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April 14, 2014

Ms. Laura Rainey
Department of Toxic Substances Control
5796 Corporate Avenue
Cypress, CA 90630

Subject: Submittal of DOE's Final Phase 3 Master Field Sampling Plan Standard Operating Procedure (SOP) 20 for Soil Vapor Sampling, Santa Susana Field Laboratory

Dear Laura:

The United States Department of Energy (DOE) is pleased to submit this Final Standard Operating Procedure (SOP) to the *Master Field Sampling Plan (MFSP) to Chemical Data Gap Investigation, Phase 3 Soil Chemical Sampling at Area IV* for your review and approval. The MFSP SOP 20 describes soil vapor sampling procedures for use on DOE-administered property at the Santa Susana Field Laboratory (SSFL) and was prepared in support of DOE ETEC Site Closure activities at the SSFL. The MFSP SOP 20 has been prepared to meet the guidelines described in the Department of Toxic Substances Control (DTSC) 2012 Advisory for Active Soil Gas Investigations, and is consistent with other soil vapor SOPs that have been previously approved by DTSC for investigations at the SSFL. A previous version of this SOP was submitted to DTSC for approval in March 2013. This revision includes edits based on comments provided via electronic memorandum from DTSC on March 28, 2014 and April 7, 2014.

I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete.

If you have any questions regarding this document, please contact me at (818) 416-0992, or Stephanie.Jennings@emcbc.doe.gov.

Sincerely,

Stephie Jennings
Deputy Federal Project Director
U.S. Department of Energy

cc: Mr. John Jones, DOE
Mr. Buck King, DTSC
Mr. Richard Hume, DTSC
Mr. Mark Malinowski, DTSC
Mr. David Dassler, Boeing
Mr. John Wondolleck, CDM Smith
Ms. Dixie Hambrick, MWH

SSFL STANDARD OPERATING PROCEDURE (SOP) 20 TO
MASTER FIELD SAMPLING PLAN TO CHEMICAL DATA GAP INVESTIGATION
PHASE 3 SOIL CHEMICAL SAMPLING AT AREA IV
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

FINAL SOIL VAPOR SOP FOR DOE SITES

Prepared For:

THE UNITED STATES DEPARTMENT OF ENERGY

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April 2014

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FINAL SOIL VAPOR STANDARD SOP FOR DOE SITES

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ACRONYMS AND ABBREVIATIONS

%D	percent difference
%RSD	relative standard deviation
Advisory	Active Soil Gas Advisory
AOC	Agreement on Consent
ASGI	Advisory – Soil Gas Investigations
bgs	below ground surface
cc	cubic centimeter
oC	degrees Celsius
COC	chain of custody
CSM	conceptual site model
DL	detection limit
DQO	data quality objective
DTSC	Department of Toxic Substances Control
EICD	electrolytic conductivity detector
ETEC	Energy Technology Engineering Center
EPA	U.S. Environmental Protection Agency
FID	flame ionization detector
ft	feet
FTL	field team leader
GC	gas chromatography
GPS	global positioning system
Hg	mercury
ICV	initial calibration verification
ID	identification
L	liter
LARWQCB	Regional Water Quality Control Board – Los Angeles
LCS	laboratory control sample
LMB	laboratory method blank
MDL	method detection limit

ACRONYMS AND ABBREVIATIONS (Continued)

µg/L	micrograms per liter
MFSP	Master Field Sampling Plan
mL	milliliter
mL/min	milliliters per minute
MS	mass spectrometry
MWH	MWH Americas, Inc.
NASA	National Aeronautics and Space Administration
PEEK	polyetheretherketone
PID	photoionization detector
PM	project manager
ppmv	parts per million by volume
PVC	polyvinylchloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QAO	quality assurance officer
QC	quality control
RCRA	Resource Conservation and Recovery Act
redox	reduction and oxidation
RPD	replicate percent difference
RFI	RCRA Facility Investigation
RI	remedial investigation
RL	reporting limit
Rocketdyne	Rocketdyne Propulsion and Power Division
RWQCB_SF	San Francisco Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SOP	standard operating procedure
SSFL	Santa Susana Field Laboratory
SSO	site safety officer
TCD	thermal-conductivity detector

ACRONYMS AND ABBREVIATIONS (Continued)

TM	Technical Memorandum
VOC	volatile organic compound
WSHP	Worker Safety and Health Program
WPA	Work Plan Addendum
WPAA	Work Plan Addendum Amendment
UHP	ultra high purity
USCS	Unified Soil Classification System

1.0 INTRODUCTION

This standard operating procedure (SOP) describes recommended soil vapor surveying procedures for use on the Department of Energy (DOE)-administered property at the Santa Susana Field Laboratory (SSFL) in Ventura County, California. It has been prepared to support the Agreement on Consent (AOC) for Remedial Action (AOC; Docket No. HSA-CO 10/11 – 037) that was signed by DOE and DTSC on December 6, 2010.

This SOP supersedes the existing Rocketdyne Propulsion and Power Division (Rocketdyne) Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Soil Gas Survey Procedure that was included in the RFI Work Plan Addendum (WPA) (Ogden, 1996) and the SSFL RFI Work Plan Addendum Amendment (WPAA) (Ogden, 2000). This SOP has been prepared to meet requirements defined by the California Department of Toxic Substances Control (DTSC), and where applicable, the guidelines described in the 2012 Advisory – Active Soil Gas Investigations (Advisory) (DTSC, Regional Water Quality Control Board – Los Angeles [LARWQCB], San Francisco Regional Water Quality Control Board [RWQCB SF]) (Appendix A).

DOE will use this SOP for the collection of soil vapor data that will be used to address data gaps identified during the data gap analysis performed as part of the Phase 3 chemical characterization program for DOE-administered property at the SSFL. This SOP is being published by DOE as SOP 20 to the Work Plan for Chemical Data Gap Investigation, Phase 3 Soil Chemical Sampling at Area IV, Santa Susana Field Laboratory (Phase 3 Work Plan, CDM Smith, 2012a). This SOP is not intended to guide any specialized soil vapor study. As professional guidance for specific activities, the procedures described in this SOP are not intended to obviate the need for professional judgment to accommodate unforeseen circumstances. Deviance from these procedures, or in the execution of project work plans, sampling and analysis plans (SAPs), or planned activities, will be approved by the DOE Project Manager (PM), the SSFL Program Quality Assurance (QA)/Quality Control (QC) Manager, and DTSC.

This SOP describes recommended surveying procedures for active soil vapor sampling only. Should the need arise for passive vapor sampling at DOE-administered property, a separate SOP will be prepared.

1.1 SSFL FACILITY INFORMATION

SSFL occupies approximately 2,850 acres, about 29 miles northwest of downtown Los Angeles, California, in the southeastern corner of Ventura County. The site includes approximately 2,850 acres of hilly terrain, with approximately 1,100 feet (ft) of topographic relief near the crest of the Simi Hills. The SSFL is separated into four administrative areas (Areas I, II, III, and IV), with undeveloped land areas to both the north and south. DOE's Energy Technology Engineering Center (ETEC) was located in a 90-acre leased portion of Area IV, the westernmost administrative area. Figure 1-1 shows the geographic location and property boundaries of the site, as well as the surrounding communities. Information regarding site history, conditions, and chemical investigations conducted at SSFL is provided in the RFI Program Report (MWH Americas, Inc. [MWH], 2004) and various remedial investigation (RI) reports prepared for DOE, NASA, and Boeing sites.

1.2 SAMPLING RATIONALE AND APPROACH

Soil vapor sampling is conducted on the DOE-administered property at SSFL to obtain VOC (including chlorinated and aromatic hydrocarbons), methane (at landfills), and other subsurface concentrations that are used to evaluate whether the nature and extent of contamination at potential source areas within DOE sites are characterized sufficiently for remediation, risk assessment (not related to the AOC), or potential vapor intrusion assessment (not related to the AOC). The sample locations are selected based on a targeted (or "biased") approach that focuses on known or suspected chemical use areas (such as tanks, buildings, and reactors). Soil vapor sampling also has been performed in areas of groundwater VOC impacts where surface release sources cannot be identified.

In areas where unconsolidated (alluvium) soils are at least 5.5 ft thick, active soil vapor samples are collected above the water table (and capillary fringe) at intervals necessary to collect the appropriate data. As discussed in the Advisory, soil vapor samples collected at depths less than 5 ft below ground surface (bgs) may be subject to barometric pressure effects and are more prone to ambient air breakthrough. In general, if characterization of VOCs in soil less than 5.5 ft bgs is needed, collection of soil samples using U.S. Environmental Protection Agency (EPA) Method 5035A (with a detection limit of 5 µg/kg for most target VOCs) will be performed rather than active soil gas sampling, as long as soils are at least 3 feet thick, except in cases where asphalt or concrete are present above the soil. Due to volatilization of VOCs in thin soils, soil samples for VOC analysis will not be collected if soils are less than 3 feet thick. Selection of the appropriate depth intervals for sampling involves site-specific decisions, and will take into consideration the thickness of the unconsolidated alluvium and the depth to the weathered bedrock. Sample depths will be adjusted as needed to target the coarsest-grained material.

The scope of this SOP is limited to active soil vapor sampling. Collection of subslab soil vapor and indoor or outdoor air samples is not within the scope of the DOE SOP. Subslab soil vapor and indoor air or outdoor sampling are not expected to be needed for DOE Phase 3 sampling; however, if determined necessary, separate SOPs will be prepared or referenced for those sampling procedures.

Active soil vapor samples will be collected and analyzed in accordance with procedures outlined in the 2012 Advisory and the 2011 DTSC Vapor Intrusion Guidance. The sampling rationale will differ depending on the conditions at any particular site. Site-specific data quality objectives (DQOs) will be developed so that soil gas sampling data are sufficient to meet the characterization needs. While it is beyond the scope of this SOP to describe the DQO process for soil vapor investigations, some key considerations are described briefly in the following bullets:

- To support vapor intrusion, advance shallow soil vapor points spaced approximately 50 to 100 ft from the original location that had concentrations above the required characterization levels. As described previously, sampling should be performed in areas where unconsolidated (alluvium) soils are at least 5.5 ft thick. When feasible, soil gas sampling data used for vapor intrusion screening should be collected near sources of VOCs in soil.
- Where deeper soil vapor samples (deeper than 10 ft in unconsolidated alluvium) are needed, vapor probes will be set just above bedrock to assess the potential off-gassing of VOCs from groundwater.

- The feasibility of active soil vapor sampling beneath paved or covered areas should be given careful consideration if it is not feasible to collect a soil vapor sample at a depth of at least 5.5 ft bgs.
- A sufficient number of vapor probes, set at depths that allow for adequate lateral and vertical delineation of VOCs in soil vapor, will be installed to determine concentration gradients. Detailed descriptions of lateral and vertical sampling requirements will be included in site-specific work plans, SAPs, and/or addendums.

Detection limits for VOCs in soil vapor are presented in this SOP based on EPA Method SW8260B, modified to use a large sample size (100-cubic-centimeter [cc] sample size) to meet the prescribed detection limits. When performing analyses using Method 8260B, DTSC recommends collection of replicate samples using Summa canisters for analysis using Method TO-15 to independently confirm the results from the field analytical method. In accordance with DTSC's vapor intrusion guidance, 10 percent of the soil vapor samples analyzed using the field analytical method will be confirmed with analyses using Method TO-15 (DTSC, 2005).

2.0 WORK PLAN AND SAMPLING AND ANALYSIS PLAN

A site-specific work plan or SAP will be prepared prior to soil vapor surveys and submitted to DTSC for review and approval before its implementation. Site-specific work plans and SAPs will be prepared to meet the sampling objectives for decision-making, risk assessment, and site action recommendations and might include proposed soil matrix sampling for the area of investigation. The work plan and SAP will present the site history, identify potential contaminant sources, present previous sampling results, describe existing groundwater conditions, and provide the proposed soil matrix and soil vapor sampling. Proposed sampling locations and DQOs will be presented. In accordance with the AOC, DTSC will be notified before implementation of the work plan and SAP.

The work plan/SAP will have enough flexibility to allow for contingencies or modifications to be made as real-time evaluation of analytical test results occurs. The decision-making criteria for these adjustments will be included in the work plan or SAP. The rationale and approach for collecting site-specific soil physical parameter data, if needed, also will be indicated in the work plan and SAP.

In compliance with the AOC, the DOE Phase 3 chemical characterization program work plan and SAP requirements are being met by the preparation of Master Field Sampling Plan (MFSP) Addenda for each of the subareas in Area IV and Northern Buffer Zone for review and approval by DTSC. The MFSP Addenda include Data Gap Technical Memorandums (TMs) that summarize the outcome of the data gap process and provide the proposed soil vapor sampling recommendations and rationale, along with figures showing the location of the Phase 3 samples.

3.0 ROLES AND RESPONSIBILITIES

Consistent with other soil vapor SOPs for the SSFL (NASA, 2012; Boeing, 2013), the project team will include the following personnel:

- **Project Coordinator:** The Project Coordinator is responsible for project implementation and has the authority to commit the resources necessary to meet project objectives and requirements. The Project Coordinator’s primary function is to ensure that technical, financial, and scheduling objectives are achieved successfully. The Project Coordinator will provide the major point of contact and control matters concerning the project. The Project Coordinator also will establish project policy and procedures to address the specific needs of the project as a whole.
- **Project Manager:** The PM will assist the Project Coordinator in day-to-day project management. The PM will be responsible for coordinating the field activities and the procurement of project subcontractors. Additional responsibilities include assisting in monitoring the progress and quality of investigative collection, preparing and reviewing preliminary data reports, and providing technical support of project activities. For some projects, the role of the Project Coordinator and PM might be fulfilled by the same individual.
- **Quality Assurance Officers:** The Program and Project Quality Assurance Officers (QAOs), including the Program QA/QC Manager, will be responsible for overseeing the review of field and laboratory produced data in the following ways:
  - Checking the application and effectiveness of the QA/QC procedures by the analytical laboratory and the project staff.
  - Serving as a resource to the PM in quality matters.
  - Aiding in the selection of analytical methodology.
  - Conducting internal quality checks of the investigation activities.
  - Providing input to the PM regarding necessary corrective actions that result from these evaluations.
- **Senior Soil Vapor Technologist:** The Senior Soil Vapor Technologist has extensive experience in soil vapor intrusion and understands the technical expectations for the data collection and its use in assessing the impacts at SSFL. The Senior Soil Vapor Technologist will work with the PM and Quality Assurance Officers (QAOs) to see that the data generated can be used for future assessments of the vapor intrusion potential.
- **Data Validation Staff:** The Data Validation Staff will assist the QAOs in the evaluation and validation of field- and laboratory-generated data using applicable guidelines for DOE sites.

- **Field Team Leader:** The Field Team Leader (FTL) will be a California Professional Geologist and is responsible for the supervision of the field team. The FTL's responsibilities include the following:
    - Working with the Site Safety Officer (SSO) to conduct operations in compliance with the Worker Safety and Health Program (WSHP) for Chemical Data Gap Investigations Phase 3 Soil Chemical Sampling at Area IV, Santa Susana Field Laboratory, Ventura County (Phase 3 WSHP, CDM Smith, 2012b). The FTL will facilitate communication and coordinate efforts among SSFL personnel, field team members, and the PM. The FTL will have a thorough understanding of the principles of soil vapor and the physical characteristics of the vadose zone.
- **Field Team Personnel:** Field Team Personnel involved in soil vapor surveys are responsible for the following:
    - The installation of soil vapor probes, the collection of samples, and the performance of other field activities as detailed in the work plan and SAP and this SOP, and in compliance with the site-specific DQOs.
    - Complying with the Phase 3 WSHP and taking reasonable precautions to prevent injury to themselves and to their fellow employees.
- **Subcontractors:** Subcontractors may be used to support the field team personnel (for example, direct rig operation or vapor probe installation). Additionally, soil vapor sampling will be analyzed by a subcontracted laboratory. Two types of laboratories might be used:
    - Mobile Laboratory: A mobile laboratory will be brought onsite for the analysis of active vapor samples collected using glass bulb containers and Tedlar bags (onsite methane analysis). At DOE-administered areas, the analysis of VOCs in active soil vapor will be primarily performed by a subcontracted mobile laboratory using EPA Method 8260B.
    - Fixed Laboratory: Fixed offsite laboratories will be used for the analysis of active vapor samples collected in Summa canisters. At DOE-administered areas, as a confirmation of EPA Method SW8260B for active soil vapor sampling, at least one replicate sample, or one per every 10 primary samples collected, will be collected in Summa canisters and sent to a fixed laboratory to be analyzed by EPA Method TO-15.

4.0 ACTIVE VAPOR INVESTIGATIONS

The active soil vapor survey is a quantitative technique for evaluating the distribution of contaminants in soil vapor. The resulting data can be used to qualitatively and quantitatively evaluate the potential for, and extent of, certain types of contamination in soil. Active soil vapor samples are collected from temporary soil vapor probes and generally are collected during dry weather to limit soil moisture variability. At the DOE-administered property at SSFL, active vapor sampling is performed for the analysis of VOCs and methane in soil vapor. The results are used for quantitative (models) and qualitative (data review and interpretation) transport and fate evaluations of the chemical sources and potential migration pathways identified in the conceptual site model (CSM), which describes the various environmental matrixes characterized at a site, their interrelationships, and exposure pathways to potential receptors. The following sections describe the methodologies used for sample collection during the program.

4.1 BACKGROUND INFORMATION

The use of soil vapor sampling to locate potential source areas of subsurface contamination is based on aqueous phase and vapor phase equilibrium in the subsurface. Because of their relatively low solubility and high vapor pressures, VOCs have a tendency to partition from the aqueous phase into the soil vapor phase. Certain semivolatile compounds also behave in this manner. Generally speaking, an organic compound with a relatively high Henry’s law constant (the ratio of a compound’s vapor pressure to its solubility in water) is likely to partition from soil or groundwater into soil vapor. The detection of VOCs in shallow soil vapor depends on the following factors: 1) the volatilization of VOCs from soil or groundwater into soil vapor, 2) analytical method sensitivities, and 3) the physical properties of the soil.

Fixed gas (oxygen and nitrogen dioxide) and biogenic gas (carbon dioxide, methane, nitrous oxide, and hydrogen sulfide) data obtained during a soil vapor survey also provide an indication of subsurface contamination. A concurrent increase in carbon dioxide and decrease in oxygen over time often indicates increased chemical or biological breakdown of organic compounds. This phenomenon usually is associated with the degradation of petroleum hydrocarbons; however, moisture content, natural organic content, and reduction and oxidation (redox) conditions in the soil also can affect fixed gas and biogenic gas ratios (Ogden, 1996).

4.2 EQUIPMENT AND SUPPLIES

The following equipment generally will be required to conduct active soil vapor surveys:

- Hydraulic driving and hammering system (Geoprobe or direct-push rig) designed to drill through pavement and install or remove sampling probes in non-remote areas
- Hand auger slide hammer and tile probe (slam bar) for the installation or removal of sampling probes in remote locations or locations with shallow soil thickness
- Temporary probes consisting of a stainless steel vapor implant hard-attached to Teflon tubing, with an airtight fitting at the surface
- Small diameter (typically, 1/4-inch outer diameter) TB12T sampling tubes made of material such as polyetheretherketone (PEEK), or Teflon (for polycyclic aromatic hydrocarbons and chlorinated solvents) that will not react or interact with site contaminants
- Swagelok or similar fittings for attaching tubing to Summa canisters
- Vacuum pump with gauge
- Oil-less air pump and evacuation chamber (or Tedlar bag) for collecting exact volumes of ambient air or soil vapor at atmospheric pressure
- 500–milliliter (mL) glass bulbs for active vapor VOC sampling by EPA Method 8260B (mobile laboratory only). Per DTSC-approval via an electronic memorandum sent to Boeing on July 1, 2013, a glass bulb size of 500-mL will be used in order to collect sufficient volume.
- 1 liter (L) Tedlar bags (methane sampling only)
- 1-L Summa canisters (1-L canisters for 5- to 10-minute samples or for shallow soil vapor samples collected at approximately 5 ft bgs
- A flow regulator (for sampling using Summa canisters; 5- or 10-minute sample = 200 milliliters per minute (mL/min) or 100 mL/min, respectively
- Stainless-steel “T” fittings for collecting duplicate samples using Summa canisters
- Equipment and materials to lay out and mark sample locations (scaled field map with location identifications [IDs], a table listing location IDs with estimated coordinates, measuring tapes, pin flags, and hand-held global positioning system [GPS] unit)
- Clean, graded (#3), kiln-dried sand or glass beads to create a permeable layer around the probe screen. Other grain sizes can be used, as long as the size is no smaller than the adjacent formation.

- Bentonite seal mixture (25-percent glass beads and 75-percent powdered bentonite clay [hi-yield type]) to grout the hole from above the screen to the ground surface
- Teflon tubing
- Silicone tubing
- Disposable gloves and equipment decontamination supplies
- 1-inch-diameter bentonite/cement grouted polyvinylchloride (PVC) pipe, solid rod, or equivalent (for boreholes greater than 40 ft only)
- Double-action hand pump (if a larger vacuum is needed during the shut-in test)

Analytical instrumentation and chemical supplies could include the following:

- Gas chromatography (GC) and mass spectrometry (MS) system
- Computer-based data management and GC integration systems
- Photoionization detectors (PIDs), Hall Electrolytic Conductivity Detectors (EICDs), flame ionization detectors (FIDs), and other detectors as necessary
- Ultra-high purity (UHP) grade, compressed analytical gases (nitrogen, helium, hydrogen, or air)
- Analytical standards for priority pollutants, gaseous hydrocarbons, and fixed and biogenic gases
- High-resolution megabore, packed, and capillary gas chromatograph columns
- Fittings, tools, plumbing, and glass syringes required for normal GC operation
- A tracer compound, such as helium, and a helium gas detector (Gem 2000 or similar) for performing leak checks

4.3 CLEARANCE

Before performing soil vapor surveys, a utility clearance will be conducted to identify the presence of subsurface utilities, biological, and/or other cultural features at locations where planned site activities involve disturbing subsurface materials. The utility clearance will be performed following the procedures outlined in SOP 1 of the Phase 3 Work Plan.

4.4 SOIL VAPOR SURVEY DESIGN

The design of the soil vapor survey will follow the sampling approach described previously unless otherwise specified in the work plan and SAP. Additional modifications might be made based on field conditions or observations, as described in the following subsections. The PM, the QA/QC Manager, and DTSC will be notified before any deviations are made from this SOP or from the work plan and SAP.

4.4.1 Sample Depth

In areas where unconsolidated alluvium soils are at least 5.5 ft thick, active soil vapor samples will be collected above the water table at the intervals necessary to collect the appropriate data to bedrock or refusal. Sampling depths will be described in the work plan and SAP. Depths will be selected to target coarse-grained layers that have the highest potential for elevated VOC concentrations. Other depths might be sampled depending on the sampling objectives (for example, to evaluate potential vapor intrusion or migration to groundwater). In addition, depths also might be modified to minimize the effects of changes in barometric pressure, temperature, or breakthrough of ambient air from the surface, and so that representative samples are collected. Consideration will be given to source location, types of chemicals of concern, changes in lithology, PID results, or preliminary data reports.

4.4.2 Sample Location

Sample locations will be selected based on a targeted (or “biased”) approach that focuses on known or suspected areas with concentrations higher than the required characterization levels. Sample locations will be described in the work plan and SAP. Sample locations might be modified based on site-specific conditions or features observed in the field, including topography, accessibility of proposed sample locations, observed soil or surface staining, PID readings, odors, preliminary data reports, soil disturbance and debris areas, low-permeability soil, no- or low-flow conditions, shallow depth to bedrock or refusal, presence of paving or cover over the soil, and discovery of previously unidentified potential sources of contamination. The staking of sample locations will performed in accordance with SOP 1 of the Phase 3 Work Plan. PID operation for the field measurement of total organic vapors will be performed following the procedures outlined in SOP 6 of the Phase 3 Work Plan. All instruments used to screen samples for VOCs will be calibrated and maintained per SOP 16 of the Phase 3 Work Plan.

4.5 PROBE INSTALLATION

Before sample collection, a lithologic boring will be completed. Lithologic boring will be performed at the location where the borehole is installed following the procedures outlined SOP 9 of the Phase 3 Work Plan. Lithologic logs will be prepared before probe installation for borings generated during the soil vapor survey. Descriptions for soil removed from the boring via continuous coring or hand auger will be recorded in the lithologic logs in accordance with the Unified Soil Classification System (USCS). Borings will be logged to depth to bedrock or refusal and lithologic logging will be performed or supervised by a California Professional Geologist.

4.5.1 Sample Tubing

Tubing will be attached from the vapor probe to the ground surface to minimize purge volume. Clean dry tubing will be used. If any moisture, water, or unknown material is present in the probe before insertion, the tubing will be replaced. The bottom end of the tubing will be attached to the vapor probe tip. The probe tip design will allow for optimum air flow and prevent air flow restriction. The connection between the tubing and the vapor probe tip will be air tight to prevent leakage. For multi-depth soil vapor boreholes, tubing of different length (or other method to distinguish the tubing for each depth) will be used to distinguish the depths of the probes installed.

4.5.2 Installation Procedure

Temporary probes will be installed using direct-push methods, drill rig, hand auger, or other techniques, as appropriate. A single depth soil vapor probe construction detail form and a multi-depth soil vapor probe construction detail form are presented in Figure 4-1 and 4-2, respectively. As shown in Figure 4-2, multiple temporary probes can be placed in a single boring to collect samples from multiple depths. The construction detail forms provide additional guidance for probe installation and will be completed during the installation of vapor probes to document compliance with, deviation from, or additional details associated with the installation of the vapor probes. The procedure for probe installation using direct-push methods is as follows:

1. Identify the proposed sample location using a scaled field map and a hand-held GPS unit.
2. Drive the Macrocore or Dual Tube sampler for continuous core samples to the desired depth. Based on observations during the completion of the lithologic borings logs, probe depths may be adjusted so that the probe will be either above or below impermeable zones (e.g., high plasticity clay) while maintaining compliance to construction specifications in this SOP. If samples will be collected at multiple depths within the same borehole, the borehole initially will be advanced to the deepest sampling point and the deepest sampling probe will be installed first. The final depth of the boring should include extra depth to include length of the screen (for 5-ft bgs with a 6-inch screen, push the probe to 5 ft, 6 inches). If using a Macrocore sampler, remove the sampler and drive rods and tag the bottom of the borehole to verify TD using a weighted measuring tape. For Dual Tube methods, leave outer casing in the boring while verifying TD.
3. Attach the ¼-inch Teflon tubing to the implant. Use enough tubing so that at least 2 feet will be left above ground. Plug the exposed end of the tubing with a cap.
4. For Dual Tube methods,

   retract one section outer casing (four or five-foot section). Calculate the volume of sand needed to fill a 3-inch section of the borehole, pour the sand down the borehole. Verify the thickness of the sand pack using a weighted tape.
5. Thread the implant and tubing down the inside of a 0.75-inch PVC pipe. Test that the implant is resting on the surface of the sand pack by giving it a gentle tug. Verify that the borehole has not collapsed by tagging the bottom of the borehole with a weighted tape.
6. Calculate the volume of sand needed to the fill the space around the implant plus an additional 3-inch space above the implant. Verify that the sand pack is at least 3 inches higher than the vapor implant using a weighted measuring tape.
7. Remove the remaining outer casing within the borehole, with the exception of the lead section, which will be left in the borehole to prevent collapse of shallow overburden. Confirm that the borehole did not collapse using a weighted tape.
8. Place a minimum of 1 foot of dry granular bentonite to prevent infiltration of the hydrated bentonite grout into the sand. Verify that the dry granular bentonite is at least 1-foot thick using a weighted tape.
9. Following placement of the dry bentonite, insert tremie pipe into the borehole to a depth just above the top of the dry bentonite seal.
10. For single completions, fill the annular space to the surface with hydrated bentonite. The bentonite should be hydrated in a container at the surface and then slowly poured into the borehole using tremie pipe. If bridging or clogging during the addition of the hydrated bentonite to the borehole occurs, dry granular bentonite may be added to ground surface in approximately 6-inch lifts. Each lift should be hydrated at a rate of 1 ounce of water for every inch of bentonite seal within the borehole. A similar procedure for deep probe construction with multiple depths will be followed – a

minimum of 1 foot of dry granular bentonite will be placed on top of the sand pack encasing each probe, followed by hydrated granular bentonite. The hydrated bentonite grout should continue until the next sand pack (Figure 4-2).

11. Finish the probe at surface with a surface seal and a gas-tight fitting valve on the tubing. At the surface, the probe is placed inside 2-inch PVC pipe with cap to prevent unauthorized access and reduce environmental damage.
12. Obtain the actual coordinates of the probe with a hand-held GPS unit; the actual coordinates will be downloaded to the DOE database
13. Record the probe installation time in the field book and prepare completion diagram.

When the depth of a borehole is such that a probe support is required (40 ft bgs for direct-push probes), the probes will be attached to the support before placement in the borehole. Support systems may be made of 1-inch-diameter bentonite/cement grouted PVC pipe, solid rod, or equivalent. The support must be properly sealed and the probes will be properly attached to the exterior of the support, as described in the Advisory. Any support system used will be described in the work plan and SAP.

If a borehole cannot be advanced, a soil vapor sample will be collected at the depth of refusal. Where bedrock or refusal are encountered at depths less than 3 ft bgs, the borehole will be abandoned, and a replacement probe will be installed within 5 ft, laterally, of the original probe where soils are at least 3 ft thick. If three refusals occur in the same area, the soil vapor sampling DQOs should be revisited to identify alternate approaches for collecting the necessary data (Section 4.6). If an active soil vapor sample cannot be collected in the area, the attempted boreholes can be abandoned and that information will be documented in the field log book and boring logs.

4.5.3 Equilibration Time

To allow for subsurface conditions to equilibrate and vapor concentrations to stabilize after probe installation, equilibration time will be at least 48 hours prior to the purge volume test, leak test, and soil vapor sampling. If probe installation methods other than direct push, drill rig, or hand auger are used, the equilibration time will be extended as required. The vapor probe installation method and equilibration time will be recorded in the field log book.

4.5.4 Abandonment

Upon completion of sampling, abandonment will be performed by removing the Teflon tubing and backfilling the borehole with a hydrated bentonite / grout mixture. For deeper wells, the top five feet of bentonite seal from ground surface should be removed before removing the Teflon tubing and backfilling the borehole.

4.6 PURGE VOLUME TEST

Before sampling, soil vapor probes will be purged so that stagnant or ambient air is removed from the sampling system and samples collected are representative of subsurface conditions. A purge volume test will be the first soil vapor sampling activity at the selected purge volume test point. This test will be located as near as possible to the anticipated or confirmed contaminant source and in an area where soil vapor concentrations are expected to be elevated. To minimize the possibility of surface air breakthrough, excessive purging will be avoided when collecting shallow samples (less than 5 ft bgs).

The following purge procedure will be followed:

1. Calculate the purge volume of the sampling system by obtaining the sum of the internal volume of the tubing used, the void space of the sand pack around the probe tip, and the volume of the sample containers (glass bulbs and Tedlar bags only). Because Summa canisters are evacuated before sampling, sample containers are included in the purge volume calculation only when glass bulbs are used.
2. Purge the monitoring point by collecting and analyzing samples for target compounds after removing one, three, and ten purge volumes. Purging will be conducted at a flow rate (approximately 200 mL/min) and vacuum conditions (less than 100 inches of water) similar to those for sample collection described later in this SOP.
3. If purging is not possible due to low- or no-flow conditions (gas will not flow or flow is severely restricted due to low-permeability soil or water saturation around the probe tip), a replacement probe will be installed within 5 ft, laterally, of the original probe. If three refusals occur in the same area, the soil vapor sampling DQOs should be revisited to identify alternate approaches for collecting the necessary data. One alternate approach that will be considered is low-flow soil gas sampling, as described in the Appendix D of the Advisory. This SOP will be updated as needed to incorporate the low-flow soil gas sampling methodology as outlined in the draft 2012 DTSC Advisory.
4. Analyze the samples to identify which purge volume yields the sample with the highest concentration of VOCs and sample the remaining probes at that purge volume. A default of three purge volumes will be extracted before sampling if VOCs are not

detected in any of the step purge tests or when collecting shallow active soil vapor samples (collected at less than 5 ft bgs).

If the site lithology is consistent, the same purge volume can be used for all soil vapor samples. Additional purge volume tests will be conducted if the site soils are variable or if the default purge volume is used and a new VOC is detected. When additional purge tests indicate that a new purge volume will be used, 20 percent of previously sampled probes in locations with similar lithology will be resampled. Depending on site conditions, DTSC might reduce or waive this requirement on a case-by-case basis. If reanalysis indicates a higher number of VOC detections (50 percent different for compounds detected at concentrations of 10 micrograms per liter [µg/L] or higher), then the previous samples from locations with similar lithology must be recollected using the new purge volume.

Unless additional purge volume tests indicate differently, the new purge volume will be used in the remaining locations.

4.7 SAMPLE COLLECTION PROCEDURE

Active vapor sampling will be performed after an appropriate amount of equilibration time has passed since probe installation and the purge volume has been selected.

4.7.1 Sample Containers

Glass bulbs, Summa canisters, and Tedlar bags may be used, as appropriate, for the analytical method used. Plastic syringes will not be used as containers for active soil vapor sampling. The following additional guidelines will be followed when identifying the appropriate sample container for analysis of active vapor:

- Glass bulbs are used for active vapor VOC analysis using EPA Method 8260B.
- Summa canisters are used for active soil vapor VOC analysis using EPA Method TO-15 and for active soil vapor methane analysis by TO-3, ASTM 3416M (EPA 3C), or ASTM D1946. These methods may be used with DTSC’s approval. If the VOC data are being used to support risk assessments or evaluation of vapor intrusion, analyses using either Method TO-15 or Method SW8260B using a large sample size are needed to achieve sufficient detection limits and quality levels.
- Tedlar bags may be used only for the analysis of methane in active vapor by EPA Method 8015B (modified for methane) and will not be used for VOC analysis. This method may be used with DTSC’s approval.

- Summa canisters will generally not be used to collect very shallow (less than 5 ft) samples, except in selected cases where near surface (< 5 ft bgs) soil vapor sampling may be conducted (e.g., in cases where asphalt or concrete are present above the soil).

The subcontracted laboratory that will perform the analyses also will be consulted in choosing the appropriate sample containers.

4.7.1.1 Decontamination

New containers either will be certified as clean by the supplier or verified to be clean by laboratory analysis. Reusable sample containers must be decontaminated after each use. Decontamination will be performed by the laboratory. To verify the decontamination procedure, one sample container of every 20 used or one every 12 hours, whichever is more frequent, will be used as a laboratory method blank (LMB). An LMB is an unused, certified sample container that has not left the laboratory. The LMB container is filled with zero-grade air and carried through the same analytical procedure as a field sample.

Reusable equipment will be decontaminated to prevent cross contamination before installing a new probe. Decontamination and equipment rinsate sampling will be performed following the procedures outlined SOP 12 of the Phase 3 Work Plan. .

4.7.1.2 Sample Identification

Sample containers will have unique identifiers that will be associated with the corresponding probe ID and depth of the sample. Unique identifiers will be assigned in accordance with the site-specific work plan or SAP. IDs previously assigned to reusable sample containers by the laboratory (such as Bulb IDs for glass bulbs) will be recorded in the field documentation (field log book, soil vapor sampling form, and chain of custody [COC]).

4.7.2 Sampling Flow Rate

A flow rate of 100 to 200 mL/min will be used. To decide if the flow rate is achievable, a vacuum gauge will be placed in-line between the sample tubing and the vacuum pump (or Summa canister). If the gauge indicates a high vacuum (greater than 100 inches of water), the flow rate will be reduced by intervals (by 25 mL/min) until the vacuum is reduced. The final flow rate will be documented.

If no flow is achieved or if a high vacuum is pulled (greater than 100 inches of water), a new probe will be installed at a greater depth. A soil matrix sample can be collected if the vacuum cannot be reduced to less than 100 inches of water at the probe location. Depending on the rationale for probe installation, the location of the probe also might be changed after evaluation of site lithology or in consultation with DTSC.

4.7.3 Vacuum Pump

A vacuum pump will be used above the shroud to collect samples in glass bulbs (Figure 4-5). To avoid contamination by the vacuum pump, samples will be collected from the intake side of the pump. Note that vacuum pumps and gauges are not used while sampling when using a Summa canister due to the presence of a vacuum inside the canister (Figure 4-3).

4.7.4 Wet Conditions

Soil gas sampling should not occur during a significant rain event (for example, 0.5 inch or greater of rain or comparable onsite watering) and should only occur after 5 days without significant rain. Likewise, areas subject to soil gas sampling should be free of standing or ponded water for at least 5 days before sampling.

At areas with potentially high moisture content (near ponds or shallow groundwater), the sampler and the analytical laboratory also will note vapor moisture in the glass bulb container or a decrease in sample surrogate recovery that might indicate high moisture content. Soil matrix sampling might be considered at these areas if high moisture content is suspected.

4.7.5 Shroud Enclosure

A shroud enclosure will be placed above the sampling equipment to allow for both a shut-in vacuum test (Section 4.7.6 below) and a helium tracer leak test (Section 4.7.7 below) of the sampling apparatus. The shroud will be equipped with a glove grommet to allow for manipulation of sampling apparatus components (valves) beneath the shroud without lifting the shroud once assembled. Two types of helium shroud designs may be used at DOE-administered sites: one designed to collect soil vapor samples using a glass bulb and a Summa canister (e.g., for test method confirmation sampling), and another designed to use with just a glass bulb. In both types of designs, tubing between the top of the probe and the sample containers should not be re-used on other probes. All tubing down-stream from the glass bulb that does not come into contact with vapor sample may be re-used.

4.7.5.1 Shroud Design for Glass Bulb in Tandem with Summa Canister

If a Summa canister is being used in tandem with a glass bulb for sampling, the following procedures for construction will be followed:

1. Assemble the sampling apparatus as shown in Figure 4-3. Silicone tubing is used to connect the 3-way valve at the end of the soil vapor probe to the glass bulb and Summa canister. Make sure there is at least 0.5-inches of the valve insert inside the silicone tubing for all connections. The three-way valve between the probe and the bulb/canister allows for directing flow to the bulb or canister. Make sure this valve is in the "Off" position toward the probe at this time.
2. Using a suitable length of ¼-inch Teflon tubing, connect the outlet end of the glass bulb to the port at the top of the shroud located beneath the vacuum array. The tubing on the outlet of the glass bulb is connected to a vacuum pump above the shroud to induce flow. The Summa canister should already have at least 30-inches of mercury (Hg) vacuum and requires no additional application of vacuum. The Summa canister should be supplied with a vacuum gauge and a 100 or 200 ml/min flow regulator.

4.7.5.2 Shroud Design for Glass Bulb Only

If a glass bulb only will be used for sampling, the following procedures for construction will be followed:

1. Assemble sampling apparatus as shown in Figure 4-4. Silicone tubing is used to connect the 3-way valve at the end of the soil vapor probe to the intake end of the glass bulb. Make sure there are at least 0.5-inches of insert in the silicone tubing for all connections. Make sure this valve is in the "Off" position toward the probe. The bulb is connected to a vacuum pump above the shroud to induce flow.
2. Connect the outlet end of the glass bulb to the port at the top of the shroud located beneath the vacuum array using a suitable length of ¼-inch outer diameter Teflon tubing.
3. During the leak testing, purge testing, and sampling, make sure the port of the 3-way valve at the top of the probe that would otherwise be connected to the Summa canister as previously described is never open to the atmosphere. A 2-way valve may be used in place of a 3-way valve to avoid confusion.

4.7.6 Shut-in Test

A shut-in test of the above-ground sampling system will be performed as described below:

1. Induce a vacuum gauge reading of at least 2x the maximum expected sampling vacuum that will be encountered at the site, or a default value of approximately 40 inches of water.
2. Shut-in tests can be performed for all or part of the sampling apparatus as necessary to diagnose and correct vacuum leaks. A test of the entire apparatus will be from the three-way valve at the top of the soil vapor probe to the “Vacuum Pump Port” on the vacuum array of the shroud enclosure (Figure 4-5). The test can be progressively shortened by shutting other valves along the apparatus.
3. Vacuum is applied to the sampling apparatus at the “Shut-In Test Port” (Figure 4-5) using either a plastic syringe or a double-action hand pump (for larger vacuums) depending on the volume of air needed to induce the desired vacuum.
4. A leak-free system will be evident if no vacuum loss is observed within the sampling manifold system for at least 1 minute.
5. Re-connect or repair any leaks before use.

4.7.7 Leak Test Procedure

A leak test will be performed at every active vapor monitoring point each time a soil vapor sample is collected. Helium, because it has not been identified as a potential contaminant on the DOE-administered portion of the SSFL and allows for leak detection in real-time so that corrective action can be taken before sampling, is recommended as a tracer gas to evaluate the potential leaks of ambient air into the sampling train. The procedure used for leak tests is as follows:

1. Select the type of shroud enclosure needed and place above the sampling equipment as described in Sections 4.7.5.
2. Close the three-way valve at the top of the probe, the two-way valves at either end of the bulb (Figures 4-3 and 4-4), and the “Valve Probe Port” in the vacuum array (Figure 4-5).
3. Connect the helium source to the “Helium In” port and the helium gas detector (Gem 2000 or similar) to the “Helium Out (Detector)” port on the side of the shroud (Figures 4-3 and 4-4).
4. The space underneath the enclosure and above the ground surface can then be flooded with helium and monitored using the helium gas detector. The concentration of helium should be kept near 10% of its target concentration during the test if possible.
5. Once a relatively stable helium concentration is established in the shroud, disconnect the helium detector and cover the port with a cap. The helium detector should then be connected to the outlet tube of the vacuum pump.

6. Open the 3-way valve at the top of the soil vapor probe and the 2-ways valves on the glass bulb so that air will flow from the probe through the glass bulb (Figures 4-3 and 4-4). The 3-way valve will be in the off position for the tube leading to the Summa canister. Do not open the valve on the Summa canister at this time.
7. Open the "Vapor Probe Port" and the "Vacuum Pump Port" valves in the vacuum array (Figure 4-5). Start the vacuum pump and observe the flow rate on the flowmeter and record. Adjust as necessary to be no more than 200 ml/min.
8. Purge the soil vapor probe at the volume determined in Section 4.6 above.
9. If a helium reading of greater than 5 percent is observed, then the probe leak check has failed and corrective action is required.
10. If helium is detected at a concentration greater than 5 percent, DOE will attempt to identify and correct the source of the leak.
11. If the source of the leak cannot be identified, a replacement vapor probe will be installed at least 5 ft from the original probe.

4.7.8 Sample Collection

Aboveground sampling equipment consists of connector tubing, a regulated flowmeter, a pressure gauge, purging equipment, and a shroud enclosure. Before beginning sample collection, vehicles in proximity to the location will be turned off to prevent sample contamination. Samples will be collected per the following steps:

1. Confirm the sample location with the label on the probe tubing.
2. Select the shroud design needed and connect the aboveground sampling equipment to the probe at the surface, as described in Section 4.7.5. Check the sampling system connections and fittings for tightness and obvious deterioration.
3. Use quick connect fittings and Teflon tubing for tightness of the system and so that chemicals in the air stream do not react with or adsorb to the tubing. Avoid compression fittings for all connections except at the Summa canister (if used).
4. Follow the shut-in test procedures in Section 4.7.6.
5. Purge the appropriate volume of air from the sampling system. Calculate the purge time by dividing the volume by the flow rate. After purging is complete, close the valve to the purge line and/or disconnect purge apparatus, as appropriate.
6. Follow the leak test procedures in Section 4.7.7.
7. For sampling using glass bulbs in tandem with Summa canisters: close the "Vapor Probe Port" on the vacuum array and shut off the vacuum pump. Using the glove grommet, close the 2-way valves on each end of the glass bulb. Move the off indicator on the 3-way valve towards the tube leading to the glass bulb. The tube to the Summa canister will now be open to the vapor probe. Open the valve to the Summa canister

and record the vacuum indicated on the canister gauge. Once the gauge reads less than 2 inches Hg, close the valve. The shroud may now be removed to retrieve the bulb and Summa canister.

8. For sampling using glass bulbs only: once the helium leak test and the appropriate purge volume has been removed from the probe, close the “Vapor Probe Port” on the vacuum array and shut off the vacuum pump. Using the glove grommet, close the 2-way valves on each end of the glass bulb. The shroud may now be removed to retrieve the bulb.
9. Close the 3-way valve and remove all tubing connections. Secure the probe as necessary.
10. Disconnect the sample container and immediately label the container with the sample ID information and collection date.
11. As described above, if Summa canisters are used, the final pressure of the canister will be measured using a pressure gauge. Record the final canister pressure on the soil vapor sampling form. The laboratory will record the pressure of Summa canisters upon receipt at the laboratory. If the canister pressure has changed by more than 3-inch Hg (approximately 10 percent of a full canister), then the samples will be flagged as compromised. If possible, re-sampling will occur. If not, analysis will proceed, and the results will be qualified during data validation. Great care should be used in comparing field pressure to laboratory pressures. It is likely that laboratory gauges will be more accurate than field gauges, and differences in pressure readings could be due to instrumentation rather than to actual leakage.
12. If condensation is noted inside the sample container, discard the sample and collect another sample in a clean container.
13. If samples are collected in glass bulbs, add the surrogates within 15 minutes of collection. Samples collected using Tedlar bags do not require surrogates. Surrogates for Summa canisters will be added by the fixed laboratory before analysis.
14. Complete documentation.
15. Store samples out of direct sunlight, and do not chill. To prevent the degradation of light-sensitive compounds, wrap glass bulbs in aluminum foil.

4.7.9 Quality Control Sampling

The following QC sampling will be performed:

- At least 1 field duplicate sample will be collected per every 20 primary samples, or 1 each day at a minimum, for each laboratory used. Duplicate samples using glass bulbs are collected immediately after the primary sample, in separate sample containers at the same location and depth as the primary sample. The analysis of the duplicate samples will be performed by the same laboratory that performs the primary sample analysis.

- When using a mobile laboratory and method SW8260B for active soil vapor sampling, at least one confirmation sample will be collected each day, or one per every 10 samples collected, and sent to a fixed laboratory to be analyzed by Method TO-15. The confirmation sample will be collected in Summa canisters as described in Section 4.7.8.

The results of the QC sampling will be evaluated by the data validation staff. The replicate percent difference (RPD) criterion for duplicate samples is 30%. Data which exceed these criteria will be flagged by the data validator as estimated. RPD criterion has not been established for confirmation samples. Evaluation of the duplicate and confirmation data will be performed to determine if additional field samples need to be collected to mitigate the increased variability in the data.

4.7.10 Documentation

Documentation of soil vapor sampling includes record-keeping information entered into field log books, as well as sample tracking information recorded on the COC.

4.7.10.1 Recordkeeping

The following information will be recorded in a field log book or on the soil vapor sampling form for documentation of the procedures used to collect soil vapor data:

- Sample identification information, including the locations and depths at which the samples were collected; sample identifiers; glass bulb identifiers; date; and time
- Field personnel involved in sample collection
- Weather conditions (temperature, wind speed and direction, barometric pressure, precipitation, etc.)
- Number of vehicles in the area and the proximity to sample probes
- Sampling methods, devices, and equipment used
- Purge volumes before sample collection. Purge volumes will be related to the volume of the sampling equipment, including the tubing connecting the sampling interval to the surface
- Volume of soil vapor extracted (volume of each sample)
- The vacuum of the canisters, if used, before and after samples were collected
- If observable, the qualitative description of the apparent moisture content of the sampling zone (dry, moist, or saturated)
- The results of the helium leak testing procedures

4.7.10.2 Chain of Custody

Samples will be shipped under proper COC. The COC will be kept as part of the sampling event documentation. Samplers must sign and date the COC when relinquishing the samples to the laboratory or courier. The laboratory or courier must sign and date the COC as having received the samples. At a minimum the following information will be included on the COC:

- Sample ID
- Sample depth
- Sample date
- Start and stop times for sampling
- Flow rate
- Purge volume
- Requested analyses
- Container type and volume
- Bulb ID (glass bulbs only)
- Turnaround time
- Project name, job number, and contact information of project coordinator
- Laboratory name and information as to whether a mobile or fixed laboratory was used
- Laboratory job number and ID
- Comments section for any other relevant observations (no-flow, low-flow, extended sampling times, etc.) from the sample collection process

An example of a COC used for active soil vapor samples is presented in Figure 4-6. The shipment of samples to offsite fixed laboratories will be performed following the procedures outlined in SOP 11 of the Phase 3 Work Plan.

4.8 ACTIVE SOIL VAPOR LABORATORY ANALYSIS

Sample analyses may be performed by an onsite mobile laboratory or a fixed offsite laboratory. Laboratories used for the analysis of the active vapor samples will be certified by the State of California for the method of analysis.

4.8.1 Target Analytes, Analytical Methods, and Method Detection Limits

Table 4-1 lists the required target analytes and the reporting limits (RLs) for EPA Method SW8260B, modified to use a large sample size (100-cc sample size) to achieve the detection limits and quality levels that meet the data needs for risk assessment or vapor intrusion evaluation. DOE will use these screening levels for the Phase 3 characterization program. For onsite field analysis, the required RLs as listed in Table 4-1 will be achieved during the DOE Phase 3 work using an onsite mobile laboratory equipped with a GC/MS instrument using a purge and trap apparatus modified to accept a 100 cc sample aliquot.

For DOE application, compounds to be reported will be the target analytes listed in Table 4-1. If other analytes are be proposed in the Phase 3 field sampling plan addenda prepared for subareas at DOE-administered property they will be added to the analyte list. Tentatively identified compounds will not be reported.

4.8.2 Calibration

Instrument setup and calibration will result in the complete resolution of target compounds. Shortened run times are allowed only if all compounds have been identified in a previous investigation and DTSC approves the change. If shortened run times are approved, no compounds may co-elute, and the initial and daily calibration checks must be performed by the shortened analysis.

4.8.2.1 Initial Calibration

An initial calibration will be performed for the target analytes listed in Table 4-1. For mobile laboratories, an initial calibration will be performed upon arrival at the site and whenever:

- The mobile laboratory changes location
- The GC column is changed
- The daily mid-point calibration check cannot meet requirements
- When specified by DTSC personnel

For stationary laboratories, initial calibrations will be performed initially for each instrument and whenever:

- The GC column is changed
- The daily mid-point calibration check cannot meet requirements
- When specified by DTSC personnel

At a minimum, at least five different concentration levels will be used for the initial calibration. The lowest concentration level must be at or below the project-specified RL (Table 4-1).

The relative standard deviation (%RSD) for the target compound average response factors will not exceed the values listed in Table 4-1.

4.8.2.2 Initial Calibration Verification

Each initial calibration will be verified by an initial calibration verification (ICV) or laboratory control sample (LCS). The ICV or LCS will contain the target compounds at concentrations at or near the mid-point of the calibration. The percent difference (%D) for each response factor will be within the values listed in Table 4-1. An additional RL level ICV/LCS will also be performed daily, prior to the analysis of any samples. A percent difference of +/-30% will be considered acceptable.

4.8.2.3 Daily Calibration Check

Each day samples are analyzed the calibration will be checked. The daily calibration check standard will contain the target compounds at concentrations at or near the mid-point of the calibration.

The %D for each response factor will be within ±15 percent, except as noted in Table 4-1.

4.8.3 Blank

At least one field blank will be analyzed each day to assess the possibility of interference or contamination from ambient air. To verify the sample container decontamination procedure, one sample container of every 20 used or 1 every 12 hours, whichever is more frequent, will be used as a method or equipment blank.

As required by the EPA Method TO-15, the method RL associated with Summa canister decontamination (method blank) should be lower than target soil vapor screening levels. The batch certification for each set of Summa canisters will be reviewed to ensure that they are below the TO-15 reporting limit for each batch. The canisters will then be considered sufficiently clean for use for DOE soil vapor sampling at the SSFL. When testing for methane at landfill sites only, a representative Tedlar® bag would be blank tested prior to use.

4.8.4 Sample Analyses

Sample analyses can begin when the requirements for initial calibration, ICV or LCS, and the daily mid-point calibration check have been met. Samples should be analyzed on the same instrument as the blank.

If condensation is noted inside the sample container, the samplers will be notified. The sample will be discarded and another sample collected in a clean container.

4.8.4.1 Holding Times

Samples should be analyzed with the following holding times:

- Glass bulbs without surrogates–30 minutes from collection to analysis
- Glass bulbs with surrogates–24 hours from collection to analysis (surrogates must be added within 15 minutes to achieve the 24 hour holding time)
- Summa canisters analyzed by TO-15–up to 30 days from collection
- Tedlar bags–six hours from collection to analysis

4.8.4.2 Surrogates

Laboratory surrogates will be added to the active vapor samples collected with glass bulbs for VOC analysis. Surrogates also will be added by the laboratory before analysis of samples collected in Summa canisters. One aromatic hydrocarbon, one early eluting, and one late eluting chlorinated hydrocarbon surrogate should be used. Surrogate recovery %D should be within ±25 percent.

4.8.4.3 Compound Confirmation

Compound confirmation generally will be performed by MS. The laboratory surrogates relative retention time shifts should be used in sample confirmation. If a shortened run time was used and peaks were detected in regions where co-elution is possible, a normal-time analysis should be performed.

4.8.4.4 Compound Quantitation

Target compounds are to be quantified using the average response factor calculated in the initial calibration. If shortened analysis times were used, the average response factor must be from an initial calibration analyzed using a shortened analysis time.

The target compounds will be reported to the RL listed in Table 4-1 when using EPA Method SW8260B. A higher RL may be reported if the compound concentration exceeds half the concentration of the highest calibration standard. In such a case, a smaller sample volume could be used or ambient air could be used to dilute the sample. Analytes not affected by high concentrations will be reported from the original analysis. If high concentrations were shown to exist in previous investigations, undiluted analyses are not required.

To verify the dilution process, a duplicate dilution should be analyzed once per day. Additionally, ambient air should be analyzed periodically during the day when dilutions are performed.

4.8.5 Last Analysis of the Sequence

The last analysis of each sequence must be one of two LCS mixtures. If there were no target compounds detected in site samples during the daily analytical sequence, then the LCS must be at the method detection limit (MDL) level. The recovery for each compound in the LCS must be at least 50 percent. If target compounds were detected in site samples during the sequence, then an LCS at the mid-point of the calibration is the last analysis of the sequence. The %D for each target compound response factor must be within ±20 percent, except as noted in Table 4-1, which must be within ±30 percent.

4.8.6 Sample Container Decontamination

The laboratory is responsible decontaminating used sample containers following the successful analysis of the sample. Summa canister decontamination will follow the decontamination procedure in Method TO-15. Glass and bulbs will be disassembled and heated (“baked-out”) at

240 degrees Celsius (^{o}C) for a minimum of 15 minutes or at 120^{o}C for 30 minutes. Sample containers will have a unique ID that will allow any sample container associated with a highly contaminated sample to be identified if additional decontamination is necessary.

4.8.7 Analytical Results Reporting

Site sample and laboratory QC sample results can be reported in retention time order or alphabetical order. The analytes in the requested list will be reported. All data, including raw data, will be submitted. For each analysis (calibration, LCS, and site samples), information will be reported as summarized in Table 4-2.

4.8.8 Performance Evaluation Samples

DTSC could provide a performance evaluation sample to the mobile laboratory and/or the fixed laboratory for analysis to assess data quality. Preliminary results will be submitted at the end of the analysis.

4.8.9 Laboratory Audits

As described in the Advisory, laboratories utilizing EPA Methods 8015B, 8260B, and TO-15 for analysis of soil vapor samples should obtain certification from the California Department of Health, Environmental Laboratory Accreditation Program (ELAP) for these methods. Accreditation under National Environmental Laboratory Accreditation Program (NELAP) for USEPA Method TO-15 for ambient air testing is acceptable as certification for soil vapor testing. DTSC could perform announced or unannounced laboratory audits of mobile and/or fixed laboratories. The laboratory must be able to provide hard copy or portable document format (PDF) copies of laboratory data, including initial calibration, daily mid-point checks, LCS, blanks, or other information as specified for the DTSC audit protocol. Failure to allow the audit or to supply the records could result in the rejection of all data.

4.8.10 Laboratory Records

The following records are to be maintained in both fixed and mobile laboratories:

- Hard-copy record of the calibration and LCS standard with:
    - Date of receipt

  - Name of supplier
  - Lot number
  - Date of preparation for intermediate standards
  - ID
  - Name of person who prepared the standard
  - Volume of concentrated standard used for dilution
  - Final volume after dilution
  - Calculated concentration after dilution
- Hard copy of each initial calibration for each instrument for the past several months
- Laboratory SOPs

4.9 METHANE SAMPLING

If the presence of methane is suspected (for example, at landfills), methane also will be included in the work plan and SAP. Methane samples may be analyzed by a GC using modified EPA Method 8015B, EPA Method TO-3, ASTM 3416M (EPA 3C), ASTM D1946, or by an appropriate hand-held instrument (Land Tech Gas Analyzer GA-90, Gas Emissions Monitor GEM-500, or GEM-2000). When methane sampling and analysis is required, the following guidance will be used:

1. The detection limit (DL) for methane analysis should not exceed 500 parts per million by volume (ppmv).
2. Summa canisters or Tedlar bags may be used for the collection of methane samples. Methane samples collected in Tedlar bags have a holding time of no more than 24 hours and will be analyzed onsite by a mobile laboratory.
3. When methane is detected at 1,000 ppmv or more, additional sampling and/or further investigation is recommended to identify the source(s).
4. At areas where methane is investigated and detected at a level of 5,000 ppmv or more, fixed and biogenic gas (oxygen, carbon dioxide, and methane) data will be obtained using a thermal-conductivity detector (TCD) or a hand-held instrument.
5. To confirm that the area is pressurized by migration of gases, pressure readings of each sampling tube system will be recorded in the field logs and reported along with the methane concentrations.
6. GC calibration will be performed per EPA SW-846 Method 8000.
7. Hand-held instruments will be calibrated in accordance with the manufacturer's instructions. When a hand-held instrument is used to analyze methane samples, at least

10 percent of all positive methane samples (more than 5,000 ppmv), rounded to the nearest whole number, will be confirmed by another hand-held instrument (different unit or brand) or by a GC method.

5.0 HEALTH AND SAFETY

Work will be performed in with accordance with the approved Phase 3 WSHP. If required, additional site-specific addendums to the Phase 3 WSHP may be prepared to address the hazards (chemical, physical, biological, or radiological) associated with any new scope of work. The site-specific addendums to the WSHP will describe specific health and safety measures to be taken during field work associated with any new scope of work.

6.0 INVESTIGATION-DERIVED WASTE

Investigation-derived waste consists of non-reusable materials generated during site investigation activities that might be contaminated with chemicals of concern identified at the site (used tubing, cords, disposable gloves, rags, and corks; soil cuttings; decontamination water, etc.). These materials will be managed in accordance with SOP 13 of the Phase 3 Work Plan and applicable federal, state, and local regulations.

7.0 AGENCY REPORTING

The information obtained during the soil vapor surveys, including COCs, subsurface lithological logs, validated active vapor analytical results, deviations from the approved work plan and SAP, data inconsistencies, results of the helium leak test, and other significant operational details regarding the soil vapor survey, will be documented in the report for the site at which samples were collected.

8.0 REFERENCES

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TABLES

TABLE 4-1
Active Soil Vapor Target Analytes
DOE SSFL Soil Vapor SOP
Page 1 of 1

Analyte	Reporting Limits (µg/L) (Low Level SW8260)	Initial Calibration Relative Standard Deviation (%)	Percent Difference (+/-)		Screening Levels in Soil Vapor (µg/L)			
			Daily Calibration Check	Last Analysis of the Sequence	Current Residential	Current Commercial/ Industrial	Future Residential	Future Commercial/ Industrial
1,1,1,2-Tetrachloroethane	0.02	15	20	20	0.16	0.55	0.33	1.10
1,1,1-Trichloroethane	0.02	15	20	20	521	1,460	1,043	2,920
1,1,2,2-Tetrachloroethane	0.024	15	20	20	0.02	0.07	0.04	0.14
1,1,2-Trichloroethane	0.02	15	20	20	0.08	0.26	0.15	0.51
1,1-Dichloroethane	0.02	15	20	20	0.76	3	2	5
1,1-Dichloroethene	0.02	15	20	20	37	102	73	204
1,2-Dichloroethane	0.02	15	20	20	0.06	0.19	0.12	0.39
Benzene	0.02	15	20	20	0.04	0.14	0.08	0.28
Carbon tetrachloride	0.02	15	20	20	0.03	0.10	0.06	0.19
Chloroethane	0.021	15	20	30	15,643	43,800	31,286	87,600
Chloroform	0.02	15	20	20	0.23	0.77	0.46	2
cis-1,2-Dichloroethene	0.02	15	20	20	31	88	63	175
Dichlorodifluoromethane (Freon 12)	0.02	15	20	30	52	146	104	292
Ethylbenzene	0.02	15	20	20	0.49	1.64	0.97	3
m & p-Xylenes	0.02	15	20	20	365	1,022	730	2,044
Methylene chloride	0.02	15	20	20	1	4	2	8
o-Xylene	0.02	15	20	20	365	1,022	730	2,044
Tetrachloroethene	0.02	15	20	20	0.21	0.69	0.41	1.39
Toluene	0.02	15	20	20	156	438	313	876
Trans-1,2-Dichloroethene	0.02	15	20	20	31	88	63	175
Trichloroethene	0.02	15	20	20	0.30	1.00	0.59	2
Trichlorofluoromethane (Freon 11)	0.02	15	20	30	365	1,022	730	2,044
Trichlorotrifluoroethane (Freon 113)	0.02	15	20	30	15,643	43,800	31,286	87,600
Vinyl chloride	0.02	15	20	30	0.016	0.05	0.03	0.10

Notes:

1. Screening levels are calculated from indoor air CHHSLs (California Human Health Screening Levels) using default attenuation factors for soil gas samples obtained from the updated DTSC vapor intrusion guidance, issued October 2011.

2. The calculated screening levels were previously published in the DTSC-approved Final NASA Soil Vapor Standard Operating Procedure for NASA Sites at the Santa Susana Field Laboratory (NASA, 2012).

3. Highlighted cells are those chemicals with CHHSLs that are less than the reporting limit.

Abbreviations:

µg/L = micrograms per liter
CHHSLs = California Human Health Screening Levels
DOE = Department of Energy
RFI = RCRA Facility Investigation
NASA = National Aeronautics and Space Administration
SSFL = Santa Susana Field Laboratory
VOC = volatile organic compound

Table 4-2
Active Soil Vapor Sample Analytical Reporting Requirements
DOE SSFL Soil Vapor SOP
Page 1 of 1

Reportable Information	Sample Type			
	Initial Calibration	**Daily Calibration Sample**	**Laboratory Control Sample**	**Active Soil Vapor**
Site name	x	x	x	x
Laboratory name	x	x	x	x
Data of analysis	x	x	x	x
Name of analyst	x	x	x	x
Instrument Identification	x	x	x	x
Normal injection volume	x	x	x	x
Injection time	x	x	x	x
Special conditions or comments	x	x	x	x
Standard source (lot number)	x	x	x	
Detector	x	x	x	x
Retention time	x	x	x	x
Standard mass or concentration	x	x	x	
Peak area	x	x	x	x
Response factor	x	x	x	
Average response factor	x			
Standard deviation of response factor	x			
Percent Relative Standard Deviation (%RSD)	x			
Acceptable range for the %RSD	x			
Percent Difference (%D)		x	x	
Acceptable range for %D		x	x	
Sample ID				x
Sampling depth				x
Purge volume				x
Vacuum pressure				x
Sampling time				x
Injection volume				x
Dilution factor				x
Concentration in µg/L				x
Total number of peaks found				x
Unidentified peaks and other comments				x
Surrogate recovery				x
Second column confirmation – record the retention time of compound name for the second column confirmation of the standard and site sample				x

Notes:

1. Reportable information with an "x" under the sample type column will be reported for that sample type. Refer to Section 4.8 of the DOE Soil Vapor SOP for additional information.

Abbreviations:

µg/L = micrograms per liter
DOE = Department of Energy
SOP = standard operating procedure
SSFL = Santa Susana Field Laboratory
SV = soil vapor

FIGURES

Single Soil Vapor Probe Construction Diagram

Probe ID/Soil ID: ______________________

Job #: __________________________________

Project: ______________________

Site: ______________________________________

Reviewed by: ____________________________

Logged by: ____________________

Drilling Contractor: _____________________

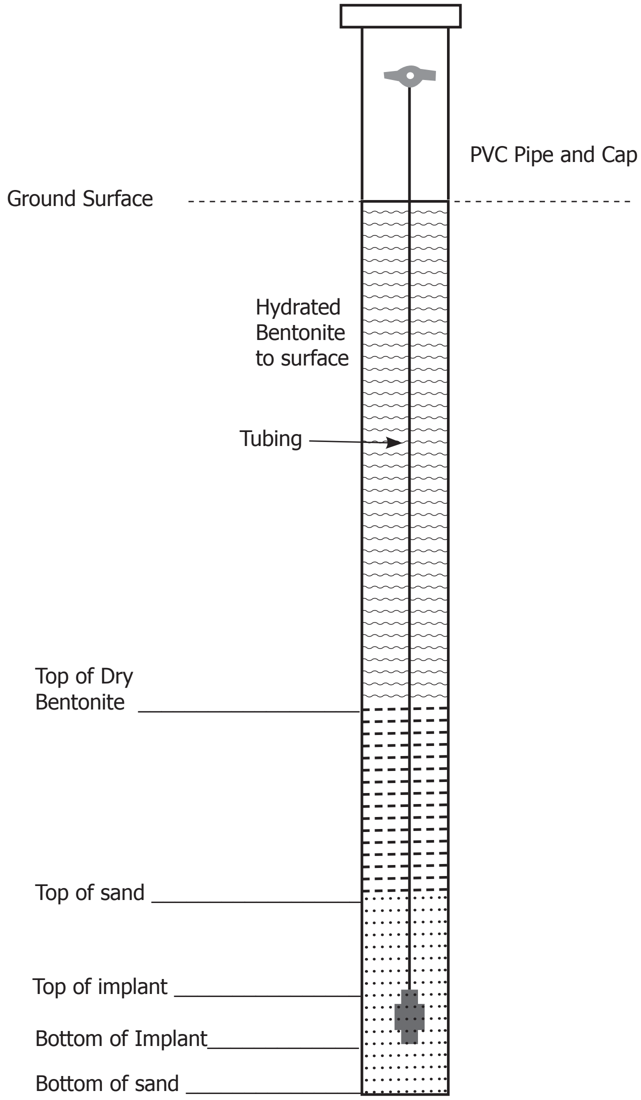
Rig Type/Method: _________________________

Driller: _________________________

Borehole TD: ___________________________

Probe Completion Date/Time: _______________

Borehole Diameter: _____________



Vapor Implant Specs

Material: __________________________

Length: ____________________________

Diameter: __________________________

Tubing Specs

Material: __________________________

Diameter: __________________________

Color: _____________________________

Sand Pack Specs

Grain Size: _________________________

Manufacturer: ______________________

Dry Bentonite

Type: ______________________________

Manufacturer: ______________________

Hydrated Bentonite

Type: ______________________________

Manufacturer: ______________________

Notes:

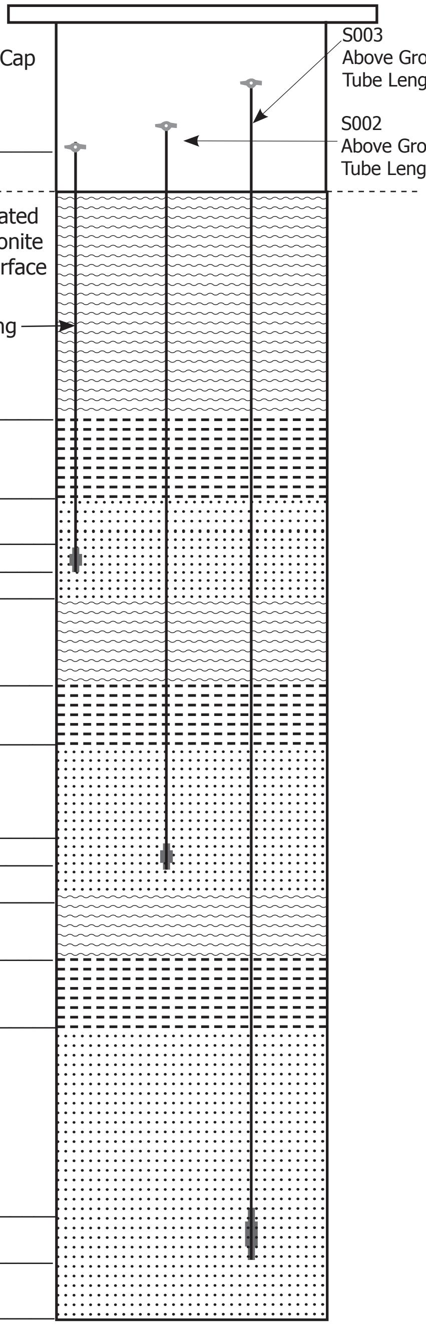
1. Probes not drawn to scale.

FIGURE 4-1

Multiple Soil Vapor Probe Construction Diagram

Page ____ of ____

Probe ID/Soil ID: ____________________
Project: ____________________
Job #: ____________________
Site: ____________________
Logged by: ____________________
Reviewed by: ____________________
Drilling Contractor: ____________________
Driller: ____________________
Rig Type/Method: ____________________
Borehole TD: ____________________
Borehole Diameter: ____________
Probe Completion Date/Time: ______________



S003
Above Ground Surface
Tube Length ____________________

S001
Above Ground Surface
Tube Length ____________________

S002
Above Ground Surface
Tube Length ____________________

Top of Dry Bentonite ____________________
Top of sand ____________________
Top of implant ____________________
Bottom of Implant____________________
Bottom of sand ____________________
Top of Dry Bentonite ____________________
Top of sand ____________________
Top of implant ____________________
Bottom of Implant____________________
Bottom of sand ____________________
Top of Dry Bentonite ____________________
Top of sand ____________________
Top of implant ____________________
Bottom of Implant____________________
Bottom of sand ____________________

Vapor Implant Specs

Material: ____________________
Length: ____________________
Diameter: ____________________

Tubing Specs

Material: ____________________
Diameter: ____________________
Color: ____________________

Sand Pack Specs

Grain Size: ____________________
Manufacturer: ____________________

Dry Bentonite

Type: ____________________
Manufacturer: ____________________

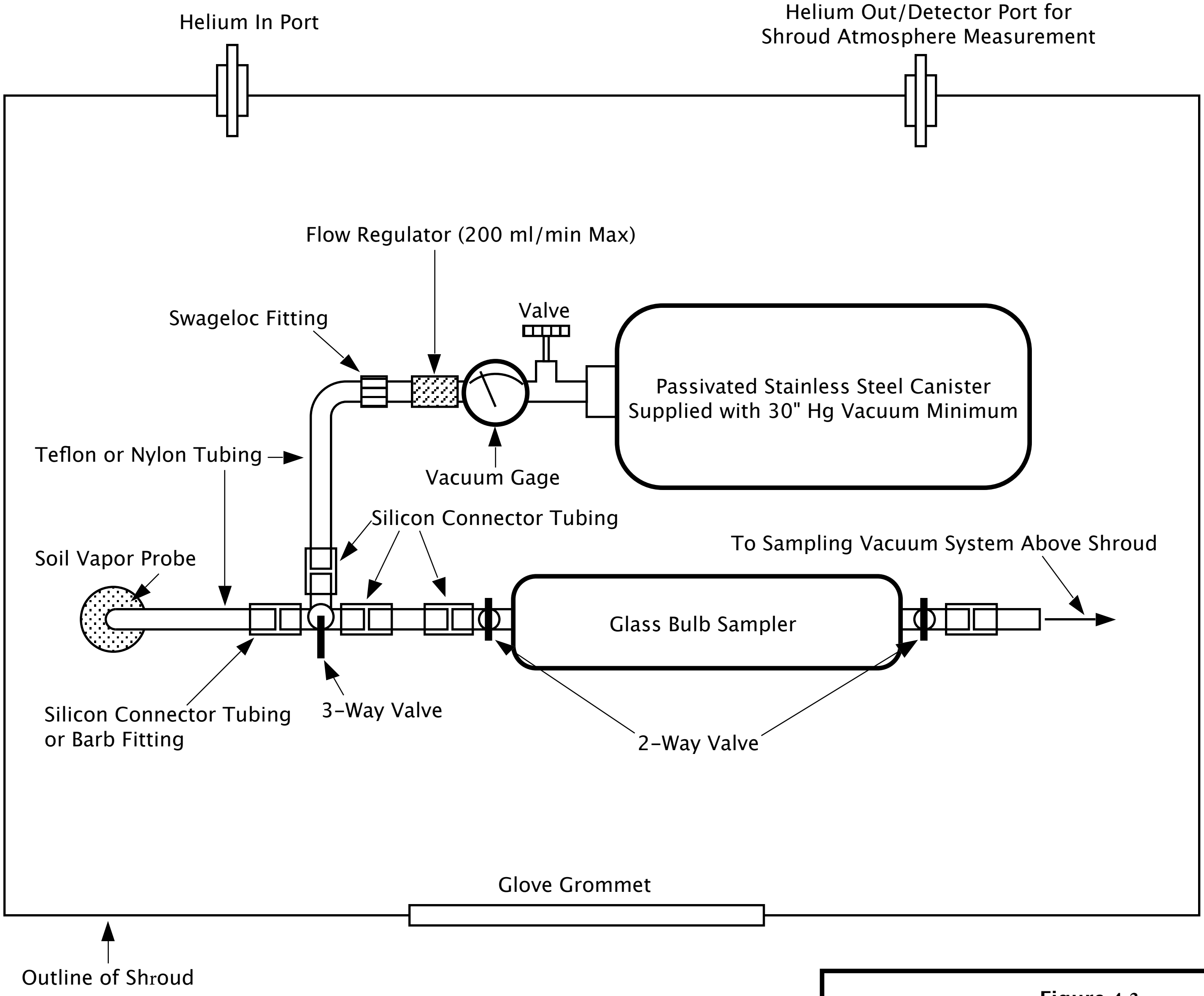
Hydrated Bentonite

Type: ____________________
Manufacturer: ____________________

Notes:

1. Probes not to scale.
2. Borings are approximately 2 inches in diameter using a Macrocore or Dual Tube sampler and can hold up to 5 soil vapor probes. If additional depths will require sampling at the same location, a second boring may need to be drilled.

FIGURE 4-2

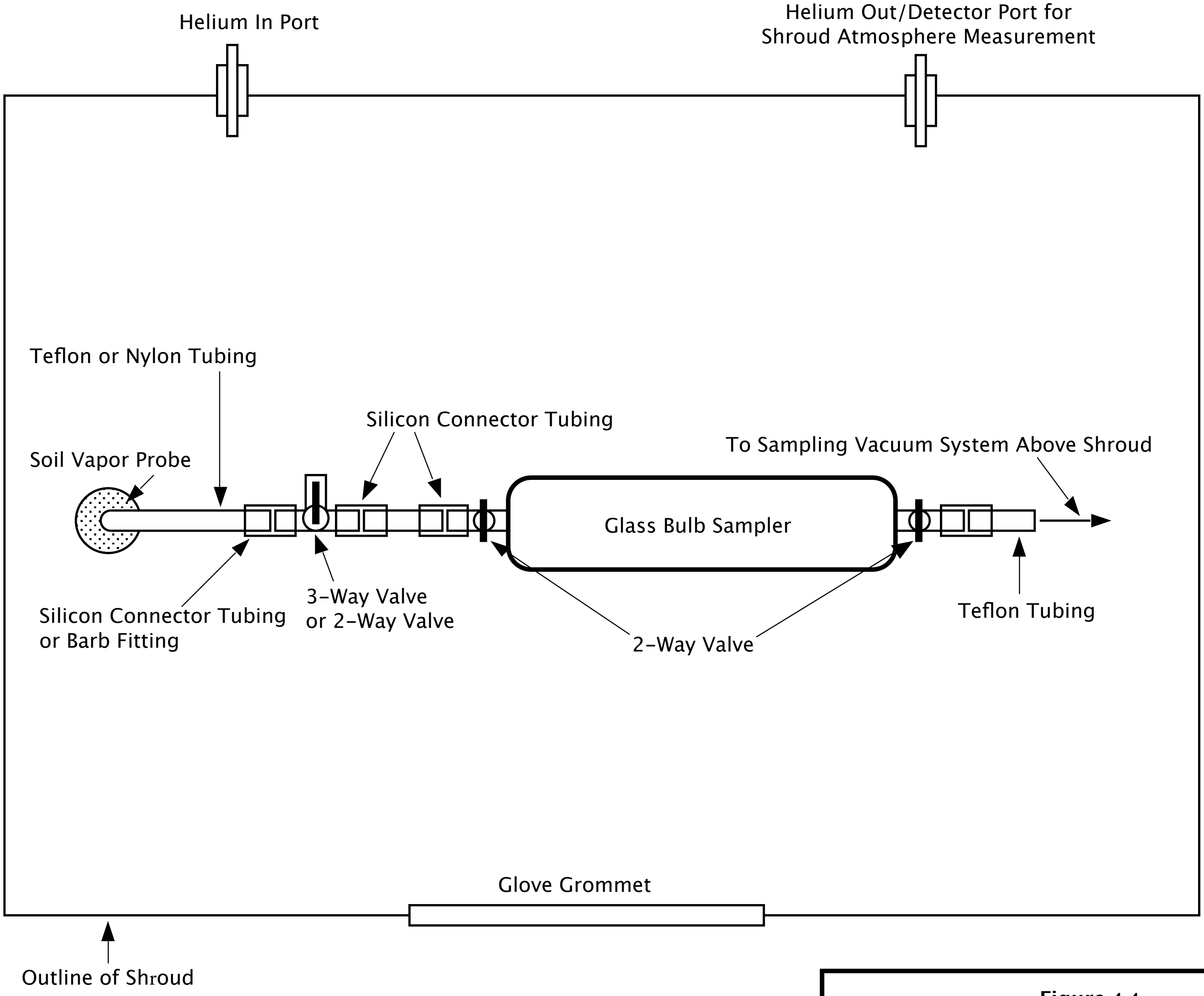


NTS

Figure 4-3

Helium Shroud and Soil Vapor
Sampling Apparatus – Top View

Source: **Environmental Support Technologies**



NTS

Figure 4-4

Helium Shroud and Soil Vapor
Sampling Apparatus – Top View

Source: **Environmental Support Technologies**

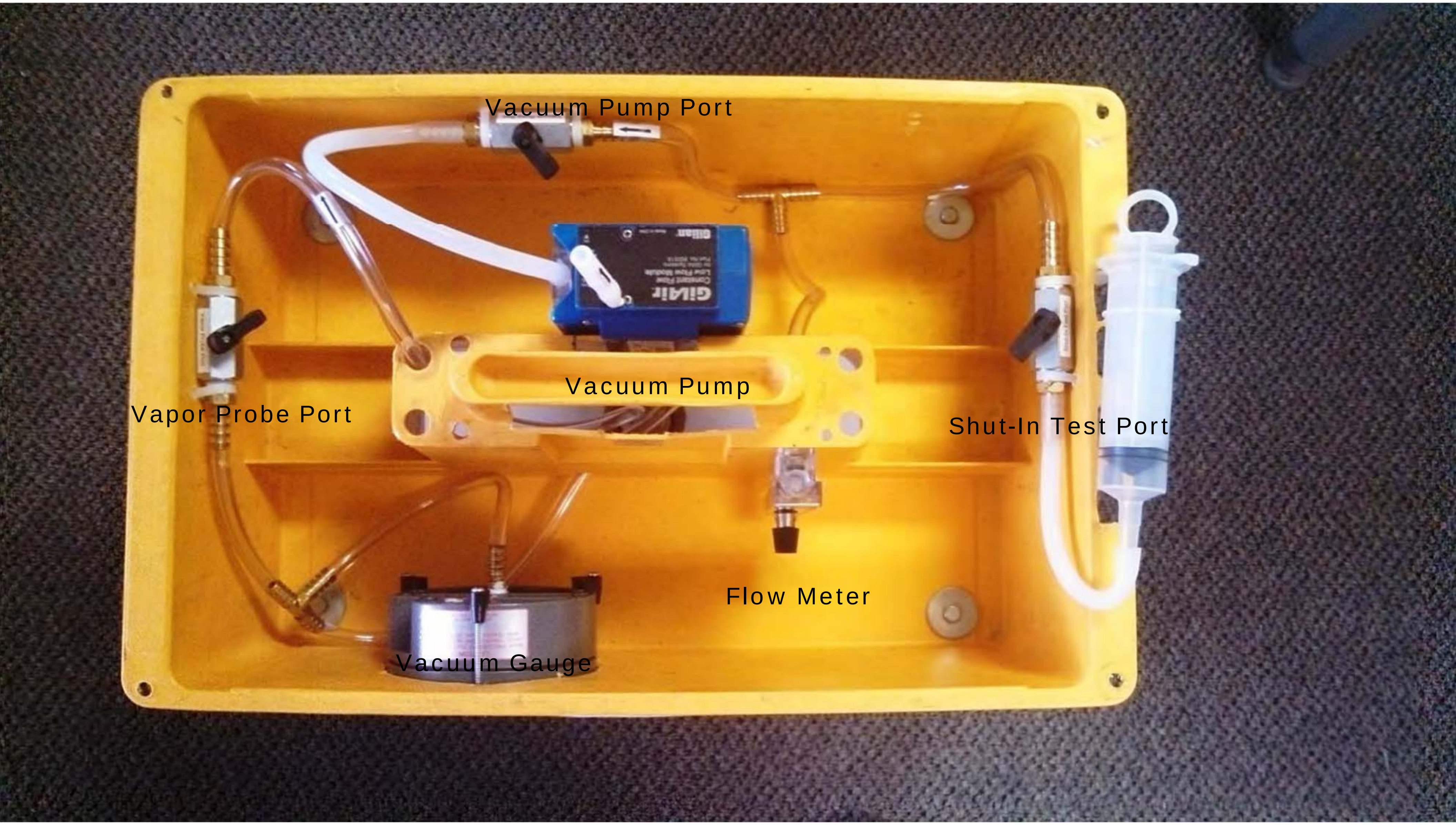


Figure 4-5
Vacuum Array

Source: Environmental Support Technologies

Chain of Custody Record

Lab Name & Address:

Page _____ of _____

Analyses Requested

Project No:

Project Name:

Project Manager:

Phone:

Fax:

Email:

Client Name:
(report and billing)

Address:
(report and billing)

☐ Mobile Lab

☐ Fixed Lab

Turn-Around Time

☐ 24 Hr. Rush*

☐ 48 Hr. Rush*

☐ Normal TAT

* Requires prior approval, additional charges apply

Lab ID (Lab use only)	Sample ID (As it should appear on report)	Depth (ft)	Purge Volume	Bulb ID	Time Sampled		Flow (ml/min)	Date sampled	Sample matrix	Containers: # and type	VOCs by 8260B	VOCs by TO-15	Isopropyl Alcohol Leak check	Methane by 8015B	Methane by D1946					Requested due date:
					start	stop														Remarks/Special Instructions

1) Relinquished by: (Sampler's Signature)	Date:	Time:	3) Relinquished by:	Date:	Time:
2) Received by:	Date:	Time:	4) Received by:	Date:	Time:
			5)Relinquished by:	Date:	Time:
			6) Received for Laboratory by:	Date:	Time:

The delivery of samples and the signature on this chain of custody form constitutes authorization to perform the analyses specified above under the Terms and Conditions set forth on the back hereof

To be completed by Laboratory Personnel:

Samples chilled? ☐ Yes ☐ No ☐ From Field

Custody seals? ☐ Yes ☐ No

All sample containers intact? ☐ Yes ☐ No

☐ Courier ☐ UPS/Fed Ex ☐ Hand carried

Sample Disposal

☐ Client will pick up

☐ Return to client

☐ Lab disposal

Laboratory Notes:

Figure 4-6 Soil Vapor Chain of Custody Form