Final Addendum 01 To Final Sampling and Analysis Plan (Field Sampling Plan / Quality Assurance Project Plan)

Treatability Study for Various Organic Compounds at Remedial Unit – C1, Building 253 Hunters Point Shipyard, San Francisco, California

ENVIRONMENTAL MULTIPLE AWARD CONTRACT (EMAC)
Contract Number N62473-07-D-3217
Contract Task Order 0004

Document Control Number
TN&A-3217-0004-0008.A1/F

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April 10, 2009

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REVIEW AND APPROVAL

TN&A Project Manager: Ms. Suman Sharma Date: April 13, 2009

TN&A Project QC Officer Ms. Ewelina Mutkowska Date: 4/13/09

Navy QA Officer: Mr. Narciso A. Ancog Date: 4/15/2009

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Transmittal Letter

To:	Diane Silva NAVFAC SW Environmental Records
Address:	Building 128 Mail Room, 1220 Pacific Highway Code EVR San Diego, CA 92132 FISC Bldg 1, 3rd Floor
From:	Sandra Megginson Date: April 20, 2009
Re:	**Treatability Study for Various Organic Compounds at Remedial Unit – C1, Building 253, Hunters Point Shipyard, San Francisco, California** **Final Accident Prevention Plan / Site Safety and Health Plan** Document Control Number: TN&A-3217-0004-0006.R1 **Final Data Management Plan** Document Control Number: TN&A-3217-0004-0007.R1 **Final Addendum 01 to Final Sampling and Analysis Plan (Field Sampling Plan / Quality Assurance Project Plan)** Document Control Number: TN&A-3217-0004-0008.A1/F **Final Transportation and Disposal Plan** Document Control Number: TN&A-3217-0004-0009.R1 **April 2009** Environmental Multiple Award Contract (EMAC) Contract Number: N62473-07-D-3217, Contract Task Order: 0004

Dear Ms. Silva:

Enclosed is the complete replacement package prepared for the following Draft versions accepted as Final: Accident Prevention Plan/Site Safety and Health Plan, Data Management Plan, Addendum 01 to the Final Sampling and Analysis Plan, and Transport and Disposal Plan; all for the Treatability Study for Various Organic Compounds at Remedial Unit – C1 (RU-C1) at Hunters Point Shipyard, San Francisco, California.

Replacement covers, signature pages, and CDs with revised DCN numbers are submitted for the Draft versions submitted in one common binder in February 2009. All were submitted under TN&A's EMAC Contract No. N62473-07-D-3217, CTO 0004 and were provided to the designated agencies for informational purposes only.

Enclosed are replacement pages for the previously submitted binders (two bound copies as distributed and one unbound copy) and four CDs (each of the four documents is submitted with its own CD containing the .pdf of that single document, and the source files in their native applications).

If you have any questions, please call me at (510) 223-1340.

Sincerely,

Sandra Megginson

Sandra Megginson
Senior Project Coordinator

AR_N00217_001548
HUNTERS POINT
SSIC NO. 5090.3.A

FINAL
SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN/QUALITY ASSURANCE PROJECT PLAN) TREATABILITY STUDY FOR VARIOUS ORGANIC COMPOUNDS AT REMEDIAL UNIT – C1, BUILDING 253

DATED 13 OCTOBER 2006

THIS RECORD IS ENTERED IN THE DATABASE AND FILED AS

RECORD NO. AR_N00217_001008

DISTRIBUTION LIST

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Table 1 Implementation Schedule

Appendix

Appendix A Standard Operating Practice No. TNFLD009A “Soil Gas Sampling Using Extraction Methods”

ACRONYMS AND ABBREVIATIONS

COCs	Contaminants of Concern
DO	Delivery Order
DQOs	data quality objectives
EMAC	Environmental Multiple Award Contract
EPA	U. S. Environmental Protection Agency
EWI	Environmental Work Instruction
FSP	Field Sampling Plan
NAVFACSW	Naval Facilities Engineering Command Southwest
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RU-C1	Remedial Unit – C1
SAP	Sampling and Analysis Plan
TN&A	T N & Associates, Inc.
TtEC	Tetra Tech EC, Inc.
VOCs	volatile organic compounds

1.0 INTRODUCTION

T N & Associates Inc. (TN&A) has prepared this Addendum 01 to the Final Sampling and Analysis Plan (SAP) [Field Sampling Plan and Quality Assurance Project Plan (FSP/QAPP)] for *Treatability Study for Various Organic Compounds at Remedial Unit – C1, Building 253 at Hunters Point Shipyard, San Francisco, California* prepared by Tetra Tech EC, Inc. (TtEC) in October 2006 (Document Control Number: ECSD-RACIV-06-0340). This work is being performed under the Environmental Multiple Award Contract (EMAC), Contract Number N62473-07-D-3217, Delivery Order (DO) 0004 from the Department of the Navy, Naval Facilities Engineering Command Southwest (NAVFACSW). This Addendum 01 to Final SAP (FSP/QAPP) was prepared to propose the following changes for continuation of the work at Remedial Unit – C1 (RU-C1) proposed in the approved Final SAP (TtEC, 2006):

1. Project team personnel changes (Section 2.0);
2. Soil vapor sample collection media (Section 3.1);
3. Field QC sample requirements (Section 3.2);
4. Data validation requirements (Section 3.3);

The Data Quality Objectives (DQOs) defined in the approved Final SAP will not change under DO 0004. Under this DO, TN&A will conduct treatability study at RU-C1, Building 253 at Hunters Point Shipyard, San Francisco, California in accordance with *Final Work Plan for Treatability Study for Various Organic Compounds at Remedial Unit – C1, Building 253 at Hunters Point Shipyard, San Francisco, California* (TtEC, 2006b). The purpose of the treatability study designed for RU-C1 is to evaluate the potential for *in situ* bioremediation (ISB) of site-specific contaminants of concern (COCs) and other contaminants historically detected on the site under anaerobic (Stage 1), nitrate-reducing (Stage 2), and aerobic (Stage 3) conditions. The primary contaminants of concern in groundwater at RU-C1 are tetrachloroethene, trichloroethene, dichloroethene isomers, and vinyl chloride (TtEC, 2006a). Other contaminants that have been historically detected on site and may require treatment include: 1,1-dichloroethane, 1,2-dichloroethane, benzene, 1,4-dichlorobenzene, and total petroleum hydrocarbons diesel and motor oil range (TtEC, 2006a). Progress of treatability study will be evaluated using groundwater and soil vapor data generated in accordance with monitoring program described in the Final SAP (TtEC, 2006a).

Sampling, analysis and quality assurance (QA) and quality control (QC) procedures for RU-C1 groundwater monitoring will be conducted in accordance with the Final SAP (FSP/QAPP) (TtEC, 2006). The Final SAP was approved by NAVFACSW Quality Assurance Officer in October 2006 (TtEC, 2006a). This Addendum 01 will be used in conjunction with the approved Final SAP (FSP/QAPP) (TtEC, 2006a). All policies and procedures set forth in the original approved Final SAP (FSP/QAPP) that were not modified in this Addendum 01 will remain in effect for this sampling and monitoring program.

The implementation schedule for sampling, analysis and reporting is summarized in Table 1. The field QA/QC and sampling procedures will focus on achieving DQOs described in the Final SAP (TtEC, 2006a) in a timely, cost-effective, and safe manner.

2.0 POINTS OF CONTACT

The following list provides revised contact information for the key contacts for the project:

Agency	Contact	Title
NAVFAC SW 1455 Frazee Rd, Ste 900 San Diego, CA 92108-4310	Ms. Melanie Kito (619) 532-0787	Lead Remedial Project Manager
NAVFAC SW 1455 Frazee Rd, Ste 900 San Diego, CA 92108-4310	Ms. Sarah Koppel (619) 532-0962	Remedial Project Manager
BRAC PMOW 410 Palm Ave. Building 1, Ste 161 San Francisco, CA 94108	Ms. Mike Mentink (415) 559-9851	Caretaker Support Officer
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TN&A 317 East Main St. Ventura, CA 93001	Ms. Ewelina Mutkowska (805) 585-6391	Project QC Officer
TN&A 3150 Hilltop Mall Road, Suite 55 Richmond, CA 94806	Mr. Ray O'Connor (919) 523-1136	Field Team Leader and On-site Safety and Health Officer

An updated project organization chart is provided in Figure 1.

3.0 SAMPLING AND ANALYSIS MODIFICATIONS

This section describes proposed modifications to soil vapor sampling media, field quality control sample collection requirements and data validation requirements.

3.1 SOIL VAPOR SAMPLE COLLECTION MEDIA

For soil vapor sample collection batch-certified clean Summa™ canisters are proposed to replace Tedlar bags proposed in the Final SAP (TtEC, 2006a). This modification will ensure better surface inertness, longer holding time (14 days instead of 72 hrs), ruggedness during sample handling and shipping, and no need to use pump for sample collection. In addition, in order to achieve SAP-required reporting limits for soil vapor Volatile Organic Compounds (VOCs) results ranging from 0.2 to 1.0 ppbv samples need to be collected using Summa™ canisters. Soil vapor samples will be collected following TN&A's Standard Operating Practice No. TNFLD009A "Soil Gas Sampling Using Extraction Methods" provided in Appendix A.

3.2 FIELD QUALITY CONTROL SAMPLES

Field QA/QC requirements will apply to the site-specific COCs included on the analyte list of VOCs by EPA Method 8260B. In accordance with the Final SAP (TtEC, 2006), field QC samples for groundwater VOC analysis will consists of field duplicates and trip blanks collected at the frequency specified in the Final SAP.

Field QC samples are not proposed for other water analyses because of the screening nature of the data. Collection and analysis of matrix spike and matrix spike duplicates for all applicable water analysis will provide sufficient precision information to meet project-specific DQOs. Groundwater samples will be collected using well-dedicated or disposable equipment and therefore no equipment blanks are anticipated.

3.3 DATA VALIDATION REQUIREMENTS

In accordance with Environmental Work Instructions (EWIs) # 1 (NAVFACSW, 2001), third-party data validation is not required for screening pilot test data and therefore groundwater and soil vapor data will not be validated for the treatability study at RU-C1.

In accordance with Final SAP (TtEC, 2006a), laboratory personnel will conduct data review including analyst review, peer review, technical review, management review, and QA review. In addition, field and laboratory data will undergo verification (Step 1) process.

4.0 REFERENCES

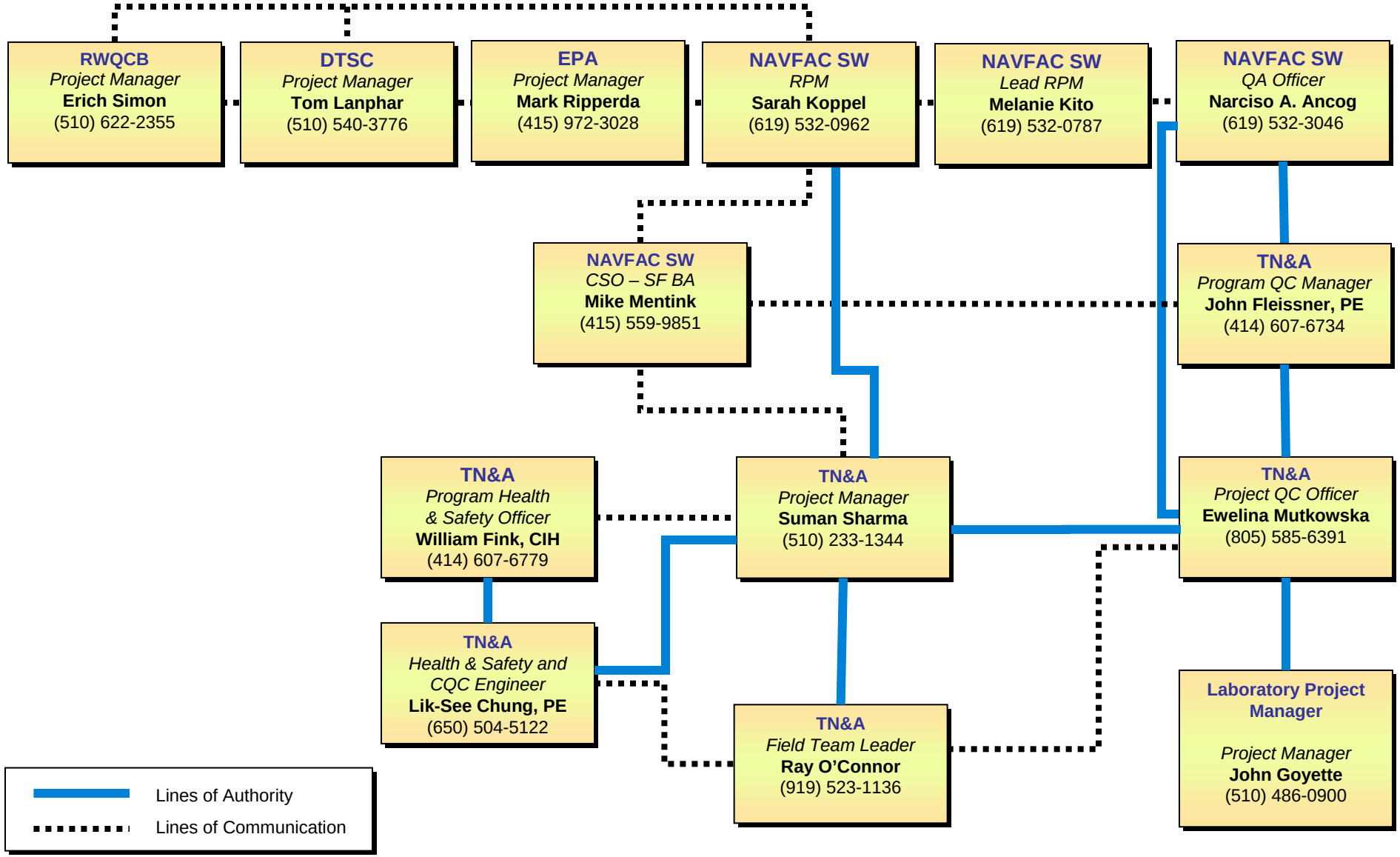
Naval Facilities Engineering Command Southwest. 2001. Environmental Work Instruction 3EN2.1, Chemical Data Validation. November.

Tetra Tech EC, Inc. (TtEC). 2006a. Final Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) for Treatability Study for Various Organic Compounds at Remedial Unit – C1, Building 253, Hunters Point Shipyard, San Francisco, California. DCN: ECSD-RACIV-06-0340. 11 October.

TtEC. 2006b. Final Work Plan for Treatability Study for Various Organic Compounds at Remedial Unit – C1, Building 253, Hunters Point Shipyard, San Francisco, California. DCN: ECSD-RACIV-06-0341. 13 October.

FIGURE

FIGURE 1
Project Organization Chart



TABLE

TABLE 1
IMPLEMENTATION SCHEDULE
Treatability Study for Various Organic Compounds at Remedial Unit – C1, Building 253
Hunters Point Shipyard, San Francisco, California

Task	Start Date	End Date	Duration [a]
Internal Draft Addendum 01 to Final SAP (FSP/QAPP)	30-Oct-08	24-Nov-08	25
Navy review of Internal Draft Addendum 01 to Final SAP	25-Nov-08	09-Dec-08	14
Prepare RTCs for Internal Draft Addendum 01 to Final SAP review comments	09-Dec-08	10-Dec-08	2
Navy review of RTCs for Internal Draft Addendum 01 to Final SAP	11-Dec-08	15-Dec-08	4
Prepare and Submit Draft Addendum 01 to Final SAP	15-Dec-08	16-Dec-08	1
Navy and Regulatory Review of Draft Addendum 01 to Final SAP	20-Feb-09	22-Mar-09	30
Prepare RTCs for Draft Addendum 1 to Final SAP Review comments	23-Mar-09	28-Mar-09	5
Navy Review of RTCs for Draft Addendum 1 to Final SAP	29-Mar-09	12-Apr-09	14
Prepare and Submit Final Addendum 1 to Final SAP	12-Apr-09	14-Apr-09	2
Conduct groundwater sampling	TBD	TBD	TBD
Sample analysis	TBD	TBD	TBD
Review and tabulate validated data	TBD	TBD	TBD

Notes:
[a] - Duration in calendar days
TBD - to be determined

Acronyms and Abbreviations:
FSP - Field Sampling Plan
QAPP - Quality Assurance Project Plan
RTCs - response to comments
SAP - Sampling and Analysis Plan

APPENDIX A

Standard Operating Practice No. TNFLD009A

“Soil Gas Sampling Using Extraction Methods”

STANDARD OPERATING PRACTICE TNFLD009A

Soil Gas Sampling Using Extraction Methods

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Table 1 Summary of Possible Causes and Prevention of Bias in Soil Gas Sampling

Attachment

Attachment 1. Soil Gas Sampling Log (example)

QC Review Signatures		
Name/Role	**Signature**	**Date**
John Fleissner, PE Corporate QC Manager	John Fleissner	20 November 2008
Nova Clite, PG Sr. Hydrogeologist	Nova Clite	20 November 2008

STANDARD OPERATING PRACTICE TNFLD009A

Soil Gas Sampling Using Extraction Methods

1.0 INTRODUCTION

1.1 SCOPE AND LIMITATIONS

The objective of this Standard Operating Practice (SOP) is to provide consistent procedures by which active extraction methods for soil gas sampling will be conducted. Active soil gas sampling is performed by withdrawing a volume of soil gas into a sample collection devise for analysis (as compared to a passive device allowed to absorb vapors over a period of time). This SOP includes methods to collect samples into a vacuum canister, sampling using a gas pump and Tedlar bag®, and packaging and shipping samples. A primary source for this SOP is the "*Standard Guide for Soil Gas Monitoring in the Vadose Zone*" of the American Society for Testing and Materials [ASTM, D5314-92(2006)]. Additional guidance and references are provided in the reference section.

The scope of this SOP is limited to soil gas sampling performed for vadose zone investigative or remedial action monitoring purposes, with samples collected from installed probes or wells using a vacuum canister or a gas pump discharging into a Tedlar® bag. This SOP does not cover the use of syringe type chemical detector devices.

1.2 SOIL GAS SURVEY

Soil gas surveys are most commonly used for sites to provide an indirect indicator of the presence of volatile organic compounds (VOC) in the subsurface. The effectiveness of this method for site characterization is dependent on the subsurface geology and conditions (e.g., porosity, preferential flow paths, and soil pore moisture), chemical and physical characteristics of the contaminants of concern (partition coefficient, volatility), climatic and seasonal influences (e.g., vadose zone temperature, frost), and sampling procedures. Soil gas sampling is a versatile, minimally intrusive, rapid, and relatively inexpensive method for evaluating volatile contaminants in the subsurface.

Limitations of soil gas sampling include: non-repeatable, semi-quantitative only, can not verify presence or absence of subsurface contaminants, and strong dependency on geological variation that can not be observed from the surface. Soil gas sampling is generally ineffective when soil moisture is above 80 to 90 percent saturation because of the lack of connected air-filled pores. With proper planning, knowledge of the applicability and limitations of the approach, active soil gas sampling can provide useful initial data in a phased site characterization.

1.3 SOIL GAS MONITORING

Soil gas monitoring is performed as part of a remedial action to determine soil vapor extraction system efficiency and performance. Generally, sampling locations and monitoring frequency for a soil gas monitoring program is established in the site-specific sampling and analysis plan (SAP) and/or long-term monitoring program plan.

2.0 SOIL GAS SURVEY SAMPLE METHODOLOGY

In general, a soil gas survey is performed by advancing a soil boring, probe, or installing a well into the vadose zone with subsequent collection of a vapor sample into a collection device under a vacuum. (TN&A SOPs TNFLD007A and 007D cover various drilling techniques that can be used for vadose zone investigations.)

Vadose zone sampling is usually performed via a sample port that is pushed directly into the ground or inserted through drill rod or pipe. Soil gas is drawn by vacuum through the port or screen through plastic (primarily polyethylene or Teflon™) tubing and into a collection vessel, such as a Summa® Canister, PUF cartridge, Tedlar™ bag, or syringe. The sampling locations are defined in the SAP. Upon retrieval, the sampling devices are immediately analyzed in the field or submitted for laboratory analysis of project-specific parameters. The resulting data may be plotted using a contouring program such as Surfer. The graphical displays of the data are used for field decision-making or to develop the next phase of investigative activities, such as subsurface soil, well installation, and groundwater sampling.

2.1 SOIL GAS SURVEY DOCUMENTATION

Sample grids and other sampling locations should be GPS surveyed, marked on a to-scale site plan, and/or sketched into the logbook, including distance between points, and distance to reference points. Other sampling records should include the identifying number of the sample device (if applicable), date and time deployed, and date and time to be retrieved.

Field personnel collecting descriptive data should remain the same and not be changed during a soil gas survey. Soil descriptions, for example, can be somewhat subjective when estimations are made as to soil moisture or soil texture. Changes in field personnel can translate into apparent changes in soil lithology that are merely functions of this subjectivity. The Field Team Leader can review field records to discover any obvious errors related to descriptive data.

Field personnel must follow the procedure in SOP No. TNFLD007B for proper characterization and logging of soils and shall use a Soil Gas Sampling Log. The soil types encountered will be classified and described based upon the Unified Soil Classification System (USCS) and standard practices developed by the American Society for Testing and Materials (ASTM), as detailed in SOP No. TNFLD007B.

2.2 FIELD QA/QC

Soil gas survey results and data quality are highly sensitive to field procedure; therefore, it is essential that field personnel consistently adhere to the SAP and this SOP for conducting the soil gas survey. Any deviations from the SOP should recorded by the Field Team Leader in a field logbook, with notes outlining the justification for the deviation.

Bias of soil gas data describes a situation of consistently lower-than-actual or higher-than-actual soil gas contaminant concentration measurements (Mayer, C. L., September 1989). Table 1 summarizes some common problems in soil gas monitoring that create biased results as well as procedures for avoiding sample bias.

2.3 MATERIALS

Soil gas sampling materials to be used include:

- Field logbooks,
- Pens, containing indelible waterproof ink,
- Hand auger, or auger drill with 1½ inch auger, or direct push rig,
- Leather or fabric gloves for auger advancement,
- Munsell soil color chart,
- Soil Gas Sampling Logs,
- Retractable steel tape with increments in 10ths and 100ths of feet, or measuring wheel,
- Latex gloves,
- Polyethylene or Teflon™ tubing for each sampling location,
- Sample containers and sampling equipment,
- Shipping boxes or coolers or onsite instrumentation such as portable PID/FID detectors, gas chromatography (GC) or GC mass spectroscopy (GC/MS), and
- Chain-of-custody forms.

3.0 SOIL GAS SAMPLING METHODS

The following sampling methods are general approaches that may need to be tailored to meet site conditions, SAP requirements, or state guidance [see for example, California Regional Water Quality Control Board – Los Angeles Region *Interim Guidance for Active Soil Gas Investigations* (LARWQCB, 1997) and subsequent Supplemental Recommendations issued jointly with the California Department of Toxic Substances Control (DTSC-LARWQCB, 2003)]

3.1 METHODS FOR DPT AND HSA VAPOR SAMPLING

Soil gas sampling may be performed using direct push techniques (DPT), hollow-stem auger (HSA) drilling rig, or other methods to advance a soil gas sampling probe (e.g. slam bar, hydraulic hammer).

3.1.1 Method for Direct Push Techniques

There are three types of Direct Push (e.g., Geoprobe®) sampling tools that can be used for sampling soil gas: (1) sampling through probe rods using an expendable point, (2) sampling through probe rods using a retractable point, and (3) sampling through inner tubing using the post-run tubing (PRT) system. The PRT system is the preferred sampling method for the following reasons:

- Increases speed and accuracy of soil gas sampling,
- Eliminates problems associated with rod leakage and sample carryover (preserves sample integrity),
- Reduces the probe rod decontamination time,
- Uses a simple design for ease of use and vacuum-tight sealing, and
- Requires no management of inner tubing during probing.

Vertical profiling consists of collecting soil gas samples from various depths at a single location. The depth of the soil gas sample with the most significant response will indicate the optimum soil sampling depth. Vertical profiling should generally be done at a number of locations during the soil gas survey to assess the variability of contaminants in the vadose zone. Knowledge of the subsurface lithology can also assist in determining the optimum depth to collect soil gas samples. New tubing must be used for each sample.

The following section describes the primary steps that must be followed when sampling soil gas using the PRT method:

1. Decontaminate all parts before use following the decontamination procedures outlined in SOP TNFLD011A.
2. Install O-rings on the expendable point holder and the PRT adapter.
3. Check the probe rods for any obstructions and test fit the adapter with the PRT fittings on the expendable point holder.
4. Connect the adapter to the end of the tubing; secure with Teflon tape, if necessary.
5. Drive the PRT tip configuration into the ground. Connect probe rods as necessary to reach the desired depth.
6. Disengage the expendable point by pulling the probe rods up approximately 1-foot (ft) when the desired depth is reached. Remove the push cap from the top probe rod.
7. Insert the adapter end of the tubing inside the probe rods.
8. Push the evacuation tubing down the probe rods until it reaches the bottom. Leave 2-feet (ft) of tubing extending out of the top of the probe rods.

9. Twist the tubing in a **counterclockwise** direction until the adapter threads have threaded into the expendable point holder. Check the connection by pulling up lightly on the tubing.
10. Connect the evacuation tubing and the in-line glass bulb or stainless steel canister to the vacuum pump system.
11. Purge the tubing and glass soil gas bulb or stainless steel canister by pumping at least three probe rod and canister volumes before collecting a sample. The gas flow rates will be monitored with a ball-type flow meter attached to the exit port of the vacuum pump.
12. Close the stopcocks in the glass bulb or stainless steel canister.
13. If the soil gas sample is collected with a syringe, puncture a silicon rubber segment in the evacuation line.
14. If the soil does not yield vapor to the applied vacuum, either pull the probe rod back farther from the tip or apply a greater vacuum pressure.
15. After collecting a sample, pull up firmly on the tubing until it releases from the PRT adapter. Remove the tubing from the probe rods and dispose.
16. Retrieve the probe rods from the ground. Visually inspect the O-ring at the base of the PRT to verify a proper seal was achieved.
17. When sampling is completed (and borehole will not be converted to well), properly abandon the hole. Patch paved surfaces were necessary.
18. Mark sample location for later survey.

3.1.2 Method for Hollow-Stem Auger Advanced Holes

Hollow-stem auger (HSA) drilling techniques can be used with Post Run Tubing (PRT) System tools to collect soil vapor samples out ahead of the drill bit. Dedicated tubing should be used for each sample. The PRT stainless steel sampling probe must be thoroughly decontaminated between each re-use.

1. Advance the borehole to approximately one foot above the desired sampling depth. Advance the reusable stainless-steel vapor probe tool by static pressure or hammering into the soil to at least one foot below the drill bit.
2. Purge the tubing and probe tool using an air pump; calculate the tubing and probe tool volume and evacuate 7 times that volume. Flow rate for the purging and total purge time must be recorded on the Soil Gas Sampling Log.
3. After purge, collect the gas sample. Again, the sample collection flow rate, total sample time must be recorded along with other sampling information. Purge and sample flow rates provide additional valuable information on local formation gas permeability.

4. Collect the sample into a Summa® Canister, PUF cartridge, Tedlar™ bag, or syringe. For soil gas surveys a Teflon®-lined syringe is typically used with mobile laboratory or field screening (e.g. photoionization detector) to obtain real-time data.
5. To reduce the potential for cross-connection of the soil vapor sample with atmosphere (especially for sandy soils), a 2 – 3 inch thick bentonite seal may be placed at the bottom of the augers after the PRT is pushed ahead of the drill bit. Wait 20 minutes to allow the seal to setup prior to collecting the sample.
6. Atmospheric breakthrough into the sampling stream may be tested by placing a sponge soaked in isopropanol at the bottom of the hollow-stem auger (ensure that the laboratory tests for isopropanol as part of the VOC analysis). Attach a string to the sponge so that the sponge can be retrieved prior to continuing drilling.
7. When sampling is completed (and borehole will not be converted to well), properly abandon the hole. Patch paved surfaces were necessary.
8. Mark sample location for later survey.

3.2 METHOD FOR GAS WELL SAMPLING

When sampling from an existing gas monitoring or vent well, the well head should be equipped with a gas sample port.

1. Calculate purge volumes of gas well; purge the well to ensure representative soil gas is in the well for sampling. Purge rates and volumes should be established in the SAP considering local geologic conditions, data quality objectives, and other factors (state guidelines, analytical requirements, etc.).
2. Connect clean tubing between the sample port and sampling device (Summa® Canister, PUF cartridge, Tedlar™ bag, or syringe).
3. Collect sample at sampling flow rate prescribed in SAP.
4. Record the date and beginning and end times of sampling, purge rates and volumes, and sampling device number (if applicable) in the logbook or on sampling form
5. Record beginning and ending pressures in sampling canister (See Section 3.3)

3.3 SUMMA® CANISTER INSTALLATION AND RETRIEVAL PROCEDURE

The following is a general method use of Summa® Canisters, which use vacuum to extract a gas sample. Summa Canisters are stainless steel canisters [generally 1 liter (L) or 6 L volume] that are shipped from the laboratory under high vacuum. Prior to shipment that canisters are leak-checked and batch certified to be free of contaminants.

The vacuum canister can be used to collect a grab sample (sample collected all at one time) or an "integrated sample" that is collected over a pre-determined period of time. Refer to TNFLD

Before going into the field for gas sample collection:

1. Verify contents of the shipped package (e.g., chain of custody form, canister, particulate filter, and gauge – if requested)
2. Verify that gauge is working properly (if indicator does not read "zero" upon arrival, the gauge either needs to equilibrate or the gauge may be damaged and unusable. Equilibrate the gauge by "cracking" the rubber plug on top of the gauge. Instructions should be included with the gauge; contact canister provider if necessary.
3. Verify and record initial vacuum of canister (vacuum should be approximately 30 inches of Hg; a potential leak is evident if vacuum shows less than 28 inches).

When ready to sample (after any required pre-sample purging is completed):

4. Remove brass cap from canister
5. Fit the canister inlet valve with a pre-cleaned stainless steel particulate filter or regulator then attach the tee fitting in the sampling line ahead of the purge pump
6. Attach the canister to the sampling line
7. Open the main valve to draw a sample into the container. Draw the sample in slowly (use of a regulator and regulator settings are pre-determined and should be in SAP)
8. After approximately one minute (when no audible sound of rushing gas can be heard) or when regulated time period is finished, close the main valve and replace the nut
9. Complete the pre-numbered sample tag and tie it to the handle of the Summa canister
10. Complete the chain-of-custody record, relinquish properly; place form in shipping container.
11. Plan canister, particulate filter, and gauge in packaging provided (no ice is necessary); tape properly for shipping; place custody seal across top flap of box (if applicable)
12. Ship accordingly to meet method holding times (refer to project-specific SAP).

3.4 CARTRIDGE SAMPLE DEVICE INSTALLATION AND RETRIEVAL PROCEDURE

A cartridge sampling device is commonly used for personal air monitoring sampling to document atmospheric contaminants in a work zone. These procedures describe the sampling of a variety of semivolatile organic compounds. A low volume (1 to 5 L/minute) sampler is used to collect vapors on a sorbent cartridge containing PUF or PUF in combination with another solid sorbent, such as XAD resin or Tenax™-TA. SVOCs are extracted from the sorbent cartridge and analyzed as described in EPA Method TO-13.

The low volume PUF sampling procedure is applicable to multi-component environments containing SVOC concentrations from 0.01 to 100 $\mu g/m^3$ over 4- to 24-hour sampling periods.

The limits of detection will depend on the nature of the analyte, sampling flow rate, and the length of the sampling period.

The following equipment and materials are needed for sampling:

- Continuous-Flow Sampling Pump. The pump should provide a constant air flow (±5%), be quiet and unobtrusive, with a flow rate capability of 1 to 5 L/minute. Calibrate the pump each morning before use, following manufacturer's instructions.
- Sampling Cartridge. Certified clean cartridges should be obtained by the designate laboratory. Cartridges should be left unopened in the protective baggie and aluminum foil until ready for sampling.
- Flow Meter. The flow meter should be able to measure flow rate from 1 – 5 L/minute. Typically, a bubble flow cell-type meter is used.

The following procedure will be used to sample soil gas with cartridges:

1. Carefully remove the clean sample cartridge from the aluminum foil wrapping (the foil is returned to baggies for later use). Attached the pump to the sampling port with flexible tubing.
2. Connect the opened sorbent tube to a calibrated personal sampling pump using flexible tubing, with the smaller sorbent section nearer to the pump. Position the sorbent tube vertically during sampling to avoid channeling and premature breakthrough.
3. Prepare any field blanks at about the same time as sampling is begun. These field blanks should consist of unused sorbent tubes from the same lot used for sample collection. Handle and ship the field blanks exactly as the samples but do not draw air through the field blanks. The field blanks should be placed at the sample location for the entire sampling period.
4. After the PUF cartridge is correctly inserted and positioned, the power switch is turned on and sampling begins. The elapsed time meter is activated and the start time is recorded. The pumps are checked during the sampling process and any abnormal conditions discovered are recorded in the logbook.
5. Collect the sample at the known air flow rate for predetermined sampling time. Check the pump during sampling to determine that the flow rate has not changed. If sampling problems preclude the accurate measurement of air volume, discard the sample.
6. Record pertinent sampling data including location of sample, time of beginning and end of sampling, initial and final air temperatures, relative humidity, and atmospheric pressure at elevation above sea level.
7. At the end of the desired sampling period, the power is turned off, the PUF cartridge removed from the sampler and wrapped with the original aluminum foil and placed in a resealable, labeled plastic baggie (e.g., Ziplock®) for transport. Using the bubble

meter, determine the Stop flow rate for each pump. Label each sample and field blank clearly, and place the label on the resealable baggie (not on the cartridge itself).

8. Pack the tubes tightly with ice and adequate padding to minimize breakage. Deliver to laboratory or place in on-site laboratory refrigerator for analysis.
9. Logbook notes should include duration of sampling (minutes) and average flow rate (LPM). The average flow rate is the Start flow rate plus the Stop flow rate divided by two. Determine the air volume (liters) of each pump for the sampling period:

$$Air\ volume(Liters) = Average\ flow\ rate(LPM) * Duration\ of\ sampling(Minutes).$$

3.5 TEDLAR BAG SAMPLE INSTALLATION AND RETRIEVAL PROCEDURE

A Tedlar bag should be used for collecting a whole air sampling where results will be reported at parts per million per volume (ppmv); in other words, for anticipated relatively high concentrations in gas. Tedlars are useful for soil or landfill gas surveys, monitoring soil vapor extraction (SVE) systems, and sampling for atmospheric/fixed gas parameters (as in a monitoring program for natural attenuation). Ambient and indoor air projects, or site closure samples, driven by risk assessment and other regulatory requirements are better served by using Summa® Canisters. The project-specific SAP should define the sampling container to be used.

Limitations:
Holding time for a sample collected in a Tedlar bag is more limited than for a Summa: 3 days for chlorinated solvents, aromatic compounds, and atmospheric/fixed gases (oxygen, nitrogen, carbon dioxide); 1 day for sulfur compounds. Tedlars are not appropriate containers for dangerous gases such as explosives, radiological or biological agents, corrosives, or extremely hazardous materials. Follow SAP for proper sample containers.

Required equipment:

- Sampling pump with low flow rates (50-200 ml) and tubing
- Alternative to sampling pump: “lung” sampler in which uses a small airtight chamber to create a vacuum around the Tedlar, causing it to fill from the sample source. Tubing is attached from the Tedlar to the sample source with tubing protruding from the chamber. The sealed chamber is then evacuated with a pump causing the bag to expand and drawing the sample through the protruding tube into the bag. The sample air never touches the air pump, thereby avoiding cross-contamination.
- Sample shipping containers
- Chain-of-custody forms, field logs, etc.

Before going to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, Tedlar bag, tubing/fittings (if requested from Tedlar supplier)
2. Check tubing and fittings with Tedlar and pump
3. Verify pump is properly decontaminated (if used to draw sample directly)

When ready to sample:

4. Perform any required pre-sample purging (refer to project-specific SAP), at minimum purge the sample port and one well-volume. Comply with sample purge rates.
5. Attach new Teflon tubing from sample port or probe to low-flow rate pump (or if using lung chamber, reusable tubing from pump to chamber is acceptable)
6. Fill out Tedlar bag sample tag
7. Attach addition new Teflon tubing from pump outlet to the Tedlar bag valve (of if using lung chamber, attach new Teflon tubing from Tedlar bag directly to sample port and place Tedlar bag into airtight chamber).
8. Open Tedlar bag valve (consider filling more than one Tedlar in case one is damaged); run air pump to generate the sample
9. Collect sample (FILL NO MORE THAN 2/3 FULL)
10. Close Tedlar bag valve by hand tightening valve clockwise
11. Protect the Tedlar bags - keep out of direct sunlight, keep away from sharp tools, well casings, etc.
12. Return Tedlar bag in boxes provided (DO NOT CHILL)
13. Fill out chain-of-custody form, properly relinquish, place form in shipping box (retain pink copy)
14. Tape box shut and affix custody seal (if used) across flap
15. SHIP PRIORITY OVERNIGHT TO MEET 3 DAY HOLDING TIME (most analyses).

4.0 REFERENCES

Air Toxics, LTD. Guide to Air Sampling and Analysis, Canisters and Tedlar Bags, 4th Edition. Available at www.airtoxics.com

ASTM, D5314-92(2006) "*Standard Guide for Soil Gas Monitoring in the Vadose Zone*"

U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, *Expedited Site Assessment Tools for Underground Storage Tank Sites, A Guide for Regulators,* EPA 510-B-97-001, March 1997, Chapter IV, ("Soil Gas Surveys").

Table 1.
Summary of Possible Causes and Prevention of Bias in Soil Gas Sampling

Result	Possible Cause	Prevention
False Negatives, that is, falsely low values	Barrier to gaseous diffusion, such as perched water, clay lenses, impervious man-made debris	Prior knowledge of site geology and subsurface characteristics. Selection of proper sampling methodology (*e.g.*, active vs. passive soil gas sampling).
	Saturation of soil pores with water (as from rain), low subsurface temperatures	Consideration of climate and seasonal effects during planning stages.
	Biological or chemical degradation of sampled constituents	Proper sample handling, packaging, express shipment to laboratory, meeting holding times.
	Problem with analytical system	Proper laboratory QA/QC, data validation procedures
False Negative or False Positive	Contamination in sampling train, sample container.	Minimize exposure of sample containers to ambient conditions before installation and after retrieval. Keep potential sources of organic vapors (petroleum fueled motors, marker pens, cleaning solutions, insect repellents, etc.) away from the sampling area and in down-wind direction. Strict adherence to equipment decontamination procedures.
False Positives, that is, falsely high values	Contamination of the analytical system	Proper laboratory QA/QC, use of trip and laboratory blanks, data validation procedures.
	Contribution of volatile organic contaminants from vegetal decomposition	Minimize exposure of sample containers to ambient conditions before installation and after retrieval.
	Significant contamination in overlying soil	Proper planning based on knowledge of site; adjust sampling grid if observed soil conditions indicate significant contamination.

ATTACHMENT 1

SOIL GAS SAMPLING LOG (Example)				
Site:		Client:		
Project ID:		Samplers:		
Sample Equipment:			Weather:	
Sample Location	**Purge Volume**	**Purge Rate:**	**Sample Start Time:**	**Sample End Time:**