

**Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia**

OPERATING PROCEDURE

Title: Soil Gas Sampling

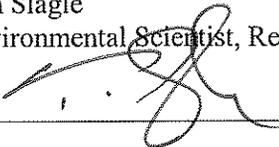
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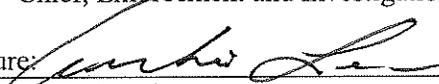
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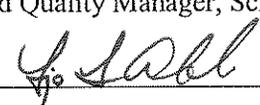
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Revision History

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<p>SESDPROC-307-R2, <i>Soil Gas Sampling</i>, replaces SESDPROC-307-R1</p> <p>Title Page: Changed Enforcement and Investigations Branch Chief from Antonio Quinones to Archie Lee.</p> <p>Revision History: Changed Field Quality Manager to Document Control Coordinator.</p> <p>Section 1.2: Added the following statement: "Mention of trade names or commercial products does not constitute endorsement or recommendation for use."</p> <p>Section 1.3: Omitted reference to the H: drive. Changed the Field Quality Manager to the Document Control Coordinator.</p> <p>Section 1.4: Updated references.</p> <p>Section 2.2: Two bullets added to bullet list</p> <p>Section 2.4: Quality Control section re-written with four bulleted definitions.</p> <p>Sections 3, 4 and 5: Sections re-written to reflect separate installation procedures (Sections 3 and 4) and sampling procedures (Section 5).</p> <p>Section 3: PRT installation procedures re-written. Decommissioning procedures added.</p> <p>Section 4: Permanent Soil Gas Implant procedures re-written. Decommissioning procedures added.</p> <p>Section 5: Sampling PRT and Permanent Soil Gas Installations added as separate sampling procedures section. Sampling procedures revised.</p>	<p>September 8, 2010</p>
<p>SESDPROC-307-R1, <i>Soil Gas Sampling</i>, replaces SESDPROC-307-R0</p> <p>General Updated referenced operating procedures due to</p>	<p>November 1, 2007</p>

<p>changes in title names and/or to reflect most recent version.</p> <p>Title Page Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch</p> <p>Section 1.3 Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities.</p> <p>Section 1.4 Alphabetized and revised the referencing style for consistency.</p> <p>Section 1.5.1 Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual.</p>	
<p>SESDPROC-307-R0, Soil Gas Sampling, Original Issue</p>	<p>February 05, 2007</p>

TABLE OF CONTENTS

1	General Information	
1.1	Purpose	5
1.2	Scope/Application	5
1.3	Documentation/Verification	5
1.4	References	5
1.5.1	<i>Safety</i>	6
1.5.2	<i>Procedural Precautions</i>	7
2	Special Sampling Considerations	8
2.1	Special Considerations for Sampling	8
2.2	Special Precautions for Soil Gas Sampling	8
2.3	Sample Handling Requirements	8
2.4	Quality Control	9
2.5	Records	9
3	Geoprobe® PRT System Installation	10
3.1	General	10
3.2	PRT System Installation Procedures	10
3.3	Decommissioning PRT Sample Locations	11
4	Geoprobe® Permanent Soil Gas Implant Installation	13
4.1	General	13
4.2	Installation of Permanent Soil Gas Sampling Implants (Typical)	13
5	Sampling PRT and Permanent Soil Gas Installations	16

1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting soil gas samples for field screening or laboratory analysis.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting and handling soil gas samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used to obtain a soil gas sample, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD Local Area Network (LAN). The Document Control Coordinator (DCC) is responsible for ensuring the most recent version of the procedure is placed on LAN and for maintaining records of review conducted prior to its issuance.

1.4 References

Geoprobe® Systems Tools and Equipment Catalog, Kejr Engineering, Inc., Salinas, Kansas, 1997.

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version

SESD Operating Procedure for Control of Records, SESDPROC-002, Most Recent Version

SESD Operating Procedure for Equipment Inventory and Management (SESDPROC-104, Most Recent Version)

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples, SESDPROC-209, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

The Yellow Field Book©, Kejr Engineering, Inc., Salinas, Kansas, 2000.

US EPA. 1999. Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS); Center for Environmental Research Information, Office of Research and Development, Cincinnati, OH; EPA/625/R-96/010b

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version

US EPA. April 13, 1981. Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples. Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273)

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

Geoprobe Systems, Direct Push Installation of Devices for Active Soil Gas Sampling & Monitoring, Technical Bulletin No. MK3098, Prepared May, 2006.

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when collecting soil gas samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when collecting soil gas samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.
- Collected samples are in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) and/or International Air Transportation Association (IATA) hazardous materials shipping requirements.
- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., shall be retained by the project leader and stored in a secure place.

2 Special Sampling Considerations

2.1 Special Considerations for Sampling

The tubing used as part of either of the described sampling systems should be Teflon® or stainless steel. As most soil gas sampling will be conducted to investigate the presence or extent of organic compounds, Teflon® tubing is required to ensure the integrity of the sample.

2.2 Special Precautions for Soil Gas Sampling

- A clean pair of new, non-powdered, disposable gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should be changed any time during sample collection when their cleanliness is compromised.
- If possible, one member of the field sampling team should take all the notes and photographs, fill out tags, etc., while the other members collect the samples.
- Use O-rings on all tooling, adapters and probe rods to ensure that the entire sampling train is air-tight. This is necessary to prevent soil ingress during installation and to maintain sample integrity by ensuring that no ambient air is introduced into the sample during collection.
- When using the Post-Run Tubing (PRT) sampling system, excavate a small depression around the rods after driving the distance of the intended open interval. Fill the depression with bentonite crumbles (not pellets) and hydrate with tap water to ensure sealing at the ground surface. Special care should be taken to keep the rod string aligned with the push axis of the probe machine.

2.3 Sample Handling Requirements

1. Soil gas samples will typically be collected by directly filling evacuated, specially-prepared stainless steel canisters (SUMMA or SilcoSteel® canisters), after sample delivery line purging.
2. The canister will be labeled and identified according to SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples (SESDPROC-209).

2.4 Quality Control

Quality control sampling for soil gas sampling investigations will consist of collection of the following types of samples, as appropriate.

- Control Sample: If applicable to the study or investigation, a control sample should be collected from a location not affected by the possible contaminants of concern and submitted with the other samples.
- Field Blank: A canister field blank, prepared prior to the investigation by ASB personnel, should also be submitted with the sample set during the investigation.
- Equipment rinsate blank: Equipment rinsate blanks should be collected if equipment, such as PRT adapters, probe rod or other sampling equipment is field cleaned and re-used to document that low-level contaminants were not introduced into the sample by the decontaminated equipment.
- Field Split: Field split samples, at a minimum frequency of one for every twenty samples, should be collected. Split samples are collected by attaching the center leg of a Swagelok® “T” to the end of the sample tubing. The remaining legs of the “T” are connected to two sample containers which are opened and filled simultaneously.

2.5 Records

Information generated or obtained by SESD personnel will be organized and accounted for in accordance with SESD records management procedures found in the SESD Operating Procedure for Control of Records (SESDPROC-002). Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation according to the procedures found in SESD Operating Procedure Logbooks (SESDPROC-010) and SESD Operating Procedure for Sample and Evidence Management (SESDPROC-005).

3 Geoprobe® PRT System Installation

3.1 General

Single event or grab sampling may be conducted using the Post-Run Tubing System (PRT). Using this system, soil gas samples can be collected quickly and with a high degree of assurance that the samples are representative of the targeted depth, i.e., using this method, there is no leakage at probe rod joints that will compromise the integrity of the sample.

The downhole components of the PRT system include:

- Sample delivery tubing
- Probe rods
- PRT Adapter
- Expendable point holder
- Expendable point

O-ring seals are used on the PRT Adapter, the expendable point holder and at all rod joints. The O-rings prevent soil ingress which can prevent air-tight docking of the PRT adapter.

3.2 PRT System Installation Procedures

The following procedures are used to collect soil gas samples using the Geoprobe® PRT system. The PRT system is available for 1.0-inch, 1.25-inch and 1.5-inch diameter probe rod. In SESD practice, 1.25-inch rods are used. All parts or accessories used in the PRT system must be selected with the appropriate diameter probe rod in mind to ensure compatibility of all components.

1. Place O-ring on PRT expendable point holder and attach to initial section of probe rod.
2. Place O-ring on expendable point and press into expendable point holder.
3. Add drive cap to probe rod and push PRT system into ground the distance of the intended open-interval. Take special care to assure that the rods are in line with the push axis of the probe machine. Dig a small depression around the rod string. Fill the depression with bentonite crumbles (not pellets) and hydrate with tap water.
4. At the desired sampling depth, attach a point popper to an extension rod and insert extension rod string into rods so that the point popper rests on the expendable point. Using the rod puller, and taking special care to maintain probe alignment with the rods, begin pulling the rods while maintaining pressure on the extension

rods. The extension rods should drop when the pull is started, indicating that the expendable point has been ejected. The rods can then be pulled to expose the desired open sampling interval.

5. Using a properly decontaminated water level sounder, check, if conditions warrant, to make sure groundwater is not present prior to proceeding with Step 6.
6. Secure the PRT adapter to a length of tubing sufficient to reach from the sampling interval to the surface, with several feet of excess tubing extending beyond the top of the probe rod to facilitate sampling. The adapter is secured tightly to the tubing using electrical tape. This will not compromise the integrity of the sample to be collected, as the sample is pulled directly through the adapter and is never exposed to the tape.
7. Run the tubing and adapter into the probe rod and, using steady downward pressure, turn the tubing counter-clockwise to dock the adapter into the top of the expendable point holder. Tug gently on the tubing to ensure that the adapter engaged with the expendable point holder. Continue rotating tubing until the adapter is firmly seated. Failure to dock could indicate that soil intruded during the push or that the expendable point was lost during the push.
8. At this point, the PRT system has been installed and is ready for sampling. If the sample can not be collected immediately, the end of the tubing should be capped with a stainless steel Swagelok® cap. Sampling is conducted using one of the procedures described in Section 5, Sampling PRT and Permanent Soil Gas Installations

3.3 Decommissioning PRT Sample Locations

Because it is impractical to pump grout through the PRT adapter on the lead probe rod, the entire string of rod must be removed before decommissioning can commence. The following methods are available, depending on conditions related to sample depth and post-removal probe hole wall stability:

1. **Direct Placement of Pellets or Grout** - If the sampling depth was fairly shallow, on the order of ten feet or less, grouting/sealing the open hole can be accomplished by directly placing bentonite pellets, hydrated in lifts, or pouring a 30% solids bentonite grout mixture from the surface. The acceptable maximum depth for this option is somewhat dependent on the stability of the hole and these methods may be used at slightly greater depths if the holes do not collapse after removal of the rod.
2. **Re-entry Grouting** - For locations where sampling was conducted at somewhat greater depths or where the surficial formations tend to collapse, the only viable option for grout placement may be to re-probe the entire depth with an expendable point. After reaching the original sample depth, the expendable point

is ejected and the hole is grouted by directly injecting grout through the inside of the rod string, as it is removed. Use of this option is dependent on the relative degree of hole stability.

4 Geoprobe® Permanent Soil Gas Implant Installation

4.1 General

Long-term soil gas sampling may be conducted using permanent soil gas sampling implants installed with the Geoprobe®. Stainless steel implants may be installed at any depth achievable by the Geoprobe® and may be installed using 1.0-inch, 1.25-inch or 1.5-inch diameter probe rod. In SESD practice, 1.25-inch probe rods are used. The implants may be installed in custom lengths, configured using a wide assortment of available implant lengths and connections. The implant screens are double-woven stainless steel mesh with 0.0057-inch (0.15 mm) pore openings.

Permanent soil gas sampling implants may also be installed using 2.125-inch diameter rods utilizing an advancing thin-walled corer to facilitate placement of the implant (see Geoprobe Systems, Direct Push Installation of Devices for Active Soil Gas Sampling & Monitoring, Technical Bulletin No. MK3098 for details of this application).

4.2 Installation of Permanent Soil Gas Sampling Implants (Typical)

The following procedures are used by to install a permanent soil gas sampling implant using the Geoprobe®. These are the general procedures which are used with 1.25-inch diameter probe rod.

1. Attach O-ring to implant point anchor.
2. Press implant point anchor into point holder and attach to first section of probe rod.
3. Push implant point anchor to the desired depth for implant installation. Using O-rings on all rod joints will prevent soil intrusion.
4. When the desired depth has been reached, attach the implant to the sample delivery tubing. This is accomplished by loosening or removing the Swagelok® fitting and pressing the tubing into the implant. When the end of the tubing is sufficiently engaged in the end of the implant, the Swagelok® fitting is tightened to secure the tubing in the implant. The Swagelok® tightening recommendation is 1 and ¼ turns after finger-tightening. It is critical that the tubing be securely attached to the implant so that it does not pull off during subsequent steps of the installation.
5. Feed the tubing into the probe rod until the implant reaches the implant point anchor. At this point, cut the tubing to allow enough tubing to remain for sampling, usually three to four feet.

6. Rotate the tubing and implant counter-clockwise, threading the implant into the anchor. If there was any soil intrusion during the push, the implant may not dock. If the implant does not dock, it is possible to salvage the installation by removing the implant and sealing the small hole on the bottom of the implant, if present, with foil or with a small sheet metal screw, then returning the implant to the hole.
7. After the implant has been docked, use a pull cap and pull the probe rod approximately one foot, exposing the implant. Observe the tubing to make sure that anchor remained in place and is not being pulled with the rod.
8. If the implant remained in place, slowly pour a measured amount of 60-100 mesh glass beads down the inside of the probe rod. The glass beads are used as a filter pack around the implant. The implant should be covered with beads to approximately six inches above the top of the implant. The volume of beads should be calculated based on the length of implant used. While pouring the beads, it is advisable to gently shake the tubing to prevent the beads from bridging inside the probe rod.
9. After placing the beads, the implant is sealed using a flowable mixture of the glass beads and fine-powdered bentonite. To accomplish this, two to three feet of rod is pulled and the mixture is slowly poured into the rod above the bead-packed implant. As with the bead placement, similar care should be taken to avoid bridging of this mixture. After placement of the bead/bentonite seal, hydrate by pouring one gallon of de-ionized water above the seal.
10. After placement and hydration of the seal, the rod string is removed and the resultant annular space is grouted using one of the following procedures, which are dependent on the depth and stability of the open hole.
 - a. If the resultant open hole is shallow (ten feet or less) and the hole walls are stable, the hole may either be filled with bentonite pellets, hydrated in lifts, or grouted using a 30% solids bentonite grout, poured from the surface.
 - b. If the hole is deeper than ten to fifteen feet, better results may be obtained by using a tremie pipe to place a pumpable grout. ½-inch PVC tremie pipe or Geoprobe nylon grout tubing is threaded down the annulus to the top of the bead/bentonite seal. The tremie is pulled off the bottom to prevent jetting out the seal and grout is pumped until the annulus is filled. Procedures are similar to those for well annular seals described in SESDGUID-101, Section 2.3.5.
11. For permanent or long-term installations the tubing should be protected by an appropriate surface completion, such as a flush vault or well protective casing, similar to well protective casings, as described in SESDGUID-101. The finish should be performed after 24 hours of grout curing.

12. After installation is complete the soil gas implant is sampled using one of the methods described in Section 5, Sampling PRT and Permanent Soil Gas Installations.

5 Sampling PRT and Permanent Soil Gas Installations

Soil gas samples may be collected from PRT and permanent soil gas implant installations using one of several methods, listed below. Canister sampling is the most common method utilized by SESD.

- Canister Sampling for Laboratory Analysis – After installation is complete and immediately prior to sampling, a flow-limiting device, consisting of a sintered stainless steel filter and a critical orifice, is attached at the sampling end of the tubing. After the device is connected to the Teflon® tubing, it is necessary to remove all stagnant or ambient air from the sample string. This volume, equal to approximately three times the volume of the sample string, should be estimated or calculated and attention must be given to not over-purging the estimated or calculated volume of the tubing and sample interval prior to sampling. Line purging can be accomplished using a low-flow pump, such as a personal air sampling pump, or a TVA1000.

After all stagnant/ambient air has been removed, the purging pump is removed and an evacuated canister is attached using a Swagelok® or other suitable secure connection. After connection, the valve on the canister is opened, pulling soil gas from the implant into the canister. Typically the sample is collected over a one-hour period, at which time the canister valve is closed and the canister tagged with pertinent sampling information. Alternatively, in some situations a mass-flow controller will be required to collect a sample over a specified, longer period of time period. This type of sampler is typically out-fitted with a gauge that will display the canister vacuum during the sampling period. When using this type of device, it is advisable to check the canister vacuum throughout the sampling period to verify filling. Gauge pressure/vacuum reading should be recorded in the project logbook.

- Real-time Field Analytical Methods – Real-time analytical measurements may be obtained from PRT or soil gas implant installations using appropriate instrumentation. The soil gas to be analyzed may be drawn directly into the instrument by the instrument pump or the instrument may be placed in line and the sample drawn into the instrument using a suitable pump connected to the discharge side of the instrument. Results may be qualitative, such as those obtained with flame ionization or photoionization detectors, or they may be quantitative, for instruments which can be calibrated to specific compounds.

**Region 4
U. S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia**

OPERATING PROCEDURE

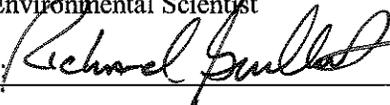
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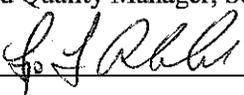
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<p>SESDPROC-303-R4, <i>Ambient Air Sampling</i>, replaces SESDPROC-303-R3.</p> <p>Table of Contents: Edited to reflect changes below.</p> <p>Section 1.7: Deleted references to the Tekran Model 2505 Mercury Vapour Calibration Unit User Manual and the Tekran Vapour Analyzer 2537A User Manual.</p> <p>Section 3.5: Deleted this Section.</p> <p>Section 3.6: Renumbered to Section 3.5.</p>	<p>January 5, 2011</p>
<p>SESDPROC-303-R3, <i>Ambient Air Sampling</i>, replaces SESDPROC-303-R2.</p> <p>Title Page: Under Approvals, changed Field Quality Manager from Laura Ackerman to Liza Montalvo.</p> <p>Section 1.2: Sentence added to indicate that mention of trade names or commercial products does not constitute endorsement or recommendation for use.</p> <p>Section 2.5: Bullet #7 edited to include the daily monitoring and recording of the refrigerator temperature.</p>	<p>October 15, 2010</p>
<p>SESDPROC-303-R2, <i>Ambient Air Sampling</i>, replaces SESDPROC-303-R1.</p> <p>General Corrected any typographical, grammatical and/or editorial errors.</p> <p>Title Page Under Author changed Danny France to Richard Guillot Under Approvals changed Branch Chief from Antonio Quinones to Archie Lee.</p> <p>History: Changed Field Quality Manager to Document Control Coordinator.</p> <p>Section 1.3: Omitted reference to the H: drive. Changed the Field Quality Manager to the Document Control Coordinator.</p>	<p>October 30, 2009</p>

<p>Section 2 All previous sections were deleted. New sections were added.</p> <p>Section 3 Section 3.1 was rewritten.</p> <p>Section 3.8 Removed to separate guidance document.</p> <p>Section 3.9 Removed to separate guidance document.</p>	
<p>SESDPROC-303-R1, <i>Ambient Air Sampling</i>, replaces SESDPROC-303-R0.</p> <p>General Corrected any typographical, grammatical and/or editorial errors.</p> <p>Title Page Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch.</p> <p>Section 1.3 Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities.</p> <p>Section 1.5 Updated referenced operating procedures due to changes in title names.</p> <p>Section 1.6.1 Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual.</p> <p>Section 1.6.2, 4th bullet Added references to the CFR and IATA's Dangerous Goods Regulations.</p> <p>Section 1.7 Updated referenced operating procedures due to changes in title names. Alphabetized and revised the referencing style for consistency. Added two references (IATA and 49 CFR).</p>	November 1, 2007
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TABLE OF CONTENTS

1 GENERAL INFORMATION	6
1.1 Purpose	6
1.2 Scope/Application	6
1.3 Documentation/Verification	6
1.4 Quality Control	6
1.5 Records	6
1.6 General Precautions	7
1.6.1 Safety	7
1.6.2 Procedural Precautions	7
1.7 References	8
2 AUDITING OF OZONE AND CARBON MONOXIDE MONITORING SITES IN THE NATIONAL PERFORMANCE AUDIT PROGRAM (NPAP)	11
2.1 Auditing Ozone Analyzers	11
2.1.1 Audit Procedure	12
2.2 Auditing Carbon Monoxide Analyzers	13
2.2.1 Audit Procedure	13
2.3 Sampling of Particulate Matter in Ambient Air as PM_{2.5} in the PM_{2.5} Performance Evaluation Program	14
2.4 Sampling of Particulate Matter in Ambient Air as PM₁₀	15
2.4.1 Sample Collection Procedure	16
2.5 Laboratory Filter Analysis of Particulate Matter in Ambient Air as PM_{2.5} in the PM_{2.5} Performance Evaluation Program	16
3 NON-CRITERIA POLLUTANT MONITORING FOR AIR POLLUTANTS FOR WHICH NATIONAL AMBIENT AIR QUALITY STANDARDS HAVE NOT BEEN ESTABLISHED	18
3.1 Formaldehyde Sampling With Dinitrophenylhydrazine Cartridges Using Method TO-11A	18
3.2 Volatile Organic Compounds (VOC) Sampling with SUMMA® Electropolished Stainless Steel Canisters or Silcosteel® Canisters Using Method TO-15A	19
3.2.1 Sample Collection Procedure	20
3.2.2 Grab Sample Collection Procedure	21
3.2.3 Time Integrated Sample Collection Procedure	21
3.3 Sampling for Semi-Volatile Organic Compounds (SVOC) Analysis with High Volume PUF Samplers Using Methods TO-4A & TO-13A	21
3.3.1 PUF Cleaning Procedure	22
3.3.2 Sample Collection Procedure	23

3.4 Collecting Samples for Metals Analysis Using the High Volume Sampler ... 23
 3.4.1 Sample Collection Procedure 24
 3.4.2 Integrated Sample Collection Procedure 24
3.5 Sampling for Dioxin And Dibenzofuran Analyses with High Volume PUF
 Samplers Using Method TO-9A 25
 3.5.1 General Information 25
 3.5.2 Sample Collection Procedure 25

1 GENERAL INFORMATION

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting ambient air samples for field screening or laboratory analysis. Air toxics, as used in this procedure, means air pollutants for which National Ambient Air Quality Standards have not been established. Criteria pollutants mean air pollutants for which National Ambient Air Quality Standards have been established.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting and handling ambient air samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are inappropriate, inadequate or impractical and that another procedure must be used to obtain an ambient air sample, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD local area network (LAN). The Document control Coordinator (DCC) is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

1.4 Quality Control

Quality control for sampling associated with ambient air monitoring is method specific. The sampling methods described in the sections that follow contain the quality control procedures appropriate for each method.

1.5 Records

Information generated or obtained by SESD personnel will be organized and accounted for in accordance with SESD records management procedures found in SESD Operating Procedure for Control of Records, SESDPROC-002. Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation in accordance with SESD Operating Procedure for Logbooks, SESDPROC-010 and SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005.

1.6 General Precautions

1.6.1 Safety

Proper safety precautions must be observed when collecting ambient air monitoring samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.6.2 Procedural Precautions

The following precautions should be considered when collecting ambient air monitoring samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.
- Collected samples are in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.
- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as bills of lading, etc., shall be retained by the project leader and stored in a secure place.

1.7 References

Ambient Monitoring Technology Information Center (AMTIC) Internet Bulletin Board: PM_{2.5} QA area (<http://www.epa.gov/ttn/amtic/pmqa.html>)

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Method TO-4A (pesticides and PCBs) and TO-13A (polynuclear aromatic compounds)

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Method TO-9A

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Method TO-11A

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Method TO-15A

International Air Transport Authority (IATA) Dangerous Goods Regulations, Most Recent Version

Neutronics Model RI-2002PA Portable Automotive Refrigerant Identifier Operation Instruction Manual

SESD Operating Procedure for Control of Records, SESDPROC-002, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-108, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples, SESDPROC-209, Most Recent Version

Title 40 Code of Federal Regulations (CFR), Part 50, Appendix A - Reference Method for the Determination of Sulfur Dioxide in the Atmosphere (Pararosaniline Method), Most Recent Version

Title 40 CFR, Part 50, Appendix B - Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High Volume Method), Most Recent Version

Title 40 CFR, Part 50, Appendix C - Measurement Principle and Calibration Procedure for the Measurement of Carbon Monoxide in the Atmosphere (Non-Dispersive Infrared Photometry), Most Recent Version.

Title 40 CFR, Part 50, Appendix D-Measurement Principle and Calibration Procedure for the Measurement of Ozone in the Atmosphere, Most Recent Version

Title 40 CFR, Part 50, Appendix F - Measurement Principle and Calibration Procedure for the Measurement of Nitrogen Dioxide in the Atmosphere (Gas Phase Chemiluminescence), Most Recent Version

Title 40 CFR, Part 50, Appendix G - Reference Method for the Determination of Lead in Suspended Particulate Matter Collected From Ambient Air, Most Recent Version

Title 40 CFR Part 50, Appendix J - Reference Method for the Determination of Particulate Matter as PM₁₀ in the Atmosphere, Most Recent Version

Title 40 CFR Part 50, Appendix L - Reference Method for the Determination of Fine Particulate Matter as PM_{2.5} in the Atmosphere, Most Recent Version

Title 40CFR Part 53 – Ambient Air Monitoring Reference and Equivalent Methods, Most Recent Version

Title 40 CFR, Part 58 – Ambient Air Quality Surveillance, Most Recent Version

Title 40 CFR, Part 58, Appendix A -Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS), Most Recent Version

Title 40 CFR, Part 58, Appendix C - Ambient Air Quality Monitoring Methodology, Most Recent Version

Title 40 CFR, Part 58, Appendix D - Network Design for State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), and Photochemical Assessment Monitoring Stations (PAMS), Most Recent Version

Title 40 CFR, Part 58, Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring, Most Recent Version

Title 49 CFR, Parts 171 to 179, Most Recent Version

US Environmental Protection Agency (US EPA) 1994. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume I, Principles, EPA/600/R-94/038a, April 1994.

US EPA. 1995. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, (revised edition) EPA/600/R-94/038d, March, 1995.

US EPA. 1998. Quality Assurance Handbook for Air Pollution Measurement System, Volume II: Part 1, Ambient Air Quality Monitoring Program, Quality System Development, EPA-454/R-98-004, August 1998 (commonly referred to as the "Red Book.").

US EPA. 1998. EPA Quality Assurance Document: Method Compendium, PM_{2.5} Mass Weighing Laboratory Standard Operating Procedures for the Performance Evaluation Program, United States Environmental Protection Agency Office of Air Quality Planning and Standards, October 1998.

US EPA. 2006. Standard Operating Procedure for Through-the-Probe Performance Evaluations of Ambient Air Quality Monitoring of Criteria Air Pollutants, January 2006.

US EPA. 1998. Quality Assurance handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods, Section 2.12, EPA/600/R-94/038b, November, 1998

US EPA. 2002. EPA Quality Assurance Guidance Document: Method Compendium, Field Standard Operating Procedures for the PM_{2.5} Performance Evaluation Program, United States Environmental Protection Agency Office of Air Quality Planning and Standards, Revision No. 2, March 2002.

US EPA. 2005. Standard Operating Procedures for Through-The-Probe (TTP) Performance Evaluations of Ambient Air Quality Monitoring of Criteria Air Pollutants, Office of Air Quality Planning and Standards, May 2005.

US EPA Quality Assurance Document: Quality Assurance Project Plan for the Performance Evaluation Program

US EPA Implementation Plan: PM_{2.5} Federal Reference Method Performance Evaluation Program, EPA Quality Assurance Guidance Document 2.12

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

2 AUDITING OF OZONE AND CARBON MONOXIDE MONITORING SITES IN THE NATIONAL PERFORMANCE AUDIT PROGRAM (NPAP)

2.1 Auditing Ozone Analyzers

The following is a synopsis of procedures which should be strictly adhered to for the auditing of ozone at ambient monitoring sites.

- The photometer (audit instrument) will meet 40 CFR Part 50, Appendix D specifications for a Primary Standard Calibration Photometer. This instrument will be re-plumbed to act as an analyzer to measure test gas concentrations.
- The photometer will be verified quarterly against a National Institute of Standards and Technology (NIST) Standard Reference Photometer before use.
- The mobile laboratory will meet the specifications of monitor reference/ equivalent designation for temperature control which is between 20-30 degrees Celsius when the analyzer is in operation.
- The probe line must meet the requirements stated in 40 CFR Part 58 for materials and sample residence time.
- Flows will be calibrated annually, and all flow calibrations will be traceable to a primary standard. Flows will be corrected to EPA standard temperature and pressure (25°C and 760 mm Hg).
- The ozone generator/calibrators flow and ozone generation output will be calibrated annually.
- The ozone generator and photometer will operate using zero air supplied by a zero air generator. The zero air scrubber components will be replaced annually or if anomalies in the zero measurement are observed. The desiccant will be regenerated when two thirds (2/3) of the blue indicating silica gel has turned pink.
- During the audit, stability of each audit point will be demonstrated for at least five minutes.
- All auditing will be performed at approximately ambient pressure (utilizing a vent for excess during the audit procedure). There should be excess air flow at the probe at all times.
- All audits will be conducted “through the probe” where the probe is safely accessible.

- Chain-of-custody must be maintained at all times (monitor will be locked in the mobile laboratory when the operator is not present to prevent tampering).

2.1.1 Audit Procedure

Auditing will be conducted using the procedures as summarized below, and in accordance with the EPA Standard Operating Procedure for Through-the-Probe Performance Evaluations of Ambient Air Quality Monitoring of Criteria Air Pollutants, and 40 CFR Part 50, APPENDIX A:

- Procedures detailed in the approved instrument manual will be used for installation, calibration, QA checks, maintenance, and repairs.
- The photometer will be verified quarterly against a National Institute of Standards and Technology (NIST) Standard Reference Photometer after major maintenance or when a quality assurance (QA) check shows an out-of-control condition exists.
- A data telemetry system, with electronic strip charting capability will be operated to record the audit progress and each audit activity will be annotated on the chart. This will serve as a permanent record and diagnostic tool.
- Prior to the audit, the audit equipment, including the photometer and calibrator, will be allowed a warm up period of at least 3 hours. During this time, the system should be conditioned with at least 200 ppb of ozone. The concentration of ozone used to condition the system must always be higher than the highest audit point that will be audited.
- The audit will consist of at least three consecutive levels where at least 80% of ozone measurements are expected to be at the monitoring site and a zero measurement. The prescribed audit levels are recorded in 40 CFR Part 58, Appendix A, 3.2.2.1.
- Audit data from the mobile laboratory and monitoring site will be recorded electronically on the NPAP Audit Worksheet. This worksheet, along with the electronic strip chart trace will be printed at the conclusion of each audit event. In addition, the NPAP Audit Worksheet will be copied and placed on the network drive for archival. A hard copy of the preliminary audit report and electronic strip chart will be provided to the site operator at the conclusion of the audit.
- After completion of the study, the mobile laboratory will be returned for inspection, maintenance, and repair. All field documentation will be retained by the Air Monitoring Staff.

2.2 Auditing Carbon Monoxide Analyzers

The following is a synopsis of procedures which should be strictly adhered to for the auditing of carbon monoxide in air.

- Calibration systems will meet 40 CFR Part 50, Appendix C specifications.
- The mobile laboratory will meet the specifications of monitor reference/ equivalent designation for temperature control which is between 20-30 degrees Celsius when the analyzer is in operation.
- The audit analyzer will be calibrated using certified concentrations of standard gases before and after use.
- The probe line must meet the requirements stated in 40 CFR Part 58 for materials and sample residence time.
- Calibrator flows will be calibrated annually, and all flow calibrations will be traceable to a primary standard. Flows will be corrected to EPA standard temperature and pressure (25°C and 760 mm Hg).
- The gas calibrator will operate using zero air supplied by a zero air generator. The zero air scrubber components will be replaced annually or if anomalies in the zero measurement are observed. The desiccant will be regenerated when two thirds (2/3) of the blue indicating silica gel has turned pink.
- During the audit, stability of each audit point must be demonstrated for at least five minutes.
- All auditing will be performed at approximately ambient pressure (utilizing a vent for excess during the audit procedure). There should be excess air flow at the probe at all times.
- All audits will be conducted “through the probe” where the probe is safely accessible.
- Chain-of-custody must be maintained at all times (monitor will be located in a locked enclosure when the operator is not present to prevent tampering).

2.2.1 Audit Procedure

Auditing will be conducted using the procedures summarized below, and in accordance with the EPA Standard Operating Procedure for Through-the-Probe Performance Evaluations of Ambient Air Quality Monitoring of Criteria Air Pollutants, and 40 CFR Part 50, APPENDIX C:

- Procedures detailed in the approved instrument manual will be used for installation, calibration, QA checks, maintenance, and repairs.
- The carbon monoxide analyzer will be verified using G1 or G2 certified tank gases before and after each audit or when a quality assurance (QA) check shows an out-of-control condition exists.
- A data telemetry system, with electronic strip charting capability will be operated to record the audit progress and each audit activity will be annotated on the chart. This will serve as a permanent record and diagnostic tool.
- Prior to the audit, the audit equipment, including the carbon monoxide analyzer and calibrator, will be allowed a warm up period of at least 6 hours. During this time, the system should be conditioned with approximately 200 ppb of ozone.
- The audit will consist of at least three consecutive levels where at least 80% of carbon monoxide measurements are expected to be at the monitoring site and a zero measurement. The prescribed audit levels are recorded in 40 CFR Part 58, Appendix A, 3.2.2.1.
- Audit data from the mobile laboratory and monitoring site will be recorded electronically on the NPAP Audit Worksheet. This worksheet, along with the electronic strip chart trace will be printed at the conclusion of each audit event. In addition, the NPAP Audit Worksheet will be copied and placed on the network drive for archival. A hard copy of the preliminary audit report and electronic strip chart will be provided to the site operator at the conclusion of the audit.
- After completion of the study, the mobile laboratory and equipment will be returned for inspection, maintenance, and repair. All field documentation will be retained by the Air Monitoring Staff.

2.3 Sampling of Particulate Matter in Ambient Air as PM_{2.5} in the PM_{2.5} Performance Evaluation Program

The following is a synopsis of procedures which should be strictly adhered to for filter based sampling of PM_{2.5} in air. The procedures below are a summarized version of the procedure described in the September 2006 Revised Quality Assurance Guidance Document, Method Compendium "Field Standard Operating Procedures for the PM_{2.5} Performance Evaluation Program" which should be referenced for all low volume PM_{2.5} sampling:

- Field personnel will take the filters, field data sheets, and COC to the monitoring site and setup the portable samplers.

- Air flow rate, barometric pressure, and two temperature measuring devices will be verified prior to each sampling event. All flow, barometric pressure and temperature standard devices are annually calibrated and traceable to a primary standard.
- An external leak check will be performed.
- The sampler will be programmed to operate and the sampling unit will be locked to prevent tampering.
- Within 8 to 16 hours following the sampling event the exposed filters will be collected, and transported refrigerated ($\leq 4^{\circ}\text{C}$) to the SESD Filter Weighing Laboratory.
- Field personnel will return the exposed filter, data downloads, field data sheets, and COC to SESD keeping a set of the data records in two separate locations.
- After sample collection, all filters will be stored in petri-slides, boxed, and archived for one (1) year at $\leq 4^{\circ}\text{C}$ and at least two (2) years at ambient room temperature $\leq 25^{\circ}\text{C}$.

2.4 Sampling of Particulate Matter in Ambient Air as PM_{10}

The following is a synopsis of procedures which should be strictly adhered to for the sampling of particulate matter as PM_{10} in air.

- All filters used will be supplied by the EPA National Filter Distribution Program, and of the same quality as supplied to the State and Local Agency Air Monitoring Stations.
- Prior to use, all filters will be checked for pinholes, and desiccated at $15^{\circ}\text{C} - 30^{\circ}\text{C} \pm 3^{\circ}\text{C}$, and less than 50 ± 5 percent relative humidity, for at least 24 hours.
- Initial and final (exposed) filter weights will be determined by air monitoring personnel. One of ten filters will be re-weighed as a quality assurance check. For batches less than ten, one filter will be re-weighed. Weights of clean filters should be within 2.8mg of original values, and exposed filters should be within 5 mg.
- After sampling, filters will be desiccated as previously described.
- Chain-of-custody must be maintained for all samples (monitor will be locked when the operator is not present to prevent tampering).

2.4.1 Sample Collection Procedure

Particulate samples will be collected using the High Volume sampler as described, and operated in accordance with 40 CFR Part 50, Appendix J, and Red Book Sections 2.10, and 2.11.

- All flow calibration orifices will be traceable to a primary standard Rootsmeter. Flows will be corrected to EPA standard temperature and pressure (25°C and 760 mm Hg).
- Volumetric flow controllers will be used on all PM₁₀ samplers. Flows will be determined using a calibrated orifice and a digital manometer.

2.5 Laboratory Filter Analysis of Particulate Matter in Ambient Air as PM_{2.5} in the PM_{2.5} Performance Evaluation Program

The following is a synopsis of procedures which should be strictly adhered to for filter based sampling of PM_{2.5} in air. The procedures below are a summarized version of the procedure described in the Quality Assurance Guidance Document, Method Compendium "PM_{2.5} Mass Weighing Laboratory Standard Operating Procedures for the Performance Evaluation Program" which should be referenced for all low volume PM_{2.5} filter analysis.

- EPA OAQPS National Filter Distribution Program will send filters to the SESD PM_{2.5} Filter Weighing Laboratory
- Upon introduction into the weighing laboratory process, each individual batch of filters will go through lot stability testing to determine a minimum equilibration time period.
- Prior to use the filters will be checked for deformities, equilibrated at 20 - 23°C ± 2°C and 30 - 40 % ± 5 % relative humidity for a minimum of 24 hours, labeled, pre-weighed (auto-entry into database), loaded into cassettes, and prepared for packaging and shipping.
- During the pre-weighing session, the filter batch should pass 100µg and 200µg balance checks (+/- 3ug), two consecutive weightings demonstrating stability (+/- 5 ug), and provide an initial laboratory blank weighing.
- The SESD Filter Weighing Laboratory will ship the pre-weighed filters and chain-of- custody (COC) forms to the field personnel.
- Filters and COC forms for Region 4 are passed directly to the field scientists.

- After sampling, filters will be transported to the SESD Filter Weighing Laboratory, logged into the database, refrigerated until a batch is completed, moved to the laboratory, unloaded from the cassettes, equilibrated for at least 24 hours, and post-weighed. The filter refrigerator temperature will be monitored and recorded on a daily basis.
- During the post-weighing session, the filter batch should pass 100mg and 200mg balance checks (+/- 3ug), post batch stability check (+/- 15ug), and laboratory blank check (+/- 15ug).
- SESD will calculate the tare weight from the laboratory analyses and will calculate a concentration from the field data. All field data and laboratory data will be archived and backup data will be kept on the network.

Chain-of-custody and all accompanying field data must be maintained for all samples.

3 NON-CRITERIA POLLUTANT MONITORING FOR AIR POLLUTANTS FOR WHICH NATIONAL AMBIENT AIR QUALITY STANDARDS HAVE NOT BEEN ESTABLISHED.

3.1 Formaldehyde Sampling With Dinitrophenylhydrazine Cartridges Using Method TO-11A

The following is a synopsis of procedures which should be strictly adhered to for the handling and field use of dinitrophenylhydrazine (DNPH) cartridges for formaldehyde sampling. The following generic procedures should be adhered to at all times.

Summary of Sampling Method:

A glass cartridge using dinitrophenylhydrazine (DNPH) is placed in a special sampler and is equipped with pumps that withdraw a calibrated air volume for a specified time to capture formaldehyde and other carbonyl compounds. The cartridges are collected and shipped to the laboratory under controlled temperature.

- Quality Control requirements will be based on the method's DQO.
- A minimum of one trip blank shall be transported per one to ten samples collected. Instrument blanks, duplicated samples or co-located samples will be based on laboratory request.
- Chain of Custody shall be maintained for all samples.
- Polyethylene or latex gloves must be worn whenever handling any of the DNPH cartridges (in the extraction laboratory, during preparation for shipment, during field set-up, in the field during preparation for return shipment, and in the laboratory during preparation for analysis and during analysis).
- All padding material shall be either clean tissue paper or polyethylene-air bubble padding. Never use polyurethane foam, cardboard, or newspaper as padding material. DNPH cartridges which have been properly prepared for shipment should be shipped in coolers with eutectic salt packs (Blue Ice).

Due to shelf life limitations, only the number of DNPH cartridges needed for a maximum of 180 days (including trip blanks and extra DNPH cartridges for breakage) should be ordered at any one time.

- On the date of shipment or when loading out for a study, the Air Monitoring Staff will remove the capped DNPH cartridges from the refrigerator in the Air Laboratory.

- An appropriate amount of packing material shall be placed in the shipping container to prevent breakage of the glass DNPH tubes. The DNPH tubes should be shipped in coolers containing eutectic salt packs (e.g., Blue Ice) to maintain a temperature of approximately 4°C. The DNPH cartridges shall be shipped the same day they are packed.
- At each sampling location the cooler will be opened and one plugged DNPH cartridge will be removed (wearing clean polyethylene or latex gloves) and the two end plugs will be removed from each end of the DNPH cartridge which will be immediately placed on the sampling train. (If it is the SKC brand, the glass ends of the tubes must be broken off. A trip blank will be placed in a sampler enclosure at one of the sites for the duration of the sampling event.
- The sampler will be manually turned on and allowed to run for five minutes. An initial flowrate should be recorded on the sample data sheet. The timer should be set to turn the sampler on and off at the desired times.
- The operator should retrieve and secure the sample as soon as possible after the sampling period ends. The sampler should manually be turned on and allowed to run for five minutes and a final flowrate and the elapsed time from the time meter should be recorded on the sample data sheet. The exposed DNPH cartridge will then be removed from the sampling train (wearing clean polyethylene, latex or nylon gloves). The two end caps will be placed on the ends of the DNPH cartridge. The DNPH cartridge will be placed back into the cooler. The same procedure is to be followed at each sampling site.
- At the end of each day on which the samples are collected, the exposed DNPH cartridges shall be either placed in a refrigerator for storage overnight or stored in the cooler. The cooler will be used to transport the samples to the laboratory. The duration of the non-refrigerated period shall be kept to a minimum but absolutely not more than two days (including the sampling event).
- Upon arrival of the DNPH cartridges at the laboratory, the samples shall be stored in a refrigerator until extraction.
- Chain-of-custody and all accompanying field data must be maintained for all samples.

3.2 Volatile Organic Compounds (VOC) Sampling with SUMMA® Electropolished Stainless Steel Canisters or Silcosteel® Canisters Using Method TO-15A

The following is a synopsis of procedures which should be strictly adhered to for the cleanup and use of Summa® canisters for sampling air for Volatile Organic Compounds (VOC) analysis.

The following procedures must be followed in the preparation and use of Summa® canisters for collecting samples for VOC analysis:

- All new Summa®/Silcosteel® canisters must be individually checked for contamination by the laboratory before use. One of each batch of 10 Summa® canisters that are subsequently cleaned must be analyzed to check for contamination.
- All sampler tubing, fittings, and wetted parts of valves must be solvent washed in hexane and heated to >100° C. These parts should then be assembled and flushed with nitrogen¹ for at least 8 hours prior to use in the sample train or in the canister cleanup apparatus.
- Each canister's valve and fitting will be inspected for damage before cleaning. Any damaged valve will be replaced with a previously cleaned (see procedure above) valve. After replacing any valve, the canister will be cleaned and analyzed to verify that it is free of contamination.
- If any canister is used to sample a high concentration source, it must be cleaned and analyzed to verify it is free of contamination before it can be used again.
- Chain-of-custody must be maintained for all samples.

1. The nitrogen should be certified 99.999% pure by the manufacturer. A scrubber should be attached to the nitrogen line after the regulator to remove any trace impurities.

3.2.1 Sample Collection Procedure

Two types of VOC samples can be collected with Summa®/ Silcosteel® canisters. The canister can be opened and allowed to fill rapidly to obtain a grab sample or filled slowly by using a flow controller to collect a time integrated sample. With either type of sample, the following general procedures should be followed:

- A Chain-Of-Custody Record should be completed detailing time of sampling, sampling interval, and signed by the person collecting the sample.
- After the sample has been collected, the Summa®/Silcosteel® canister should be capped, an EPA pre-numbered tag should be completed and attached to the canister, and the canister should be placed in a shipping container with a copy of the Chain-Of-Custody Record and sealed with EPA sample custody tape.

3.2.2 Grab Sample Collection Procedure

Before a grab sample is collected for VOC analysis in a Summa®/Silcosteel® canister, the canister inlet valve should be fitted with a pre-cleaned stainless steel particulate filter. At the sample collection location, the main valve should be opened and the canister allowed to fill. After about one minute (when no audible sound of rushing gas can be heard), the main valve of the Summa® canister should be closed and capped.

3.2.3 Time Integrated Sample Collection Procedure

This sample collection method involves the use of a flow controller or a sampler containing a flow controller to slowly meter the flow of air entering a Summa®/Silcosteel® canister. With this method, a sample is collected over a longer period of time than with a grab sample. If a constant flowrate was maintained, the resulting sample will have a VOC content that is the average of the VOC concentrations during the sampling interval. The following procedures should be followed to collect time integrated samples:

- **Cleaning and Adjustment**
All sampler systems should be checked for contamination prior to use or after any major repair. This is accomplished by metering humidified zero air to the inlet of the sampler. Excess zero air should be vented with a Swagelok® tee from the sampler inlet to atmosphere. The evacuated canister should then be filled at the normal sampling rate with the zero gas and verified by the laboratory to be free from contamination.
- **Sample Collection**
Prior to sampling the flow controller will be calibrated a mass flow meter. The flowrate should be adjusted so that at the end of the sampling interval the ending pressure of the canister is approximately 0.9 atm. The final canister vacuum should be between 5 inches and 1 inch of Hg. The final flowrate should be at least 1 scc/min.

After sample collection, all canisters should be tagged with an EPA pre-numbered tag with all of the information filled out. Place the canister in a shipping container and seal the container with EPA sample custody tape.

3.3 Sampling for Semi-Volatile Organic Compounds (SVOC) Analysis with High Volume PUF Samplers Using Methods TO-4A & TO-13A

The following is a synopsis of procedures which should be strictly adhered to for use of the High Volume Polyurethane Foam (PUF) sampling method for collecting samples for semi-volatile organic compound (SVOC) analysis including pesticides and polychlorinated biphenyls.

The following procedures must be followed during preparation of PUF sampling media when using the High Volume PUF method for collecting samples for SVOC analysis:

- All PUF sampling media should be pre-cleaned, loaded into High Volume PUF sample cartridges, and sealed in solvent washed cans by the extraction laboratory prior to use.
- Chain-of-custody shall be maintained for all samples.

3.3.1 PUF Cleaning Procedure

- The Air Monitoring Staff has responsibility for buying the PUF media and cutting the PUF plugs. PUF media should be specified as not containing any fire retardants. It should be stored in the dark to prevent photo-oxidation. It should be less than two years old, and should be stored in a pesticide-free environment.
- Care should be exercised in cutting the PUF. It should be thoroughly wet with tap water prior to cutting. A drill press and stainless steel PUF cutting die should be used. The drill press area should be free of oil and a polyethylene cutting block should be used to stop the die at the bottom of the drill press stroke (do not use wood). Water should be sprayed on the die to help prevent snagging as the PUF is cut. After the plugs are cut, they should be rinsed with tap water and followed by a rinse with analyte-free water. Finally, the excess water should be squeezed out.
- The PUF/XAD cartridges are assembled using a modified glass sleeve containing an extra-extra coarse frit to retain the XAD resin in the following manner. A 3/4-inch layer of XAD resin is poured on top of the frit followed by a 1½-inch PUF plug to retain the XAD resin.
- The assembled PUF/XAD cartridges are delivered to the extraction laboratory for cleaning and checking. The extraction laboratory will be given a minimum of three weeks notice for cleaning and checking the PUF/XAD cartridges. The cleaned PUF/XAD cartridges should be wrapped in aluminum foil and packed in pre cleaned metal cans or glass jars cushioned by new polyethylene bubble wrap to prevent breakage during shipment. Prepared PUF/XAD sample cartridges that are pre-packed in solvent washed metal cans will be obtained from the extraction laboratory prior to sampling. The cans should be packed inside coolers frozen eutectic salt packs (Blue Ice) to maintain a temperature of less than 15°C.

3.3.2 Sample Collection Procedure

The following procedure will be followed for all High Volume PUF/XAD sampling.

- Powder-free latex gloves will be used when handling all PUF/XAD cartridges and quartz particulate pre-filters. Assure that the red silicon upper and lower gaskets, located in the cartridge housing, are in place. Then remove the PUF/XAD cartridge from the shipping container, remove from the foil and insert the cartridge into the High Volume sampler's chamber. The pre-filter should be installed in the filter holder using caution not to over tighten the fittings. The foil should be placed back in the shipping container. The container should be labeled with site ID, operator's name, and sample date, and placed in the High Volume sampler enclosure until the sample is collected.
- The High Volume sampler should be turned on and allowed to run for two minutes. An initial flowrate should be recorded on the sample data sheet. The timer should be set to turn the sampler on and off at the desired times.
- The operator should retrieve and secure the sample as soon as possible after the sampling period ends. The sampler should then be manually turned on and allowed to run for two minutes. A final flowrate should be recorded on the sample data sheet. The final flowrate should be at least 150 liters per minute. The PUF/XAD cartridge should be removed, and the quartz pre-filter folded and placed in the top of the PUF/XAD cartridge. The PUF/XAD cartridge and pre-filter should be re-wrapped in the original aluminum foil and placed back in the shipping container. The container should then be tightly sealed. Complete the sample data sheet and Chain-Of-Custody Record and seal the shipping container with a sample custody seal. Finally, the shipping container containing the sample should be placed in a cooler containing frozen eutectic salt packs (at a nominal temperature of ~ 15° C). When all samples are collected from all sites, the cooler should be sealed with sample custody tape for transport back to the laboratory.
- Upon arrival of the metal container at the laboratory, the samples shall be stored in the metal container in a refrigerator until submitted for extraction.

3.4 Collecting Samples for Metals Analysis Using the High Volume Sampler

The following is a synopsis of procedures which should be strictly adhered to for the collection of samples for metals analysis in air using the High Volume sampler:

- All quartz filters used will be supplied by the EPA National Filter Distribution Program, and of the same quality as supplied to the State and Local Agency Air Monitoring Stations.
- Prior to use, all filters will be checked for pinholes, and desiccated at 15°C - 30°C, ± 3°C, and less than 50 percent relative humidity, ± 5 percent, for at least 24 hours.
- A filter field blank will be taken to the field, but not exposed. Filter field blanks will be analyzed by the laboratory to determine the concentration of metals contained in the filter matrix. The number of filter blanks will be determined based on a minimum of one blank for each ten samples collected.
- Chain-of-custody must be maintained for all samples.

3.4.1 Sample Collection Procedure

Samples will be collected using the High Volume sampler as described, and operated in accordance with 40 CFR, PART 50, APPENDIX B:

- All flow calibration orifices will be traceable to a Primary Standard Rootmeter. Flows will be corrected to EPA standard temperature and pressure (25°C and 760 mm Hg).
- Digital manometers used to determine flow rates will be calibrated by the factory annually.
- Air Monitoring Staff personnel will remove a 2-inch strip of the exposed filter from one end and discard it. Two 1-inch strips will be cut from the same end and transported to the laboratory for analysis.

3.4.2 Integrated Sample Collection Procedure

The following procedure should be followed to collect time integrated samples:

- Initial and final flow rates will be determined with a calibrated orifice and a digital manometer.
- After the sample has been collected, the filter will be folded lengthwise and placed in a filter holder. The filter holder is then placed in an envelope and the envelope sealed.
- A Chain-Of-Custody Record should be completed which contains the time of sampling, the sampling interval, and the signature of the person taking the sample.

After sample collection, all sample envelopes will be placed in an appropriate container. An EPA custody seal will be placed on the container. Filters will be cut by the Air Monitoring Staff and transported to the laboratory for analysis.

3.5 Sampling for Dioxin and Dibenzofuran Analyses with High Volume PUF Samplers Using Method TO-9A

3.5.1 General Information

The following is a synopsis of procedures which should be strictly adhered to for use of the High Volume Polyurethane Foam (PUF) sampling method for collecting samples for polychlorinated dibenzo-p-dioxins and dibenzofurans analyses.

Since this method requires High-Resolution Mass Spectrometry which the Region 4 laboratory does not have, all sample media preparation and analysis will have to be contracted. At least one month's notice prior to sampling should be given to obtain a contract laboratory for any dioxin and dibenzofuran analysis. It is important that the contract specify a number of details to assure accurate results:

- All of the PUF media and a representative number of each batch of quartz pre-filters should be checked by the contract laboratory to assure that there is no contamination. Each PUF plug should be pre-spiked by the contract laboratory with dioxin and dibenzofuran surrogates as a check of the accuracy of the method.
- Each set of PUF plugs and quartz filters should be securely packed in sealed containers and in coolers to prevent damage during shipment. The sampling media should be shipped air freight to minimize the time between cleanup and sampling.
- Chain-of-custody shall be maintained for all samples.

3.5.2 Sample Collection Procedure

The following procedure will be followed for the collection of all High Volume PUF samples for dioxins and dibenzofurans analyses.

Latex gloves will be used when handling all PUF cartridges and quartz particulate pre-filters. Assure that the red silicon upper and lower gaskets are in place in the PUF cartridge housing. Remove the PUF cartridge from the shipping can. Unwrap and insert the PUF cartridge into the High Volume (Hi-Vol) PUF sampler's chamber. Install the pre-filter in the filter holder using caution not to over-tighten the fittings. The removed aluminum foil should be placed in the

shipping container which then should be resealed. The container should be labeled with the site ID, the operator's name, and the sample date, and placed in the Hi-Vol PUF sampler enclosure until the sample is collected. The Hi-Vol PUF sampler should be turned on and allowed to run for two minutes. An initial flowrate should be recorded on the sample data sheet. The timer should be set to turn the sampler on and off at the desired times.

The operator should retrieve and secure the sample as soon as possible after the sampling period ends. The sampler should then be manually turned on and allowed to run for two minutes and a final flowrate recorded on the sample data sheet. The final flowrate should be at least 150 liters/minute. The PUF cartridge should be removed, and the quartz pre-filter folded and placed in the top of the PUF cartridge. The PUF cartridge and pre-filter should be re-wrapped in the original aluminum foil and placed back in the shipping container and the container should be tightly sealed. Complete the sample data and sample custody sheets. Each shipping container should have a sample custody seal. Finally, the shipping container containing the sample should be placed in a cooler containing frozen eutectic salt packs (at a nominal temperature of $\sim 4^{\circ}\text{C}$). When all samples are collected from all sites, the cooler should be sealed with sample custody tape for shipment to the contract laboratory.

Upon arrival of the metal container at the contract laboratory, the samples shall be stored in the metal container in a refrigerator until submitted for extraction.

Soil Gas Sampling Using Single or Nested Ports

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I. Scope and Application

This document describes the procedures for installing semi-permanent or permanent single or nested soil-gas ports and collecting soil-gas samples. Nested soil-gas ports allow for the generation of discrete data as a function of depth and time. Samples are collected for the analysis of volatile organic compounds (VOCs) by United States Environmental Protection Agency (USEPA) Method TO-15 (TO-15). Method TO-15 uses a 1-liter, 3-liter or 6-liter SUMMA® passivated stainless steel canister. An evacuated SUMMA canister (less than 28 inches of mercury [Hg]) will provide a recoverable whole-gas sample of approximately 5 liters when allowed to fill to a vacuum of 6 inches of Hg. The whole-air sample is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GS/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv). Optionally, the whole air sample can also be analyzed for permanent gasses such as oxygen and carbon dioxide.

The following sections list the necessary equipment and provide detailed instructions for the installation of semi-permanent or permanent single or nested soil-gas ports (using direct-push technology or a hollow stem auger) and the collection of soil-gas samples for VOC analysis.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training. Site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR), may be appropriate at some sites. ARCADIS field sampling personnel will be well versed in the relevant standard operating procedures (SOPs) and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading soil-gas sample collection activities must have previous soil-gas sampling experience.

III. Health and Safety Considerations

All sampling personnel should review the appropriate health and safety plan (HASP) and job loss analysis (JLA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific installation. Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances. For vapor port installation, drilling with a direct-push drilling rig

or hollow stem auger rig should be done only by personnel with prior experience using such of equipment.

IV. Equipment List

The equipment required to install single or nested soil vapor ports is presented below:

- Appropriate personal protective equipment (PPE ; as required by the HASP and JLA);
- Appropriate drill rig to reach necessary sample depth (hollow stem auger, direct-push rig, etc)
 - Hollow stem auger rig with interconnecting augers. The inner diameter of typical augers ranges from 2.25-inches to 7.75-inches; the auger size should be chosen should be large enough to accommodate the number of nested ports that will be installed inside the boring.
 - Direct-push rig (e.g., -Geoprobe) equipped with interconnecting 4-foot lengths of steel drive rods (2.25-inch-diameter, or 3.25-inch diameter depending on the number of ports to be installed).
- 1/4-inch outside diameter (OD) x 1/8-inch inside diameter (ID) tubing (Teflon, Teflon lined, or nylon). Note that Nylaflo tubing has a somewhat higher background level of BTEX and much poorer recovery of trichlorobenzene and naphthalene than Teflon, so it should not be used on site where these compounds are a concern (Hayes, 2006)
- Stainless steel sample screens with sacrificial point (one per sample depth to weight sample screen, available from Geoprobe). Typically 6" long for sized for 1/4-inch OD tubing.
- Stainless steel, or Teflon ball valve or needle valve (one per sample depth to match sample tubing) for sample line termination.
- Commercially available clean sand filter pack or glass beads having a grain size larger than 0.0057-inch (pore diameter of screen)

- Granular and powdered bentonite (Benseal[®], Volclay[®] Crumbles, or equivalent)
- Down hole measuring device
- Distilled or Deionized water for hydration of bentonite
- Plastic or aluminum tags for permanently labeling port with sample depth, and port identification number. It is no recommended to write on or affix adhesive tape to tubing as these methods fail over time.
- Well cover for permanent installation, This should be a traffic rated road box for exterior installations or an appropriate clean-out cover for interior installations.
- Photoionization Detector (PID) (with a lamp of 11.7 eV).

The equipment required for soil-gas sample collection from single or nested ports is presented below:

- 1,3, or 6 – liter stainless steel SUMMA[®] canisters (order at least one extra, if feasible) (batch certified canisters or individual certified canisters as required by the project)
- Flow controllers with in-line particulate filters and vacuum gauges; flow controllers are pre-calibrated to specified sample duration (e.g., 30 minutes, 8 hours, 24 hours) or flow rate (e.g., 200 milliliters per minute [mL/min]); confirm with the laboratory that the flow controller comes with an in-line particulate filter and pressure gauge (order at least one extra, if feasible). Flow rate should be selected based on expected soil type (see below)
- Decontaminated stainless steel 1/4-inch Swagelok (or equivalent) fittings (e.g., nuts, ferrules and backers)
- Decontaminated stainless steel Swagelok or comparable “T” fitting and needle valve for isolation of purge pump.
- Stainless steel or brass “T” fitting (if collecting duplicate [i.e., split] samples). Swage-lok or comparable

- Portable vacuum pump capable of producing very low flow rates (e.g., 100 to 200 mL/min) with vacuum gauge. Purging flow rate should also be selected based on expected soil type (see below).
- Rotameter or an electric flow sensor if vacuum pump does not have an accurate flow gauge (Bios DryCal or equivalent).
- Tracer gas testing supplies if applicable (refer to tracer SOP)
- Photoionization Detector (PID) (with a lamp of 11.7 eV)
- Appropriate-sized open-end wrench (typically 9/16-inch, 1/2-inch, and 3/4-inch)
- Down hole measuring device (e.g., water level probe, tape measure)
- Portable weather meter, if appropriate
- Chain-of-custody (COC) forms
- Sample collection logs (attached)
- Field Book

V. Cautions

The following cautions and field tips should be reviewed and considered prior to installing or collecting a single or nested soil-gas sample.

- When drilling to install sampling ports, be mindful of utilities that may be in the area. Follow ARCADIS utility location procedure. If the driller is concerned about a particular location, consult the project manager about moving it to another location. Do not hesitate to use Stop Work Authority; if something doesn't seem right stop and remedy the situation.
- Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens (sharpies), wear/apply fragrances, or smoke cigarettes/cigars before and/or during the sampling event.

- Ensure that the flow controller is pre-calibrated to the proper sample collection duration (confirm with laboratory). Sample integrity can be compromised if sample collection is extended to the point that the canister reaches atmospheric pressure. Sample integrity is maintained if sample collection is terminated prior to the target duration and a measurable vacuum (e.g., 3-7–inches Hg) remains in the canister when sample collection is terminated. Do not let sample canister reach atmospheric pressure (e.g., 0-inches Hg).
- Care should be taken to ensure that nested ports are installed at the target sample depths within the sand filter pack.. Sampling personnel should work closely with the driller to accomplish this.
- When introducing granular bentonite to the boring, the material should be introduced slowly and hydrated properly. Consult the bentonite manufacturer's instructions on the bag to determine the proper amount of to be used. When hydrated properly bentonite forms a thick clay mass that remains moist. The hydration step is crucial in the installation process and if not done properly the integrity of the bentonite seal can be compromised.
- Using prehydrated bentonite is best and should be discussed with drilling subcontractor.
- The purge flow rate of 100 ml/min should be suitable for a variety of silt and sand conditions but will not be achievable in some clays without excessive vacuum. Thus lower flow rates may be necessary in clay. A low vacuum (<10" of mercury) should be maintained. Record the measured flow rate and vacuum pressure during sample collection.

The cutoff value for vacuum differs in the literature from 10" of water column (ITRC 2007) to 136" of water column or 10" of mercury (http://www.dtsc.ca.gov/lawsregspolicies/policies/SiteCleanup/upload/SMBR_ADV_activesoilgasinvst.pdf). A detailed discussion of the achievable flow rates in various permeability materials can be found in Nicholson 2007. Related issues of contaminant partitioning are summarized in ASTM D5314-92. Passive sampling approaches can be considered as an alternative for clay soils although most passive methods for soil gas do not yield a quantitative concentration in soil gas.

- It is important to record the canister pressure, start and stop times and ID on a proper field sampling form. You should observe and record the

time/pressure at a mid-point in the sample duration. It is a good practice to lightly tap the pressure gauge with your finger before reading it to make sure it isn't stuck.

- Ensure that there is still measureable vacuum in the SUMMA® after sampling. Sometimes the gauges sent from labs have offset errors, or they stick.
- When sampling carefully consider elevation. If your site is over 2,000' above sea level or the difference in elevation between your site and your lab is more than 2,000' then pressure effects will be significant. If you take your samples at a high elevation they will contain less air for a given ending pressure reading. High elevation samples analyzed at low elevation will result in more dilution at the lab, which could affect reporting limits. Conversely low elevation samples when received at high elevation may appear to not have much vacuum left in them.
http://www.uigi.com/Atmos_pressure.html.
- If possible, have equipment shipped a two or three days before the sampling date so that all materials can be checked. Order replacements if needed.
- Requesting extra canisters from the laboratory should also be considered to ensure that you have enough equipment on site in case of an equipment failure.
- Soil-gas sampling should not proceed within 5 days following a significant rain event (1/2-inch of rainfall or more). Exceptions to this requirement may be appropriate depending on site climatic conditions, soil gas point depth and soil drainage characteristics. However since this requirement is frequently contained in regulatory documents, any exception to this requirement must be discussed with client and/or regulatory representatives. ITRC (2007) discussed the conditions when this requirement may not be necessary: *"Infiltration from rainfall can potentially impact soil gas concentrations by displacing the soil gas, dissolving VOCs, and by creating a "cap" above the soil gas. In many settings, infiltration from large storms penetrates into only the uppermost vadose zone. In general, soil gas samples collected at depths greater than about 3–5 feet bgs or under foundations or areas with surface cover are unlikely to be significantly affected. Soil gas samples collected closer to the surface (<3 feet) with no surface cover may be affected. If the moisture has penetrated to the*

sampling zone, it typically can be recognized by difficulty in collecting soil gas samples. “

VI. Procedure

Single or Nested Soil-Gas Monitoring Point Installation

The procedure used to install semi-permanent or permanent single or nested soil-gas ports will vary based upon the method of boring installation. In most situations a temporary well casing will need to be installed to keep the down hole formation from collapsing during port installation. The following steps will detail installing nested soil-gas ports through a temporary well casing.

If the nested ports will be installed at shallow depths, or the formation is thought to be stable enough to not collapse, a temporary well casing may not be necessary to facilitate the installation of the sample ports. Either way, the steps for installing the sample ports are nearly identical. These following steps should be discussed with the drilling subcontractor and altered based on the methods chosen for a given project.

1. Advance boring to bottom of deepest sampling interval and install a temporary well casing. Care should be taken to ensure that the terminal depth of the boring does not reach groundwater or the capillary fringe. Soil-gas probes should not be installed in groundwater or the capillary fringe. Moisture conditions and/or other observations (such as depth to water in nearby monitoring wells) should be recorded on the soil-gas collection log, as indicated.
2. Cut a length of 1/4-inch tubing slightly longer (e.g., 4 to 5 feet) than the collection depth. Attach a stainless steel sample screen and sacrificial point to the tubing and lower the screen and attached tubing through the boring.
3. Assure that the sample screen has reached the bottom of the boring and record this depth.
4. Begin simultaneously filling in the area around the sample screen with sand filter pack and retracting the temporary well casing. The casing should be lowered back down onto the sand every few inches to compact the sand around the screen. Sand should be introduced 3-inches below the screen, to cover the 6-inch sample screen and extend 3-inches above the screen for a total of 12 inches of sand. Closely monitor the amount of sand added to the borehole with a tape measure or water level probe.

5. With the proper sand pack in place begin slowly introducing 6-inches of dry granular bentonite into the boring. This dry Bentonite will prevent water from entering the sand filter pack during hydration.
6. A slurry of hydrated bentonite should be placed above the dry granular bentonite to the next sample depth (for nested ports) or to the ground surface (for single ports).
7. Properly label the sample tubing with a permanent label to designate the sample number and screen depth.
8. Affix a Swagelok fitting and valve to the end of the tubing.
9. Add an inch or two of dry granular Bentonite over the bentonite slurry prior to installing the subsequent sand filter pack and screen.
10. Repeat steps 2-8 until all the sample depths are installed.
11. With all semi-permanent or permanent single or nested ports installed and labeled, a well cover may be installed.
 - a. For permanent installations, the well cover should be rated for whatever type of traffic it may encounter in the future. For interior installations a brass clean-out cover available from a plumbing supply store may provide adequate protection. For exterior installations in high traffic areas a heavy duty groundwater well cover may be appropriate.
 - b. For a semi-permanent installation, a well cover is generally not necessary as the tubing will be removed within several days.
12. All soil-gas points should be allowed to sit and equilibrate for a minimum of 24-hours before proceeding to soil-gas sample collection.

Soil-Gas Sample Collection

The following steps should be used to collect a soil-gas sample from each of the single or nested probes installed using the above procedure.

1. Record the following information on the sample log, if appropriate (contact the local airport or other suitable information source [e.g., site-specific measurements, weatherunderground.com] to obtain the information):
 - a. wind speed and direction;
 - b. ambient temperature;
 - c. barometric pressure; and
 - d. relative humidity.
2. Assemble the sample train by removing the cap from the SUMMA canister and connecting the Swagelok T-fitting to the can using a short length of 1/4-inch OD Teflon tubing. The flow controller with in-line particulate filter and vacuum gauge is then attached to the T-fitting. The Swagelok (or similar) two-way valve is connected to the free end of the T-fitting using a short length of 1/4-inch OD Teflon tubing (precleaned stainless steel tubing could also be used)..
3. When collecting duplicate or other quality assurance/quality control (QA/QC) samples as required by applicable regulations and guidance, couple two SUMMA canisters using stainless steel Swagelok duplicate sample T-fitting supplied by the laboratory. Attach flow controller with in-line particulate filter and vacuum gauge to duplicate sample T-fitting provided by the laboratory.
4. Attach Teflon sample tubing to the flow controller using Swagelok fittings.
5. Remove the flush Swagelok cap from the sample port and install a Swagelok nut, ferrules, and sample tubing into the sub-slab port.
6. Connect the two-way valve and the portable purge pump using a length of Teflon sample tubing.
7. Record on the sample log and COC form the flow controller number with the appropriate SUMMA® canister number.
 - a. Perform a leak-down-test by replacing the nut which secures sample tubing with the cap from the canister or closing the valve on the sample port. This will create a closed system. Open the canister

valve and quickly close it; the vacuum should increase approaching 30" Hg. If there are no leaks in the system this vacuum should be held. If vacuum holds proceed with sample collection; if not attempt to rectify the situation by tightening fittings.

8. The seal around the soil-gas sampling port and the numerous connections comprising the sampling train will be evaluated for leaks using helium as a tracer gas. The helium tracer gas will be administered according to the methods established in the appropriate guidance documents and SOP: Administering Tracer Gas.
9. Open the two-way valve and purge the soil-gas sampling port and tubing with the portable sampling pump. Purge approximately three volumes of air from the soil-gas sampling port and sampling line using a flow rate of 200 mL/min. Purge volume is calculated by the following equation "purge volume = $3 \times \pi \times \text{inner radius of tubing}^2 \times \text{length of tubing}$. Purge air should be vented away from personnel and sampling equipment, a length of tubing or Tedlar bag can be used for this purpose. Measure organic vapor levels and tracer gas within the Tedlar bag, as appropriate.
10. Close the two-way valve to isolate the purge pump.
11. Open the SUMMA® canister valve to initiate sample collection. Record on the sample log (attached) the time sampling began and the canister pressure.

If the initial vacuum pressure registers less than -25 inches of Hg, then the SUMMA® canister is not appropriate for use and another canister should be used.

12. Take a photograph of the SUMMA® canister and surrounding area unless prohibited by the property owner.
13. Check the SUMMA canister pressure approximately half way through the sample duration and note progress on sample logs.
14. Steps 2-10 should be repeated for each of the nested soil-gas ports; samples can be collected concurrently.

Termination of Sample Collection

1. Arrive at the SUMMA® canister location at least 1-2 hours prior to the end of the required sampling interval (e.g., 8, 24-hours)..
2. Record the final vacuum pressure. Stop collecting the sample by closing the SUMMA® canister valves. The canister should have a minimum amount of vacuum (approximately 6 inches of Hg or slightly greater).
3. Record the date and time of valve closing on the sample log and COC form.
4. Close the valve on the nested soil-gas sample tubing or replace Swagelok cap.
5. Once all the nested samples have been collected, be sure the well cover (if applicable) is properly re-installed and secured.
6. Remove the particulate filters and flow controllers from the SUMMA® canisters, re-install the brass plugs on the canister fittings, and tighten with the appropriate wrench.
7. Package the canisters and flow controllers in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canisters should not be preserved with ice or refrigeration during shipment.
8. Complete the appropriate forms and sample labels as directed by the laboratory (e.g., affix card with a string).
9. Complete the COC form and place the requisite copies in a shipping container. Close the shipping container and affix a custody seal to the container closure. Ship the container to the laboratory via overnight carrier (e.g., Federal Express) for analysis.

VII. Soil-Gas Monitoring Point Abandonment

If the single or nested soil-gas ports were installed in a semi-permanent manner, and the soil-gas samples have been collected, the soil-gas monitoring points will be abandoned by pulling up the sample tubing. Since the boring is filled with bentonite and sand, no additional abandonment steps are necessary. Ensure that the boring location and surrounding area are returned to as close to their original appearance as possible.

VIII. Waste Management

The waste materials generated by these activities should be minimal. Personal protective equipment, such as gloves and other disposable equipment (i.e., tubing) should be collected by field personnel for proper disposal. Any soils brought up from the borehole should be disposed of in a manner consistent with the project workplan.

IX. Data Recording and Management

Measurements will be recorded on the sample log at the time of measurement with notations of the project name, sample date, sample start and finish time, sample location (e.g., GPS coordinates, distance from permanent structure), canister serial number, flow controller serial number, initial vacuum reading, and final pressure reading. Field sampling logs and COC records will be transmitted to the Project Manager.

X. Quality Assurance

Duplicate samples should be collected in the field as a quality assurance step. Generally, duplicates are taken of 10% of samples, but project specific requirements should take precedence.

Soil-gas sample analysis will generally be performed using USEPA TO-15 methodology or a project specific constituent list. Method TO-15 uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits (typically 0.5-ppbv for most VOCs). A trip blank sample will accompany each shipment of soil-gas samples to the laboratory for analysis. Trip blanks assess potential sample contamination resulting from the transportation and storing of samples.

Duplicate soil gas samples should be collected via a split sample train, allowing the primary and duplicate sample to be collected from the soil-gas probe simultaneously.

XI. References

ASTM – “Standard Guide for Soil Gas Monitoring in the Vadose Zone”, D5314-92.

ITRC “Vapor Intrusion Pathway: A Practical Guide”, January 2007, Appendix F: “regulators Checklist for Reviewing Soil Gas Data”

New York State Department of Health (NYSDOH). 2005. DRAFT "Guidance for Evaluating Soil Vapor Intrusion in the State of New York" February 23, 2005.

Nicholson, P, D. Bertrand and T. McAlary. "Soil Gas Sampling in Low-Permeability Materials"
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Hayes, H. C., D. J. Benton and N. Khan "Impact of Sampling Media on Soil Gas Measurements"
Presented with short paper at AWMA Vapor Intrusion Conference, January 2006,
Philadelphia, PA.



Sub-slab Soil Vapor Sample Collection Log

Client:		Sample ID:	
Project:		Boring Equipment:	
Location:		Sealant:	
Project #:		Tubing Information:	
Samplers:		Miscellaneous Equipment:	
		Subcontractor:	
		Equipment:	
Sampling Depth:		Moisture Content of Sampling Zone):	
Time and Date of Installation:		Approximate Purge Volume:	

Instrument Readings:

Date	Time	Canister Vacuum (a) (inches of Hg)	Temperature (°F)	Relative Humidity (%)	Air Speed (mph)	Barometric Pressure (inches of Hg)	PID (ppb)

(a) Record canister information at a minimum at the beginning and end of sampling

SUMMA Canister Information:

Size (circle one):	1 L 6 L
Canister ID:	
Flow Controller ID:	
Notes:	

Tracer Test Information (if applicable):

Initial Helium Shroud:	
Final Helium Shroud:	
Tracer Test Passed:	Yes No
Notes:	

General Observations/Notes:

Approximating One-Well Volume (for purging):

When using 1¼-inch "Dummy Point" and a 6-inch sampling interval, the sampling space will have a volume of approximately 150 mL. Each foot of ¼-inch tubing will have a volume of approximately 10 mL.