/box contains an entry with the appropriate information. If something on the field form or in the field computer does not apply, that shall be indicated using "NA".

13. Care shall be taken to verify the readings during each water level measurement period. Any significant changes in water level will be noted by comparing the most recent measurement with past measurements. This comparison can be performed on the field computer and with the field binder gauging table when entering the data.

14. Decontaminate the water level probe as described in SOP No. 4 Decontamination after any measurement is taken.

15. Place disposable equipment into a plastic garbage bag for disposal. Check with the IDW Coordinator, or designee, for proper disposal guidance.

4. Documentation

The appropriate information will be entered into the field computer and/or on the water level data sheet in the field during gauging activities. A field logbook will also be kept during water level measurement activities describing decontamination procedures, calibration procedures, monitoring procedures, and other activities/observations during water level measurement. Refer to SOP No. 8 Field Reporting and Documentation for additional documentation information.

Periodic Water Level Record

Project No: ______________________ Toughbook D: ______________________

Quarter: ______________________ Personnel: ______________________

Date: ______________________ Interface Probe make/ID: ______________________

Well No.	Date	Time	Depth to Product (ft btoc)	Product Confirmed [if present] (circle one)	Product Thickness	Depth to Water (ft btoc)	Depth to Bottom (ft btoc)	Bolts Condition or Bollard Condition	Lock Present (well secured)	Working Cap Present (inc. vent)	Well Labeled	Pad Condition	Manhole (Lid/Vault) Condition	PID at Well Head	Comments
				P B			-								
				P B			-								
				P B			-								
				P B			-								
				P B			-								
				P B			-								
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				P B			-								
				P B			-								

Product Confirmation Method:
P = On interface probe
B = Using a clear bailer

Bolt Condition:
G = Good Condition
S = Stripped
M = One or Both Missing (but needed)

Bollard Condition:
G = Good Condition
L = Leaning/tilted
D = Damaged or Loose
M = Missing (but needed)
NA = Not Applicable (no bollards necessary)

Well Pad Condition:
G = Good Condition
B = Broken, Cracked or Crumbling
F = Floating
NA = Not Applicable (pad not present)

Manhole Condition
G = Good Condition
BL = Broken Lid
BE = Broken Ear
NA = Not Applicable (no manhole)

Wells highlighted in green need to be gauged within 24-hrs of each other and within 24-hrs of wells in the WRR that are also highlighted in green

INTERFACE PROBE FIELD CHECKS PERFORMED PRIOR TO USE EACH DAY

DATE ______________ ______________ ______________ ______________

CHECK RESULTS ______________ ______________ ______________ ______________

______________ ______________ ______________ ______________

Examples include: probe good not reading oil not reading water battery replaced etc.

Surface condition assessment – the overall objective is to assess the condition of the wellheads. Wellheads need to be secured from vandalism and surface water entry and constructed such that they do not pose a trip hazard.

Specific instructions regarding well integrity assessments and designations below. List all conditions that may apply.

Example : one bolt stripped / one bolt missing = S / M

<u>Bolts Condition (for flush mount)</u>

Objective for bolt inspection - Flushmount well lid is firmly secured in place by bolts. All bolts present, and not stripped; bolts must be removed by tool (wrench / drill), and not by hand, in order to lift manhole lid.

1. If flush mount well, and one or both bolts are missing = M
2. If flush mount well, and one or both bolts are stripped = S
3. If flush mount well, and both bolts are in good condition (properly grip manhole lid) = G

<u>Bollard Condition (for stick up)</u>

Objective for bollard inspection - Stick up well is properly protected by bollards if in high traffic area. All bollards straight, secure, undamaged.

1. If stick up well, and one or more bollards are leaning/tilted = L
2. If stick up well, and one or more bollards are damaged/loose = D
3. If stick up well, and one or more bollards are missing, but needed (high traffic area) = M
4. If stick up well, and bollards are not necessary (low traffic area) = NA
5. If stick up well, and bollards are in good condition = G

<u>Lock Present/Well Secured</u>

Objective for well security/lock inspection - Well can only be opened by AECOM staff with designated key; well cap is securely placed on well casing and can't be removed by hand (lifted up with lock still on)

1. If well is locked with padlock/key, padlock works easily with key = Y/N
2. If well is locked by Flushlock Well Plug, Flushlock Key works easily with plug = Y/N
3. In both cases of padlock/key and Flushlock Well Plug/Flushlock Key, well can only be opened with key = Y/N

<u>Working Cap Present</u>

Objective for cap inspection - Cap properly protects well from external elements. If stick up well, cap is vented; if flushmount, cap is used as provided by manufacturer.

1. Working cap = cap can only be removed from well by unlocking (cap cannot be pulled with lock still attached)
2. Well Wizard cap = working cap

<u>Well Lableled</u>

Objective for well label inspection - Well is easily identifiable, labeled with all portions of well ID.

1. Well Labeled = Full well ID easily visible
2. If any portion of well ID unidentifiable, well is re-labeled with paint pen during inspection

<u>Well Pad Condition</u>

Objective for well pad inspection - Well pad is stable, flat surface surrounding monitoring well. Pad does not allow water to pool around monitoring wells; pad does not present trip hazard accessing monitoring wells.
- Any cracks documented, and should be assessed by task manager.

1. If concrete well pad is broken/cracked/crumbling = B
2. If stick up well, and pad is floating (there is space between concrete pad and ground) = F
3. If no well pad installed = NA
4. If well pad in good condition = G

<u>Manhole Condition (for flush mount)</u>

Objective for manhole inspection - Manhole properly protects flushmount well casing, creating secure and stable surface for manhole lid cover. No

1. If any portion of lid broken off = BL
2. If one or both ears inside vault are broken = BE
3. If well does not have manhole (for stick up) = NA
4. If manhole in good condition = G

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to describe equipment and field procedures necessary to collect groundwater samples and operate the dedicated Well Wizard pumps for monitoring wells in the Shell Wood River Refinery (WRR) groundwater monitoring program. This SOP serves as a supplement to information which might be in a project Work Plan and is intended to be used together with other SOPs.

2. Other SOPs Referenced in this SOP

- SOP No. 3 – Calibration and Maintenance of Field Instruments
- SOP No. 4 – Decontamination
- SOP No. 8 – Field Reporting and Documentation
- SOP No. 10 – Well Gauging Measurements
- SOP No. 23 – Quality Assurance Samples
- SOP No. 24 – Soil and Groundwater Sample Identification, Packaging and Shipping
- SOP No. 25 – Sample Containers, Preservation and Holding Times
- SOP No. 26 – Sample Control and Custody Procedures

3. Equipment

Equipment typically used during well purging and sampling:

- Well keys
- Assorted tools (safety knife, drill, screwdriver, clamp, etc.)
- Air monitoring equipment
- Water level indicator or water/product interface probe with 0.01-foot increments
- Compressor
- Controller for the QED Well Wizard pumps (MP10 or similar)
- Air hoses and connections/splitters
- Water quality parameter meter(s) with appropriate sensors (Hanna/Lamotte or similar)
- Disposable nitrile gloves
- Paper towels or Kimwipes

- Trash bag or bucket
- Calculator
- Field Logbook
- Field data sheets
- Waterproof permanent marker or pen
- Field computer
- Plastic buckets
- 55-gallon drums or truck-mounted tank for holding purged water
- Plastic sheeting, plastic tote, or other means of secondary containment to use during purging and sampling
- Well construction information for well(s) to be sampled
- Map showing location of well(s) to be sampled
- Appropriate decontamination equipment
- Appropriate health and safety equipment
- Cooler with ice
- Sample bottles and labels. Sample bottles with preservatives added will be obtained from the analytical laboratory. Several extra sample bottles will be obtained in case of breakage or other problems.
- Plastic sheeting, plastic tote, or other means of keeping sample bottles off the ground and clean.

4. Sampling Procedures

This section provides the step-by-step procedures for collecting groundwater samples in the field via dedicated Well Wizard pumps. Observations made during groundwater sample collection shall be recorded in the field logbook, on field data sheets, and/or in the field computer in accordance with procedures described in SOP No. 8 Field Reporting and Documentation.

1. Before any purging or sampling begins, all reusable well probes, and other sampling devices shall be decontaminated. Mobile decontamination supplies will be provided so that equipment can be decontaminated in the field (SOP No. 4 Decontamination).

2. Electronic equipment used during sampling includes water quality parameter meter(s), and a water level or water/product interface measurement probe. Before going into the field, the sampler shall verify that these instruments are operating properly. The water quality parameter meter(s) require calibration prior to use every day. Calibration times and readings will be recorded in the field logbook and/or on daily calibration sheets to be kept in the project file. Specific instructions for calibrating the field instruments are provided in SOP No. 3 Calibration and Maintenance of Field Instruments and the instrument manuals.

3. Before well purging begins, the following procedures will be performed at each well:

    - The condition of the outer well casing, concrete well pad, protective posts (if present), and any unusual conditions of the area around the well will be noted on the field data sheets and/or in the field computer.
    - The presence of a working lock and its condition (e.g., locked) will be verified.
    - Clean plastic sheeting or other form of secondary containment for purgewater collection will be placed around the well.
    - The well will be opened.
    - Appropriate readings will be taken in the breathing zone with a flame ionization detector (FID) or photoionization detector (PID) according to the Health and Safety Plan. The reading will be recorded on the field data sheets and/or in the field computer.
    - The condition of the inner well cap, tubing connections, and casing will also be noted.

4. Groundwater elevations will be measured to the nearest 1/100-foot at each monitoring well using an electronic water level or interface probe. The groundwater measurements, screened intervals, and total monitoring well depth will be recorded on the field data sheet and/or in the field computer A detailed description of monitoring well gauging procedures, including well head vapor readings, is provided in SOP No. 10 Well Gauging Measurements.

5. The presence of nonaqueous-phase liquids (NAPL), dense or light, will be determined using an oil-water interface probe and confirmed by observation on the probe or via clear bailer. If NAPL is identified, its thickness will be measured. The presence of light

or dense NAPLs will preclude sampling of the groundwater itself. Note it, close the well and continue to the next well.

6. Following measurement of the static water levels, the monitoring wells will be purged of at least three (3) well volumes. The well purge volume is calculated with one of the following equations:

   If a packer is present to isolate the water column around the screened interval:

   [(TD of well) – (bottom of packer)] x (ft to gal conversion[1]) x 3 = __________ gallons
   (ft btoc) (ft btoc) (see footnote) # Vols Calculated Purge Volume

   If no packer is present and the full water column height is to be considered:

   [(TD of well) – (WL)] x (ft to gal conversion[1]) x 3 = __________ gallons
   (ft btoc) (ft btoc) (see footnote) # Vols Calculated Purge Volume

   If work is being performed at a group of wells, perform this calculation for all wells in the group prior to proceeding to the next step.

7. Set up the compressor and connections as follows to maximize groundwater flow and minimize sampling time:

   a. If a packer is present in the well, attached the pressure gauge (black hose with gauge attached) to the smaller quick-connect fitting at the well head. If no packer is present, skip this step. Attach one end of the air hose to the pressure gauge hose, if present, or the larger quick-connect fitting at the well head. If only one well is being sampled, use the vented air hose, with the vent at the well head. If multiple wells are being sampled at a time, do not use the vented air hose for either well.

   b. Attach the other end of the air hose to the "out" connection of the control box. If multiple wells are being sampled at a time, connect the "+" splitter to the "out" connection of the control box and connect the air line from each well to the splitter.

      - If you use the splitter to sample multiple wells at a time at a cluster of 4 wells (e.g., P-89A, P-89B, P-89C, P-89D), the sequence is typically as follows but will vary from well cluster to cluster depending on operational packers and purge volume calculations:

[1] For a 1-inch diameter well, use 0.0408 gal/ft; For a 1.5-inch diameter well, use 0.0918 gal/ft; For a 2-inch diameter well, use 0.163 gal/ft; For a 4-inch diameter well, use 0.652 gal/ft; For a 6-inch diameter well, use 1.468 gal/ft.

i. Purge "B" and "C" well first. Typically, the volume required to be removed from "A" is twice that to be removed from "C".

ii. Sample "C" well first.

iii. Once "C" well is sampled, disconnect the air hose from the "C" well and move to "D" well

iv. Begin purging "D" well.

v. Sample "D" well.

vi. Once "D" well is sampled, disconnect the air hose from the "D" well and move to "A" well.

vii. Begin purging "A" well.

viii. Sample "A" well.

ix. Once "A" well is sampled, disconnect both ends of the air hose connected to "A" well.

x. Sample "B" well.

- Typically, using the splitter to sample multiple wells at a time can make for fast paced work. Make sure to keep watch of the 5-gallon buckets used to collect/measure purged water to prevent overflow.

8. Verify the compressor has enough gasoline in its tank to perform the sampling to be done. Connect the compressor air hose to the "in" connection of the control box.
9. Verify the compression ring in the open end of the elbow joint for the tubing at the well head is in good condition. Replace if necessary.
10. Place the elbow joint and accompanying rigid tubing to the water tubing at the well head and tighten the fitting for a secure fit.
11. Place secondary containment (shallow totes or plastic sheeting) on the ground and place the 5-gallons buckets to collect the purged water within the secondary containment.
12. Prepare the sample bottles and labels for each sample to be collected.
    - Verify sample bottles, including lids and seals (if present), are intact. This can be done by removing and replacing the bottle lid, and by inspecting the lid for presence of seal, if applicable.

13. Start the compressor, turn the control box on (MP-10 or similar), and begin purging the well(s).

14. Purging will continue until the required volume of water has been removed (minimum 3 well volumes). If the well is pumped dry during purging, consult the Task Manager.

15. Once the appropriate amount of water has been purged from the well, collect a sample for groundwater quality parameters:

    - Rinse the sample cup with distilled water and fill with sample water.
    - Immerse the probes in the sample and swirl gently, keeping the probes in the sample until the display stops flashing or readings have generally stabilized.
    - Record the water quality parameters of the sample.
    - Repeat previous steps if additional readings are to be collected.
    - When finished, decontaminate the sample cup and sonde as described in SOP No. 4 Decontamination.

16. Samples for chemical analysis will be collected within 24 hours after purging is completed. For quickly recovering wells, a sample may be collected immediately after purging is completed.

    The following sampling procedure is to be used:

    a) Identification labels for sample bottles will be filled out for each well.

    b) Bottles will be kept clean and off the ground using plastic sheeting, plastic tote, or similar.

    c) If collecting a sample for VOC analysis, attempt to obtain the ideal flow rate of 200-300 mL/minute. VOC sample vials shall be completely filled so the water forms a convex meniscus at the top, then capped so that no air space exists in the vial. Turn the vial over and tap it to check for bubbles, which indicate air space.

        i. If air bubbles are observed in the sample vial, repeat the procedure until no air bubbles appear (reattempting zero headspace within a sample vial may be performed up to 3 times prior to a new sample vial being required).

    d) After VOC sample bottles are filled, sample bottles for additional analysis shall be filled in the order given below:

- Gas sensitive parameters (e.g., ferrous iron, methane, alkalinity)
- Semivolatiles organic compounds (SVOCs)
- Petroleum hydrocarbons
- Total metals (unfiltered)
- Dissolved metals (field filtered)
    - In-line filters (0.45 micron) – purge about 100-1000 mL through the filter prior to sample collection.

e) Fill bottles for metals and general minerals almost full.

f) Check sample bottle cap tightness and verify the lid of the sample bottle is tight and not cross threaded.

g) Record time of sampling in the field logbook, in the field computer, and/or on the groundwater sampling datasheet.

h) Replace "L" tubing within well

i) The well cap will be replaced and well locked.

j) Field documentation will be completed, including the chain-of-custody (SOP No. 26 Sample Control and Custody Procedures).

k) Wipe off sample bottles to remove any dirt, moisture and/or contamination that may have become adhered to the outside of the bottle.

l) Label each sample bottle. Refer to SOP No. 24 Sample Classification, Packaging and Shipping.

m) Place the sample containers on ice in a cooler to maintain the samples at approximately 4ºC as described in SOP No. 25 Sample Containers, Preservation and Holding Times.

n) Ship the cooler to the laboratory for analysis within 24-48 hours of sample collection in accordance with the procedures described in SOP No. 24 Sample Classification, Packaging and Shipping.

o) Decontaminate the sample equipment as described in detail in SOP No. 4 Decontamination.

p) Complete a field data sheet for groundwater samples with information from each sampling location. The sampling data sheet will be completely filled in. If items on the sheet do not apply to a specific location, the item will be labeled as not applicable (NA).

q) Keep field notes the field logbook and/or the field computer. Refer to SOP No. 8 Field Reporting and Documentation for additional information.

17. Once purging and sampling is completed, either turn off the compressor, or move the air hose connection to the next well to be sampled (refer to **Step 7** above for clarification).

Quality assurance/quality control (QA/QC) samples will be collected during groundwater sampling (SOP No. 23 Quality Assurance Samples).

5. Decontamination

Decontamination of any reusable field/sampling equipment will be performed as described in SOP No. 4 Decontamination.

6. Documentation

Field data sheets and a field logbook shall be completed during field activities (SOP No. 8 Field Reporting & Documentation). Both the data sheets and field logbook shall be legibly completed using indelible ink and shall be signed and dated by the person completing the page.

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to define the standard procedure and typical equipment for collection of groundwater samples in monitoring wells, extraction wells, or piezometers using low-flow techniques for Shell projects in Hartford and Roxana, Illinois. The term "Low Flow" refers to the velocity that the groundwater is removed from the soil formation immediately adjacent to the well screen.

In this technique, in order to withdraw water from within the well screen and to lessen drawdown, a pump that minimizes disturbance to the groundwater is operated at a low flow rate. The well is only purged within the screened interval until specific parameters have stabilized. Therefore, the groundwater samples collected are representative of the water bearing formation and hydraulically isolated from the water in the casing. The need to purge three well volumes, as required in traditional techniques, is not necessary with low flow purging and sampling. The low flow procedure described in this SOP is not necessarily applicable for every site or for wells screened in materials with very low permeability. This SOP serves as a supplement to information which might be in a project Work Plan and is intended to be used together with other SOPs.

2. Other SOPs referenced in this SOP

- SOP No. 3 Calibration and Maintenance of Field Instruments
- SOP No. 4 Decontamination
- SOP No. 8 Field Reporting and Documentation
- SOP No. 10 Well Gauging Measurements
- SOP No. 23 Quality Assurance Samples
- SOP No. 24 Sample Classification, Packaging and Shipping
- SOP No. 25 Sample Containers, Preservation and Holding Times
- SOP No. 26 Sample Control and Custody Procedures

3. Equipment

The following equipment is typically needed:

- Well keys
- Assorted tools (socket, screwdriver, drill, clamps, etc.)
- Water level indicator or water/product interface probe with 0.01-foot increments

- New synthetic rope (to alleviate raising and lower of the submersible pump by the electrical wires)
- Pump and required accessories (described in more detail in following section)
- Deep cycle marine battery, or vehicle battery
- Graduated cylinder, measuring cup, or similar
- Water quality parameter meter with appropriate sensors (YSI Pro DSS or similar)
- Flow-through cell
- Disposable nitrile gloves
- Paper towels or Kimwipes
- Trash bag or bucket
- Calculator/Stopwatch
- Field Logbook
- Groundwater sampling data sheet
- Chain-of-Custody form
- Waterproof permanent marker or pen
- Field computer
- Plastic buckets
- 55-gallon drums or truck-mounted tank for holding purge water
- Plastic sheeting, plastic tote, or other means of secondary containment
- Well construction information for well(s) to be sampled
- Map showing location of well(s) to be sampled
- Appropriate decontamination equipment
- Appropriate health and safety equipment (e.g., photoionization detector (PID))
- Canopy
- Cooler with ice

- Sample bottles and labels. Sample bottles with preservatives added will be obtained from the analytical laboratory. Several extra sample bottles will be obtained in case of breakage or other problems.
- Plastic sheeting, plastic tote, or other means of keeping sample bottles off the ground and clean.

4. Sampling Procedures

This section provides the step-by-step procedure for collecting groundwater samples in the field. Observations made during groundwater purging and sampling shall be recorded in the field logbook, on field data sheets, and/or in the field computer in accordance with procedures described in SOP No. 8 Field Reporting and Documentation.

The well sampling order shall be dependent on expected levels of contamination in each well, if known, and shall be determined prior to sampling. Sampling shall progress from the least contaminated to the most contaminated well, to the extent possible. Quality assurance/quality control (QA/QC) samples shall also be collected during groundwater sampling (SOP No. 23 Quality Assurance Samples).

A. Any reusable equipment used in the sampling procedure that could contact groundwater shall be properly decontaminated before each use (SOP No.4 Decontamination).

B. Equipment shall be calibrated based on the manufacturers' instructions. Refer to SOP No. 3 Calibration and Maintenance of Field Instruments for additional information.

C. Before well purging begins, the following steps shall be performed at each well:

  - Inspect the well and surrounding site for security, damage, and evidence of tampering. If damage or tampering is evident, contact the task or project manager for guidance.
  - Setup work/exclusion zone per site Traffic Control Plan.
  - Place clean plastic sheeting or similar in the work area near the well to keep equipment and sample bottles clean.
  - Measure ambient volatile organic compounds (VOCs) background levels in the immediate vicinity of the well (i.e., using a PID or similar per the Health and Safety Plan (HASP)).

- Check wind direction and stay upwind of well head to the extent possible.
- Remove the well cap and immediately measure VOCs at the rim of the well and record the readings in the field logbook, in the field computer, and/or on the groundwater sampling data sheet. Give the water in the well adequate time to reach equilibrium (check with Task Manager for details).

D. Measure the groundwater depth to the nearest 1/100-foot. A detailed description of monitoring well gauging procedures is provided in SOP No. 10 Well Gauging Measurements.

E. If NAPL is encountered during gauging, contact the task or project manager for further direction.

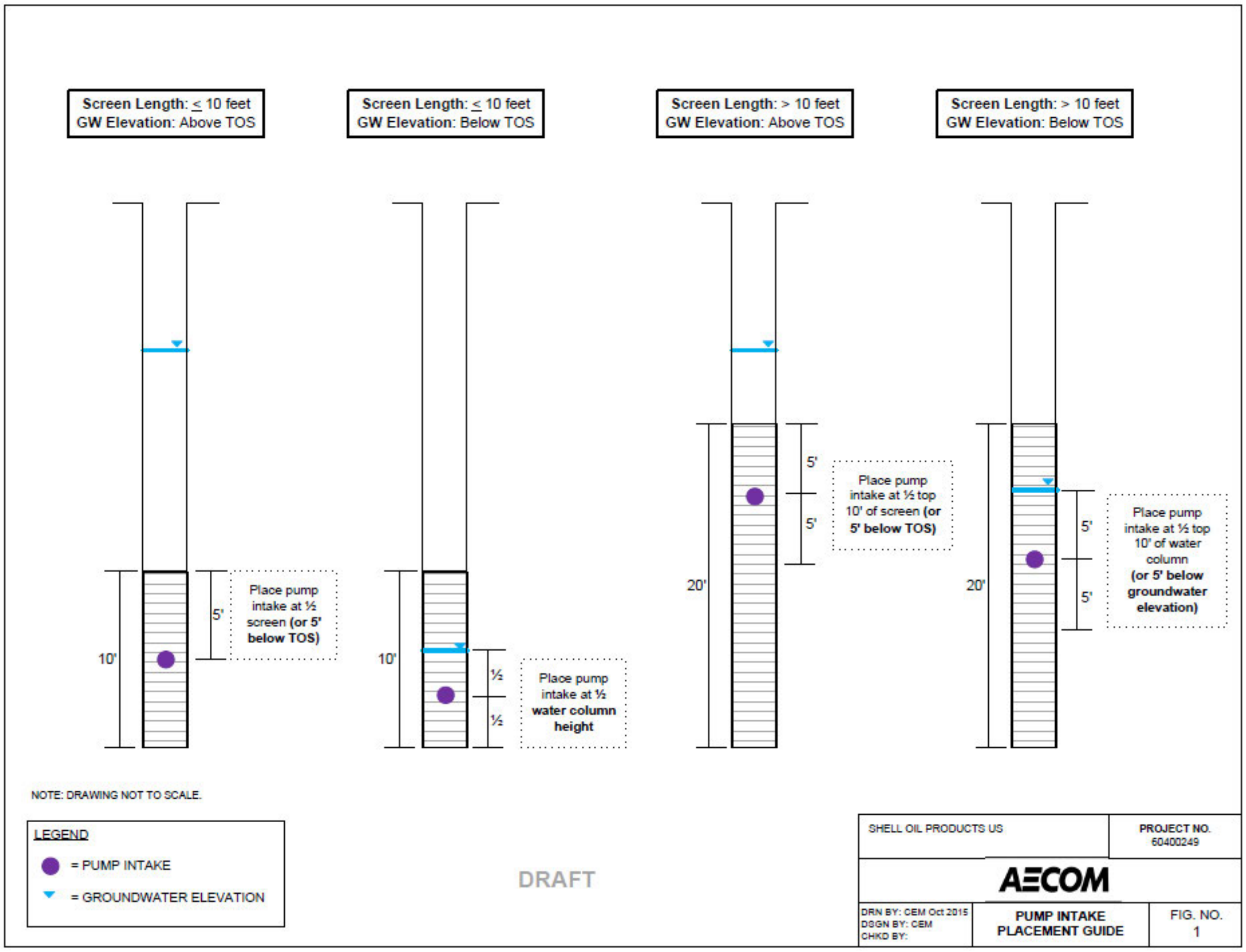
F. Slowly and carefully lower the sampling pump into the well. The pump must be capable of flow rates between about 50 and 500 mL per minute[1].

G. Place the pump intake as indicated below[2]. Measure pump placement from the top of the well down to the pump.

- If the well screen is ≤ 10 feet, place the pump intake near the midpoint of the well screen or water column, whichever is deeper.
- If the well screen is > 10 feet, place the pump intake 5 feet below the top of the well screen or water column, whichever is deeper. If water column height is < 10 feet, place pump intake at midpoint of water column.

[1] A peristaltic pump can only be used for shallow applications as it can cause degassing of groundwater and loss of volatiles. Inertial lift foot-valve type samples and bailers cause too much groundwater disturbance and shall not be used for low-flow sampling activities.

[2] In situations in which contaminants of interest are known to concentrate in a certain location of the screened zone (i.e., at the bottom), it may be desirable to position the pump intake to target this zone instead.



H. Connect tubing from the pump to the flow-through cell. Determine the volume of water to fill the flow-through cell.

I. Connect the submersible pump to the power source.

- If a deep cycle marine battery will be used, connect the pump power cord to the battery.
- If a vehicle battery with the vehicle running will be used for an adequate power supply, the following will be performed:
  - The vehicle will be positioned such that it is not over a significant amount of vegetation (e.g., vegetation shall not contact the bottom of the vehicle) and exhaust will not interfere with work area.
  - The parking brake will be applied.

- A fire extinguisher will be staged nearby for easy access, if necessary.
- Personnel will remain near the vehicle while running so the vehicle may be promptly shut off in case of fire, etc.

J. Start the pump at a low flow rate, approximately 50 to 100 mL/min or the lowest flow rate possible. The pumping rate can be increased up to 200 to 300 mL/min, which is the optimum flow rate for sampling VOCs[3].

K. Continue collecting water level measurements after every flow-through cell volume until the measurements indicate that significant drawdown is not occurring.

- Drawdown shall not exceed 25% of the distance between the top of the well screen and the pump intake. For example, for a 4-foot screen (saturated), the pump shall be placed at the midpoint of the screen (two feet from the top of the screen to the pump intake). With a safety factor of 25%, this would require drawdown not to exceed six inches.
- If drawdown exceeds 25% of the distance from the pump intake to the top of the screen even while pumping is occurring at the lowest flow rate possible, samplers shall contact the task manager.

L. Collect parameter readings after each flow-through cell volume. Record parameter readings on the groundwater sampling data sheet, in the field logbook, and/or in the field computer. The time between parameter measurements is calculated as follows:

$$T = \frac{V}{Q}$$, where

T = time between measurements (minutes)

V = volume of the flow-through cell (liters)

Q = purge flow rate (liters per minute)

[3] Low flow sampling can be performed up to 500 mL/min as long as significant drawdown does not occur.

M. Purging will continue until specific parameters have stabilized over three consecutive flow-through cell volumes (**4 consecutive readings**) or until a specific time requirement is met, whichever happens first.

- **Table 1** provides guidelines that may be used for parameter stabilization as specified by USEPA, ASTM, and in the Nielsen and Nielsen Technical Guidance on Low-Flow Purging and Sampling and Minimum-Purge Sampling (Nielsen and Nielsen, 2002).
- **Table 2** provides the guidelines to be used for groundwater sampling activities on Shell projects. **Table 2** combines relevant stabilization guidelines from **Table 1** in combination with limitations in accuracy for readings collected by the YSI Pro DSS (typical low flow equipment used on the Shell groundwater projects).

Table 1. Stabilization Guidelines for Low-Flow Sampling

Parameter	Stabilization Guidelines		
	EPA	ASTM	Nielsen & Nielsen
DO	+/- 10% or <0.5 mg/L	+/- 10% or +/-0.2 mg/L, whichever is greatest	+/- 10% or +/-0.2 mg/L, whichever is greatest
ORP	+/- 10 mV	+/- 20 mV	+/- 20 mV
PH	+/- 0.1 units	+/- 0.2 units	+/- 0.2 units
Specific Conductivity	+/- 3%	+/- 3%	+/- 3%
Temperature	+/- 3%	Not Specified	+/- 0.2 ºC
Turbidity	+/- 10% or <5 NTU	Not Specified	Not Specified

Table 2. Stabilization Guidelines used for GW Sampling

Parameter	Stabilization Guidelines (using above standards combined with YSI Pro DSS, or similar accuracies)
DO	+/- 10% or +/-0.2 mg/L, whichever is greatest
ORP	+/- 20 mV
PH	+/- 0.2 units
Specific Conductivity	+/- 5% or +/-2µs/cm
Temperature	Not Specified; Monitor and record
Turbidity	Visually Sediment Free, when practical; Monitor and record

- A canopy or other may be utilized, as feasible, in an effort to shield the flow-through cell from the weather and elements that may interfere with stabilization parameter readings (i.e. sun and wind).
- If, after a considerable number of readings have been taken, parameters have not stabilized, samplers shall contact the task or project manager for further guidance.
- For Rand and Roxana GW sampling activities, contact the Task Manager after two hours of purging for further guidance.

N. After the relevant parameters have stabilized, disconnect or bypass the flow-through cell for sampling.

O. A new pair of disposable nitrile gloves shall be put on immediately before sampling.

P. Verify sample bottles, including lids and seals (if present), are intact. This can be done by removing and replacing the bottle lid, and by inspecting the lid for presence of seal, if applicable.

Q. Collect the sample directly from the tubing (e.g. sample shall not flow through the flow-through cell while filling bottle sets). Do NOT allow the sample tubing to come into contact with the sample bottles, and do NOT place sample bottles on the ground (e.g., place bottles in plastic tub, on plastic sheeting, or similar).

R. The constituents will be sampled for in the order given below:

- VOCs – Vials shall be completely filled so the water forms a convex meniscus at the top, then capped so that no headspace exists in the vial. Turn the vial over and tap it to check for bubbles, which indicate headspace. If air bubbles are observed in the sample vial, remove the lid and attempt to fill the vial two more times (being careful not to dump out any groundwater or preservative, if applicable, currently in the vial). If air bubbles are present twice more, discard the sample vial and repeat the procedure with a new vial. If, after three attempts, air bubbles are still in the vial, contact the Task Manager, make a note of this in the field logbook and on the chain-of-custody (COC), and place the vial in the cooler.

- Gas sensitive parameters (e.g., ferrous iron, methane, alkalinity)
- Semivolatile organic compounds, polynuclear aromatic hydrocarbons (PAHs) pesticides, polychlorinated biphenyls, and herbicides
- Total petroleum hydrocarbons (TPH)
- Total metals (unfiltered)
- Explosives
- Any filtered analytes (use in-line filters if possible) – About 100-1000 mL shall be purged through the filter prior to sample collection

S. Check sample bottle cap tightness and verify the lid of the sample bottle is tight and not cross threaded.

T. Wipe off sample bottles to remove any dirt, moisture and/or contamination that may have become adhered to the outside of the bottle.

U. Label each sample bottle. Refer to SOP No. 24 Sample Classification, Packaging and Shipping.

V. Place the sample containers on ice in a cooler to maintain the samples at approximately 4ºC as described in SOP No. 25 Sample Containers, Preservation and Holding Times.

W. Remove the interface probe from the well and decontaminate (SOP No. 4 Decontamination).

X. Turn off the pump and remove from the well.

Y. Place designated tubing within a plastic zipper bag labeled with the well ID. If tubing is not to be saved, properly dispose (contact the IDW Coordinator or designee).

Z. Sample equipment shall be decontaminated (SOP No. 4 Decontamination).

AA. Record time of sampling and constituents to be analyzed for in the field logbook, in the field computer, and/or on the groundwater sampling data sheet.

BB. Chain-of-custody procedures shall be started (SOP No. 26 Sample Control and Custody Procedures).

CC. Ship the cooler to the laboratory for analysis within 24-48 hours of sample collection in accordance with the procedures described in SOP No. 24 Sample Classification, Packaging and Shipping.

DD. PPE and other disposable supplies will be containerized and disposed of appropriately. Check with IDW Coordinator for further instructions.

EE. Record all pertinent information in the field logbook, field computer, and/or on all field sheets. Refer to SOP No. 8 Field Reporting and Documentation for additional information.

5. Decontamination

Decontamination of any reusable field/sampling equipment will be performed as described in SOP No. 4 Decontamination.

6. References

ASTM D6771-02, Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations, American Society for Testing and Materials. Dated September 1, 2018.

Nielsen, David and Nielsen, Gillian. Technical Guidance on Low-Flow Purging and Sampling and Minimum-Purge Sampling. Second Edition. NEFS-TG001-02. April 2002.

USEPA. Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells. EQA SOP – GW4. Dated July 3, 1996, revised September 19, 2017.

USEPA. Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures. EPA/540/S-95/504. Dated April 1996.

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to provide the standard procedure for developing or redeveloping a groundwater monitoring well. The objective of groundwater monitoring well development or redevelopment is to clear the well of accumulated sediments so that representative groundwater samples and water quality measurements and/or water levels may be collected for Shell projects in Hartford and Roxana, Illinois. Development activities are typically performed when a well, intended for sampling, is installed. Redevelopment activities are typically performed based on the following criteria[1]:

- If the well is sampled as part of a routine groundwater sampling program, when 10% or more of a well screen has been occluded by sediment; or
- If the well in only gauged (and not sampled) as part of a routine groundwater sampling program, when 75% or more of a well screen has been occluded by sediment.

Accumulated sediments are typically suspended in the water column in order to be removed. This procedure discusses the use of a check valve with an actuator pump to suspend and remove sediments. Other methods to suspend sediments include:

- using a surge block,
- injecting air into the water column of the well, or
- using a submersible pump, an air bladder pump, air-lift, or a bailer.

This SOP serves as a supplement to information which might be in a project Work Plan or scope of work and is intended to be used together with other SOPs.

2. *Other SOPs referenced in this SOP:*

- SOP No. 4 Decontamination
- SOP No. 8 Field Reporting and Documentation
- SOP No. 10 Well Gauging Measurements

3. *Equipment*

Information and equipment typically used during well development includes:

- Well installation information
- Well keys
- Disposable latex or nitrile gloves

- Assorted tools (drill, safety utility knife, screwdriver, tubing cutters, etc.)
- Pump and required accessories (battery, tubing, control box, etc.) or air-lift equipment (typically provided by a subcontractor)
- Electronic water level indicator or oil/water interface probe with 0.01-foot increments
- Graduated cylinder, measuring cup or similar
- Paper towels or Kimwipes (decontamination equipment)
- Calculator
- Bound field logbook and/or groundwater (re)development sheet
- Waterproof pen or permanent marker
- Plastic Buckets or truck-mounted poly tank
- Plastic sheeting, plastic tote, or other means of secondary containment to use during purging
- 55-gallon drums or portable tanks, if needed
- Appropriate health and safety equipment (e.g. photoionization detector (PID), etc.)

Additional equipment typically used during well (re)development for wells with LNAPL includes:

- Water/product interface probe with 0.01-foot
- *NuWell 220* dispersant polymer

4. Procedure if no LNAPL present

The following procedures will be used when using a check valve with an actuator pump (i.e., Waterra Hydrolift II) to develop a new well or redevelop an existing well which does NOT contain LNAPL.

1. Put on a new, unused pair of disposable latex or nitrile gloves.
2. Approach the well from upwind, unlock and remove the well cap, and monitor the air quality at the well head and in the breathing zone with a PID.

[1] Redevelopment criteria presented are guidelines based on site knowledge and experience and are not a formal or regulatory requirement.

3. Measure the depth to groundwater to the nearest hundredth of a foot (SOP No. 10 Well Gauging Measurements).
4. Measure the total depth of the well to the nearest hundredth of a foot (SOP No. 10 Well Gauging Measurements). Note whether the bottom of the well feels hard or soft (this may be easier to determine with a weighted tape measure).
5. Remove the water level indicator or interface probe from the well and decontaminate.
6. Calculate the amount of water to be removed.

   installed depth – depth to water = height of water column

   height of water column * gallons/foot conversion = 1 well volume

Well Diameter	Gal/ft Conversion
0.75 inch	0.0229
1 inch	0.0408
1.5 inches	0.0918
2 inches	0.163
4 inches	0.652
6 inches	1.468

   - For Development of newly installed wells: Remove 1x the amount of water added by drillers during installation, along with 5 well volumes of water.
   - For Redevelopment of existing wells: Remove 3 well volumes of water.

7. Attach a stainless-steel check valve to the appropriately sized
   - Waterra SS-19 standard flow check valve threads onto 1/2-inch inner diameter by 5/8-inch outer diameter HDPE tubing
     - May be used for wells up to 100 feet below ground surface
   - Waterra SS-32 high flow check valve threads onto 3/4-inch inner diameter by 1-inch outer diameter HDPE tubing
     - Recommended for wells deeper than 100 feet below ground surface
8. Lower check valve end of tubing into the well until the check valve reaches the bottom of the well.
9. Hang the Waterra Hydrolift, or similar actuator, on the well protector, if possible, and secure with ratchet strap. If this is not possible, find some other way to mount and

secure or stabilize the actuator near and above the well pipe (i.e., stabilized with sandbag on the ground for a flush-mounted well).

10. Install the clamp arm into the top slot of the clamp arm support at the appropriate location for tubing placement within the center of the well pipe. Secure the clamp arm with the cotter pin.
11. Ensure check valve is resting at the bottom of the well. Ensure the actuator is resting as its lowest stroke position. This will ensure that any sediment at the bottom of the well will be suspending during (re)development.
12. Close the tubing clamp bracket with the tubing extending through the correct slot for its size (tight fit but tubing not crimped).
    - If the tubing is not a snug fit into one of the slots, hose clamps will be required above and below the tubing clamp bracket.
13. Tighten tubing clamp bracket by screwing down the knob.
14. Cut the tubing to the desired length for collection of discharged groundwater.
15. Secure the discharge end of the tubing into a drum, bucket, poly tank or similar purge water collection vessel.
16. Plug the power cord for the actuator into a generator or inverter.
17. Turn the pump on. Adjust the speed/pumping rate as possible/necessary to pump at a sufficient rate to allow the sediments to be removed.
    - The actuator and check valve surge the well screen and purge the groundwater at the same time.
18. (Re)Development is potentially completed when the following criteria have been achieved:
    - Water being purged is visually sediment free.
    - Required volume of water has been removed (refer to Step 6 above).
    - Installed depth is measured.
19. Once (re)development is thought to be completed, turn off the actuator and unplug the power cord.
20. Open the tubing clamp bracket and free the tubing.
21. Remove the tubing and check valve from the well. Attempt to roll/coil tubing during removal.

22. Re-measure the total well depth.

$$\frac{\text{installed total well depth} - \text{sump length} - \text{measured total well depth}}{\text{screen length}}\ (100\%) = \%\ \text{occlusion}$$

- If the measured depth indicates 10% or more occlusion for sampled well screens (or 75% or more occlusion for gauged well screens), repeat steps 8 through 21.
- If the measured depth indicates less than 10% well screen occlusion for sampled wells (or less than 75% well screen occlusion for gauged wells) and sediment has been removed from the screen to the extent practicable, go to Step 23.

23. Remove (unthread) check valve from end of tubing. Appropriately discard tubing (check with IDW Coordinator for further instruction) or designate for future use.

24. Decontaminate check valve (SOP No. 4 Decontamination)

Note in the field logbook and on any field datasheets the approximate number of gallons of water removed during development of each well, well screen depth interval, depth to bottom prior to well development, and depth to bottom after well development.

5. Procedure if LNAPL is present

The following procedures will be used when using a check valve with an actuator pump (such as the Waterra Hydrolift II) to develop a new well or redevelop a submersible pump to develop a new well or redevelop an existing well in which LNAPL is observed. The procedures below assume that **Steps 1** and **2** in **Section 4** above have been completed

1. Measure the total depth of the well to the nearest hundredth of a foot. Note whether the bottom of the well feels hard or soft.

2. Calculate the amount of water to be removed.

   installed depth – depth to water = height of water column

   height of water column * gallons/foot conversion = 1 well volume

Well Diameter	Gal/ft Conversion
0.75 inch	0.0229
1 inch	0.0408
1.5 inches	0.0918
2 inches	0.163
4 inches	0.652
6 inches	1.468

6. Add *NuWell 220*, or similar, dispersant polymer into the well in accordance with the dosage guide below or the manufacturer's dosage recommendations

   - 2" monitoring well – add 0.12 ounces per foot of water within the well (Example: 20-foot deep 2" monitoring well, DTW = 7 feet;

     13 feet of water * 0.12 ounces per foot = 1.56 oz of *NuWell 220*)

   - 4" monitoring well – add 0.46 ounces per foot of water within the well.

7. Complete **Steps 7** through **24** in **Section 4** above.

Note in the field logbook and on any field data sheets the amount of *NuWell 220*, or similar, dispersant polymer added to the well, the approximate number of gallons of water removed during development of each well, well screen depth interval, depth to bottom prior to well development, and depth to bottom after well development.

7. Documentation

A Groundwater Monitoring Well Development datasheet or Groundwater Monitoring Well Redevelopment datasheet shall be completed for each well. A field logbook shall also be kept during field activities (SOP No. 8 Field Reporting & Documentation). Both the data sheets and field logbook shall be legibly completed using indelible ink and shall be signed and dated by the person completing the page.

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to define the standard Quality Assurance/Quality Control (QA/QC) samples for Shell projects in Hartford and Roxana, Illinois. QA/QC samples are typically collected during field studies for various purposes which include the isolation of site effects (control samples), define background conditions (background sample), and evaluate field/laboratory variability (e.g., matrix spikes/matrix spike duplicates (MS/MSDs), equipment blanks, trip blanks, duplicates, split samples). This SOP serves as a supplement to information which might be in a project Work Plan or scope of work and is intended to be used together with other SOPs.

2. Other SOPs referenced in this SOP

- SOP No. 24 Sample Classification, Packaging and Shipping
- SOP No. 26 Sample Control and Custody Procedures

3. Equipment

The following equipment is typically used:

- Insulated coolers (hard plastic or metal)
- Nitrile gloves, or similar
- Field forms such as Chain of Custody (COC) or sample collection sheet
- Custody seals
- Logbook
- Ice
- Protective packing material (e.g. bubble wrap, protective foam pack)
- Re-sealable storage bags
- Sample containers and labels
- Waterproof pen/marker
- Trash bags, or laboratory provided cooler lining bags

3. QA/QC Samples

Refer to the scope of work for a description of relevant QA/QC samples.

- Background Sample – A sample (usually a grab sample) collected from an area, water body, or site similar to the one being studied, but located in an area known or thought to be free from pollutants of concern.
- Split Sample – Two or more representative subsamples taken from one environmental sample in the field. Prior to splitting, the environmental sample is homogenized to correct for sample heterogeneity that would adversely impact data comparability. Field split samples can be analyzed by different laboratories (interlaboratory comparison) or by the same laboratory (intralaboratory comparison). Field splits are typically used to assess sample handling procedures from field to laboratory and laboratory's comparability.
- Field Duplicate – Field duplicates are samples collected side by side or by collecting one sample and immediately collecting the second sample. Field duplicates represent the precision of the whole method, site heterogeneity, field sampling and the laboratory analysis. When results for both duplicate and sample values are greater than 5 times the practical quantitation limit (PQL), satisfactory precision is indicated by a relative percent difference (RPD) less than or equal to 25% for aqueous and soil vapor samples, and 50% for soil samples. Where one or both of the results of a field duplicate pair are reported at less than 5 times the PQL, satisfactory precision is indicated if the field duplicate results agree within 2 times the quantitation limit for aqueous samples and within 5 times the quantitation limit for soil samples. Field duplicate results that do not meet these criteria may indicate unsatisfactory precision of the results.
- Trip Blanks – A sample, which is supplied by the laboratory, using analyte free and headspace free water prior to the sampling event and is stored with the investigative sample bottles and samples throughout the sampling event. They are then packaged for shipment with the other samples and submitted for analysis. At no time after their preparation are trip blanks to be opened before they reach the laboratory. Trip blanks are used to assess volatile organic compound (VOC) cross contamination of samples during storage and/or transportation back to the laboratory (a measure of sample handling variability resulting in positive bias in contaminant concentration). If VOC samples are shipped, trip blanks are required for each cooler containing VOC samples.

- Equipment Blanks – A sample collected using distilled or deionized water which has been collected using decontaminated investigative sample collection equipment in the same manner that investigative samples are collected (e.g. run over/through equipment). In the case of groundwater collection pumps, a new/clean section of tubing shall be attached to the pump and used to collect the equipment blank sample, in the same manner as the collection of investigative samples. The equipment blank sample identifies contamination resulting from the field equipment, sampling procedure, sample container, or preservative. Equipment blanks are often associated with collecting rinse blanks of equipment that has been field cleaned. Equipment blanks shall be labelled with the ID of the next sample to be collected.
- Temperature Blanks – A container of water shipped with each cooler of samples requiring preservation by cooling to ≤ 6°C (ice). The temperatures of the blanks are measured at the time of sample receipt by the laboratory.
- Field Blanks – A sample that is prepared in the field to evaluate the potential for contamination of a sample by site contaminants from a source not associated with the sample collected (for example air-borne dust or organic vapors which could contaminate a soil sample). Analyte-free water is taken to the field in sealed containers or generated on-site. The water is poured into the appropriate sample containers at pre-designated locations at the site. Field blanks shall be collected in dusty environments and/or from areas where volatile organic contamination is present in the atmosphere and originating from a source other than the source being sampled.
- Material Blanks – Samples of sampling materials (e.g., material used to collect/wipe samples, etc.), construction materials (e.g., well construction materials), or reagents (e.g., organic/analyte free water generated in the field, water from local water supplies used to mix well grout, etc.) collected to measure any positive bias from sample handling variability. Commonly collected material blanks are listed below:
    - <u>Wipe Sample Blanks</u> – A sample of the material used for collecting wipe samples. The material is handled, packaged, and transported in the same manner as all other wipe samples with the exception that it is not exposed to actual contact with the sample medium.
    - <u>Grout Blanks</u> – a sample of the material used to make seals around the annular space in monitoring wells.
    - <u>Filter Pack Blanks</u> – a sample of the material used to create an interface around the screened interval of a monitoring well.

  - Construction Water Blanks – a sample of the water used to mix or hydrate construction materials such as monitoring well grout.

  - Organic/Analyte Free Water Blanks – a sample collected from a field organic/analyte free water generating system. The sample is normally collected at the end of sampling activities since the organic/analyte free water system is recharged prior to use on a study. On large studies, samples can be collected at intervals at the discretion of the project leader. The purpose of the organic/analyte free water blank is to measure positive bias from sample handling variability due to possible localized contamination of the organic/analyte free water generating system or contamination introduced to the sample containers during storage at the site. Organic/analyte free water blanks differ from field blanks in that the sample shall be collected in as clean an area as possible (a usual location for the organic/analyte free water system) so that only the water generating system/containers are measured.

- Matrix Spike – A sample collected in the same manner as the investigative sample, with known concentrations of analytes added by the laboratory prior to laboratory analysis, which is introduced into a second aliquot. The spiked sample is processed through the entire analytical procedure. Analysis of the matrix spike is used to assess the accuracy and precision of the analytical process on an analytical sample in a particular matrix and can be indicative of matrix effects/analyte recoveries. A group of up to 20 field samples of the same matrix (e.g., water, soil, sediment, waste) being analyzed for the same constituents may be associated with a single matrix spike (MS) sample of a matrix spike/matrix spike duplicate (MS/MSD) pair.

- Matrix Spike Duplicate – A sample collected in the same manner as the investigative sample, with known concentrations of analytes added by the laboratory prior to laboratory analysis (same concentrations of analytes as the matrix spike), which is introduced into a third sample aliquot. The spiked sample is processed through the entire analytical procedure. Analysis of the matrix spike duplicate is an additional measure of accuracy and precision.

4. Sample Containers

Certified commercially clean sample containers shall be supplied by the contract analytical laboratory. The lab shall indicate the type of sample to be collected in each bottle type, and the preservative (if applicable) of each bottle. A work plan or other project documentation may list the appropriate sample containers for the specific analyses require for each project/task.

5. Sample Preservation

Samples shall be preserved prior to, or at the time of the sample collection. Chemical preservatives, if necessary, are typically added to the sample containers by the laboratory prior to shipment to the field.

After QA/QC sample collection, the QA/QC sample shall be recorded on the chain of custody (COC) (see SOP No. 26 Sample Control and Custody Procedures for additional information). Each container shall be labeled and stored on ice at $\leq 6°C$ in an insulated cooler until packed for shipment to the laboratory. The ice or the sample bottles shall be bagged in sealed storage bags, or as otherwise recommended by the laboratory. Freezing samples shall not be permitted. Any breakable sample bottles need to be wrapped in protective packing material (e.g., bubble wrap, protective foam pack) to prevent breakage during shipping (see SOP No. 24 Sample Classification, Packaging and Shipping for additional information).

6. QA/QC Sample Collection Frequency

The table below outlines common frequencies for QA/QC sample collection. Refer to the project work plan or scope of work for a description of relevant QA/QC samples.

QA/QC Sample	Frequency
Background Sample	Optional/Project or Task Specific
Split Sample	Optional/Project or Task Specific
Field Duplicate Sample	One per 10 samples collected per matrix; Project or Task Specific
Trip Blank	One per cooler containing VOC samples; Project or Task Specific
Equipment Blanks	One per 10 samples collected; Project or Task Specific
Temperature Blanks	Laboratory specific; One per cooler; Project or Task Specific
Field Blanks	Optional/Project or Task Specific; One per 20 samples collected per matrix
Material Blanks	Optional/Project or Task Specific; One per matrix
Matrix Spike	One per 20 samples collected per matrix; Project or Task Specific
Matrix Spike Duplicate	One per 20 samples collected per matrix; Project or Task Specific

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to define the standard protocols for soil and groundwater sample identification, labeling, packaging, and shipping for Shell projects in Hartford and Roxana, Illinois. This SOP serves as a supplement to information which might be in a project Work Plan or scope of work and is intended to be used together with other SOPs.

3. Other SOPS referenced in this SOP

- SOP No. 8 Field Reporting and Documentation
- SOP No. 26 Sample Control and Custody Procedures
- SOP No. 51 Vapor Sampling Classification, Packaging and Shipping
- SOP No. 58 Westhollow LNAPL Sampling

2. Equipment

The following equipment is typically needed for sample identification, packaging and shipping:

- Field forms such as Chain of custody (COC) or sample collection sheet
- Sample bottles (laboratory provided)
- Sample labels
- Waterproof pen or similar
- Trash bag or similar for lining cooler
- Bubble wrap, and/or protective foam pack
- Ice
- Re-sealable storage bags
- Custody seal
- Clear packing tape
- Shipping label
- Waterproof cooler (hard plastic or metal)

3. Procedures

Sample Identification

Samples collected during site activities shall have discrete and site-specific sample identification code (ID). These sample IDs are necessary to identify and track each of the many samples collected for analysis during the life of project. In addition, the sample IDs can be used in a database to identify and retrieve the analytical results received from the laboratory.

Each sample is identified by a unique code which indicates the specific project, site identification, sample location number, sample matrix identifier, sample depth, and/or date. If used, sample matrix identifiers may include the following:

CPT –	Cone Penetrometer Testing
DUP –	Duplicate Sample
EB –	Equipment Blank
GP –	Geoprobe
GWP –	Groundwater Profile
LNAPL –	Light non-aqueous phase liquid
MS –	Matrix Spike Sample
MSD –	Matrix Spike Duplicate Sample
MW –	Monitoring Well
PM –	Performance Monitoring
PZ –	Piezometer
RAND –	Rand Site
ROST –	Rapid Optical Screening Tool
ROX –	Roxana Site
TB –	Trip Blank
VMP –	Vapor Monitoring Point
WRR –	Wood River Refinery

An example of the sample identification number codes for a groundwater monitoring well sample collected for field analysis for the Shell Sites will be:

MW13-PROJ-070713-EB.

Where "MW" indicates Monitoring Well, "13" indicates the well location, "PROJ" indicates the abbreviated project name (ROX, WRR, etc.), "070713" indicates the date, and "EB" indicates an equipment blank.

The project abbreviation, sample sequence, sampling locations, and sample type will be established prior to field activities for each sample to be collected. On-site personnel will obtain assistance from the Task or Project Manager in defining any special sampling requirements.

Sample Labeling

1. Fil out sample labels using black waterproof ink.
2. A designated member of the sampling team shall fill out sample labels as completely as possible prior to beginning field sampling activities each day. Below is information typically included on a sample label:
   - Sampler's company affiliation
   - Project/Site location
   - Sample identification code
   - Date and time of sample collection
   - Analyses required
   - Method of preservation or preservative (if any)
   - Sample matrix (i.e., soil, groundwater, surface water)
   - Sampler's signature or initials.
3. Complete the date, time and sampling initials/signature at the time of sample collection. Wiped off the sample bottle to remove any dirt, moisture and/or contamination that may have become adhered to the outside of the bottle.
4. Affix the sample label(s) to the sample bottle(s).
5. Apply clear tape over the label in order to keep the label attached to the sample and to keep the label legible.

   a. If waterproof or weatherproof labels are used to label sample bottles, clear tape is NOT required.

   b. If a sample bottle displays a tared weight from the laboratory, clear tape will NOT be used.

Sample Packaging and Shipping

For packaging and shipping of air or soil vapor samples, refer to SOP No. 51 Vapor Sampling Classification, Packaging and Shipping. For packaging and shipping of LNAPL samples, refer to SOP No. 58 Westhollow LNAPL Sampling. Below describes packaging and shipping procedures for water and soil samples.

1. Store sample bottles on ice at ≤6°C in an insulated cooler until packed for shipment to the laboratory.
2. For shipment, Line coolers with a trash bag or similar.
3. Verify caps of sample bottles are tight and not cross threaded.
4. Wiped off sample bottle to remove any dirt, moisture and/or contamination that may have become adhered to the outside of the bottle.
5. To the extent possible, wrap sample containers in protective packing material (e.g., bubble wrap, protective foam pack), and place in re-sealable storage bag(s).
6. Place bagged samples right side up in a lined cooler and surround with ice.
7. Place a temperature blank within each sample cooler for temperature measurements per laboratory specific requirements.
8. Place a trip blank sample within each sample cooler containing samples for VOC analysis.
9. Complete a chain-of-custody (COC) form (placed in a separate sealed storage bag).
   a. The COC may be specific to the samples included within each shipping container or may be comprehensive of all samples collected during a particular day/sampling period, regardless of the number of shipping containers.
10. Place a custody seal over the lid and body of the cooler on the side from which the cooler is opened.
11. Wrap the cooler with clear packing tape, including over the custody seal, for delivery to the laboratory.

12. Hand deliver sample cooler(s) or ship by overnight express carrier for delivery to the analytical laboratory. Samples shall be shipped or delivered daily to the laboratory. Daily deliveries help ensure hold times are met in the event laboratory re-analyses are needed or there are carrier delays including any packages lost in transit.

Sample Documentation and Tracking

Field Notes - Documentation of observations and data acquired in the field will be recorded on field sampling sheets, in a bound field logbook and/or in a field computer to provide a permanent record of field activities. Refer to SOP No. 8 Field Reporting and Documentation for additional information.

Sample Chain-of-Custody - During field sampling activities, traceability of the sample must be maintained from the time the samples are collected until laboratory data are issued. The sampling team member(s) will be responsible for initiating and filling out the COC form during sample collection. Information on the custody, transfer, handling, and shipping of samples will be recorded on a COC form.

A member of the sampling crew will sign the COC form over to the person or party responsible for delivery of the samples to the laboratory, retain a copy of the COC form, document the method of shipment, and send the original COC form with the samples. Additionally, an electronic copy of the COC shall be forwarded to applicable project contacts (e.g., task manager, project chemist, etc.). Each time custody of the samples is transferred, the COC shall be signed by both parties. Refer to SOP No. 26 Sample Control and Custody Procedures for additional information about COCs.

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to define the standard protocols for sample containers, preservation and hold times for Shell projects in Hartford and Roxana, Illinois. This SOP serves as a supplement to information which might be in a project Work Plan or scope of work and is intended to be used together with other SOPs.

2. Other SOPs referenced in this SOP

- SOP No. 24 Sample Classification, Packaging and Shipping

3. Equipment

The following equipment is typically required for this SOP:

- Waterproof coolers (hard plastic or metal)
- Custody seals
- Field forms such as Chain of Custody (COC) or sample collection sheet
- Field notebook
- Ice
- Bubble wrap, and/or protective foam pack
- Clear packing tape
- Re-sealable storage bags
- Sample containers and labels
- Waterproof pen
- Permanent marker
- Nitrile gloves, or similar
- Trash bags, or laboratory provided cooler lining bags

4. Sample Containers

Certified commercially clean sample containers will be obtained from the contract analytical laboratory. The lab will indicate the type of sample to be collected in each bottle type, and the preservative (if applicable) of each bottle. The work plan may list the appropriate sample containers for the specific analyses required for each project.

5. Sample Preservation

Samples will be preserved prior to, or at the time of the sample collection, if applicable. Chemical preservatives, if necessary, are typically added to the sample containers by the laboratory prior to shipment to the field. In some cases, preservatives may be added to the sample containers in the field by sampling personnel.

After sample collection, each container will be labeled and stored on ice at ≤6°C in an insulated cooler until packed for shipment to the laboratory. The ice or samples will be bagged per laboratory specific requirements. Freezing samples will not be permitted. Any breakable sample bottles need to be wrapped in protective packing material (e.g., bubble wrap, protective foam pack) to prevent breakage during shipping. Refer to SOP No. 24 Sample Classification, Packaging and Shipping for additional information.

6. Sample Hold Times

Samples will be hand delivered or shipped via overnight express carrier for delivery to the analytical laboratory. All samples must be shipped for laboratory receipt and analyses as soon as possible and within specific holding times. This may require daily shipment of samples with short holding times. The hold time varies for each type of analysis, and therefore, it will be necessary to check with the lab to verify the hold times to determine how frequently samples need to be sent to the lab. Typical hold times are provided in **Table 1**.

Table 1 Typical Sample Holding Times & Preservation

Analysis	Holding Time	Preservation
Alkalinity	14 days	Cool to ≤6°C
Ammonia NH3	28 days	Cool to ≤6°C - H2SO4 to pH<2
Asbestos	1 year	None
BOD 5	48 hours	Cool to ≤6°C
BOD 5 Inhibited	48 hours	Cool to ≤6°C
BTEX	14 days	Cool to≤6°C; HCl
Chloride	28 days	Cool to ≤6°C
Chlorophyll	24 hrs to filtration - 28 days after filtration	Freeze filters in 90% acetone
Chromium VI (Hexavalent) in water	24 hours	Cool to ≤6°C
COD	28 days	Cool to ≤6°C - H2SO4 to pH<2
Conductivity	28 days	Cool to ≤6°C
Cyanide in Soil	14 days	Cool to ≤6°C
Cyanide in Water	14 days	Cool to ≤6°C NaOH to pH>12; 0.6 g ascorbic acid

Table 1 Typical Sample Holding Times & Preservation

Analysis	Holding Time	Preservation
EDB/DBCP	14 days	Cool to≤6°C; pH<2 (zero headspace)
Fluoride in Soil	28 days	Cool to ≤6°C
Fluoride in Water	28 days	Cool to ≤6°C
Grain Size Sediment	6 months	None required
Guaiacols/Catechols/Phenols	30 days	Cool to≤6°C; H2SO4 to pH<2
Halogenated Hydrocarbons HH	7 days water/14 days soil	Cool to ≤6°C
Hardness	6 months	HNO3 to pH<2
Herbicides	7 days water/14 days soil	Cool to ≤6°C
Hydrocarbon chlorinated	7 days water/14 days soil	Cool to ≤6°C Ascorbic acid
Ignitability	None	Cool to ≤6°C
Iron and sulfur bacteria	6 hours	Cool to≤6°C; 0.008% Sodium Thiosulfate
Mercury in Water	28 days	Cool to≤6°C; HNO3 to pH<2
Metals -- Except Cr(6) and Hg	180 days	HNO3 to pH <2
Metals, dissolved	6 months	Filter - then add HNO3 to pH<2
Nitrate NO3-	48 hours	Cool to ≤6°C
Nitrate-Nitrite	28 days	Cool to≤6°C; H2SO4 to pH<2
Nitrite NO2-	48 hours	Cool to ≤6°C
Nitrogen Pesticides	7 days water/14 days soil	Cool to ≤6°C
TPH DRO/ORO	7 days water/14 days soil	Cool to ≤6°C
TPH GRO	14/14 days	Cool to ≤6°C pH<2 (zero headspace)
Oil & Grease in Water	28 days	Cool to≤6°C; HCl to pH<2
Oil and Grease in Soil	28 days	Cool to ≤6°C
PAH Hazardous Waste Designation w/o HPLC	7 days water/14 days soil	Cool to ≤6°C
PAH Polynuclear Aromatic Hydrocarbons	7 days water/14 days soil	Cool to ≤6°C
PCBs only	7 days water/14 days soil	Cool to ≤6°C
Percent Solids Soil/Tissue	7 days	Cool to ≤6°C

Table 1 Typical Sample Holding Times & Preservation

Analysis	Holding Time	Preservation
Personal Monitors	None	None
Pesticides/PCBs	7 days water/14 days soil	Cool to ≤6°C
pH	24 hours	Cool to ≤6°C
Phenolics in Soil (4AAP)	28 days	Cool to ≤6°C
Phenolics in Water (4AAP)	28 days	Cool to≤6°C; H3PO4; FeSO4 and CuSO4
Phosphorus, Total and Dissolved	28 days	Cool to≤6°C; H2SO4 to pH<2
PM10	1 year	Cool to ≤6°C
PM2.5	30 days	Cool to ≤6°C
Semivolatile Organics /SVOCs	7 days water/14 days soil	Cool to ≤6°C
Settleable Solids (SS)	48 hours	Cool to ≤6°C
Specific conductance	28 days	Cool to ≤6°C
Sulfate	28 days	Cool to ≤6°C
Sulfide	7 days	Zinc acetate; NaOH to pH>9
TOC in Soil	28 days	Cool to ≤6°C
TOC in Water	28 days	Cool to≤6°C; H2SO4 to pH<2
Total Dissolved Solids (TDS)	7 days	Cool to ≤6°C
Total Kjeldahl Nitrogen (TKN)	28 days	Cool to≤6°C; H2SO4 to pH<2
Total Non-Volatile Solids (TNVS)	7 days	Cool to ≤6°C
Total Non-Volatile Suspended Solids (TNVSS)	7 days	Cool to ≤6°C
Total Persulfate Nitrogen (TPN)	28 days	Cool to≤6°C; H2SO4 to pH<2
Total Solids (TS)	7 days	Cool to ≤6°C
Total Suspended (TSS)	7 days	Cool to ≤6°C
Total Volatile Solids (TVS)	7 days	Cool to ≤6°C
Tributyl tin	7 days water/14 days soil	Cool to ≤6°C
Turbidity	48 hours	Cool to ≤6°C
Volatile Organics/VOCs	7 days water/14 days soil	Cool to≤6°C; HCl to pH<2 (zero headspace)

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to define the standard procedure for the control and custody of environmental samples for Shell projects for Hartford and Roxana, Illinois. This SOP serves as a supplement to information which might be in a project Work Plan or scope of work and is intended to be used together with other SOPs.

2. Other SOPs referenced in this SOP

- SOP No. 8 Field Reporting and Documentation
- SOP No. 24 Soil and Groundwater Sample Classification, Packaging and Shipping
- SOP No. 51 Vapor Sample Classification, Packaging and Shipping

3. Equipment

The following equipment is typically needed for sample control and custody procedures:

- Waterproof shipping container(s) (e.g., coolers)
- Custody seals
- Field forms such as a Chain of Custody (COC) or sample collection sheet
- Field notebook
- Re-sealable bags
- Waterproof pen
- Permanent markers
- Nitrile gloves, or similar

3. Sample Control and Custody

Once the samples are collected, they must remain in the custody of the sampler or another worker from the site. The samples can also remain unattended in a locked vehicle or jobsite trailer so that tampering with the samples will not be possible.

During field sampling activities, traceability of the samples must be maintained from the time the samples are collected until the laboratory data is issued. Initial information concerning the collection of the samples will be recorded on the COC and in the field logbook as outlined in SOP No. 8 Field Reporting and Documentation.

COC forms will be used to document the transport and receipt of samples from the field to the lab. Information required on a COC includes the following:

- Samplers signature and company affiliation
- Company contact information (address, project contact, telephone, email)
- Project number/Project name
- Purchase Order (PO) number (typically same number as project number)
- Date and time of sample collection
- Sample IDs
- Sample matrix
- Analyses requested
- The total number of containers being sent to the lab for each sample
- The appropriate preservative used (where applicable), designating the number of containers to be analyzed with that preservative
- If any samples are to be placed on hold at the laboratory, this shall be clearly indicated on the COC in the comments section
- Turnaround time (TAT) requested
- Deliverables requested
- Signature of person(s) relinquishing custody, dates, and times
- Signature of person(s) accepting custody, dates, and times
- Method of shipment
- Shipping air bill number (if appropriate)
- Custody seal number
- Appropriate project-specific Incident and SAP numbers (for Shell projects)
- Special instructions or field notes, if applicable
- Numerated pages (Page__of__)
    - Verify with the task manager and/or laboratory coordinator for potential maximum number of samples per sample delivery group (SDG).

The sampling team members will be responsible for initiating and filling out the COC form during sample collection. The COC will be signed by a sampling team member to relinquish custody of the samples to a shipping carrier, courier service, laboratory, or to another team member who is responsible for packing/shipping containers. If another team member is packing the shipping container (cooler, box, etc.), they will sign the COC to relinquish custody to the shipping carrier, courier service, or laboratory. Each time custody of the samples is transferred, the COC shall be signed by both parties.

Information on the custody, transfer, handling, and shipping of samples will be recorded on a COC form. If the COC is not three-part (minimum) carbon-copy form, then photocopy the COC after initial signatures have been obtained, and before the samples and original copy leave the site (i.e., samples given to courier, delivery company or similar). One COC form will be included in each shipping container of samples and if samples are not hand delivered, the COC will be placed in a resealable bag and placed inside the shipping container(s).

- The COC may be specific to the samples included within each shipping container or may be comprehensive of all samples collected during a particular day/sampling period, regardless of the number of shipping containers.
- If there are multiple shipping containers in a shipment, then the COC included in each shipping container will designate the container number based on the total number of containers (e.g., cooler 2 of 6, box 1 of 4, etc.). In addition, the COC and/or logbook will indicate the custody seal number of each container. This designation can be made in the comments section or in the margins of the COC.

Additionally, an electronic copy of the COC will be forwarded to applicable project contacts (e.g., task manager, project chemist, etc.).

Refer to SOP No. 24 Soil and Groundwater Sample Classification, Packaging and Shipping for more information regarding packing and shipping of soil and groundwater samples. Refer to SOP No. 51 Vapor Sample Classification, Packaging and Shipping for more information regarding packing and shipping of vapor samples. Upon receipt at the laboratory, the person receiving the samples will sign the COC form. The original COC will remain with the samples until final disposition of the samples by the laboratory. The laboratory will dispose of the samples in an appropriate manner after data reporting (standard disposal times are laboratory dependent).

1. Objective

The purpose of this Standard Operating Procedures (SOP) is to define the standard procedure SOP and necessary equipment for collection of soil vapor samples from vapor monitoring points / sampling ports using stainless steel canisters for Shell projects in Hartford and Roxana, Illinois. This SOP serves as a supplement to information which might be in a project Work Plan and is intended to be used together with other SOPs.

2. Other SOPs referenced in this SOP:

- SOP No. 4 Decontamination
- SOP No. 26 Sample Control and Custody Procedures
- SOP No. 51 Vapor Sampling Classification, Packaging and Shipping
- SOP No. 52 Soil Vapor Field Lab Screening

3. Equipment

The following equipment is typically needed:

- Logbook
- Disposable nitrile gloves
- Cut resistant gloves
- Ultra-fine permanent marker
- Paper towels
- Decontamination equipment
- Soil vapor sampling field sheets and/or field computer
- Small brush or broom
- Charcoal filter
- 15 mL hand pump
- 60 mL syringe or equivalent
- Peristaltic pump with battery
- Rotameter or equivalent
- Photoionization Detector (PID) (e.g., RAE Instruments MultiRAE or equivalent)

- Flame Ionization Detector (FID) (e.g., Thermo Scientific TVA-2020 or equivalent)
- Lower Explosive Limit (LEL) meter (e.g., RAE Instruments MultiRAE or equivalent)
- Landfill gas detector (e.g., Landtec GEM-2000 or equivalent)
- Stainless steel canisters with flow controllers (supplied by the laboratory)
- 1-Liter Tedlar® bags (new or decontaminated as outlined in SOP No. 4 Decontamination) – 2 per sample
- Black trash bag for storing Tedlar® bag samples
- Bentonite grout
- Foam padding for shroud-ground seal
- Sample train assembly (configuration and parts shown on **Figure 1**)
- Vacuum gauge (0 – 30 inches Hg)
- Teflon® tubing (laboratory-grade) – 1/8” ID – ¼” OD
- Tygon® tubing (laboratory-grade) – 3/16” ID – 3/8” OD
- Tracer gas (e.g., Grade 5 helium)
- Tracer gas shroud (e.g., plastic tote)
- Tracer gas meter (e.g., Dielectric Technologies MGD-2002 or equivalent)
- Watch or timer
- Fully stocked toolbox
  - Ratchet set (**$^1/_2$, $^9/_{16}$, $^5/_8$, $^3/_4$, $^7/_8$, $^{15}/_{16}$**)
    - Safety cutting tools
    - Rubber mallet
    - Wire brush
    - Pry bar
    - Wrenches (7/16, ½, 9/16, 5/8)
- Bilge pump for removing water from vaults
- Shipping supplies (e.g., UN boxes, shipping labels, hazard labels, packing tape)

4. Vapor Port Development Purging

If the port has been newly installed, the port must be developed by purging 3 volumes of the sampling assembly including 3 volumes of the sand pack. If development is not required, proceed to **Section 4** or **Section 5** below for the appropriate sampling procedures

1. Open vapor point vault to check integrity of individual soil vapor monitoring port(s) (VMP). Each port shall have a hose barb connected to a 3-way polycarbonate stopcock (3-way) using silicone tubing. The 3-way shall be in the “off” position.
2. Connect peristaltic pump and Tygon tubing connected to the 3-way.
3. Connect charcoal filter exhaust to the discharge end of the tubing assembly.
4. Calculate Purge volume:
   - Vapor Port tubing (1/8-in diameter): 2.41 mL/foot (single volume)
   - Sample train assembly / Tygon® tubing (1/4-in diameter): 9.65 mL/foot (single volume)
   - Sand Pack: 18,765 mL (4.95 gallons – single volume – assuming 18-inch-thick sand pack)
5. Open 3-way and begin purging port at a rate no greater than 2 L/min. Document time started.
6. Once 3 volumes are reached, stop pump and close 3-way. Document time stopped.
7. Move to next depth or replace vault cover and clean up at location.

5. Vapor Port Sampling – With No Tracer Gas

To perform vapor port sampling with tracer gas shroud, proceed to **Section 5** below.

1. Set up at VMP. Turn off vehicle. If vehicle will be left running per health and safety procedures, prevent sample and sample media from being exposed to vehicle exhaust.
2. Open vapor point vault to check integrity of individual soil VMP(s). Each port shall have a hose barb fitting connected to a 3-way valve using silicone tubing. The 3-way shall be in the “off” position.
3. Perform stainless steel canister vacuum check, per the steps listed in **Section 6** of this SOP.

4. Remove hose barb fitting from port and set up the sample assembly using the configuration shown in **Figure 2**. The flow controller (one for each stainless-steel canister provided by the laboratory) shall be connected to the stainless-steel canister inlet. Do not re-use flow controllers between samples. Flow controllers can be set to different rates as specified by the project work plan, depending on size of container to be filled. For a 1-Liter stainless steel canister, approximately 5 minutes is a standard collection time (~167 ml/min).
5. Perform sample train leak check, per the steps listed in **Section 6** of this SOP.
6. Calculate Purge volume:
    - Vapor Port tubing (1/8-in diameter): 2.41 mL/foot (single volume)
    - Sample train assembly (1/4-in diameter): 9.65 mL/foot (single volume)
7. Purge the three volumes from the vapor monitoring port purge using the 60 mL syringe. If pullback is observed on the 60 mL syringe and the purge cannot be completed, the VMP screen may be saturated with water and will not yield a representative sample. If this happens, do not sample the VMP. Similarly, if water or LNAPL is observed in the syringe during the purge, do not sample the VMP. Record purge results in field computer and on sample sheets.
8. Remove the 3-way and connect the sample train to the VMP using Swagelok® fittings.
9. Open Port Valve and Valve #1. Use 60 mL syringe to purge 30 mL (approximately three times the volume of the sample train assembly).
10. Close Valve #1.
11. Open stainless-steel canister valve completely and record the time in the field computer or on sample sheets.
12. Allow the canister to fill until the vacuum gauge reads between -5 and -10 inches Hg; however, an ideal sample shall have approximately -5 inches Hg remaining after sampling is complete. When ambient temperatures are below freezing, close canister valve when the vacuum gauge reading is -8 inches Hg[1]. For a 1-Liter canister, filling shall take approximately 5 minutes but may require more or less time depending on formation materials[2]. If the vacuum gauge reading drops below -5 inches Hg before

[1]Sample will undergo thermal expansion (some loss of vacuum) when moved from a cold outdoor setting to a warmer indoor setting. By closing the canister valve at -8 inches Hg, the sample will be able to undergo thermal expansion without reaching 0 inches Hg. The larger the difference between outdoor and indoor temperatures, the greater the loss of vacuum.
[2] Other sized canisters will take different amounts of time to sufficiently fill.

approximately 5 minutes, close the stainless-steel canister valve completely. Record the time in the field computer and on sample sheets.

13. Connect peristaltic pump to tubing connected to Valve #1 and open Valve #1 to collect a sample in a sample bag. The sample bag shall be filled at a rate no greater than 200 ml/min. Use a rotameter to measure flow rate, and adjust pump speed to approximately 200 mL/min.
14. Disconnect the sample train from the VMP and reconnect the 3-way.
15. Disconnect flow controller, stainless steel canister, and used tubing from sample assembly.
16. From the soil vapor in the Tedlar® sample bag obtain readings for total volatile organics with a FID, PID and for CO_2, CH_4, LEL, and oxygen (O_2) with a landfill gas detector. Record readings in field computer and on sample sheets. If FID or PID is not on-site, label and retain bag for screening at field trailer. Tedlar® sample screening shall be performed in accordance with SOP No. 52 Soil Vapor Field Lab Screening.
17. Perform stainless steel canister vacuum check, per the steps listed in **Section 6** of this SOP.
18. Setup on the next port depth or replace vault cover and clean up at location.
19. Decontaminate any non-designated equipment (e.g., sample assembly) following procedures listed in **Section 7**.

6. Vapor Port Sampling – With Tracer Gas Shroud

To perform vapor port sampling with no tracer gas shroud, proceed to **Section 4** above.

1. Set up at VMP. Turn off vehicle. If vehicle will be left running per health and safety procedures, prevent sample and sample media from being exposed to vehicle exhaust.
2. Open vapor point vault to check integrity of individual VMP(s). Each port shall have a hose barb fitting connected to a 3-way valve using silicone tubing. The 3-way shall be in the “off” position.
3. Perform stainless steel canister vacuum check, per the steps listed in **Section 6** of this SOP.

4. Remove hose barb fitting from port and set up the sample assembly using the configuration shown in **Figure 3**. The flow controller (one for each stainless-steel canister provided by the laboratory) shall be connected to the stainless steel canister inlet. Do not re-use flow controllers between samples. Flow controllers can be set to different rates as specified by the project work plan, depending on size of container to be filled. For a 1-Liter stainless steel canister, approximately 5 minutes is a standard collection time (~167 ml/min).
5. Perform sample train leak check, per the steps listed in **Section 6** of this SOP.
6. Calculate Purge volume:
    - Vapor Port tubing (1/8-in diameter): 2.41 mL/foot (single volume)
    - Sample train assembly (1/4-in diameter): 9.65 mL/foot (single volume)
7. Purge the three volumes from the vapor monitoring port purge using the 60 mL syringe. If pullback is observed on the 60 mL syringe and the purge cannot be completed, the VMP screen may be saturated with water and will not yield a representative sample. If this happens, do not sample the VMP. Similarly, if water or LNAPL is observed in the syringe during the purge, do not sample the VMP. Record purge results in field computer and on sample sheets.
8. Remove the 3-way and connect the sample train to the VMP using Swagelok® fittings.
9. Open Port Valve and Valve #1. Use 60 mL syringe to purge 30 mL (approximately three times the volume of the sample train assembly).
10. Close Valve #1.
11. Place an enclosure shroud over the VMP and assembled sample train as shown in **Figure 3**. The shroud shall have openings for:
    - Introduction of tracer gas;
    - Pressure relief to the atmosphere and access of a tracer gas monitoring device;
    - Tygon tubing to connect to the peristaltic pump for Valve #1

    The shroud shall have sufficient glove access to open or close all valves within. As shown in **Figure 3**, the shroud must also be sealed to the ground with hydrated bentonite (or equivalent) or foam padding.
12. Introduce tracer gas into the shroud at a known rate until the atmosphere within the shroud contains a sufficient quantity (typically 20% to 50%) of tracer gas.

13. Connect peristaltic pump to Valve #1 using Tygon tubing, open Valve #1, and collect sample bag #1. The sample bag shall be filled at a rate no greater than 200 ml/min.
14. Close Valve #1.
15. From the soil vapor in Tedlar® sample bag #1, obtain readings for tracer gas with tracer gas detector. If tracer gas readings are elevated, analyze sample bag #1 using a landfill gas detector to obtain a direct methane reading. See **Section 6** for acceptance criteria.
16. Open stainless-steel canister valve completely and record the time in field computer or on sample sheets.
17. Allow the canister to fill until the vacuum gauge reads between -5 and -10 inches Hg; however, an ideal sample shall have approximately -5 inches Hg remaining after sampling is complete. When ambient temperatures are below freezing, close canister valve when the vacuum gauge reading is -8 inches Hg[3]. For a 1-Liter canister, filling shall take approximately 5 minutes but may require more or less time depending on formation materials.[4] If the vacuum gauge reading drops below -5 inches Hg before approximately 5 minutes, close the stainless-steel canister valve completely. Record the time in the field computer and on sample sheets. Record the concentration of tracer gas within the shroud after closing the canister valve.
18. Connect peristaltic pump to tubing connected to Valve #1 and open Valve #1 to collect sample bag #2. The sample bag shall be filled at a rate no greater than 200 ml/min.
19. Break seal on the shroud and disconnect flow controller, stainless steel canister, and used tubing from sample assembly.
20. From the soil vapor in sample bag #2 obtain readings for total volatile organics with a PID, for CO_2, CH_4, LEL, and oxygen (O_2) with a landfill gas detector, and for tracer gas concentration with the tracer gas detector. See **Section 6** for acceptance criteria. Record readings in field computer or on field sheets. If FID or PID is not on-site, label and retain Tedlar® sample bag #2 for reading at field trailer. Tedlar® sample screening shall be performed in accordance with SOP No. 52 Soil Vapor Field Lab Screening.

[3]Sample will undergo thermal expansion (some loss of vacuum) when moved from a cold outdoor setting to a warmer indoor setting. By closing the canister valve at -8 inches Hg, the sample will be able to undergo thermal expansion without reaching 0 inches Hg. The larger the difference between outdoor and indoor temperatures, the greater the loss of vacuum.

[4]Other sized canisters will take different amounts of time to sufficiently fill.

21. Perform stainless steel canister vacuum check, per the steps listed in **Section 6** of this SOP.
22. Disconnect the sample train from the VMP and reconnect the 3-way.
23. Move to next depth or replace vault cover and clean up at location.
24. Decontaminate any non-designated equipment (e.g., sample assembly) following procedures listed in **Section 7**.

7. Quality Control

Quality control procedures have been developed to verify equipment integrity, sample quality, and sample repeatability.

In addition to the procedures listed below, the following items are also of concern:

- Care shall be taken to keep all sampling equipment, especially the stainless-steel canisters, safe from damage.
- No samples are to be collected in an area where vehicle or other equipment exhaust is being discharged. Do not place samples or sample media directly on asphalt, gravel, or other ground surfaces.

<u>Field Duplicates</u>

A field duplicate shall be collected for 10% of the samples collected.

Field duplicates are collected by using a sample assembly with an additional 3-way union. A stainless-steel canister with a flow controller is attached to each of the 3-way unions on the assembly. For sampling, both stainless steel canister valves shall be opened and closed simultaneously. Use the appropriate procedure described above to collect samples.

<u>Stainless Steel Canister Vacuum Check</u>

The stainless-steel canister vacuum check shall be performed for 100% of the stainless-steel canisters.

<u>Prior to Sampling</u>

1. Remove brass cap from stainless steel canister. Brass cap will not be present if canister is configured with quick connect fitting.
2. Attach the pressure gauge provided by the laboratory to the stainless-steel canister inlet.
3. Open valve one-half turn, then close valve.
4. Record reading on the canister tag. If the canister does not show a vacuum or shows a vacuum of less than -26 inches Hg, then:

- Label the canister tag with "Insufficient vacuum – No Sample";
- Set canister aside for return to the laboratory;
- Record canister ID number to share with task manager and lab coordinator; and
- Contact task manager and lab coordinator if number of canister failures affect field work.

5. Make sure valve is closed tight, but not overtight.
6. Remove the pressure gauge.
7. If not immediately using the stainless-steel canister for sample, place and tighten brass cap on stainless steel canister (not applicable if canister is configured with quick connect fitting).

After Sampling

1. Attach the pressure gauge provided by the laboratory to the stainless-steel canister inlet.
2. Open valve one-half turn, then close valve.
3. Record reading. There shall still be a vacuum in the stainless-steel canister. The final vacuum on the canister shall be between -10 inches of Hg to -2 inches of Hg. If the final vacuum does not fall within this range, contact the task manager immediately to determine the value of using another stainless-steel canister to recollect the sample.
4. Make sure valve is closed tight, but not overtight.
5. Remove the pressure gauge.
6. Place and tighten brass cap on stainless steel canister (not applicable if canister is configured with quick connect fitting).

Sample Train Vacuum Leak Check

The sample train leak check shall be performed for 100% of the samples collected.

1. Assemble the sampling apparatus as shown in **Figure 1**.
2. Keep the stainless-steel canister closed, and Valve #1 in the "open" position.
3. Attach the 15 mL hand pump to sample train at Valve #1.
4. Withdraw air from the sampling apparatus until a vacuum between 20 and 25 inches Hg is achieved. Close Valve #1. Use flow controller's built-in vacuum gauge to observe the induced vacuum for at least five minutes. If the flow controller's vacuum gauge does not function properly, notify the task manager.

5. If the change in vacuum over five minutes is equal to or less than 0.5 inches Hg, the system leak rate is acceptable.
6. If the change in vacuum over five minutes is greater than 0.5 inches Hg, check, tighten or replace the fittings and connections and repeat the leak check.

Tracer Gas Check

An appropriate number of samples shall be collected using a tracer gas, as per the project work plan or activity plan.

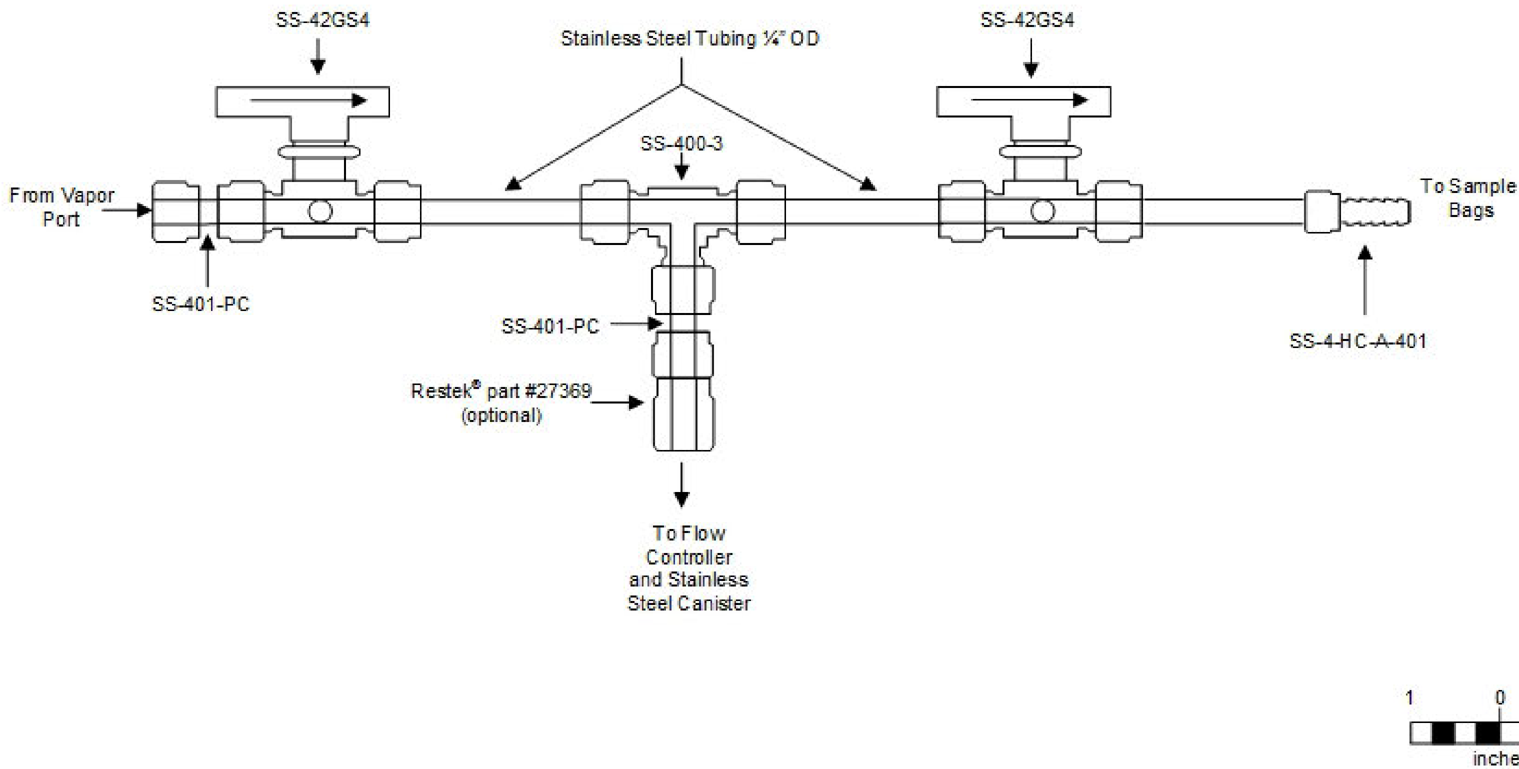
1. Tracer gas shall be introduced near the VMP to test the integrity of the probe seal and the above ground connections.
2. Collect the soil vapor sample per procedures in **Section 5**.
3. If the concentration of the tracer gas in a sample is ≤10% of the concentration of the tracer gas in the shroud:
    - Prior to stainless steel canister sampling: continue with sample collection.
    - Following stainless steel canister sampling: the sample is acceptable.
4. If the concentration of the tracer gas in the sample is >10% of the concentration of the tracer gas in the shroud:
    - Prior to stainless steel canister sampling: check methane levels.
        - If methane reading ≥2%, continue with sample collection.
        - If methane reading ≤2%, stop sample collection. Check fittings and valves before restarting sample collection.
    - Following stainless steel canister sampling: check methane levels.
        - If methane reading ≥2%, the results may be biased high by methane. Call task manager to discuss.
        - If methane reading <2%, sample likely compromised; do not use sample. Call task manager to inform of need for re-sample.
    - If a sample is found to be compromised, 2 additional attempts (3 attempts total) shall be made to collect a sample.
        - With each additional attempt, check stainless-steel tubing and fittings for holes and loose connections, and place an additional layer of bentonite seal in the interior of the well vault.
        - After 3 attempts, if a successful sample has not been collected, the VMP shall not be sampled for that quarter.

8. Decontamination

- Non-designated stainless-steel assemblies shall be thoroughly decontaminated by purging with at least half a liter of air (e.g., with hand pump or peristaltic pump).
- If a stainless-steel assembly comes into contact with groundwater, it shall be decontaminated using a Liquinox® detergent wash followed by a distilled water rinse. Discuss with task manager before re-using the assembly.
- If a stainless-steel assembly comes into contact with LNAPL, immediately call task manager and segregate the contaminated components from other sample media.
- Multiple stainless-steel assemblies shall be available to sample crews to allow for equipment to be cleaned and dried sufficiently before being reused.
- Tedlar® bags may be decontaminated if it meets the criteria listed in SOP No. 4 Decontamination.

9. Shipping

- Sample information shall be recorded on a chain of custody for the laboratory following procedures outlined in SOP No. 26 Sample Control and Custody Procedures.
- Samples shall be shipped to the laboratory following DOT regulations. If there is the possibility that samples may be classified as hazardous, samples must be shipped as such. For procedures, see SOP No. 51 Vapor Sampling Classification, Packaging and Shipping, and check with one of the office hazardous shipping personnel.

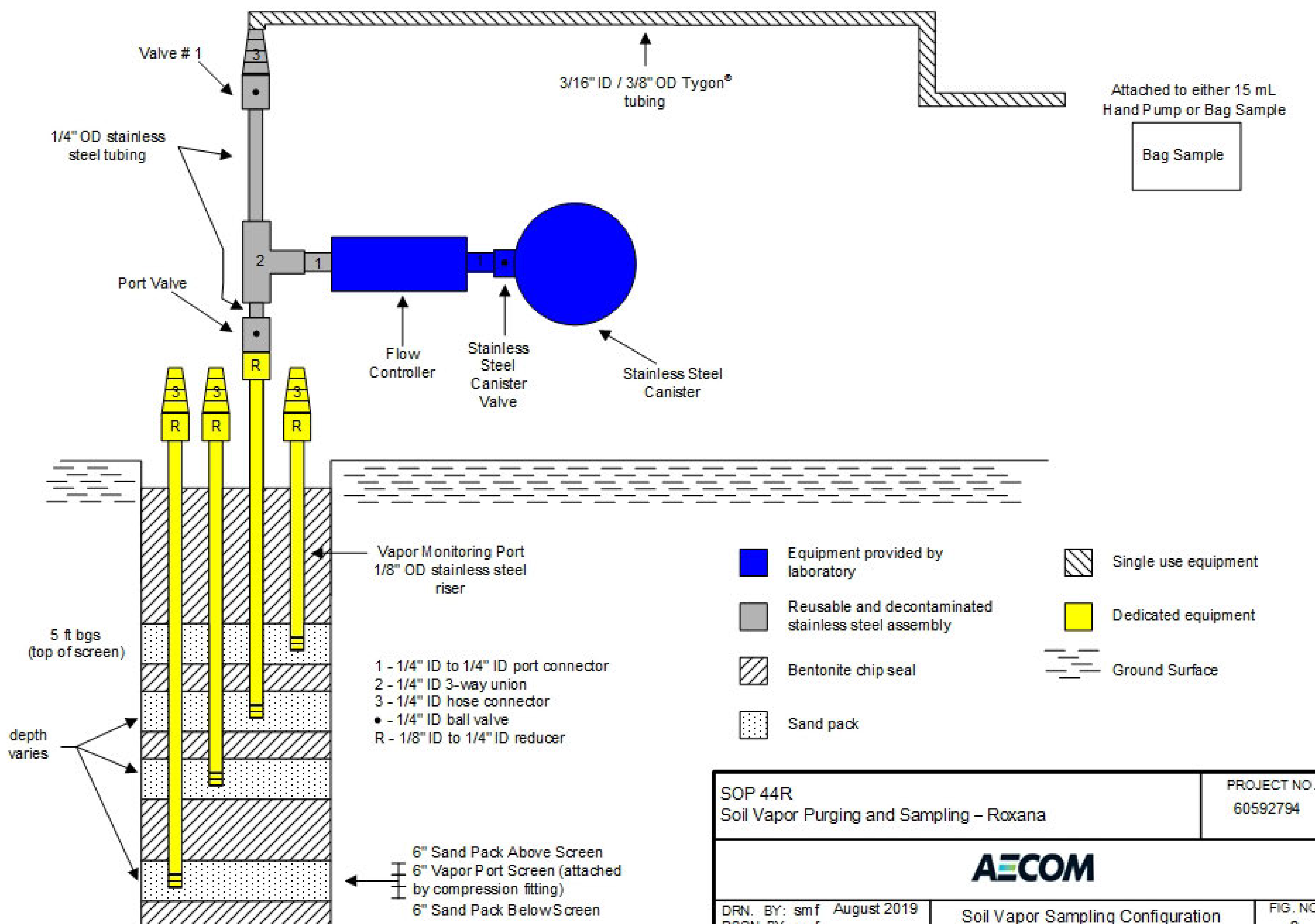


Notes:
1) All components listed with Swagelok® part numbers (if applicable).
2) All components made by Swagelok® unless otherwise noted.
3) Assembly shown for standard sample.
4) Duplicate assembly includes an additional 3-way union between the two shown.
5) All fittings shown are compression fittings with SS-400-Set ferules and SS-402-1 nuts.
6) Restek® part #27369 is a female quick connect fitting that may be used to connect sampling assembly to flow controller when flow controller is outfitted with accompanying Restek® part #27373 (male quick connect fitting).

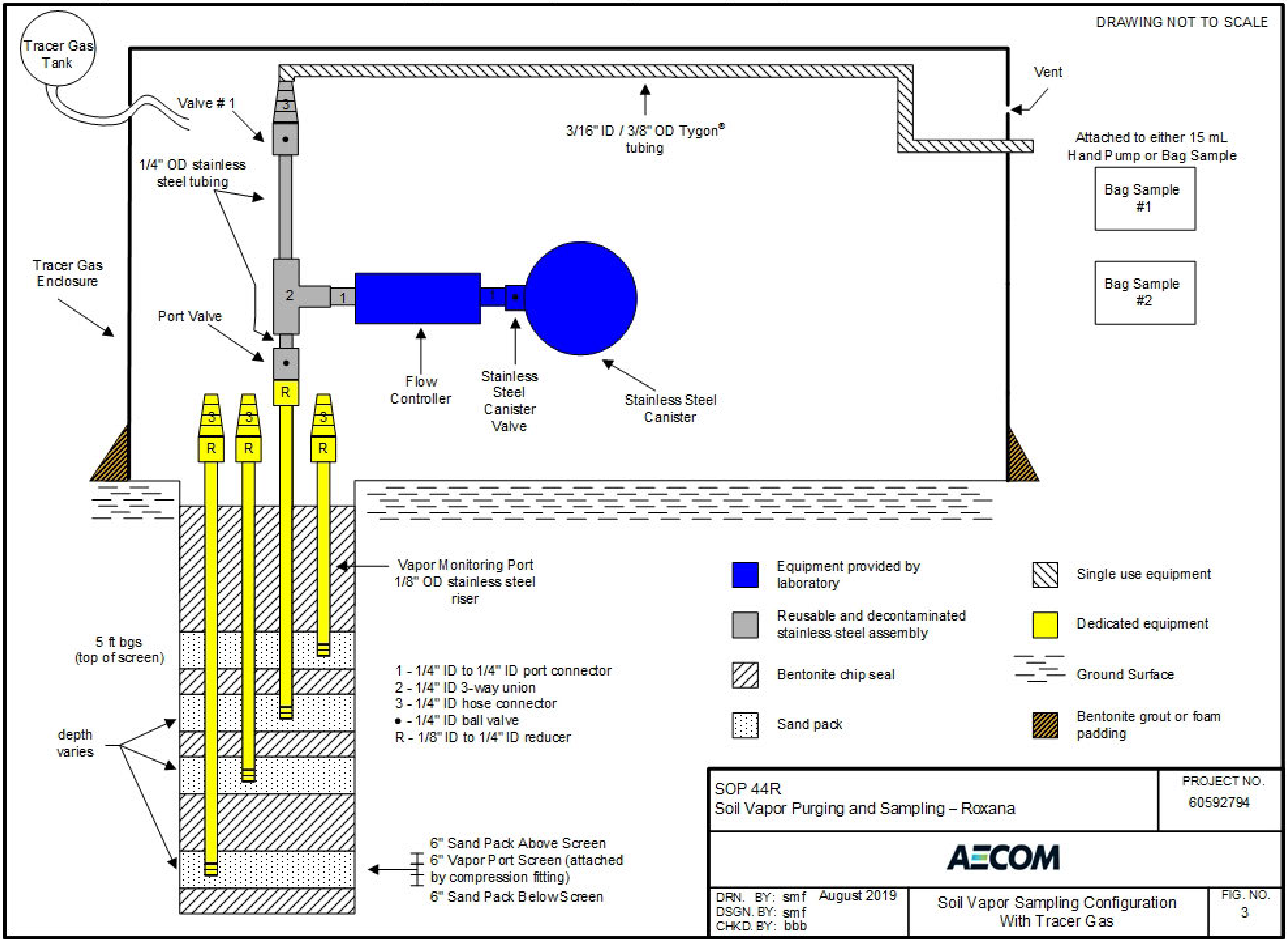
Source: https://swagelok.com/products.aspx; Accessed June 13, 2019.
Source: https://www.restek.com/catalog/view/53581; Accessed June 13, 2019.

SOP 44R Soil Vapor Purging and Sampling – Roxana		PROJECT NO. 60592794
AECOM		
DRN. BY: smf August 2019 DSGN. BY: smf CHKD. BY: bbb	Soil Vapor Sampling Assembly	FIG. NO. 1

DRAWING NOT TO SCALE



SOP 44R Soil Vapor Purging and Sampling – Roxana		PROJECT NO. 60592794
AECOM		
DRN. BY: smf August 2019 DSGN. BY: smf CHKD. BY: bbb	Soil Vapor Sampling Configuration No Tracer Gas	FIG. NO. 2



SOP 44R
Soil Vapor Purging and Sampling – Roxana

PROJECT NO. 60592794

AECOM

DRN. BY: smf August 2019
DSGN. BY: smf
CHKD. BY: bbb

Soil Vapor Sampling Configuration With Tracer Gas

FIG. NO. 3

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to provide a consistent methodology for data and soil vapor sample collection related to the Shell Roxana soil vapor extraction (SVE) remediation system. This SOP serves as a supplement to information which might be in a project Work Plan and is intended to be used together with other SOPs. This SOP is applicable to:

- Collecting data from and sampling Roxana Soil Vapor Extraction (SVE) wells
- Collecting data from and sampling the West Fenceline and Public Works header lines and/or the Regenerative Thermal Oxidizer (RTO) exhaust stack.

2. Other SOPs referenced in this SOP

- SOP No. 4 Decontamination
- SOP No. 10 Well Gauging Measurements
- SOP No. 51 Vapor Sample Classification, Packaging and Shipping
- SOP No. 52 Soil Vapor Field Laboratory Screening
- SOP No. 53 Dwyer Digital Manometer

3. Equipment

The following equipment is typically used for SVE well data collection and sampling:

- Pry bars (2) (if needed)
- Extension cord (if needed)
- SVE Data Collection sheets
- Impact driver (or socket set) with 3/4, 1/2, 5/8 and 9/16 sockets, or adjustable wrench (if needed)
- Oil/Water Interface probe
- Isopropyl alcohol
- Liquinox detergent (or equivalent)
- Potable or distilled water
- Dwyer Series 475 Mark III Digital manometer (measuring appropriate range(s)), or equivalent

- Nut driver – 5/16 (if needed)
- Paper towels
- PPE
    - ANSI Class II safety vest
    - Hardhat
    - Nitrile gloves
    - Cut Resistant gloves
    - Safety glasses
    - Safety goggles (when working within Wood River Refinery (WRR))
    - Steel-toe boots
    - FRC Clothing (when working within WRR)
- Power inverter (if needed)
- Sump pump (if needed)
- Geotech® peristaltic pump (or equivalent)
- 1- Liter Tedlar® bags (new or decontaminated as outlined in SOP No. 4 Decontamination)
- Traffic barricades (orange cones with flags)
- Wheel chocks
- Tygon® tubing – 3/16” ID x 3/8” OD
- Teflon® tubing – 3/16” ID x 1/4” OD
- Black collection bag (trash bag) and collection string

The following equipment is typically used for the West Fenceline and Public Works header line and RTO exhaust stack data collection and sampling:

- Combination wrench 1/2 and 9/16 inch
- Extension cord
- GAST® high flow vacuum pump
- Geotech® peristaltic pump

  - Dwyer Series 475 Mark III Digital manometer (measuring appropriate range(s)), or equivalent
  - PPE
    - ANSI Class II safety vest
    - Hardhat
    - Nitrile gloves
    - Safety glasses
    - Safety goggles
    - Steel-toe boots
    - FRC Clothing
- Summa canister
- Pressure gauge
- Regulators (flow controllers)
- Calibrated rotameter (or equivalent)
- Sample train
- 1-Liter Tedlar® bags (new or decontaminated as outlined in SOP No. 4 Decontamination)
- Tygon® tubing – 3/16" ID x 3/8" OD
- Teflon® tubing – 1/8" ID x 1/4" OD
- Black collection bag (trash bag) and collection string

4. Procedures for SVE Wells

This section provides step-by-step procedures for data collection and soil vapor sampling of SVE wells. The field data sheet (attached) or the appropriate fields in the SVE Monitoring software shall be filled out completely with the appropriate observations and data collected during sampling. All applicable components of the Health and Safety Plan, including completion of Task Hazard Analysis (THA) forms, shall be followed while performing the activities described in this SOP.

Upon Arrival at Well

1. Position truck between the well to be sampled (work zone) and on-coming traffic, turn on hazard lights available with the truck in use. Initiate parking brake.
2. Place traffic cones with flags in front of and behind the truck. Place wheel chocks around one of the tires of the truck.
3. Unlock the well vault, remove well vault bolts, use pry bars (if needed) to release vault latch, and pry open vault lid for underground wells or open above ground well vault to access well. Engage safety latch, weight and/or chain (if present) to secure vault lid in open position. Record position of main SVE valve.
4. Use a sump pump to drain rainwater from the vault, if present.
    - If water in vault has **NO** evidence of sheen water can be pumped to the surrounding ground/road surface.
    - If water in vault has evidence of sheen water must be pumped into 5–gallon containers. Containerized water from wells located within the refinery is transported to Site 9 in WRR for proper management. Containerized water from wells located outside the refinery is transported to Tannery property for proper management.

Sample Collection

1. Connect manometer to sample port and record the vacuum on the SVE well by connecting the appropriate digital manometer (SOP No. 53 Dwyer Digital Manometer) to the sample port of the well and turning the sample port lever to the open position. If the vacuum reading fluctuates, record the most consistent reading.
2. Write the well ID, date, sample time, vacuum, and sampler's initials on the Tedlar® bag.
3. Connect a clean piece of disposable Tygon® tubing to the sample port of the SVE well or use dedicated tubing if present.
4. Insert Tygon® tubing into the peristaltic pump head.
5. Connect power cord to peristaltic pump and plug into battery, vehicle cigarette lighter, or other available power source (car battery adapter).
6. Inset hard plastic (e.g. Teflon) reducer on end of Tedlar® bag which shall later connect to Tygon® tubing.

7. Turn on the peristaltic pump with sample port open to purge Tygon® tubing for approximately 10 seconds.
8. Connect Tedlar® bag to Tygon® tubing.
9. Once the Tedlar® bag is approximately 90% full (shall not be tight with tension), close valve on Tedlar® bag, turn peristaltic pump off, close sample port, remove Tygon® tubing from Tedlar® bag and sample port. When ambient temperature is below 50°F, bag Tedlar® bag shall only be filled approximately 75% to allow for thermal expansion when brought in to truck.
10. Place Tedlar® bag sample in black collection bag to minimize exposure to sunlight while other samples are being collected and transported to on-site screening lab.

Fluid Level Measurement

1. If necessary, close the well valve a little or completely if the water/LNAPL reading is not clear or difficult to obtain.
2. Remove the sample plug from the well cap.
3. Turn the interface probe on and lower probe into the SVE well. Record fluid levels and total depth as described in SOP No. 10 Well Gauging Measurements. If water in SVE well is splashing and an accurate reading cannot be obtained, reduce well vacuum by partially closing the well valve and collect reading as quickly as possible as described in Step 1. Additionally, record if the bottom surface of the well is hard or soft. Decontaminate the probe and tape as described in SOP No. 4 Decontamination.
4. Record the condition of the probe and tape upon removal (e.g. clean, visual or olfactory evidence of petroleum hydrocarbon, sludge, foam, silt) and any well defects or maintenance issues.
5. Replace the sample plug into the well cap.
6. Return the main SVE valve to its original position, if adjusted in Step 1 and/or 3 above.
7. Disengage safety latch, weight and/or lower vault lid. Replace well vault bolts (if needed) and lock the well vault.
8. Load traffic cones and other equipment and move to next well location.

5. Procedures for the Header Lines and Exhaust Stack

This section provides step-by-step procedures for data collection and soil vapor sampling of the Public Works, West Fenceline, and Inidividual Headers located immediately upstream of the VLS units and the RTO Exhaust stack.

5.1. Data/Sample Collection at the Regenerative Thermal Oxidizer (RTO) Unit – PW, WFL, and Individual Header Lines

1. Connect appropriate manometer to sample port on the header line and record the vacuum (SOP No. 53 Dwyer Digital Manometer). Write the sample ID, date, sample time, vacuum, and sampler's initials on the Tedlar® bag.
2. Connect one end of a clean piece of disposable Tygon® tubing, or dedicated tubing if present, to the header sample port and the other end to the inlet port of the GAST® high flow sample pump.
3. Connect clean section of Tygon® tubing to the outlet port of the GAST® high flow sample pump.
4. Connect power cord to GAST® high flow pump and plug into AC power source, (extension cord with GFI plugged into wall outlet)
5. Inset hard plastic reducer on end of Tedlar® bag which shall later connect to Tygon® tubing.
6. Turn on the GAST® high flow pump with sample port open and allow pump to run for approximately 10 seconds to purge the tubing.
7. Connect Tedlar® bag to Tygon® tubing on the outlet port of the GAST® high flow sample pump.
8. Once the Tedlar® bag is approximately 90% full (shall not be tight with tension), close valve on Tedlar® bag. When ambient temperature is below 50°F, bag Tedlar® bag shall only be filled approximately 75% to allow for thermal expansion when brought into truck.
9. Turn GAST® high flow pump off, close sample port, and remove/dispose of Tygon® tubing from Tedlar® bag and sample port.
10. Place Tedlar® bag with sample in black collection bag on sample collection string to minimize exposure to sunlight while other samples are being collected and transported to on-site screening lab.

5.2. Summa Canister Sample Collections - PW and WFL Header Lines

Prior to Sampling - PW and WFL Header Lines

1. Attach the vacuum gauge provided by the laboratory to the stainless-steel canister inlet.
2. Open valve completely.
3. Record the vacuum reading on the canister tag. If the canister does not show a vacuum or shows a vacuum of less than -26 inches of Hg, then:
    - Label the canister tag with "Insufficient vacuum – No Sample";
    - Set canister aside for return to the laboratory; and
    - Contact task manager and lab coordinator if canister failures affect field work.
4. Close valve completely.
5. Remove the vacuum gauge.

Sampling - PW and WFL Header Lines

1. Collect a Tedlar® bag sample using steps 1 through 10 from Section 5.1 above.
2. Thread the sample train to the particulate filter and then quick-connect the setup to the canister.
3. Turn on the GAST® high flow pump with sample port open and allow pump to run for approximately 10 seconds to purge the tubing.
4. Using a clean piece of disposable silicone tubing, connect the hose barb attached to the sample train to the exhaust port on the GAST® pump.
5. Open the sample canister. Allow sample to enter the canister until the vacuum reads approximately between -5 and -10 inches of Hg. **The vacuum gauge shall reach less than -10 inches Hg but shall not be allowed to drop below -2 inches of Hg.**
6. Close valve to sample port and turn off GAST® pump.
7. Close the sample canister valve completely and remove the sample train.
8. Close the sample port on the header line.

After Sampling - PW and WFL Header Lines

1. Attach the vacuum gauge provided by the laboratory to the stainless-steel canister inlet using quick connect fittings.

2. Open valve completely.
3. Record reading. There shall still be a vacuum in the stainless-steel canister. If the final vacuum reading is not between -10 and -2 inches Hg, contact the task manager or project manager immediately to determine the value of using another stainless steel canister to recollect the sample.
4. Close valve completely.
5. Remove the vacuum gauge.

5.3. Data/Sample Collection at the Regenerative Oxidizer Unit – Exhaust Stack

1. Connect 0.00 - 1.00 in wc manometer to sample port on the exhaust stack and record the vacuum (SOP No. 53 Dwyer Digital Manometer). Write the sample ID, date, sample time, vacuum, differential pressure, and sampler's initials on the Tedlar® bag.
2. Connect the piece of dedicated disposable Tygon® tubing connected to the sample port vacuum line of the exhaust stack and insert into peristaltic pump.
3. Inset hard plastic reducer on end of Tedlar® bag which shall later connect to Tygon® tubing.
4. Attach pump head to the lower RPM shaft on the Geotech® peristaltic pump. Turn on peristaltic pump with sample port open. Allow pump to run for at least 60 seconds to purge the sample line.
5. Use a calibrated rotameter or equivalent to set the speed of the peristaltic pump at approximately 125mL/min to 140mL/min.
6. 10 seconds after the beginning of poppet valve switch, connect Tedlar® bag to Tygon® tubing.
7. 10 seconds after 2 cycles of poppet valve switching, close valve on Tedlar® bag. Note if a full 6 minuet interval did not take place and discuss with task manager.
8. Turn peristaltic pump off, close sample port, and remove/dispose of Tygon® tubing from Tedlar® bag and sample port.
9. Place Tedlar® bag with sample in black collection bag on the sample collection string to minimize exposure to sunlight while other samples are being collected and transported to on-site screening lab.

5.4. Summa Canister Sample Collection – Exhaust Stack

Prior to Sampling - Exhaust Stack

1. Attach the vacuum gauge provided by the laboratory to the stainless-steel canister inlet using quick connect fittings.
2. Open valve completely.
3. Record reading on the canister tag. If the canister does not show a vacuum or shows a vacuum of less than -26 inches of Hg, then:
    - Label the canister tag with "Insufficient vacuum – No Sample";
    - Set canister aside for return to the laboratory; and
    - Contact task manager and lab coordinator if canister failures affect field work.
4. Close valve completely.
5. Remove the vacuum gauge.

Sampling - Exhaust Stack

1. Collect a Tedlar® bag sample using steps 1 through 7 from **Section 5.3** above.
2. Thread the sample train to the particulate filter, which is then threaded to the regulator. Quick-connect the setup to the canister.
3. Using a clean piece of disposable silicone tubing, connect the hose barb attached to the sample train to the sample port on the exhaust stack.
4. 10 seconds after hearing the poppet valve switch, open the sample canister. Allow sample to enter the canister though 2 cycles of poppet valve switching, and the vacuum reads approximately between -5 and -10 inches of Hg. Sample collection shall end approximately 10 seconds after two additional poppet valve switches (total sample collection time shall be approximately 6 minutes. Note if a full 6 minute interval did not take place and discuss with task manager. **The vacuum gauge shall reach less than -10 inches Hg but shall not be allowed to drop below -2 inches of Hg.**
5. Close the sample canister valve completely and remove the sample train.
6. Close the sample port on the exhaust line.

After Sampling - Exhaust Stack

1. Attach the vacuum gauge provided by the laboratory to the stainless-steel canister inlet using quick connect fittings.
2. Open valve completely.
3. Record reading. There shall still be a vacuum in the stainless-steel canister. If the final vacuum reading is not between -10 and -2 inches Hg, contact the task manager or project manager immediately to determine the value of using another stainless steel canister to recollect the sample.
4. Close valve completely.
5. Remove the vacuum gauge.

5. *Sample Screening, Classification, Packaging and Shipping*

Refer to SOP No. 51 Vapor Sample Classification, Packaging and Shipping for information related to packing and shipping samples to the laboratory for analysis, if necessary. Refer to SOP No. 52 Soil Vapor Field Laboratory Screening for information related to on-site field laboratory screening of samples collected.

SVE Monthly Effectiveness

Well ID	Date	Tech	Time Arrived	Valve Position Arrival	% Open	Vacuum (In H2O)	Tedlar Sample Time	DTP	DTW	DTB	Hard/Soft Bottom	Tape Condition	Valve Position Departure	% Open	Time Left	Comments
SVE-3R				Open / Closed									Open / Closed			
SVE-4				Open / Closed									Open / Closed			
SVE-5				Open / Closed									Open / Closed			
SVE-6				Open / Closed									Open / Closed			
SVE-7				Open / Closed									Open / Closed			
SVE-8				Open / Closed									Open / Closed			
SVE-9				Open / Closed									Open / Closed			
SVE-10				Open / Closed									Open / Closed			
SVE 11				Open / Closed									Open / Closed			
SVE-12				Open / Closed									Open / Closed			
SVE-13				Open / Closed									Open / Closed			
SVE-14				Open / Closed									Open / Closed			
SVE-15				Open / Closed									Open / Closed			
SVE-16				Open / Closed									Open / Closed			
SVE-17				Open / Closed									Open / Closed			
SVE-18				Open / Closed									Open / Closed			
SVE-19				Open / Closed									Open / Closed			
SVE-20				Open / Closed									Open / Closed			
SVE-21				Open / Closed									Open / Closed			
SVE-22				Open / Closed									Open / Closed			
SVE-23				Open / Closed									Open / Closed			
SVE-24				Open / Closed									Open / Closed			
SVE-25				Open / Closed									Open / Closed			
SVE-26				Open / Closed									Open / Closed			
SVE-27				Open / Closed									Open / Closed			
SVE-28				Open / Closed									Open / Closed			
SVE-29				Open / Closed									Open / Closed			

SVE Monthly Effectiveness

Well ID	Date	Tech	Time Arrived	Valve Position Arrival	% Open	Vacuum (in H2O)	Tedlar Sample Time	DTP	DTW	DTB	Hard/Soft Bottom	Tape Condition	Valve Position Departure	% Open	Time Left	Comments
SVE-30				Open / Closed									Open / Closed			
SVE-31				Open / Closed									Open / Closed			
SVE-32				Open / Closed									Open / Closed			
SVE-33				Open / Closed									Open / Closed			
SVE-34				Open / Closed									Open / Closed			
SVE-35				Open / Closed									Open / Closed			
SVE-36				Open / Closed									Open / Closed			
SVE-37				Open / Closed									Open / Closed			
SVE-38				Open / Closed									Open / Closed			
SVE-39				Open / Closed									Open / Closed			
SVE-40				Open / Closed									Open / Closed			
SVE-41				Open / Closed									Open / Closed			
SVE-42				Open / Closed									Open / Closed			
SVE-43				Open / Closed									Open / Closed			
SVE-44				Open / Closed									Open / Closed			
SVE-45				Open / Closed									Open / Closed			
SVE-46				Open / Closed									Open / Closed			
SVE-47				Open / Closed									Open / Closed			

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to provide a consistent methodology for the collection of soil vapor samples from vapor monitoring points related to the Shell Roxana Soil Vapor Extraction (SVE) system. This SOP details the necessary procedures to follow so that representative samples are collected. These procedures are applicable to any soil vapor sample collected at vapor monitoring points (VMPs). Important uses of these data include:

- SVE system performance evaluation
- Hydrocarbon plume definition

This SOP serves as a supplement to information which might be in a project Work Plan and is intended to be used together with other SOPs.

2. Other SOPs referenced in this SOP:

- SOP No. 4 Decontamination
- SOP No. 52 Soil Vapor Field Laboratory Screening
- SOP No. 53 Dwyer Digital Manometer

3. Equipment

The following equipment is typically used for sample collection.

- Dwyer Series 475 Mark III Digital manometer (or equivalent) (0-40 in. wc.)
- Rite-in-the-Rain logbook
- 1-Liter Tedlar® bags (new or decontaminated as outlined in SOP No. 4 Decontamination)
- Tygon® or silicone tubing (or equivalent) - 3/16” ID x 3/8” OD
- Polyethylene tubing – 3/16” ID x 1/4” OD
- Peristaltic pump – 60-350 RPM
- Battery for peristaltic pump
- BIOS DC-LITE flow calibrator or calibrated rotameter (0-500 mL/min)
- 60-mL syringe
- Crescent wrench (or equivalent hand tools)
- Ratchet with ½, 9/16, ¾, 5/8, 7/8 and 15/16-inch sockets

- Metal wire brush
- Circular brush for bolt holes
- Rubber mallet
- Magnet for VMP lids
- Black collection bag (trash bag)
- String for Tedlar® bags that acts like a fish stringer and keeps samples organized
- Index cards for recording VMP vacuum, time, and any additional commentary
- Laminated map of VMP locations
- Dry erase marker
- Paper towels
- Broom
- Kneeling pads
- Extra traffic cones for VMPs when stabilizing
- Traffic flags
- Wheel chocks
- Bilge pump for removing water from vault to access sample ports
- New or dedicated 3-way micro valves for purging and sampling

4. Procedures

Initial Vacuum/Pressure Measurement

Using a Dwyer Series 475 Mark III digital manometer, the initial vacuum/pressure is measured. Basic manometer operation instructions can be found in SOP No. 53 Dwyer Digital Manometer.

At VMP monitoring locations the positive fitting of the manometer shall be connected to the VMP. The negative fitting on the manometer shall remain open to the atmosphere. The pressure and time are immediately read and recorded to the nearest hundredth of an inch (or tenth of an inch if using 0-200 inwc manometer) of water column on field sheets that are used for data entry in the field laboratory (SOP No. 52 Soil Vapor Field Laboratory Screening). Immediately following the recording of the vacuum/pressure measurement, the VMP shall be closed to the atmosphere.

VMP Purging

After obtaining the initial vacuum/pressure measurements and prior to soil vapor sample collection, each monitoring location shall be purged a predetermined amount based on the volume of the VMP riser and screen. The purge volume shall be equivalent to a minimum of three VMP volumes. The actual purge volume will be provided on field sheets. If the VMP will not yield the purge volume or if water and/or light non-aqueous phase liquid (LNAPL) are encountered during purging, this observation shall be documented on the appropriate field sheets (logbook and index cards). The VMP screen is presumed to be submerged when this condition is encountered. No sample is to be collected and no stabilized reading is required.

To purge VMP monitoring locations, a 60-mL plastic syringe is attached to the VMP to allow the removal of the required purge volume. The syringe plunger shall be drawn back to evacuate a purge volume.

VMP Sampling

Upon completion of VMP purging, soil vapor sample collection using Tedlar® bags may commence. If water and/or LNAPL are encountered during sample collection, this observation shall be documented on the appropriate field forms (logbook and index cards). Note that samples which indicate the presence of water and/or LNAPL shall not be analyzed.

Tedlar® Bag Samples

Air samples for on-site screening shall be collected using a Tedlar® bag and a peristaltic pump. For VMP monitoring locations, the inlet of the peristaltic pump tubing is attached to the VMP and the positive pressure (output) side of the peristaltic pump shall be attached to the inlet side of the flow calibrator (or rotameter) using designated tubing. Prior to flow-rate adjustment and sample collection, the sample identification, samplers' initials, date, time of initial vacuum reading, and initial vacuum/pressure reading (if applicable) shall be clearly marked on the Tedlar® bag.

Flow Rate Adjustment

The rotameter[1] shall be used to adjust the flow rate of the peristaltic pump to allow a flow rate of 200 mL/minute. For VMPs, this adjustment shall be performed by observing the flow rate indicated by the ball height and adjusting the peristaltic pump to allow a flow rate of 200 mL/minute. *Notes: The initial settings on the pump shall be set to allow for the minimum flow possible. It is important to set the flow rate as quickly as possible in order to minimize the amount of additional sample purge.* After setting the sample flow, sample collection shall be

[1] Rotameters are checked and calibrated on an annual basis.

immediately initiated. Care shall be taken at this time to avoid unintentionally adjusting (by bumping or handling) the pump speed control.

Sample Collection

After setting the sample flow, the rotameter shall be removed from the sample train and a new or decontaminated, pre-labeled one-liter Tedlar® bag shall be connected to the tubing exiting from the output side of the peristaltic pump. A wire tie shall be used, if necessary, to make the connection between the bag and the pump a leak-proof fitting. Immediately open the valve on the Tedlar® bag approximately one turn. *Please note: The sample time is the same time as the acquisition of the initial vacuum/pressure reading. If a vacuum/pressure reading was not collected, the sample start time shall be documented on the appropriate field forms (Field computer and index cards).* Based on the flow rate to collect a 1-liter vapor sample, the peristaltic pump shall be allowed approximately five (5) minutes to collect the sample. Total sample collection time, which may exceed five (5) minutes, is dependent on the soil characteristics of the stratum from which the sample is being collected. Upon retrieval of the one-liter sample volume, close the valve on the Tedlar® bag, turn off the peristaltic pump, and leave the VMP open to the atmosphere to allow for venting. Place the sample bag in a black trash bag or container that will minimize exposure to sunlight. These samples are taken to the field laboratory for screening throughout the day (refer to SOP No. 52 Soil Vapor Field Laboratory Screening).

Duplicate samples shall be collected with a stainless-steel "T" sample splitter (disposable tubing shall be connected to either side of the sample splitter with a Tedlar® bag attached to each tubing). If sample splitter is not available, they may be collected by repeating the procedure detailed above immediately after the first sample (original sample) has been collected. Duplicate samples shall be obtained at a frequency of one per every twenty original samples collected.

Post-Sample Collection

Dismantle the sample train, dispose of all non-dedicated lines used for sample collection. New sample lines at each sample location shall be used, except for dedicated equipment. Non-dedicated, reusable equipment shall be decontaminated according to SOP No 4 Decontamination.

Venting

Following sample collection, VMPs are vented (opened to atmosphere) for a minimum of 15 minutes. This allows for VMP stabilization to occur.

Final (Stabilized) Vacuum/Pressure Measurement

After venting, a final, stabilized vacuum/pressure measurement shall be recorded. A pressure is considered to be stabilized when it does not fluctuate more than 5% in one minute. The manometer shall be allowed a maximum of one (1) minute to stabilize before the vacuum/pressure is recorded. If the manometer does not stabilize within the 1-minute period, the range in which the vacuum/pressure fluctuates over an additional one (1) minute period shall be documented on the appropriate field forms (logbook and index cards). The highest reading observed within the observed range shall also be recorded on the appropriate field forms (logbook and index cards). (*Please note: If the manometer reading fluctuates between two vacuums, the lowest vacuum observed shall be recorded on the field forms (logbook and index cards). If the manometer reading fluctuates between a vacuum and a pressure, the highest pressure observed shall be recorded on the field forms (logbook and index cards). If the manometer reading fluctuates between two pressures, the highest/strongest pressure observed shall be recorded on the field forms (logbook and index cards). In all cases, the range in the manometer readings over the additional one-minute period shall be recorded on the field forms (logbook and index cards).*

At VMP monitoring locations, the manometer shall be turned on, zeroed, and connected to the port as it was for the initial pressure. Once the pressure is stabilized the reading shall be taken. The manometer can then be removed and the VMP can be closed to the atmosphere.

Note: Any monitoring location where water/LNAPL is encountered during purge or Tedlar® bag collection, where the requisite volume cannot be purged, or where the VMP screen is submerged will not have a stabilized pressure collected. If ports are found to be submerged, it is documented both in the logbook and index cards.

1. Purpose and Scope

The purpose of this Standard Operating Procedure is to define the standard protocols for sample classification, packaging and shipping of air and soil vapor samples for Shell projects in Hartford and Roxana, Illinois. This SOP serves as a supplement to information which might be in a project Work Plan and is intended to be used together with other SOPs.

2. Other SOPs referenced in this SOP

- SOP No. 8 Field Reporting and Documentation
- SOP No. 26 Sample Control and Custody Procedures

3. Equipment

The following equipment is typically used for sample classification, packaging and shipping:

- Chain of Custody (COC)
- Custody seals
- Sample canisters
- Sample labels
- Waterproof pen
- Permanent marker
- UN-approved shipping box
- Shipping labels
- Packing materials
- Packing tape

4. Procedures

Sample Identification

Samples collected during site activities shall have discrete and site-specific sample identification numbers. These sample IDs are necessary to identify and track each of the many samples collected for analysis during the life of a project. In addition, the sample IDs can be used in a database to identify and retrieve the analytical results received from the laboratory.

Each sample is identified by a unique code which indicates the sample location type, sample location number, sample depth, and/or date collected. The sample locations will be numbered sequentially.

An example of the sample identification number codes for a vapor monitoring port collected for field analysis will be: VMP-1-5-090110.

Where "VMP" indicates a Vapor Monitoring Port sample, "1" indicates the site location number, "5" indicates the top of the sample depth interval (ft bgs), "090110" indicates the MMDDYY date the sample was collected.

The sampling locations and sample sequence identifiers will be established prior to field activities for each sample to be collected. On-site personnel will obtain assistance from the Task or Project Manager in defining any special sampling requirements. Other sample identification may be specified by the Task or Project Manager on an individual project basis.

Sample Labeling

Sample labels will be filled out as completely as possible by a designated member of the sampling team prior to beginning field sampling activities each day. The date, time, sampler initials/signature, and the last field of the sample identification number shall not be completed until the time of sample collection. All sample labels shall be filled out using waterproof ink. At a minimum, each label shall contain the following information:

- Sampler's company affiliation
- Project/Site location
- Sample identification code
- Date and time of sample collection (time shall include both start and stop time)
- Analyses required
- Canister ID
- Initial and final vacuum readings
- Sampler's signature or initials.
- Field logbook

Sample Handling and Shipping

After sample collection, each container will be labeled as described above, and then stored in a fashion which will protect the stems of the stainless-steel canisters. A determination will be made prior to sample shipment if the samples will be handled as hazardous materials for shipping and transportation purposes. If the samples are to be handled as hazardous material, a trained hazardous material shipper will be required to pack and ship samples.

When shipping samples designated as hazardous material, the sample containers will be placed right side up in a UN approved shipping box with a “This End Up” sticker, two “Cargo Aircraft Only” stickers (front and back of box), and a “Flammable Gas” placard. No more than the specified number of samples will be placed in an individual box for shipment (check regulations prior to packing). If the samples are designated non-hazardous, they do not require a UN approved shipping box or stickers/placards, and there is no limit to the number of canisters shipped in a box.

A chain-of-custody (COC) form will accompany each box. The COC may be specific to the samples included within each shipping container or may be comprehensive of all samples collected during a particular day/sampling period, regardless of the number of shipping containers. Applicable package tracking number(s) shall be written on the COC.

A custody seal will be placed over both flaps on both the top and bottom of the box and covered in clear tape, so custody seals are visible. The box will then be taped closed for delivery to the laboratory. Samples will be hand delivered or shipped by overnight carrier for delivery to the analytical laboratory. All samples must be shipped for laboratory receipt and analyses within specific holding times.

Sample Documentation and Tracking

Field Notes

Documentation of observations and data acquired in the field will be recorded on field sampling sheets, and in a bound field logbook to provide a permanent record of field activities. Refer to SOP No. 8 Field Reporting and Documentation for additional information.

Sample Chain-of-Custody

During field sampling activities, traceability of the sample must be maintained from the time the samples are collected until laboratory data are issued. The sampling team member(s) will be responsible for initiating and filling out the COC form in the field during sample collection. Information on the custody, transfer, handling, and shipping of samples will be recorded on a COC form. The COC shall contain project and sample specific information. Sample labels shall be checked against the COC to ensure accuracy.

A member of the sampling crew shall sign the COC form over to the person or party responsible for delivery of the samples to the laboratory, retain a copy of the COC form, document the method of shipment, and send the original COC form with the samples. Additionally, an electronic copy of the COC shall be forwarded to applicable project contacts (e.g., task manager, project chemist, etc.). Each time custody of the samples is transferred, the COC shall be signed by both parties. Each COC shall be scanned and saved to the appropriate electronic location. Refer to SOP No. 26 Sample Control and Custody Procedures for additional information about COCs.

1. Introduction

The purpose of this Standard Operating Procedure (SOP) is to provide a consistent methodology for the screening of Tedlar® bag soil vapor samples from the Shell projects in Hartford and Roxana, Illinois. This SOP details the necessary procedures to follow in order to ensure that valid total vapor phase hydrocarbons, oxygen, methane and carbon dioxide concentration data are collected and adequately documented. These procedures are applicable to any vapor sample collected at the Rand, Roxana, or WRR sites, but are particularly useful for samples collected from vapor monitoring ports (VMPs), soil vapor extraction (SVE) wells, and sub-slab (SS) ports that are located throughout the Village of Roxana. Important uses of these data include:

- Evaluation of indoor air or sub-slab methane concentrations
- Screening of indoor air or sub-slab petroleum hydrocarbon concentrations
- Evaluation of the performance of the Roxana Soil Vapor Extraction System.
- Evaluation of the performance of the Rand Avenue Remediation System
- Ambient air samples can either be collected and analyzed on-location using real-time instrumentation or collected in Tedlar® bags and analyzed at a dedicated sample screening station.

This SOP serves as a supplement to information which might be in a project Work Plan and is intended to be used together with other SOPs.

2. Other SOPs referenced in this SOP

- SOP No. 4 - Decontamination

3. Equipment

The following materials are typically used to perform sample screening, either on-site or at a dedicated sample screening station:

- Thermo Scientific TVA-2020 (TVA-2020) and Landtec GEM-2000 (GEM-2000) real-time monitors (or similar);
- Calibration gas cylinders, including;
  - Methane in air at concentrations of 50, 500, and 5,000 ppmv; and 32,500 ppmv (3.25% by volume)
  - Isobutylene in air at concentrations of 50 and 1,000 ppmv
  - Hydrocarbon-free air (Ultra Pure zero air)

  - 50% by volume methane/35% by volume CO_2

- Demand-flow regulator for calibration gas cylinders
- SKC sorbent tubes (part # 226-09) used for methane determination
- ¼-inch O.D. Teflon™ or Tygon™ tubing cut to length
- 10-to-1 dilution probe (Thermo Environmental Instruments Part #CR010MR)
- Disposable 3-way plastic valves (Qosina 3-way Stopcock, 2 Female Luer Locks, Male Luer Slip [Part # 13127]) used to switch the sample between methane and total hydrocarbon analyses.
- 1-liter Tedlar® bags (new or decontaminated as outlined in SOP No. 4 Decontamination)

4. Procedure

The following instruments shall be used to screen soil vapor samples:

- Two TVA-2020 instruments (primary and secondary) or performance equivalent for volatile organic compounds (VOCs) and methane by flame ionization detector (FID) and for VOCs by photoionization detector (PID)
- Landtec GEM-2000 or performance equivalent for methane, lower explosive limit (LEL), oxygen and carbon dioxide.

Immediately prior to use, each instrument shall undergo a calibration check. In the event that instrument accuracy is not within 10% of the designated calibration check standard concentration, the instrument shall be recalibrated. Field personnel shall follow applicable instrument operation SOP's and/or manufacturer's recommended procedures for the calibration and operation of the instruments. Calibration data shall be documented on the appropriate calibration forms for each instrument.

Calibration Procedures Applicable to All Field Screening Analyses

Instruments shall be calibrated in accordance with applicable SOPs and/or manufacturers recommended procedures immediately prior to sample screening. If the screening instruments are to be used throughout the workday, a mid-day calibration check shall be performed. Further, the TVA-2020 instrument detectors and associated dilution probe shall be bump checked (1-point accuracy check) approximately every two hours in order to document instrument stability. In the event that a bump check indicates a deviation greater than ± 10% from the designated bump-gas concentration, a full instrument calibration shall be performed. Due to negligible (<5%) instrument drift throughout the day, the GEM-2000 shall not undergo bi-hourly bump checks. Instead, if the GEM-2000 is used throughout the work day, calibration accuracy checks shall be conducted at approximately midday.

As stated above, calibration of the GEM-2000 and TVA-2020 shall be performed in accordance with applicable SOPs and/or manufacturer recommended procedures. However, the wide range of petroleum hydrocarbons and methane concentrations present at the site (i.e., greater than four orders-of magnitude) may be outside of the linear range of the TVA-2020 FID. To meet a primary data quality objective of the project (i.e., to quickly and accurately determine whether a potentially explosive condition is present at a sampling location), the FID calibration shall be based on a calibration standard that is approximately 10% of the LEL for methane (5,000 ppmv). However, additional QC procedures shall be implemented to ensure quality data for both hydrocarbon and methane concentrations.

The linearity of instrument response shall be verified by using 50, 500, and 5000 ppmv methane standards. If significant non-linear response (i.e., greater than 15% relative root mean square error) is observed, a nonlinear calibration curve shall be developed. The relative response factor for isobutylene (which is used here as a surrogate for petroleum vapors) shall be determined by using a 1,000 ppmv (nominal) isobutylene calibration standard. (1,000 ppmv is approximately 10% of the LEL for gasoline.)

Calibration shall be considered adequate when check standards are within +/- 10%. If the calibration check standards are outside that range, a second check standard shall be run and if the check standard fails again, the instrument shall be recalibrated and data obtained since the last check standard was successfully run shall be flagged as estimated values.

Screening of Concentrated Samples Utilizing a Dilution Probe

Because samples will need to be analyzed which are above the measurement range of the FID or which may not have sufficient oxygen content to analyze reliably, dilution of some samples shall be required prior to screening. The 10:1 dilution probe shall be calibrated using the 32,500 ppmv methane standard. Calibration of the dilution probe is considered complete when the FID response to this standard is within ± 5% of 3,250 ppmv.

The critical orifice in the dilution probe is density-dependent. As it will be calibrated using a 3.25% methane standard that has a density of 98.6% that of air, samples that have a density significantly different from that shall be subject to some level of deterministic error. Samples that have extremely high hydrocarbon or methane concentrations have the potential to have significantly varying densities, which can introduce significant error when the screening relies on the dilution probe. For example, error in excess of 10% will be present at concentrations of methane above 40% (if significant concentrations of petroleum hydrocarbons are not present).

Because the average density of petroleum hydrocarbon vapors is variable, the error is not as readily quantified for elevated concentrations petroleum hydrocarbons. Assuming an average density of 2.5 times that of air (i.e., density equivalent to isopentane), error in excess of 10% will be present at concentrations of petroleum hydrocarbon above 17% (if significant concentrations of methane are not present).

The density error associated with methane and heavier hydrocarbons have the potential to offset each other. Because the average density of measured hydrocarbon will not be known, data associated with an estimated error greater than 10% due to the presence of hydrocarbon or methane shall be flagged as estimated, rather than corrected for an assumed density. As the concentrations at which significant error is introduced are well above project action levels, estimated concentrations at these ranges are considered adequate to meet project data quality objectives.

Screening of Samples Utilizing a Charcoal Scrubber Tube to Filter Heavy Hydrocarbons

Use of the sorbent tube to screen out hydrocarbons other than methane affects the function of the FID instrument by lessening the flow of air through the detector. Preliminary testing indicates that a 25% to 30% reduction in instrument response occurs over the linear calibration range of the instrument. To calibrate the instrument for use of the sorbent tube, the 50, 500 and 5,000-ppmv methane standards shall be run with the sorbent tube to determine the relative response of the instrument to methane passed through the sorbent tube. The relative response factor (RRF) for each calibration standard shall be calculated as:

$$RRF = \frac{FID_{sorb}}{FID_{raw}}$$

Where;

RRF = relative response factor;

FID_{sorb} = Instrument response with sorbent tube; and

FID_{raw} = Instrument response to calibration standard without sorbent tube

The average RRF shall be used as a correction factor for samples analyzed using the sorbent tube. It is not necessary to correct instrument response (other than multiplying the displayed value by 10) when using the 10:1 dilution probe in conjunction with the sorbent tube. When using the dilution probe, the majority (approximately 90%) of the sample that is analyzed is actually dilution air that does not pass through the sorbent tube.

5. Sample Screening

Whenever possible, the soil vapor samples collected for the various work tasks shall be screened on the same day of collection. If same-day screening is not possible due to time constraints, instrument problems, etc., the samples shall be screened within 24-hours of sample collection. If samples are stored overnight, they shall be placed in a black trash bag or other opaque container to prevent light from reaching the samples. Most soil vapor samples collected in Tedlar® bags shall be screened at a fixed location using the instrumentation noted above. The fixed location facilitates the use of the instrumentation, allows for a more stable environment in which to screen the samples, and provides adequate space in which to perform the screening and complete the associated documentation. However, to allow rapid screening of indoor air and sub-slab soil vapor, such samples can be analyzed on site, using the same field instrumentation. The calibration of these instruments, as outlined in **Section 3.0**, shall be performed in such a way that instrument response is most accurate in the concentration range that corresponds to project action levels.

The TVA-2020 has been configured with a switching device (disposable 3-way valve) to allow sample to be passed through an SKC carbon sorbent tube to remove petroleum hydrocarbons (i.e., site data indicate that the remainder will be primarily methane).

Procedures for Sample Screening On Site

- Screen air sample with GEM-2000 landfill gas analyzer. Quickly document methane %, LEL %, oxygen and carbon dioxide concentrations on the appropriate sample screening data sheet;
- Screen sample with the TVA-2020 PID instrument and quickly document the concentration on the appropriate data sheet; and
- Screen the sample with the TVA-2020 FID without the sorbent tube and quickly record the total hydrocarbon concentration (THC) on the appropriate data sheet.
    - If THC = zero, then screening of sample is complete and it is not necessary to screen through sorbent tube; record 0.0 ppm as methane value on the appropriate data sheet.
    - If THC > zero, proceed with steps below;
- Set the TVA-2020 to sample through the SKC sorbent tube used in conjunction with the FID.

Calculate the methane concentration as;

$$C_{meth} = \frac{\text{FID}}{\text{RRF}};$$

Where

C_{meth} = methane concentration (ppmv); and

FID = FID reading (ppmv)

- The petroleum hydrocarbon concentration portion of the FID response shall be calculated as;

$$PHC = C_{raw} - C_{meth};$$

Where

PHC = petroleum hydrocarbon concentration (ppmv); and

C_{raw} = FID reading without sorbent tube (ppmv)

Procedures for Sample Screening at a Dedicated Sample Screening Station

The sampling instrumentation for the dedicated sample screening station has been configured such that the TVA-2020 can be operated with a 10:1 dilution valve, if concentrations are outside the operational range of the FID (i.e., if there is insufficient oxygen to support the FID flame or if the sample is above the linear range of the instrument).

- Open the valve on the Tedlar® bag sample approximately one turn and attach to the inlet of the GEM-2000 landfill gas analyzer. Quickly document methane %, LEL %, oxygen and carbon dioxide % using the Tedar® Data Entry program on dedicated field computer, or the appropriate sample screening data sheet;
- Screen sample with the TVA-2020 PID instrument and quickly document the concentration using the Tedar® Data Entry program on dedicated field computer, or the appropriate data sheet (secondary TVA-2020 PID shall be used to confirm PID results as needed in case of anomalous results, very low concentrations, etc.); and
- Screen the sample with the TVA-2020 FID without the sorbent tube and quickly record the total hydrocarbon concentration (THC) using the Tedar® Data Entry program on dedicated field computer, or on the appropriate data sheet.
    - If THC = zero, then screening of the sample is complete and it is not necessary to screen through sorbent tube; record 0.0 ppm as methane value

using the Tedar® Data Entry program on dedicated field computer, or on the appropriate data sheet.

- If THC > zero, proceed with steps below;

- Set the TVA-2020 to sample through the SKC sorbent tube used in conjunction with the FID.

Calculate the methane concentration as;

$$C_{meth} = \frac{FID}{RRF};$$

Where

C_{meth} = methane concentration (ppmv); and

FID = FID reading (ppmv)

- If the oxygen concentration in the sample is less than approximately 14%, configure the TVA-2020 for use with a 10-to-1 dilution probe. The dilution probe will allow for the sample to be screened by FID without flameout associated with low oxygen concentration samples. If the oxygen concentration is below 14% in a sample but a flameout does not occur on the TVA-2020, it shall be screened without the 10-to-1 dilution probe. The dilution probe must be separately calibrated and shall be used for sample screening by FID only. If the 10-to-1 dilution probe is used, the displayed concentrations must be multiplied by 10;
- Set the TVA-2020 to sample through the SKC sorbent tube. Record the reading as the methane concentration using the Tedar® Data Entry program on dedicated field computer, or on the appropriate data sheet. If the 10-to-1 dilution probe is used, the displayed concentration (FID) must be multiplied by 10, and the RRF shall not be used;
- The petroleum hydrocarbon (PHC) concentration portion of the FID response shall be calculated as:

$$PHC = C_{raw} - C_{meth}.$$

- After screening of the Tedlar® bag sample is complete, set aside the Tedlar® bag for cleaning according to SOP No. 04 Decontamination.

Procedures Applicable to All Sample Screening

Because the samples are collected in 1-liter Tedlar® bags, the samples must be removed from the instrument inlets as soon as a stable reading can be documented. Failure to do so will overly deplete sample volume and result in an inadequate amount of sample volume to complete all the screening parameters. Larger bags cannot be used due to time constraints during sample collection.

Because concentrations of hydrocarbons in some samples are elevated, the carbon in the sorbent tube can be saturated with hydrocarbon relatively quickly. If possible, use historical data to screen samples from low hydrocarbon concentration samples to high hydrocarbon concentration samples to avoid sorbent tube saturation. Therefore, the following protocols are in place to assure quality data:

The sorbent tube shall be replaced after use with 20 samples (if THC in sample was zero and sorbent tube was not used on sample, don't count as a "use");

- The sorbent tube shall also be replaced if breakthrough is observed (readily apparent) or if concentrations do not go to zero after sample is removed from analyzer inlet; and associated sample lines (Teflon™ or Tygon™ tubing), valves, etc. shall be replaced if concentrations do not return to zero after sample is removed from analyzer inlet.
- TVA-2020 PID glass bulb shall be cleaned according to manufacturer's instructions. Nothing but lens cleaning paper shall ever make contact with glass bulb.

6. Conclusion

The screening of soil gas samples must be conducted in an organized and precise manner. The resultant data will be valid only if proper procedure and associated QA/QC is followed. It is imperative that personnel conducting the sample screening strictly adhere to the protocol detailed above.

1. Introduction to the Dwyer Digital Manometer

The purpose of this Standard Operating Procedure (SOP) is to define the standard protocols for operating the Dwyer Series 475 Mark III Digital Manometer. It's used by personnel in the field to measure vacuum/pressure at wells throughout the Shell projects in Hartford and Roxana, Illinois. Personnel responsible for using a manometer shall read the manufacturer's instruction manual and/or be trained in the operation of the instrument. This SOP serves as a supplement to information which might be in a project Work Plan and is intended to be used together with other SOPs.

2. Other SOPs referenced in this SOP

None.

3. Zeroing the Manometer

The manometer is zeroed before each measurement. Only zero the manometer when both fittings are open to atmosphere. This is done by either depressing the "zero" button located on the front of the manometer or adjusting the knob ("zero adjust knob") on the top of the manometer (depending on which model is being used) while both positive and negative connections are open to the atmosphere. The "zero" button will automatically zero the instrument. If manometer is zeroed using the knob, the knob must be turned either clockwise (more positive) or counterclockwise (more negative) depending upon whether the manometer is reading positive or negative.

4. Vacuum / Pressure Measurement

The manometer shall be set on the "inches of water column" unit setting which can be done by depressing the "E/M" button and scrolling until "in/H2O" is found.

The positive fitting of the manometer shall be connected to the appropriate vacuum measurement fitting located on the well. The negative fitting on the manometer shall remain open to the atmosphere. The vacuum/pressure is immediately read and recorded to the nearest hundredth of an inch (or tenth of an inch if using 0-200 manometer) of water. If the reading is out of range of expected values, inspect the tubing for water or obstructions, and inspect both manometer fittings. If the reading is fluctuating, record the most consistent value. The manometer can then be removed from the vacuum measurement fitting.

5. Maintenance and Calibration

If the "low bat" indicator is lit on the manometer display, the battery needs to be replaced. A weak battery can cause improper operation or inaccurate measurements. The battery is changed by unscrewing the flathead screws located on the bottom of the manometer and removing the battery plate. The 9-volt alkaline battery will slide out and can then be unclipped from the wiring. Install a fresh battery and secure the battery plate. When replacing the cover, be sure the rubber sealing gasket is properly seated in the gasket channel of the endcap. Note the endcap will only fit one way.

If the manometer comes in contact with water or other conditions which cause the display to either not power on, or to read incorrectly, the manometer shall be sent back to the manufacturer for calibration.

Exceeding the range of the manometer will not damage it or affect calibration if the maximum pressure is not exceeded. Exceeding the maximum pressure will cause permanent damage to the sensor and may rupture the housing and/or cause injury. The maximum pressure is shown on the rear label of the manometer.

Manometers shall be sent back to the manufacturer or certified calibration agency every twelve (12) months for calibration following the “Manometer Calibration Schedule.” Calibration and maintenance records as well as calibration certificates are maintained on site.

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to define the standard procedure for recovering Light Non-Aqueous Phase Liquid (LNAPL) from groundwater monitoring wells, piezometers, soil vapor extraction (SVE) wells, etc. for the Shell projects in Hartford and Roxana, Illinois. This SOP serves as a supplement to information which might be in a project Work Plan and is intended to be used together with other SOPs. This SOP is not intended to be used for situations where a dedicated pump/removal system is warranted due to the amount of product.

2. Other SOPs referenced in this SOP

- SOP No. 4 Decontamination
- SOP No. 8 Field Reporting and Documentation
- SOP No. 10 Well Gauging Measurements

3. Equipment

The following equipment is typically needed:

- Well keys
- Assorted tools (drill, socket, screwdriver, clamps, etc.)
- Photo Ionization Detector (PID)
- Lower Explosive Limit (LEL) Monitor
- Oil/Water Interface probe with 0.01-foot increments
- Disposable nitrile gloves
- Trash bag or bucket
- Field logbook
- Field datasheets
- Waterproof permanent marker or pen
- Appropriate NAPL recovery instruments (i.e. bailers, peristaltic pump, etc.)
- Container for collecting recovered LNAPL and to measure amount recovered (i.e., metal gas can or bucket with lid)
- Plastic sheeting, plastic tote, or other means of secondary containment to use during recovery
- Appropriate decontamination equipment

- Appropriate health and safety equipment

4. Groundwater/LNAPL Level Measurement Procedures

Groundwater/LNAPL level measurement procedures shall be completed in accordance with SOP No. 10 Well Gauging Measurements. Observations made during the fluid level measurement will be recorded in the field logbook and/or on appropriate field datasheets in accordance with the procedures defined in SOP No. 8 Field Reporting and Documentation.

Appropriate personal protective equipment (PPE), as described in the Health and Safety Plan (HASP), will be worn during well opening, fluid level measurement, LNAPL recovery and decontamination.

5. LNAPL Recovery Procedures

When LNAPL is encountered while performing fluid level measurements, LNAPL presence will be confirmed by visual observations of the interface probe or by use of a clear plastic bailer or similar.

1. At SVE well locations, verify that the valve is closed so that the well is turned off and not under a vacuum from the SVE system.
2. Record static depth of LNAPL and groundwater and calculate the LNAPL thickness. Multiply the LNAPL thickness by the area of the inside diameter of the well casing to calculate the volume of LNAPL in the well.

Well Diameter (in)	Gallons per Foot	Liters per Foot
1	0.041	0.155
2	0.163	0.617
4	0.653	2.472
6	1.469	5.561

3. If the thickness of the LNAPL is measurable, but not practically recoverable (check with task manager regarding potential particular recovery thresholds), LNAPL recovery will not be attempted. If LNAPL is measurable and practically recoverable, LNAPL recovery shall be attempted.
   a. The recovery threshold for SVE wells is typically 0.20 feet LNAPL thickness[1].

[1] Recovery threshold presented is guideline based on site knowledge and experience and is not a formal or regulatory requirement.

   b. The recovery threshold for groundwater monitoring wells is typically 0.10 feet LNAPL thickness[2].

4. If LNAPL recovery will not be performed, perform decontamination procedures in accordance with SOP No. 4 Decontamination.
5. If LNAPL recovery is to be performed, determine the most effective and practical means of recovery by use of, but not limited to, any of the following equipment:
   a. Bailer (may be dedicated or designated to a particular well);
   b. Peristaltic pump (tubing may be dedicated or designated to a particular well);
   c. Spill Buddy™ pump, or similar;
   d. Absorbent sock.
6. Use plastic sheeting, plastic tote, or similar, to minimize the potential for downhole equipment, LNAPL, or recovered water coming into contact with the ground.
7. Recover LNAPL.
   a. If using a bailer:
      i. Slowly lower a bottom-filling bailer into the well until it reaches LNAPL/groundwater interface;
      ii. Pull bailer out of the well.
      iii. Discharge the collected LNAPL into a designated temporary storage container[3].
         1. If the temporary storage container is a 5-gallon bucket or similar, the bailer contents may be discharged by carefully inverting the bailer to pour the contents from the top.
         2. If the temporary storage container is a metal gas can or similar, the bailer contents shall be discharged using a sample release device (typically included in the package with the bailer).
      iv. Repeat as necessary.
   b. If using a peristaltic pump, Spill Buddy™ pump, or similar:

[2] Recovery threshold presented is guideline based on site knowledge and experience and is not a formal or regulatory requirement.
[3] The temporary storage container will typically be a 5-gallon bucket at the Rand Site or within the Wood River Refinery. The temporary storage container will typically be a metal gasoline can at the Roxana Site.

i. Lower the pump intake to the appropriate depth with the LNAPL thickness.

ii. Begin recovering LNAPL from the well.

c. If using an absorbent sock:

i. Lower the sock into the well no deeper than the LNAPL/groundwater interface.

ii. Allow the absorbent sock to remain in the well for a predetermined amount of time, or as specified by the manufacturer.

iii. Pull the sock from the well, collect a LNAPL/groundwater interface reading.

iv. Dispose of the sock in an appropriate container or squeeze the sock out into a temporary storage container, and place the sock back in the well, as manufacturers' specifications allow.

v. Coordinate with the IDW Coordinator for proper management and disposal of residuals generated.

8. Periodically take another depth to groundwater and depth to LNAPL reading, removing the LNAPL recovery equipment, if necessary.

9. LNAPL recovery activities shall cease when one of the following has occurred:

   a. Only a sheen of LNAPL is observed within the bailer;

   b. No more LNAPL is practically recoverable (i.e., too much water also being collected); or

   c. A maximum of 30 minutes has been reached (assuming that 30 minutes is sufficient time to remove about 1 volume of the LNAPL within the well).

10. Take a depth to groundwater and depth to LNAPL reading upon completion of LNAPL recovery activities.

11. Record all pertinent information on the LNAPL Recovery During Well Gauging field sheet (example attached). If items on the sheet do not apply to a specific location, the item will be labeled as not applicable (NA). Include a comment regarding the reason recovery efforts were ceased (refer to Step 9 above for guidance).

12. Containerize disposable equipment for proper disposal. Decontamination of impacted equipment or PPE may be required prior to disposal. Check with the project IDW Coordinator or designee for additional information.
13. Transfer LNAPL into the designated storage container (e.g., drum, lube cube, or similar) for staging pending recycling/recovery.

6. Documentation

An LNAPL recovery sheet (attached) shall be completed for each well requiring LNAPL recovery. Field data sheets shall include field personnel, date, well ID, interface probe ID, field laptop ID, initial and final fluid levels, height of LNAPL column, volume of LNAPL in well, volume of LNAPL recovered, and any additional field observations or comments. A field logbook shall also be kept during field activities describing, among other things, LNAPL recovery procedures, LNAPL recovery amounts, and other field observations. Both the data sheets and notebook shall be legibly completed using indelible ink and shall be signed and dated by the person completing the page. Refer to SOP No. 8 Field Reporting and Documentation for additional information.

LNAPL RECOVERY DURING WELL GAUGING

PROJECT NO: ____________________ WELL ID: ____________________

DATE: ____________________ INTERFACE PROBE ID: ____________________

PERSONNEL: ____________________ FIELD COMPUTER ID: ____________________

DEPTH TO LNAPL: ____________ ft btoc

SCREEN SATURATED? Yes No

DEPTH TO WATER: ____________ ft btoc

HEIGHT OF LNAPL: ____________ ft

DEPTH TO TOP OF SCREEN: ____________ ft btoc

VOLUME OF LNAPL: ____________ gal
(ht * 0 041 for 1" well)
(ht * 0.163 for 2" well)
(ht * 0 653 for 4" well)
(ht * 0.785 for 6" well)

WELL HEAD PID: ____________ ppm

DURING LNAPL RECOVERY:

Time	DTP (ft btoc)	DTW (ft btoc)	Ht of LNAPL (ft)

NOTES:

Gauge periodically during LNAPL recovery to monitor for recharge.

LNAPL recovery will continue until one of the following has occurred:
a) Only a sheen of LNAPL is observed within the bailer
b) No more LNAPL is practically recoverable (i.e., too much water also being collected); or
c) A maximum of 30 minutes has been reached

VOLUME RECOVERED: ____________ gal
(if amount recovered is not measurable (i.e., <0.5 gal), record "TRACE" above)

DEDICATED BAILER ESTABLISHED AT WELL? Yes No

COMMENTS:

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