

SOIL GAS MONITORING WORK PLAN

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PLAN**

**SOUTHERN CALIFORNIA GAS
COMPANY
PLAYA DEL REY STORAGE
FACILITY
PLAYA DEL REY, CALIFORNIA**

Prepared for

Southern California Gas Company
8141 Gulana Avenue
Playa Del Rey, California 90293-7930

29868671.10000
June 3, 2009



URS Corporation
2020 East First Street, Suite 400
Santa Ana, California 92705

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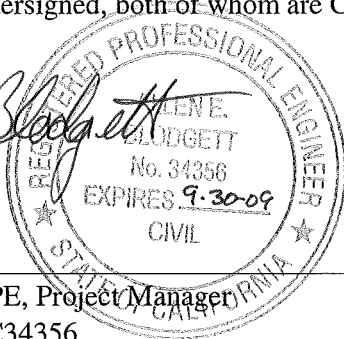
By:

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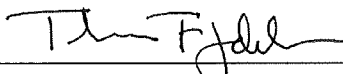
This Soil Gas Monitoring Work Plan for the Southern California Gas Company Playa Del Rey Storage Facility located at 8141 Gulana Avenue in the City of Playa Del Rey was prepared by URS on behalf of the Southern California Gas Company in a manner consistent with the level of care and skill ordinarily exercised by professional engineers, geologists, and environmental scientists. This workplan was prepared by the undersigned, both of whom are California registered professionals.

URS Corporation

Allen E. Blodgett, PE, Project Manager
California PE No. C34356

6/2/09
Date



Tom Zdeb, PG, CIH, Senior Scientist
California PG No. 7916

6/2/09
Date

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Playa Del Rey Storage Facility, Playa Del Rey, CA**

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ACRONYMS

ASTM	American Society for Testing and Materials
bgs	Below ground surface
CPUC	California Public Utilities Commission
DOT	Department of Transportation
DTSC	Department of Toxic Substances Control
EPA	Environmental Protection Agency
Facility	Playa Del Rey Storage Facility
ft	Feet
GPR	Ground penetrating radar
Hg	Mercury
HSP	Health and Safety Plan
ID	Identification
mL	Milliliter
PPE	Personal protective equipment
ppmv	Parts per million by volume
PRT	Post run tubing
pv	Purge volume
PVC	Polyvinyl chloride
QC	Quality control
RWQCB	Regional Water Quality Control Board
SoCalGas	Southern California Gas Company
URS	URS Corporation
USA	Underground Service Alert
VOCs	Volatile organic compounds

1.0 INTRODUCTION

URS Corporation (URS) has prepared this Soil Gas Monitoring Program Work Plan (Work Plan) on behalf of the Southern California Gas Company (SoCalGas), a Sempra Energy Utility, to provide information pertaining to the proposed soil gas monitoring program for the Playa Del Rey Storage Facility (Facility) located in Playa Del Rey, California. The location of the primary area of the Facility is shown on Figure 1.

The purpose of this work plan is to present proposed soil gas exploration activities, sample collection locations, sample collection methodologies, and sample analyses to evaluate for the potential presence and nature of any natural gas in subsurface soil vapor at the Facility.

The scope of work that has been developed to meet these objectives is summarized below:

- ◆ Prepare a site specific Health and Safety Plan (HSP) for field operations to be conducted at the Facility;
- ◆ Soil gas sampling at a depth of four feet below ground surface (bgs);
- ◆ Analysis of soil gas samples using a mobile laboratory;
- ◆ Collect a second set of soil gas samples at depths of 5, 10, and 20 feet bgs;
- ◆ Analysis of phase two soil gas samples by mobile and possibly fixed laboratories; and
- ◆ Prepare reports summarizing the soil gas sampling activities and sample analyses with conclusions and recommendations.

The soil gas monitoring program will be performed under the direct responsible supervision of Mr. Allen E. Blodgett, P.E., and Mr. Tom Zdeb, P.G., C.I.H., with URS. Mr. Blodgett is licensed as a civil engineer in the state of California and has over 20 years of directly applicable experience in the environmental field. Mr. Zdeb is licensed as a professional geologist and certified industrial hygienist in the state of California and has over 20 years of directly applicable experience in the environmental field. Technical documents produced by URS will be signed and sealed by Mr. Blodgett and Mr. Zdeb.

The Facility background, location and description, and a discussion of proposed sampling and analysis methodologies are presented in the following sections.

1.1 BACKGROUND

The Facility is located at 8141 Gulana Avenue in Playa Del Rey, California (Figure 1). The geographic area where the Facility is located spans the Ballona Wetlands, which are at an elevation near sea level, and a bluff located on the south side of the wetlands. The top of the bluff is at an approximate elevation of 150 ft mean sea level. The Facility is a natural gas storage field consisting of a compressor plant (located at the top of the bluff), a tank farm (located at the toe of the bluff), a number of injection and extraction well sites that are located outside of the primary areas of the Facility, and the storage field which is located in a sandstone formation at a depth of approximately 6,100 feet bgs. The approximate

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boundaries of the storage field extend beyond the property lines of the ground surface footprint of the Facility (i.e., the compressor plant and tank farm). The approximate boundaries of the storage field are from Marquesa Way to Mindanao Way on the north, along 92nd Street on the south, along Park Hill Drive from 92nd Street north through State owned lands on the east, and the Pacific Ocean on the west (Figure 2). The Playa Del Rey storage field was originally an oil field that produced during the 1930s. In 1942, after oil production had dropped due to decreasing pressure in the geologic formation, the US government initiated underground storage of natural gas. SoCalGas purchased the Facility in 1955, and continues to operate it today. The Facility possesses 57 wells which are used for various functions: injection/withdrawal of gas, fluid production, brine injection, and reservoir observation. Three compressors are used to inject the gas underground.

On December 20, 2007, the California Public Utilities Commission (CPUC) approved a settlement agreement of complaint cases relating to the Facility. As part of this settlement agreement, SoCalGas agreed to have a soil gas monitoring program performed. The soil gas monitoring program SoCalGas proposes to implement in response to that agreement is described below.

1.2 WORK PLAN ORGANIZATION

The proposed scope of work for the soil gas monitoring activities is presented in this Work Plan which has been organized into the following sections:

Section 1.0	Introduction
Section 2.0	Work Plan
Section 3.0	Reporting
Section 4.0	Schedule
Section 5.0	References

2.0 WORK PLAN

The objective of the proposed work is to evaluate the potential presence of methane naturally occurring from local sources (e.g., biodegradation of organic material) or processed natural gas. Processed natural gas is primarily methane, but has components (e.g., helium and light hydrocarbons) which are not found in methane occurring from biogenic sources.

For methane, delta ^{13}C normally refers to the ratio of ^{13}C (isotopic carbon) to ^{12}C (normal carbon) which in general occurs at a ratio of approximately 1 to 100. This ratio, however, varies according to the origin of the methane since living organisms tend to have an affinity for retaining ^{13}C when respired or metabolized. The result is that the concentration of ^{13}C is measurably lower in methane derived from the metabolism of living organisms versus methane obtained from thermal breakdown of buried hydrocarbons (i.e., natural gas) where the latter ratio is generally measurably higher.

In a somewhat related manner, the amount of another isotope of carbon, ^{14}C , may be used to evaluate the approximate age of a hydrocarbon such as methane. This is based on the fact that ^{14}C is radioactive with a half life of approximately 7,500 years. ^{14}C is pervasive in the environment and all organisms tend to accumulate it and, to a slightly lesser extent, emit it as a byproduct of metabolism. Thus tissues of living organisms and the methane they generate contain measureable amounts of ^{14}C . When an organism dies, the accumulation process ends and after about 50,000 years the radioactive decay process reduces all the ^{14}C present in the organism to ^{12}C . Thus methane generated from thermally degraded hydrocarbon that is essentially composed of organisms that died long ago, has little or no measurable ^{14}C component. This allows ^{14}C to be used to differentiate methane generated from current sources (biogenic methane) from those that are approximately 50,000 years or more in age (thermogenic or petroleum sources).

This work consists of collecting and analyzing soil gas samples to evaluate the presence and concentration of methane or processed natural gas in soils around the Facility components.

2.1 INVESTIGATION ACTIVITIES

The soil vapor sampling program will be performed under the direct supervision of Allen Blodgett, a registered California Professional Engineer, and Tom Zdeb, a registered California Professional Geologist and Certified Industrial Hygienist. A description of the proposed exploration methods proposed is presented below.

2.1.1 Health and Safety Plan

Pursuant to Health and Safety Code 1910.120, URS prepared a Site-specific Health & Safety Plan (HSP) for field operations to be conducted at the Facility.

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The HSP:

- ◆ Identifies and describes potentially hazardous materials that may be encountered during field operations;
- ◆ Specifies personal protective equipment (PPE) and clothing for onsite activities; and
- ◆ Outlines measures that will be implemented in the event of an emergency.

URS field personnel and onsite subcontractors will review requirements of the HSP and sign an acknowledgment form prior to commencing field work.

2.1.2 Utility Clearance

Underground Services Alert (USA) will be notified of our intent to conduct subsurface explorations at least 48 hours prior to initiation of intrusive field tasks. Proposed locations of subsurface exploration will be clearly marked with white paint or surveyors flagging as required by USA. USA will contact utility owners of record within the vicinity and notify them of our intention to conduct subsurface explorations in proximity to buried utilities. The utility owners of record, or their designated agents, will be expected to clearly mark the position of their utilities on the ground surface throughout the area designated for exploration. In addition, the proposed probe locations will be reviewed in the field with representatives of the Facility to help identify conflicts with subsurface utilities and structures.

In the exploration areas where the presence of underground services or utilities is unclear or unknown, surface geophysics will be used in an effort to identify subsurface lines and obstructions. Geophysical methods may include magnetic, electromagnetic, and ground penetrating radar (GPR) line location.

2.1.3 General Scope and Order of Site Explorations

The general scope and order of the proposed explorations for characterization of the soil gas conditions at the Facility are as follows. Each exploration activity is described in detail in the following sections.

- ◆ Perform a soil gas survey at a depth of 4 feet (ft) bgs. Soil gas probes will be installed at approximately 150 locations. The approximate locations are shown on the figures presented in Appendix A. Soil gas probes will be installed and sampled in accordance with the January 2003 *Advisory for Active Soil Gas Investigations*, (Appendix B) issued jointly by the California Department of Toxic Substances Control (DTSC) and Regional Water Quality Control Board (RWQCB). Soil gas samples will be analyzed for C1-C6+ hydrocarbons following United States Environmental Protection Agency (EPA) Method 8015(M) in a mobile analytical laboratory.
- ◆ Provide a report of the results of the first phase of soil gas sampling, including recommendations for the proposed second phase of sampling.
- ◆ Perform a second phase of soil gas sampling at depths of 5, 10, and 20 ft bgs. Soil gas probes will be installed at up to 25 locations. The locations of these probes will be selected based on the results of the first phase of soil gas sampling. Gas pressure will be measured in each equilibrated probe prior to sampling. Soil gas samples will then be collected from each probe. Samples to be analyzed by the mobile lab will be collected in 125 milliliter (ml) glass sample bulbs. Samples to be analyzed in fixed laboratories will be collected in Tedlar bags or proprietary containers

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supplied by the laboratory performing the isotopic analyses. The samples will be analyzed for C1-C6+ straight chain hydrocarbons along with ethene, propene, and isobutane following EPA Method 8015(M) in a mobile analytical laboratory. Except where noted, this suite of compounds will collectively be referred to as C1-C6+ in this workplan. In probes where methane is measured at a concentration in excess of 25,000 parts per million by volume (ppmv), samples will be taken for analyses of aromatic hydrocarbons following Method 8015(M) and for delta ¹³C. In probes where methane is measured at a concentration in excess of 50,000 ppmv, samples will be collected for measurement of the helium concentration. Where methane is measured at a concentration in excess of 250,000 ppmv, samples will be collected for measurement of delta ¹⁴C.

- ◆ Provide a report of the results of the second phase of soil gas sampling.

2.2 SOIL GAS SURVEY

The soil gas survey will be conducted in accordance with the *Advisory for Active Soil Gas Investigations*, DTSC and RWQCB, January 28, 2003. A description of probe installation and sample collection procedures is provided below.

2.2.1 Sample Locations and Depths

Shallow Soil Gas Sample Locations

Approximately 150 soil gas samples will be collected at a depth of 4 ft bgs throughout the Facility and satellite well sites. In general, two soil gas probes will be located at each of the Facility's active well locations. In areas where two or more Facility wells are located in close proximity to each other, fewer soil gas probe locations may be used to be representative of the group of wells. The remaining shallow soil gas probe locations were selected throughout the compressor plant and the tank farm with preference given to neighboring residential parcels. Shallow soil gas probe locations are shown on the figures presented in Appendix A, and the rationale for each probe location is given in Table 1.

5, 10, and 20 Ft bgs Soil Gas Sample Locations

In addition to the 4 ft bgs soil gas samples, soil gas samples will be collected from depths of 5, 10, and 20 ft bgs at up to 25 locations selected based on the results of the 4 ft bgs samples. The exact locations of the multi-depth probes will be proposed in a report summarizing the shallow probe sampling results. Proposed locations will be submitted to SoCalGas for review and approval prior to proceeding with installation.

2.2.2 Shallow Soil Gas Probe Installation

Shallow soil gas probes will be installed using a pneumatic and/or hydraulic drive system. The probe tip design consists of a post-run tubing (PRT) and drop-tip system. The soil gas probes are constructed of 1-inch diameter hardened steel and have a sampling port located at the tip; the sampling port is protected during installation by an expendable tip. This design prevents clogging of the sampling port and cross-contamination from soil during insertion. The probe will be pneumatically and/or hydraulically driven into the ground. After the probe is advanced to a depth of 4 feet bgs, the probe rods will be pulled up

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approximately 6 inches to expose the sampling port to the soil. An inert ¼-inch Teflon® tubing with a threaded tip tube will be inserted down the center of the probe to the sampling port, and the threaded PRT fitting will then be screwed onto the sampling port. After probe installation, hydrated bentonite will be used to seal around the drive rod at the ground surface to prevent ambient air intrusion. After sampling is completed, the probe rods and tubing will be withdrawn from the borehole, and the borehole annulus will be backfilled with hydrated bentonite and capped with material matching the surrounding area.

In the event that water is encountered in a probe during installation, the probe will be abandoned and reinstalled within 3 ft of the original probe location. The reinstalled probe will be set a depth that is 1 ft higher than the original depth. If water is encountered at a depth of 3 ft bgs or less the location will be abandoned and a probe will not be installed at that location. Rather, an alternate location will be selected (using rationale in Section 2.2.1) in coordination with SoCalGas in order to meet the total of 150 probes.

2.2.3 Multi-Depth Soil Gas Probe Installation

The multi-depth soil gas probes will be pneumatically and/or hydraulically advanced to the desired depth (i.e., approximately 5, 10 or 20 ft bgs). The multi-depth soil gas probes will be installed through 1 ½-inch outside diameter hardened steel rods equipped with a drop tip. Once the desired depth is achieved, the steel rods will be retracted slightly leaving behind the drop tip and exposing native formation. A measured section of ¼-inch outside diameter semi-rigid Teflon® tubing (or similar) will be attached to a vapor sampling implant (soil gas probe) constructed of double woven stainless-steel wire screen approximately 6 inches in length. The tubing with vapor sampling implant will be suspended within the steel rods at the desired depth, and granular filter pack material (sand) will be placed around the screen. The soil gas probe will be completed with a hydrated bentonite annular seal and a flush-mount surface completion well vault. Probe installation procedures are provided below.

The soil gas probe construction materials (sand, vapor sampling implant, and granular bentonite) will be installed through the direct-push steel rods (an open boring will be acceptable if continuous depth verification can be obtained using a measuring tape). The filter pack surrounding the vapor sampling implant will consist of #2/12 sand (or similar) introduced into the steel rods to approximately 3 inches above/below the vapor sampling implant. The filter pack will be approximately 12 inches long. Following filter pack placement, small diameter tremie tubing will be inserted into the annular space within the steel rods to assist in water placement for bentonite hydration. The annular seal material will consist of #8 bentonite crumbles (or similar). The bentonite placement will be conducted simultaneously as water is placed through the tremie tubing. The tremie tubing will be retracted slowly allowing a continuous supply of water to hydrate the bentonite annular seal. Bentonite hydration will commence approximately 12 inches above the filter pack, which will leave the lowest portion of bentonite dry.

The procedure described above will be repeated at depths of approximately 5, 10 and 20 ft bgs, utilizing three separate borings. The three borings will be spaced approximately 1 foot apart. The cluster of three probes will be in the shape of a triangle. Each soil gas probe will be labeled for its specific depth. All three soil gas probes will be completed and maintained at the ground surface inside one 18 to 24-inch diameter well vault using rapid-set concrete.

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In the event that water is encountered in a probe during installation, the probe will be abandoned and reinstalled within 3 ft of the original probe location. The reinstalled probe will be set a depth that is 1 ft higher than the original depth. If water is encountered at a depth of 3 ft bgs or less the location will be abandoned and a probe will not be installed at that location.

2.2.4 Soil Gas Sample Collection and Analysis

Purge Testing: To ensure that stagnant or ambient air will be adequately purged from the sampling system prior to sampling, a purge volume versus concentration test will be conducted at the first soil gas probe location. One "purge volume (pv)" will be estimated from a summation of the sample container volume, internal volume of tubing used, and volume of space at the probe tip. The volume of the probe tip and tubing at 4 ft bgs when utilizing 0.25 inch diameter tubing and exposing 6 inches of soil to the PRT is approximately 200 milliliters (mL) for 1 pv, 600 mL for 3 pv, and 1,400 mL for 7 pv. Soil gas samples will be collected in gas-tight sampling bulbs using each of the above purge volumes, and each sample will be analyzed for C1-C6+ hydrocarbons by the mobile laboratory. The purge volume yielding the highest concentration of C1-C6+ hydrocarbons will then be used for subsequent samples.

A separate purge test will be required for each type of lithology and a separate purge test may be required at each depth if it cannot be established that the soils at the various depths are the same lithology. The soil lithology will be evaluated by drilling and sampling at least one soil boring below the bluff and one at the top of the bluff. Soil samples will be obtained from each boring from depths of 0 to 20 ft bgs and will be classified in accordance with the Unified Soils Classification System. It is likely that probes placed below the bluff will require a separate set of purge tests to be conducted from those installed at the top of the bluff.

Leak Testing: Leak testing will be conducted to confirm that leakage does not occur during soil gas sampling resulting in sample dilution with ambient air. A tracer gas (isopropyl alcohol) will be used to test for atmospheric breakthrough. The tracer gas will be released near the ground surface adjacent to the probe. The soil gas samples collected from the probe will be analyzed for the tracer gas.

Sampling and Analysis Procedures: The probe and tubing, with a valve closed at the surface, will be allowed to equilibrate for a minimum of 30 minutes after the bentonite seal is hydrated. After the end of this time period, a magnehelic or similar pressure gauge with a sensitivity of no less than 0.01 inch of water will be used to measure pressure that may be present in the probe. This will be accomplished by attaching the pressure sensing gauge to the valve and opening the valve to see if any pressure is evident. This value will be recorded in the field log book.

The soil gas samples will then be collected in 125 ml glass gas sample bulbs supplied by an onsite mobile laboratory. This will be accomplished by drawing samples from the tubing through the stopcock located at each end of the glass sample bulbs, using a pump set at a flow rate of less than 200 ml/min. After purging a volume of gas determined to be appropriate from the purge testing, the sample will be collected by closing the stopcock next to the pump followed by the one located closest to the probe.

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After the soil gas sample is collected in 125 ml glass sample bulbs, the glass bulbs will be labeled with the sample identification number (consisting of the letters SG followed by a sequential sample number), sample depth, date and time of sample collection, and sampler's initials, and they will be transferred to the onsite mobile laboratory under chain-of-custody documentation. Samples will be analyzed within 30 minutes of collection for C1-C6+ straight chain hydrocarbons per EPA Method 8015(M) with carbon chain breakdown. In addition to the straight chain hydrocarbons, this breakdown will include ethene, propene, and isobutane. To quantify the individual hydrocarbons, gas standards will be used that include the individual straight chain hydrocarbons up to and including C6 (hexane) and will also include a separate standard for ethene, propene, and isobutane.

During the second phase of soil gas sampling, samples will be collected and analyzed for C1-C6+ straight chain hydrocarbons as described above. For samples containing methane at a concentration greater than 25,000 ppmv, aromatic hydrocarbons, when present, will be identified and quantified in the manner presented in the Exploration Technology Inc. (ETI) report dated January 5, 2000. In particular, aromatic hydrocarbons, as used in the ETI report, refer to the following four categories of aromatic hydrocarbons: C6 – benzene; benzene – toluene; toluene – xylene; and xylene plus, where C6 – benzene includes all the hydrocarbons identified using EPA Method 8015M with a boiling point greater than C6 (hexane) and less than benzene. Similarly, the other three categories each include all hydrocarbons with boiling points greater than the first member and less than the second, with the exception of xylene plus where all the hydrocarbons identified with boiling points greater than xylene are summed. All four categories of aromatic hydrocarbons will be reported in benzene ECUs.

In accordance with the settlement agreement, at the multi-depth soil gas probe locations if, based on the analyses of C1-C6+ hydrocarbons, additional samples are required at the location, they will be collected in Tedlar bags, or proprietary containers supplied by the laboratory performing the isotopic analyses, for analysis by an off-site laboratory for carbon isotopes and/or helium as follows: If methane concentrations exceed 25,000 ppmv, samples will be analyzed for delta ¹³C. If methane concentrations exceed 50,000 ppmv, samples will be analyzed for helium. If methane concentrations exceed 250,000 ppmv, samples may be subjected to ¹⁴C determination.

The Tedlar bag samples will be collected utilizing a vacuum box. Teflon® tubing will be connected to the vacuum box inlet. A vacuum pump will also be connected to the vacuum box to evacuate the air inside the box. The Tedlar bag will be attached to the inlet tubing via an airtight connection inside the vacuum box. Once a vacuum is applied to the vacuum box, the Tedlar bag will begin to fill with vapor from the soil gas probe. Once the Tedlar bag is approximately 80% full, the vacuum pump will be turned off and the vacuum box will be opened, the Tedlar bag valve will be closed, and the Tedlar bag will be detached from the inlet connection. The sample will be labeled as described above, added to a chain-of-custody, and transported to the off-site laboratory for analysis.

New sample tubing and Tedlar bags will be used for each sample.

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Soil gas samples will be analyzed for carbon isotopes as previously outlined in Section 2.1.3 by Isotech Laboratories located in Champagne, IL. Soil gas samples will be analyzed for helium by the SoCalGas Laboratory located in Pico Rivera, CA.

2.2.5 Equipment Decontamination

Equipment used during field exploration and sampling will be decontaminated prior to use at each boring and sampling point to reduce the potential for the introduction of contamination and cross-contamination in accordance with the guidelines and procedures discussed below. These procedures are necessary to ensure quality control in decontamination of field equipment and to serve as a means to identify and correct potential errors in the sample collection and sample handling procedures.

Sampling equipment that comes into contact with potentially contaminated soil or water will be decontaminated consistently to assure the quality of samples collected. Decontamination will occur prior to and after each use of a piece of equipment. Sampling devices used will be decontaminated using the following procedures:

- ◆ Non-phosphate detergent and tap water wash, using a brush if necessary;
- ◆ Initial deionized/distilled water rinse; and
- ◆ Final deionized/distilled water rinse.

Equipment will be decontaminated onsite in a pre-designated area on plastic sheeting, and clean bulky equipment will be stored on plastic sheeting in uncontaminated areas. Decontaminated small equipment will be stored in plastic bags. Equipment stored more than a few hours will be covered. Decontamination water produced will be placed in a Department of Transportation (DOT)-approved 55-gallon drum and labeled as decontamination water with the date and boring numbers. Disposition of decontamination fluids will be evaluated upon receipt of analytical results.

2.3 QA/QC

Field duplicates for soil gas will be collected at a frequency of one per 10 samples. Field duplicates are used to assess the total variance of the sampling method used, including the laboratory analysis.

Trip blank samples, in general, are primarily used to assess the potential for the contamination of sample containers as received from the laboratory. When trip blanks are prepared in the field they may also aid in identifying contamination from the containers, handling of samples in the field, and transport of samples to the laboratory. In addition, trip blanks may also reveal potential problems with contamination issues that occur at the laboratory. A Tedlar bag filled with “zero air” (air known to contain less than .001% contaminants) by the SoCalGas laboratory will be used as a trip blank for samples sent to them for analysis for helium. The trip blank will be transported with each shipment of samples from the Facility to the fixed laboratory. The trip blank will be analyzed for helium.

2.4 INVESTIGATION DERIVED WASTE

Decontamination water will be placed in DOT-approved 55-gallon drums. Drums will be sealed and labeled with the date, boring number, contents, and corresponding depth interval. The disposition of the generated waste will be evaluated upon completion of laboratory analysis and it will be disposed of accordingly.

3.0 REPORTING

Following completion of the 4 ft bgs sampling field and laboratory work, the results will be summarized in a draft report. The report will include figures on which the final probe locations are shown and tabular summaries of the analytical laboratory data. Descriptions of the probe installation, testing, and sampling procedures will be provided. Processed natural gas is primarily methane, but has components (e.g., helium and light hydrocarbons) which are not found in methane occurring from biogenic sources. The results of the C1-C6+ hydrocarbons analyses will be used to delineate areas where methane has been detected. Such detections may be an indication of the presence of processed natural gas. These areas will be selected for further analyses to evaluate if the methane detected is from processed natural gas or from local sources (e.g., biodegradation of organic material). Conclusions drawn from the results of this phase of testing will be provided along with specific recommendations for the next phase of field and laboratory work.

The draft report will be sent to SoCalGas for review and comment. Following receipt of SoCalGas' comments the report will be revised accordingly and the final report will be issued.

Following the completion of the deeper sampling field and laboratory work, the results will be summarized in a draft report. The report will include figures showing the final probe locations and tabular summaries of the analytical laboratory data. Descriptions of the probe installation, testing, and sampling procedures will be provided.

For methane, delta ^{13}C normally refers to the ratio of ^{13}C (isotopic carbon) to ^{12}C (normal carbon) which in general occurs at a ratio of approximately 1 to 100. This ratio, however, varies according to the origin of the methane since living organisms tend to have an affinity for retaining ^{13}C when respired or metabolized. The result is that the concentration of ^{13}C is measurably lower in methane derived from the metabolism of living organisms versus methane obtained from thermal breakdown of buried hydrocarbons (i.e., natural gas) where the latter ratio is generally measurably higher.

In a somewhat related manner, the amount of another isotope of carbon, ^{14}C , may be used to evaluate the approximate age of a hydrocarbon such as methane. This is based on the fact that ^{14}C is radioactive with a half life of approximately 7,500 years. ^{14}C is pervasive in the environment and all organisms tend to accumulate it and, to a slightly lesser extent, emit it as a byproduct of metabolism. Thus tissues of living organisms and the methane they generate contain measureable amounts of ^{14}C . When an organism dies, the accumulation process ends and after about 50,000 years the radioactive decay process reduces all the ^{14}C present in the organism to ^{12}C . Thus methane generated from thermally degraded hydrocarbon that is essentially composed of organisms that died long ago, has little or no measurable ^{14}C component. This allows ^{14}C to be used to differentiate methane generated from current sources (biogenic methane) from those that are approximately 50,000 years or more in age (thermogenic or petroleum sources). These relationships will be used to evaluate if the methane detected is processed natural gas or from local sources (e.g., biodegradation of organic material). Conclusions drawn from the results of the shallow and deeper testing will be provided.

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The draft report will be sent to SoCalGas for review and comment. Following receipt of SoCalGas' comments the report will be revised accordingly and the final report will be issued.

4.0 SCHEDULE

The first phase field program is anticipated to begin within two weeks following receipt of Work Plan approval by SoCalGas. Field and laboratory work for the first phase of the evaluation will require approximately four weeks to complete. It is anticipated that the draft report for this phase of the work will be submitted to SoCalGas approximately four weeks after completion of the field and laboratory work.

The second phase field program is anticipated to begin within two weeks following receipt of SoCalGas' approval of recommendations in the first phase report. The exact scope of the second phase field and laboratory program will be based on the results of the first phase program; hence, the schedule for completing the second phase cannot be established at this time. However, at a maximum, the field and laboratory work for the second phase of the evaluation may require up to approximately three months to complete. It is anticipated that the draft report for this phase of the work will be submitted to SoCalGas approximately 6 weeks after completion of the field and laboratory work.

5.0 REFERENCES

DTSC and RWQCB, 2003. Advisory for Active Soil Gas Investigations. January 2003.

Exploration Technologies, Inc. 2000. Field and Laboratory Procedures for Soil Vapor Sampling. Playa Vista, Los Angeles, California. January 5, 2000.

Tables

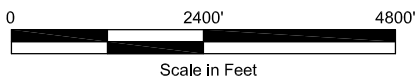
**Table 1
Probe Location Rationale**

WELLS	Primary Drawing	Field Reference Drawings Only		Number of Probes	Probe Location Rationale
Injection/Withdrawal (25)					
Elliott 1	19534-A			2	Evaluate well location
McAdams 1	19536-A			2	Evaluate well location
McAdams 2	19537-A			2	Evaluate well location
Pomoc 1	19535-A			2	Evaluate well location
SCP 1	19535-A			2	Evaluate well location
F 1	19538-A			2	Evaluate well location
L 1	19505-A			2	Evaluate well location
L 3	19539-A			2	Evaluate well location
L 4	19540-A			2	Evaluate well location
SoCal 1	19729-A			2	Evaluate well location
SoCal 5	D-17309	D-17310		2	Evaluate well location
SoCal 6	D-17309	D-17311		2	Evaluate well location
SoCal 7	D-17309	D-17312		2	Evaluate well location
Treasure 8	19504-A			2	Evaluate well location
Vidor 6	19508-A			2	Evaluate well location
Vidor 7	19511-A			2	Evaluate well location
Vidor 8	19507-A			2	Evaluate well location
Vidor 9	19506-A			2	Evaluate well location
Vidor 10	19512-A			2	Evaluate well location
Vidor 11	19513-A			2	Evaluate well location
Vidor 12	19514-A			2	Evaluate well location
Vidor 13	19515-A			2	Evaluate well location
Vidor 16	19517-A			2	Evaluate well location
Vidor 17	19518-A			2	Evaluate well location
Stewart 1	31892-3001-D.PIP			2	Evaluate well location
Water Removal (5)					
Blackline 1	T-173-1-A	31279-5012-D.ELC		2	Evaluate well location
SoCal 2	24796-A			2	Evaluate well location
SoCal 3	24796-A			2	Evaluate well location
SoCal 4	24796-A			2	Evaluate well location
24-2	19522-A			2	Evaluate well location
Production/Monitoring (4)					
Fast 1	31251-5002-D.ELC			2	Evaluate well location
Harlan 1	31251-5002-D.ELC			2	Evaluate well location
Vidor 18	22562-A	23047-A		2	Evaluate well location
Covington 1	31892-3001-D.PIP			2	Evaluate well location
Migration Return (3)					
Del Rey 15	22139-A	22146-A	22230-A	2	Evaluate well location
Del Rey 18	22141-A	22146-A	22230-A	2	Evaluate well location
SoCal 8	31251-3002-D.PIP	31251-5002-D.ELC		2	Evaluate well location
Observation (19)					
Del Rey 4	22109-A			2	Evaluate well location
Del Rey 5	22109-A			2	Evaluate well location
Del Rey 9	22109-A			2	Evaluate well location
Del Rey 10	90060-018.PLN			2	Evaluate well location
Del Rey 11	-			2	Evaluate well location
Del Rey 12	-			2	Evaluate well location
Del Rey 13	22137-A	22146-A	22230-A	2	Evaluate well location
Del Rey 14	22138-A	22146-A	22230-A	2	Evaluate well location
Del Rey 17	22140-A	22146-A	22230-A	2	Evaluate well location
Del Rey 19	22142-A	22146-A	22230-A	2	Evaluate well location
Harper 1	19526-A			2	Evaluate well location
Vidor 1	22109-A			2	Evaluate well location
Vidor 2	22109-A			2	Evaluate well location
Vidor 3	22109-A			2	Evaluate well location
Vidor 5	-			2	Evaluate well location
Vidor 14	-			2	Evaluate well location
24-1	19520-A			2	Evaluate well location
27-1	19521-A			2	Evaluate well location
Vidor 15	19516-A			2	Evaluate well location
Water Injection (1)					
Riegle 1	31892-3001-D.PIP			2	Evaluate well location
Main Facility				23	Grid spacing/near Facility structure/near adjacent residence
Tank Farm				13	Grid spacing/near Facility structure
Total Number of Probes				150	

Figures



Source: Thomas Bros. Maps, Los Angeles Street Guide, 2006.



URS Corporation

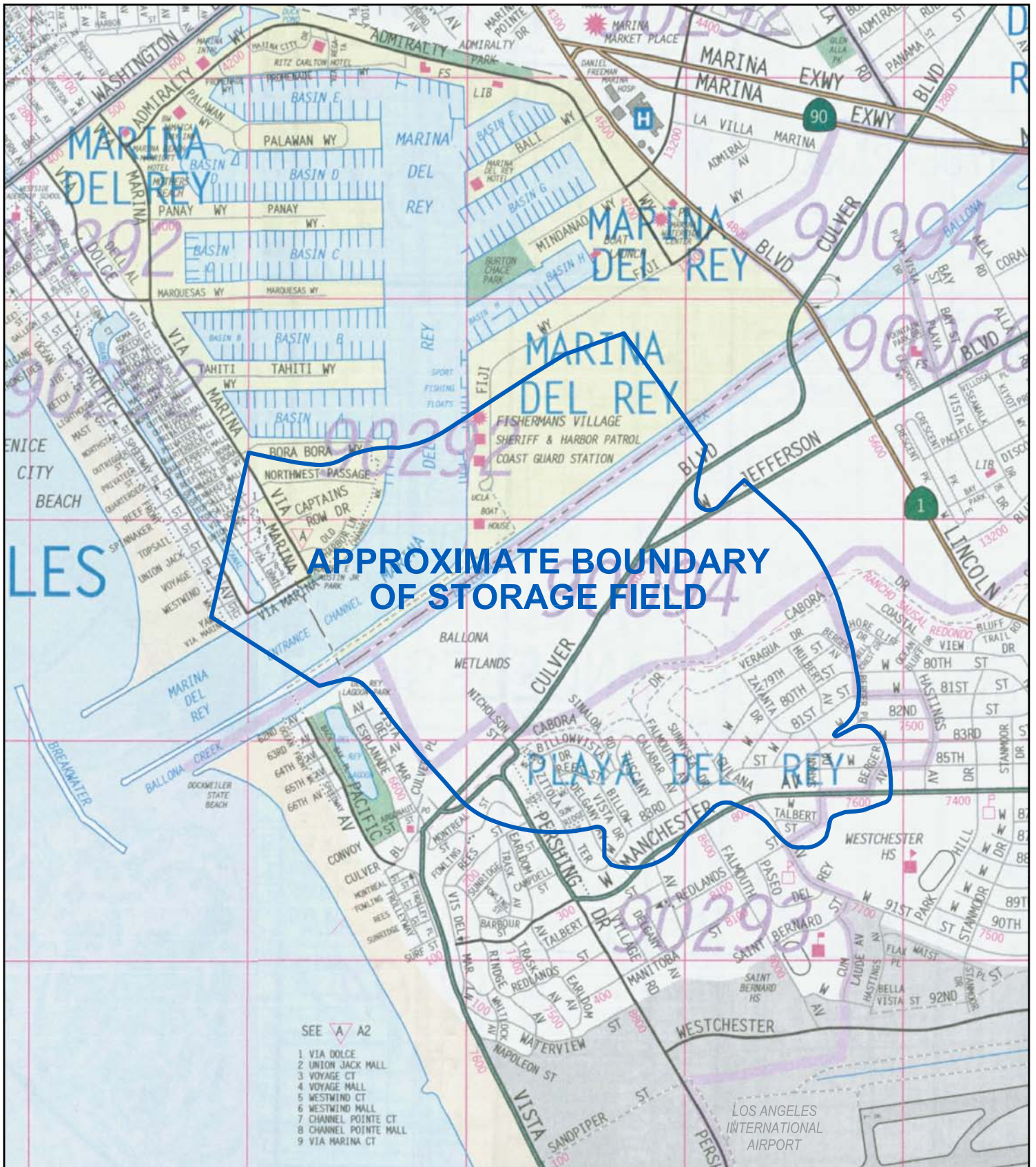
FACILITY LOCATION MAP

Proj. No.: 29868671

Date: MAR 2009

Project: SoCal Gas
Playa Del Rey
Storage Facility

Figure: 1



Source: Thomas Bros. Maps, Los Angeles Street Guide, 2006.



URS Corporation

SITE PLAN

Proj. No.: 29868671

Date: MAR 2009

Project: SoCal Gas
Playa Del Rey
Storage Facility

Figure: 2

Appendix B

DTSC/RWQCB Advisory for Active Soil Gas Investigations



Gray Davis, Governor
 Winston H. Hickox, Agency Secretary
 California Environmental Protection Agency

Tom Zdeb
 Finalized 2/05/03



Department of Toxic Substances Control

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January 28, 2003

To: Interested Parties

ADVISORY – ACTIVE SOIL GAS INVESTIGATIONS

In a coordinated effort, the Department of Toxic Substances Control (DTSC) and the California Regional Water Quality Control Board – Los Angeles Region (LARWQCB) have jointly developed the "Advisory – Active Soil Gas Investigations" (see the attached). This document is to ensure that consistent methodologies are applied during active soil gas investigations to produce high quality data for regulatory decision-making. The document has been reviewed by other government organizations and by the soil gas consulting community. Their comments have been considered and, where appropriate, incorporated in the document. This is an on-going effort to streamline the characterization of gas phase contaminant sites. As additional knowledge and experience are obtained, this Advisory may be modified as appropriate.

This document is issued by DTSC and LARWQCB as an Advisory subject to review and revision as necessary. The information in this Advisory should not be considered as regulations. Mention of trade names or commercial products does not constitute the Agency's endorsement or recommendation.

If you have any questions regarding this document, please contact the joint-agency project coordinator Mr. Joe Hwong, of DTSC, at (714) 484-5406.

Sincerely,

Edwin F. Lowry
 Director
 Department of Toxic Substances Control

Dennis A. Dickerson
 Executive Officer
 California Regional Water Quality Control Board
 Los Angeles Region

Enclosure

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see our Web-site at www.dtsc.ca.gov.

bcc: Dr. Yue Rong – LARWQCB
Dr. Rebecca Chou – LARWQCB
Ms. Dorothy Rice – DTSC/HQ
Mr. Hamid Saebfar – DTSC/Glendale
Ms. Sharon Fair – DTSC/Glendale
Mr. Joe Hwong – DTSC/Cypress

ADVISORY – ACTIVE SOIL GAS INVESTIGATIONS

As a coordinated effort, this document is issued by the California Regional Water Quality Control Board – Los Angeles Region (LARWQCB) and Department of Toxic Substances Control (DTSC) as an Advisory subject to review and revision as necessary. Mention of trade names or commercial products does not constitute the Agency's endorsement or recommendation. The information in this Advisory should not be considered as regulations. In this Advisory, "Agency" should mean LARWQCB and/or DTSC.

1.0 INTRODUCTION

Active soil gas investigations are useful to obtain vapor phase data at sites potentially affected by volatile organic compounds (VOCs), including chlorinated and aromatic hydrocarbons. Active soil gas investigations may also be used to investigate sites potentially affected by methane and hydrogen sulfide, and to measure fixed and biogenic gasses (e.g., oxygen, carbon dioxide, or carbon monoxide). Among other things, the data can be used to identify the source and determine the spatial distribution of VOC contamination at a site, or to estimate indoor air concentrations for risk assessment purposes.

For site characterization, the Agency encourages both soil gas and soil matrix sampling. Typically, soil gas data are more representative of actual site conditions in coarse-grained soil formations while soil matrix data are more representative of actual site conditions in fine-grained soil formations. For evaluating the risk associated with vapor intrusion to indoor air, soil gas data are the preferred contaminant data set, where practicable. Flux chamber and passive sampling methods are not discussed in this Advisory. Any sites where such sampling methods are necessary will be addressed separately.

On February 25, 1997, LARWQCB re-issued the "Interim Guidance for Active Soil Gas Investigation" (ASGI) as guidance for investigating sites with potential VOC contamination. Unless otherwise noted in this Advisory, the active soil gas investigation should be performed in accordance with the most current ASGI.

2.0 SUPPLEMENTAL RECOMMENDATIONS

The following sections supplement the ASGI in an effort to ensure that consistent methodologies are applied during soil gas investigations to produce reliable and defensible data of high quality. All sampling probe installation, sampling, and analytical procedures, whether or not discussed below, are subject to Agency review and approval.

- 2.1 Project Management
- 2.2 Soil Gas Sampling Probe Installation
- 2.3 Purge Volume Test
- 2.4 Leak Test
- 2.5 Purge/Sample Flow Rate
- 2.6 Soil Gas Sampling
- 2.7 Analysis of Soil Gas Samples

2.1 Project Management

2.1.1 Workplan: An appropriate workplan should be prepared and submitted to the Agency for review and approval at least 30 days prior to its implementation. Any variations or deviations from this Advisory should be specified in the workplan. The soil gas workplan can either be incorporated as part of a comprehensive site investigation workplan or as a stand-alone document, depending on site-specific circumstances.

2.1.2 Field Activities

- A. The Agency should be notified 10 working days prior to implementation of field activities. All necessary permits and utility clearance(s) should be obtained prior to conducting any investigations described in this Advisory.
- B. All engineering or geologic work (e.g., logging continuous soil cores, soil description) should be performed or supervised by a California Registered Professional in accordance with the Business and Professions Code, Chapters 7 and 12.5, and the California Code of Regulations, Title 16, Chapters 5 and 29.

In addition, for proposed school sites, all work performed should be under the direction and supervision of a project coordinator experienced in soil gas investigations [e.g., an Environmental Assessor as defined in Education Code Section 17210(b)].

- C. Evaluation of raw data by Agency staff may occur either in the field or in the office.
 - 1. Hard copies of the complete raw laboratory data, including handwritten data and field notes, should be provided to the Agency staff upon request.
 - 2. Adjustments or modifications to the sampling program may be required by Agency staff to accommodate changes mandated by evaluation of the data set or unforeseen site conditions.
- D. Investigation derived wastes (IDWs) should be managed as hazardous waste until proven otherwise or until specifically approved by the Agency as being non-hazardous waste. IDWs should be handled and disposed in accordance with federal, state and local requirements.

E. Field Variations

1. To expedite the completion of field activities and avoid potential project delays, contingencies should be proposed and included in the project workplan (e.g., soil matrix samples will also be collected if clayey soils [as defined in the Unified Soil Classification System (USCS)] are encountered during the proposed soil gas investigation).
2. The Agency field staff should be informed of any problems, unforeseen site conditions, or deviations from the approved workplan. When it becomes necessary to implement modifications to the approved workplan, the Agency should be notified and a verbal approval should be obtained before implementing changes.

- F. Soil Matrix Sampling Requirements: Companion soil matrix sampling may be conducted concurrently with a soil gas investigation (in accordance with the ASGI, Section 5.0), except where extremely coarse-grained soils (as defined in USCS) are encountered or when specifically excluded by the Agency.

2.1.3 Soil Gas Investigation Reports: A soil gas investigation report including a discussion of field operations, deviations from the approved workplan, data inconsistencies, and other significant operational details should be prepared. The report may either be a stand-alone document in a format recommended by the Agency or be included within a site-specific assessment report. At a minimum, the report should contain the following:

- A. Site plan map and probe location map at an appropriate scale as specified in the workplan (e.g., scale: one inch = 40 feet);
- B. Final soil gas iso-concentration maps for contaminants of concern at the same scale as the site plan map;
- C. Summary tables for analytical data, in micrograms per liter ($\mu\text{g/L}$), in accordance with the ASGI;
- D. Legible copies of field and laboratory notes or logs;
- E. All analytical results and Quality Assurance/Quality Control (QA/QC) information including tables and explanations of procedures, results, corrective actions and effect on the data, in the format specified by the Agency; and
- F. Upon request, all raw data including chromatograms and calibration data should be submitted to the Agency.

2.2 Soil Gas Sampling Probe Installation

- 2.2.1 Lithology: Site soil or lithologic information should be used to select appropriate locations and depths for soil gas probes. If on-site lithologic information is not available prior to conducting the soil gas investigation, at least one (1) continuously cored boring to the proposed greatest depth of the soil gas investigation should be installed at the first sampling location, unless specifically waived or deferred by Agency. Depending on site conditions, additional continuously cored borings may be necessary.
- A. Lithologic logs should be prepared for all borings (e.g., continuously cored borings, soil matrix sampling, geotechnical sampling, etc.). Note: This does not apply to direct-push soil gas probe installations.
 - B. Information gathered from the continuously cored borings may include soil physical parameters, geotechnical data and contaminant data.
 - C. If low-flow or no-flow conditions (e.g., fine-grained soil, clay, soil with vacuum readings that exceed approximately 10 inches of mercury or 136 inches of water) are encountered, soil matrix sampling using EPA Method 5035A should be conducted in these specific areas. Also see Section 4 of LARWQCB's "General Laboratory Testing Requirements for Petroleum Hydrocarbon Impacted Sites" on use of EPA Method 5035A.
 - D. If the bottom five (5) feet of a continuously cored boring is composed of clay or soil with a vacuum exceeding approximately 10 inches of mercury or 136 inches of water, the continuously cored boring should be extended an additional five (5) feet to identify permeable zones. If the extended boring is also composed entirely of clay, the boring may be terminated. Special consideration should always be given to advancing borings and ensuring that a contaminant pathway is not being created through a low permeability zone.
- 2.2.2 Sample Spacing: A scaled site plan depicting potential or known areas of concern (e.g., existing or former sumps, trenches, drains, sewer lines, clarifiers, septic systems, piping, underground storage tanks [USTs], chemical or waste management units) should be provided in the project workplan. Sample spacing should be in accordance with the most current ASGI and may be modified based on site-specific conditions with Agency approval. To optimize detecting and delineating VOCs, the grid spacing should be modified to include biased sampling locations.

- 2.2.3 Sample Depth: Sample depths should be chosen to minimize the effects of changes in barometric pressure, temperature, or breakthrough of ambient air from the surface; and to ensure that representative samples are collected. Consideration should be given to the types of chemicals of concern and the lithology encountered.
- A. At each sample location, soil gas probes should be installed at a minimum of one sample depth, generally at five (5) feet below ground surface (bgs), in accordance with the most current ASGL.
 - B. Samples should be collected near lithologic interfaces or based on field instrument readings (e.g., Flame Ionization Detector [FID], Photo Ionization Detector [PID]) from soil cuttings and/or cores to determine the location of maximum analyte concentrations at the top or bottom of the interface depending upon the analyte.
 - C. Multi-depth sampling is appropriate for any of the following locations:
 - 1. Sites identified with subsurface structures (e.g., USTs, sumps, clarifiers, waste or chemical management units), subsurface sources (e.g., oil fields, artificial fill, buried animal waste), changes in lithology, and/or contaminated groundwater. Soil gas probes should be emplaced below the base of any subsurface structures, sources or backfilled materials in the vadose zone. Collection of deeper samples should be done in consultation with Agency staff;
 - 2. Areas with significantly elevated VOC concentrations detected during shallow or previous vapor sampling;
 - 3. Areas where elevated field instrument readings are encountered from soil matrix cuttings, cores or samples; or
 - 4. In the annular space of groundwater monitoring wells during construction, where an assessment of the vertical extent of soil gas contamination is necessary.
 - D. If no lithologic change or contamination is observed, default sampling depths may be selected for multi-depth sampling. For example, soil gas samples may be collected at 5, 15, 25, 40 feet bgs, etc., until either the groundwater is encountered or VOCs are not detected, whichever comes first.
 - 1. Additional samples may be necessary based on site conditions.
 - 2. For Preliminary Endangerment Assessments: When 40 feet bgs is reached, collection of deeper samples may be waived.

However, assessment and/or characterization of the deeper vadose zone may be required in the future to protect groundwater resources.

2.2.4 Sampling Tubes: Sampling tubes should be of a small diameter (1/8 to 1/4 inch) and made of material (e.g., nylon, polyethylene, copper or stainless steel) which will not react or interact with site contaminants. For example, metal tubes should not be used for collection of hydrogen sulfide samples.

- A. Clean, dry tubing should be utilized at all times. If moisture, water, or an unknown material is present in the probe prior to insertion, the tubing should be decontaminated or replaced.
- B. After use at each location:
 - 1. Non-reusable (e.g., nylon or polyethylene) sampling tubes should be discarded; or
 - 2. Reusable sampling tubes should be properly decontaminated as specified in Section 2.2.7.
- C. A drawing of the proposed probe tip design and construction should be included in the project workplan.

2.2.5 Soil Gas Probe Emplacement Methods

- A. Permanent or Semi-permanent Soil Gas Probe Methods: Permanent or semi-permanent soil gas probes may be installed, using a variety of drilling methods. Please note that the mud rotary drilling method is not acceptable for soil gas probe emplacement. Other drilling methods such as air rotary and rotosonic can adversely affect soil gas data during and after drilling and will require extensive equilibration times. Therefore, they are not recommended. Other soil gas probe designs and construction (e.g., soil gas wells or nested wells) may be appropriate and should be discussed with Agency staff prior to emplacement. When additional sampling is not anticipated per consultation with the Agency, such probes may be properly removed or decommissioned after completion of the soil gas investigation.
 - 1. The probe tip should be emplaced midway within a minimum of one (1) foot of sand pack. The sand pack should be appropriately sized (e.g., no smaller than the adjacent formation) and installed to minimize disruption of airflow to the sampling tip. See Figure 1 for more information.
 - 2. At least one (1) foot of dry granular bentonite should be emplaced on top of each sand pack to preclude the infiltration

of hydrated bentonite grout. The borehole should be grouted to the surface with hydrated bentonite. With respect to deep probe construction with multiple probe depths, the borehole should be grouted between probes. One (1) foot of dry granular bentonite should be emplaced between the filter pack and the grout at each probe location. See Figure 2 for more information.

3. The use of a downhole probe support may be required for deep probe construction (e.g., 40 feet bgs for direct push probes).
 - a. Such probe support may be constructed from a one-inch diameter bentonite/cement grouted PVC pipe or other solid rod, or equivalent, allowing probes to be positioned at measured intervals.
 - b. The support should be properly sealed or solid (internally or externally) to avoid possible cross-contamination or ambient air intrusion.
 - c. The probes should be properly attached to the exterior of the support prior to placement downhole.
 - d. Alternative probe support designs should be described in the project workplan. If probe support will not be used for deep probes, justification should be included in the project workplan.
4. Tubing should be properly marked at the surface to identify the probe location and depth.
5. As-built diagrams for probes or wells should be submitted with the soil gas investigation report detailing the well identification and corresponding probe depths. A typical probe construction diagram may be submitted for probes with common design and installation.
6. Unless soil gas probes are removed or decommissioned, probes should be properly secured, capped and completed to prevent infiltration of water or ambient air into the subsurface and to prevent accidental damage or vandalism. For surface completions, the following components may be installed:
 - a. Gas-tight valve or fitting for capping the sampling tube;
 - b. Utility vault or meter box with ventilation holes and lock;
 - c. Surface seal; and
 - d. Guard posts.

- B. Temporary Soil Gas Probe Emplacement Method: In general, the drive rod is driven to a predetermined depth and then pulled back to expose the inlets of the soil gas probe. After sample collection, both the drive rod and tubing are removed.
1. During installation of the probe, hydrated bentonite should be used to seal around the drive rod at ground surface to prevent ambient air intrusion from occurring.
 2. The inner soil gas pathway from probe tip to the surface should be continuously sealed (e.g., a sampling tube attached to a screw adapter fitted with an o-ring and connected to the probe tip) to prevent infiltration.

2.2.6 Equilibration Time: During probe emplacement, subsurface conditions are disturbed. To allow for subsurface conditions to equilibrate, the following equilibration times are recommended:

- A. For probes installed with the direct push method where the drive rod remains in the ground, purge volume test, leak test, and soil gas sampling should not be conducted for at least 20 minutes following probe installation.
- B. For probes installed with the direct push method where the drive rod does not remain in the ground, purge volume test, leak test, and soil gas sampling should not be conducted for at least 30 minutes following probe installation.
- C. For probes installed with hollow stem drilling methods, purge volume test, leak test, and soil gas sampling should not be conducted for at least 48 hours (depending on site lithologic or drilling conditions) after the soil gas probe installation.
- D. Probe installation time should be recorded in the field log book.

2.2.7 Decontamination: After each use, drive rods and other reusable components should be properly decontaminated to prevent cross contamination. These methods include:

- A. 3-stage wash and rinse (e.g., wash equipment with a non-phosphate detergent, rinse with tap water, and finally rinse with distilled water); and/or
- B. Steam cleaning process.

2.3 Purge Volume Test

To ensure stagnant or ambient air is removed from the sampling system and to assure samples collected are representative of subsurface conditions, a

purge volume versus contaminant concentration test should be conducted as the first soil gas sampling activity at the selected purge test point. The purge volume test is conducted by collecting and analyzing a sample for target compounds after the removal of appropriate purge volumes.

2.3.1 Purge Test Locations: The purge test location should be selected as near as possible to the anticipated or confirmed contaminant source, and in an area where soil gas concentrations are expected to be greatest based on lithology (e.g., coarse-grained sediments). The first purge test location should be selected through the workplan approval process or as a field decision in conjunction with Agency staff.

2.3.2 Purge Volume: The purge volume or "dead space volume" can be estimated based on a summation of the volume of the sample container (e.g., glass bulbs), internal volume of tubing used, and annular space around the probe tip. Summa™ canisters, syringe, and Tedlar™ bags are not included in the dead space volume calculation. The Agency recommends step purge tests of one (1), three (3), and seven (7) purge volumes be conducted as a means to determine the purge volume to be applied at all sampling points.

- A. The appropriate purge volume should be selected based on the highest concentration for the compound(s) of concern detected during the step purge tests. The purge volume should be optimized for the compound(s) of greatest concern in accordance with Section 2.2 of the ASGI.
- B. If VOCs are not detected in any of the step purge tests, a default of three (3) purge volumes should be extracted prior to sampling.
- C. The step purge tests and purging should be conducted at the same rate soil gas is to be sampled (see Section 2.5).
- D. The purge test data (e.g., calculated purge volume, rate and duration of each purge step) should be included in the report to support the purge volume selection.

2.3.3 Additional Purge Volume Test

- A. Additional purge volume tests should be performed to ensure appropriate purge volumes are extracted if:
 - 1. Widely variable or different site soils are encountered; or
 - 2. The default purge volume is used and a VOC is newly detected.

- B. If a new purge volume is selected after additional step purge tests are conducted, the soil gas investigation should be continued as follows:
1. In areas of the same or similar lithologic conditions:
 - a. Re-sample 20 percent of the previously completed probes. This re-sampling requirement may be reduced or waived in consultation with Agency staff, depending on site conditions. If re-sampling indicates higher detections (e.g., more than 50 percent difference in samples detected at greater than or equal to 10 µg/L), all other previous probes should be re-sampled using the new purge volume.
 - b. Continue the soil gas investigation with the newly selected purge volume in the remaining areas.
 2. In areas of different lithologic conditions: Continue the soil gas investigation with the newly selected purge volume in the remaining areas.

2.4 Leak Test

Leakage during soil gas sampling may dilute samples with ambient air and produce results that underestimate actual site concentrations or contaminate the sample with external contaminants. Leak tests should be conducted to determine whether leakage is present (e.g., the leak check compound is detected and confirmed in the test sample after its application).

- 2.4.1 Leak tests should be conducted at every soil gas probe.
- 2.4.2 Leak Check Compounds: Tracer compounds, such as pentane, isopropanol, isobutene, propane, and butane, may be used as leak check compounds, if a detection limit (DL) of 10 µg/L or less can be achieved. These compounds may be contained in common products such as shaving cream.
- 2.4.3 A leak check compound should be placed at any location where ambient air could enter the sampling system or where cross contamination may occur, immediately before sampling. Locations of potential ambient air intrusion include:
- A. Sample system connections;
 - B. Surface bentonite seals (e.g., around rods and tubing); or
 - C. Top of the Temporary Soil Gas Probe (see Section 2.2.5.B).

- 2.4.4 The leak test should include an analysis of the leak check compound. If a leak check compound is detected in the sample, the following actions should be followed:
- A. The cause of the leak should be evaluated, determined and corrected through confirmation sampling;
 - B. If the leak check compound is suspected or detected as a site-specific contaminant, a new leak check compound should be used;
 - C. If leakage is confirmed and the problem can not be corrected, the soil gas probe should be properly decommissioned;
 - D. A replacement probe should be installed at least five (5) feet from the original probe decommissioned due to confirmed leakage, or consult with Agency staff; and
 - E. The leak check compound concentration detected in the soil gas sample should be included and discussed in the report.

2.5 Purge/Sample Flow Rate

Sampling and purging flow rates should not enhance compound partitioning during soil gas sampling. Samples should not be collected if field conditions as specified in Section 2.6.4 exist.

- 2.5.1 The purging or sampling flow rate should be attainable in the lithology adjacent to the soil gas probe.
- A. To evaluate lithologic conditions adjacent to the soil gas probe (e.g., where no-flow or low-flow conditions), a vacuum gauge or similar device should be used between the soil gas sample tubing and the soil gas extraction devices (e.g., vacuum pump, Summa™ canister).
 - B. Gas tight syringes may also be used to qualitatively determine if a high vacuum soil condition (e.g., suction is felt while the plunger is being withdrawn) is present.
- 2.5.2 The Agency recommends purging or sampling at rates between 100 to 200 milliliters per minute (ml/min) to limit stripping, prevent ambient air from diluting the soil gas samples, and to reduce the variability of purging rates. The low flow purge rate increases the likelihood that representative samples may be collected. The purge/sample rate may be modified based on conditions encountered in individual soil gas probes. These modified rates should be documented in the soil gas report.

2.6 Soil Gas Sampling

After the soil gas probe is adequately purged, samples should be collected by appropriate methodologies.

2.6.1 Sample Container: Samples should be collected in gas-tight, opaque/dark containers (e.g., syringes, glass bulbs wrapped in aluminum foil, Summa™ canisters), so that light-sensitive or halogenated VOCs (e.g., vinyl chloride) will not degrade.

- A. If a syringe is used, it should be leak-checked before each use by closing the exit valve and attempting to force ambient air through the needle.
- B. If syringe samples are analyzed within five (5) minutes of collection, aluminum foil wrapping may not be necessary.
- C. EPA Method TO-14A, TO-15, or an equivalent air analysis method, requires samples be collected in Summa™ canisters.
- D. If a Summa™ canister is used, a flow regulator should be placed between the probe and the Summa™ canister to ensure the Summa™ canister is filled at the flow rate as specified in Section 2.5.2.
- E. Tedlar™ bags should not be used to collect VOC samples.
- F. Specific requirements for methane and hydrogen sulfide sample containers are specified in Section 2.7.9.

2.6.2 Sample Collection

- A. Vacuum Pump: When a vacuum pump is used, samples should be collected on the intake side of the vacuum pump to prevent potential contamination from the pump. Vacuum readings or qualitative evidence of a vacuum should be recorded on field data sheets for each sample.
- B. Shallow Samples: Care needs to be observed when collecting shallow soil gas samples to avoid sample breakthrough from the surface. Extensive purging or use of large volume sample containers (e.g., Summa™ canisters) should be avoided for collection of near-surface samples [e.g., shallower than five (5) feet bgs].

2.6.3 Sample Container Cleanliness and Decontamination

- A. Prior to its first use at a site, each sample container should be assured clean by the analytical laboratory as follows:
1. New containers should be determined to be free of contaminants (e.g., lubricants) by either the supplier or the analytical laboratory; and
 2. Reused/recycled containers: Method blank(s), as specified in Section 2.7.1.A, should be used to verify sample container cleanliness.
- B. After each use, reusable sample containers should be properly decontaminated.
1. Glass syringes or bulbs should be disassembled and baked at 240° C for a minimum of 15 minutes or at 120° C for a minimum of 30 minutes, or be decontaminated by an equivalent method.
 2. Summa™ canisters should be properly decontaminated as specified by appropriate EPA analytical methods.
 3. During sampling activities using reused/recycled sampling containers (e.g., glass syringes, glass bulbs), at a minimum one (1) decontaminated sample container per 20 samples or per every 12 hours, whichever is more often, should be used as a method blank (as specified in Section 2.7.1.A) to verify and evaluate the effectiveness of decontamination procedures.
- C. Plastic syringes should be used only once and then properly discarded.

2.6.4 Field Conditions: Field conditions, such as rainfall, irrigation, fine-grained sediments, or drilling conditions may affect the ability to collect soil gas samples.

- A. Wet Conditions: If no-flow or low-flow conditions are caused by wet soils, the soil gas sampling should cease. In addition, the Agency recommends that the soil gas sampling should not be conducted during or immediately after a significant rain event (e.g., 1/2 inch or greater) or onsite watering.
- B. If low flow conditions are determined to be from a specific lithology, a new probe should be installed at a greater depth or a new lateral location should be selected after evaluation of the site lithologic logs (See Section 2.2.1) or in consultation with Agency staff.

- C. If moisture or unknown material is observed in the glass bulb or syringe, soil gas sampling should cease until the cause of the problem is determined and corrected.
- D. If refusal occurs during drilling, soil gas samples should be collected as follows or in consultation with Agency staff.
 - 1. For sample depths less than five feet, collect a soil gas sample following the precautions outlined in Section 2.6.2.B.
 - 2. For sample depths greater than five feet, collect a soil gas sample at the depth of refusal.
 - 3. A replacement probe should be installed within five (5) feet laterally from the original probe decommissioned due to refusal. If refusal still occurs after three tries, the sampling location may be abandoned.

2.6.5 Chain of Custody Records: A chain of custody form should be completed to maintain the custodial integrity of a sample. Probe installation times and sample collection times should be included in the soil gas report.

2.7 Analysis of Soil Gas Samples

2.7.1 Quality Assurance/Quality Control (QA/QC): The soil gas analytical laboratory should comply with the project Quality Assurance Project Plan (QAPP) and follow the QA/QC requirements of the most current ASGI and the employed EPA Method. If there is any inconsistency, the most restrictive and specific requirements should prevail. The analytical data should be consistent with the Data Quality Objectives (DQOs) established for the project. The Agency staff may inspect the field and/or laboratory QA/QC procedures. Copies of the QA/QC plan and laboratory calibration data should be presented to the Agency field staff upon request.

Field QC samples should be collected, stored, transported and analyzed in a manner consistent with site samples. The following QC samples should be collected to support the sampling activity:

A. Sample Blanks

- 1. Method Blanks: Method blanks should be used to verify the effectiveness of decontamination procedures as specified in Section 2.6.3.B.3 and to detect any possible interference from ambient air.
- 2. Trip Blanks for Off-site Shipments: Whenever VOC samples are shipped offsite for analysis, a minimum of one (1) trip blank

per day should be collected and analyzed for the target compounds. Trip blanks, consisting of laboratory grade ultra pure air, are prepared to evaluate if the shipping and handling procedures are introducing contaminants into the samples, and if cross contamination in the form of VOC migration has occurred between the collected VOC samples. Trip blank containers and media should be the same as site samples.

B. Duplicate Samples: At least one (1) duplicate sample per laboratory per day should be field duplicate(s). Duplicate samples should be collected from areas of concern.

1. Duplicate samples should be collected in separate sample containers, at the same location and depth.
2. Duplicate samples should be collected immediately after the original sample.

C. Laboratory Control Samples and Dilution Procedure Duplicates: Laboratory Control Samples (LCS) and Dilution Procedure Duplicates (DPD) should be done in accordance with the most recent ASGI (Sections 3.5.0 and 3.12.4, respectively).

D. Split Samples: The Agency staff may request that split samples be collected and analyzed by a separate laboratory.

2.7.2 Laboratory Certification: Although the California Department of Health Services, Environmental Laboratory Accreditation Program (ELAP) does not currently require certification for soil gas analytical laboratories, the Agency recommends laboratories utilizing EPA Methods 8260B, 8021B, and 8015B for analyses of soil gas samples obtain ELAP certifications for such EPA analytical methods accordingly. The Agency or DTSC's Hazardous Materials Laboratory (HML) staff may inspect the laboratory.

2.7.3 Detection Limits for Target Compounds: Analytical equipment calibration should be in accordance with the most current ASGI. Consideration and determination of appropriate DLs should be based on the DQOs of the investigation.

- A. The DL for leak check compounds should be 10 µg/L or less (see Section 2.4.2). The DL for oxygen (O₂) and carbon dioxide (CO₂) should be one (1) percent or less. The DLs for methane and hydrogen sulfide are specified in Section 2.7.9.
- B. If the investigation is being conducted to delineate the extent of contamination, a DL of 1 µg/L is appropriate for all targeted VOCs.

- C. If the soil gas data are to be used to support risk assessment activities, a DL of 1 µg/L may be appropriate for the initial screening when evaluating all targeted VOCs. If the data are non-detect for all targeted VOCs, additional sampling with lower DLs is not required. If VOCs are detected, additional sampling, using a DL of 0.1 µg/L, may be required to confirm the non-detection of carcinogenic VOCs [see the Toxicity Criteria Database of the California Environmental Protection Agency, Office of Environmental Health Hazard (OEHHA), or the Integrated Risk Information System (IRIS) Database of the United States Environmental Protection Agency]. A DL of 0.1 µg/L may be proposed and used for all carcinogenic target VOCs from the beginning of the investigation.
- D. Based on site-specific DQO needs, lower DLs may be required. Examples of sites requiring site-specific DQO needs include, but are not limited to, chlorinated solvents sites, former industrial facilities and landfills. Several less common VOCs, not included on the ASGI-targeted compound list, may require lower detection limits [e.g., bis(chloromethyl)ether, DBCP (1,2-dibromo-3-chloropropane), or ethylene dibromide] when they are known or suspected to be present.
- E. If the required DLs cannot be achieved by the proposed analytical method, additional sample analysis by a method achieving these DLs [e.g., EPA Method 8260B with selective ion method (SIM), TO-14A, TO-15] may be required. Use of these methods should comply with the QA/QC requirements as specified in Section 2.7.1.
- F. For results with a high DL reported (e.g., due to matrix interference or dilution), the laboratory should provide a written explanation. Re-sampling and analyses may be required at the appropriate DL for a specific compound.

2.7.4 Sample Handling: Exposure to light, changes in temperature and pressure will accelerate sample degradation. To protect sample integrity:

- A. Soil gas samples should not be chilled;
- B. Soil gas samples should not be subjected to changes in ambient pressure. Shipping of sample containers by air should be avoided; and
- C. If condensation is observed in the sample container, the sample should be discarded and a new sample should be collected.

2.7.5 Holding Time: All soil gas samples (e.g., samples of VOCs, methane, fixed gases, or biogenic gases), with the exception of hydrogen sulfide samples, should be analyzed within 30 minutes by an on-site mobile laboratory. Hydrogen sulfide samples should be analyzed as specified in Section 2.7.9.B.2. Under the following conditions, holding times may be extended and analyses performed off-site:

- A. Soil gas samples collected in glass bulbs with surrogates added within 15 minutes of collection may be analyzed within 4 hours after collection;
- B. Soil gas samples collected in Summa™ canisters may be analyzed within 72 hours after collection; and
- C. Methane samples may be analyzed as specified in Section 2.7.9.A.2.

2.7.6 Analytical Methods

A. VOC Samples: All VOC samples should be analyzed using only a Gas Chromatograph/Mass Spectrometer (GC/MS) method (e.g., EPA Method 8260B, used for analysis of soil gas samples, EPA Method TO-14A or TO-15, or equivalent), except at well-characterized sites (e.g., VOCs are known to be present and confirmed based on previous GC/MS analyses). A non-GC/MS method (e.g., EPA Method 8021B, used for analysis of soil gas samples) may be used only for routine monitoring of VOC contamination at well-characterized sites.

If during routine monitoring, new VOC(s) were detected by a non-GC/MS method, then at least 10 percent of the samples with each newly identified VOC should be confirmed by a GC/MS method. Thereafter, routine monitoring can resume with the non-GC/MS method, including the new analyte(s).

B. Methane and Hydrogen Sulfide Samples: These gas samples should be analyzed using methods specified in Section 2.7.9.

2.7.7 Auto samplers may be used if:

- A. One (1) sample is introduced at a time;
- B. The sample vials are gas-tight and never opened after the sample is added;
- C. Proper holding times are maintained (see Section 2.7.5); and
- D. All samples are secured and under proper custody.

2.7.8 Target Compounds

A. VOCs

1. ASGI-Targeted Compounds: The ASGI (dated February 25, 1997) includes 23 primary and four (4) other target VOCs. All quantifiable results should be reported.
 2. Others: The estimated results of all Tentatively Identified Compounds (TICs) or non-ASGI-targeted compounds detected should be included in the report. If TICs or non-ASGI-targeted compounds are identified, contact the Agency to determine whether additional action is required (e.g., running additional standards to quantify TICs or non-ASGI compounds) and whether the use of these estimated data for risk evaluation is appropriate.
- B. Leak Check Compounds: All quantifiable results should be reported as specified in Section 2.4.4.E.
- C. Specific Compounds: Based on the site history and conditions, analyses for specific compounds may be required by the Agency staff. Examples include:
1. In areas where USTs or fuel pipelines are identified, soil gas samples should be analyzed for oxygenated compounds [e.g., methyl tertiary butyl ether (MTBE), ethyl tertiary butyl ether (ETBE), di-isopropyl ether (DIPE), tertiary amyl methyl ether (TAME), tertiary butyl alcohol (TBA), and ethanol];
 2. At oilfield sites where semi-VOCs or Total Petroleum Hydrocarbons (TPHs) are detected in the soil gas samples, fixed and biogenic gas (O₂, CO₂, and CH₄) data should be obtained using a Thermal-Conductivity Detector (TCD) or a hand-held instrument;
 3. At petroleum contaminated sites (including oilfields), dairies, wetlands, landfills or other sites where the presence of methane and/or hydrogen sulfide is suspected, soil gas samples should be analyzed for methane and/or hydrogen sulfide;
 4. At sites where use of chlorinated solvents with 1,4-dioxane is suspected or known to exist, soil gas samples may be analyzed for 1,4-dioxane with a detection limit of 1 µg/L; or
 5. See Section 2.7.9.A.4 below.

2.7.9 Methane and Hydrogen Sulfide Sampling Programs: If the presence of methane and/or hydrogen sulfide is suspected, they should also be included in the analytical plan. After evaluating the initial soil gas data, the Agency may recommend that testing for methane or hydrogen sulfide cease.

A. Methane Sampling Program: Methane samples may be analyzed by a GC using modified EPA Method 8015B, EPA Method TO-3, or ASTM 3416M (EPA 3C), or by an appropriate hand-held instrument (e.g., Land Tech Gas Analyzer GA-90, Gas Emissions Monitor GEM-500, GEM-2000).

1. Detection Limit: The DL for methane analysis should not exceed 500 parts per million by volume (ppmv).
2. Methane Sample Containers: In addition to the gas-tight sample containers previously specified in Section 2.6.1, Tedlar™ bags may be used for collection of methane samples with a holding time of no more than 24 hours.
3. Methane Screening Level: 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 sites where methane is investigated and detected at a level of 5,000 ppmv or more, fixed and biogenic gas (O₂, CO₂, and CH₄) data should be obtained using a Thermal-Conductivity Detector (TCD) or a hand-held instrument.
5. To determine that the area is pressurized by migration of gases, pressure readings of each sampling tube system should be recorded in the field logs and reported along with the methane concentration.
6. Special GC Requirements: The GC method requires calibration curves for analytes such as methane since it is not a normal target analyte for such an analytical method.
7. Special Hand-Held Instruments Requirements: Hand-held instruments should be calibrated in accordance with the manufacture's instructions. When a hand-held instrument is used to analyze methane samples, the Agency recommends that at least 10 percent of all positive methane samples (e.g., more than 5,000 ppmv), rounded to the nearest whole number, be confirmed by another hand-held instrument (different unit or brand) or by a GC method.

B. Hydrogen Sulfide Sampling Program: Hydrogen sulfide may be analyzed by a GC using the South Coast Air Quality Management District (SCAQMD) Method 307-91 or EPA Method 16, or by an

appropriate hand-held instrument (e.g., LTX-310 calibrated for hydrogen sulfide or Jerome 631-X).

1. Detection Limit: The DL should be equal to or less than 0.5 ppmv or be sensitive enough to allow for a modeled ambient air concentration (at least one microgram per cubic meter) at the soil surface.
2. Holding Time: Hydrogen sulfide samples should be extracted directly into a hand-held analyzer within 30 minutes of collection to minimize the risk of losing the hydrogen sulfide due to reaction with active surfaces. If a hand-held instrument is not used, hydrogen sulfide samples should be analyzed as below:
 - a. Within 30 minutes of collection, using the GC procedures; or
 - b. Within 24 hours of collection, if a surrogate is added to the samples, or 100 percent duplicate samples are collected.
3. Sample Containers: The following sample containers are recommended:
 - a. Minimum one (1) liter black Tedlar™ bag fitted with polypropylene valves or the equivalent;
 - b. 100-ml gas-tight syringe fitted with an inert valve and wrapped in aluminum foil;
 - c. Gas-tight glass bulb wrapped in aluminum foil; or
 - d. Glass-lined or silicon coated Summa™ canister.
4. Precautions
 - a. Since hydrogen sulfide is extremely unstable in the presence of oxygen and moisture, contact of hydrogen sulfide samples with them should be avoided.
 - b. Due to the high reactivity of hydrogen sulfide gas, contact of hydrogen sulfide samples with metallic or other non-passive surfaces should be avoided during sample collection, storage and analysis.
 - c. Care must be taken so that GC components do not react with the sample. Typically glass-lined injection ports and Teflon™ tube packed columns are used to avoid loss of hydrogen sulfide due to reaction with active surfaces.

3.0 SOIL PARAMETERS

If the soil gas data will be used in a health risk assessment, an estimation of the indoor air concentration should be performed using soil gas data with an Agency approved or modified predictable indoor air model. Default values of input parameters may be used in accordance with the approved indoor air modeling guidance and in consultation with Agency staff. If default values are not used, site-specific soil parameters should be obtained as discussed below.

To assess health risk, indoor air quality, the threat of groundwater contamination from VOCs, or to evaluate the effectiveness of a proposed remedial technology, the following soil matrix parameters should be obtained from a minimum of three (3) sample locations (at depths* corresponding to or associated with the detected VOCs) for each soil type in association with the soil gas investigation:

- 3.1 Soil description performed and presented in accordance with the Unified Soil Classification System (USCS);
- 3.2 Density;
- 3.3 Organic carbon content of the soil** (by the Walkee Black Method);
- 3.4 Soil moisture;
- 3.5 Effective permeability***;
- 3.6 Porosity; and
- 3.7 Grain size distribution analysis (curve) and evaluation of fine-grained soil content (by wet sieve analysis and any supplementary methods as necessary) to determine the percent clay, silt and sand. (The grain size distribution analysis will be used to classify the soil in accordance with the U. S. Soil Conservation Service [SCS] soil type, which is the same as the U. S. Department of Agriculture soil type.)

* Samples may be collected from proposed depths at the continuously cored boring.

** This input parameter is required for soil matrix VOC samples only. This parameter sample should not be collected from an impacted area.

*** As an alternative, the measurements of saturated hydraulic conductivity may be used to estimate vapor permeability.

4.0 REFERENCES

Additional information may be found in the following documents:

American Society for Testing and Materials (ASTM), "Standard Guide for Soil Gas Monitoring in the Vadose Zone, ASTM Standard D 5314-92," January 1993; Reapproved 2001; website <http://www.astm.org>

California Regional Water Quality Control Board, Los Angeles Region, "Interim Guidance for Active Soil Gas Investigation," February 25, 1997

California Regional Water Quality Control Board, Los Angeles Region, "General Laboratory Testing Requirements for Petroleum Hydrocarbon Impacted Sites," June 22, 2000

U.S. Environmental Protection Agency, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA Publication SW-846, Third Edition," November 1986, as amended by Updates I (Jul. 1992), II (Sep. 1994), IIA (August 1993), IIB (Jan. 1995), III (Dec. 1996), IIIA (Apr. 1998), IVA (Jan. 1998) and IVB (Nov. 2000); website <http://www.epa.gov/SW-846/main.html>

U.S. Environmental Protection Agency, "U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, EPA 540/R-94/012," February 1994; website <http://www.epa.gov/region09/qa/superfundclp.html>

U.S. Environmental Protection Agency, "Soil Gas Sampling, SOP#: 2042, Revision #: 0.0," June 1, 1996; website http://www.ert.org/respns_resrcs/sops.asp

U.S. Environmental Protection Agency, "Summa Canister Cleaning Procedures, SOP #1703, Rev. #: 0.0," 09/01/94; website http://www.ert.org/respns_resrcs/sops.asp

California Environmental Protection Agency (Cal/EPA), Office of Environmental Health Hazard (OEHHA), Toxicity Criteria Database; website <http://www.oehha.ca.gov/risk/ChemicalDB/index.asp>

United States Environmental Protection Agency, Integrated Risk Information System (IRIS) Database; website <http://www.epa.gov/iris/>

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FOR MORE INFORMATION

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Figures – Soil Gas Probe Emplacement Methods

Figure 1 – Permanent/Semi-permanent Gas Probe Construction Diagram

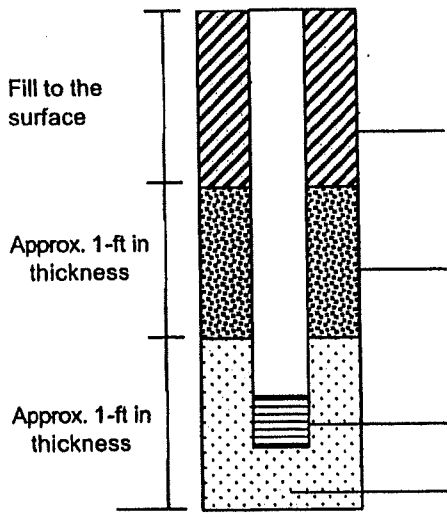
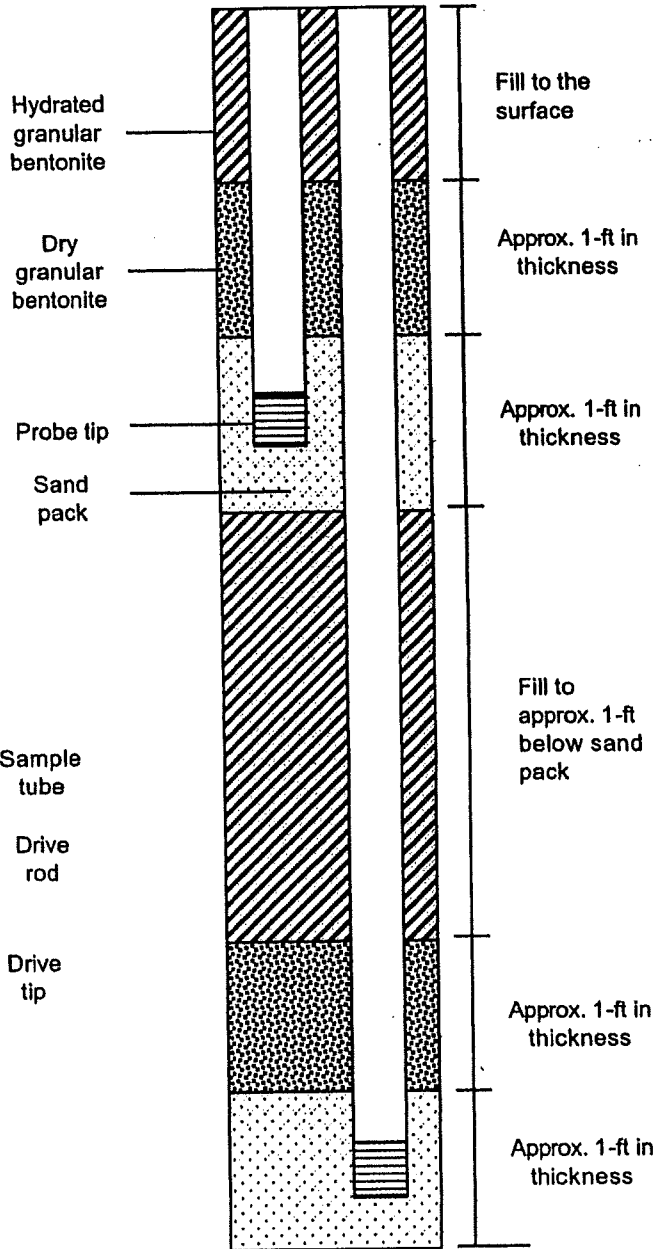


Figure 2 – Multi-depth Gas Probe Construction Diagram



Temporary Gas Probe Method

