APPENDIX A

REVISED FIELD SAMPLING PLAN

REVISED
FIELD SAMPLING PLAN

EXPANDED SOIL VAPOR EXTRACTION
PILOT TEST AT OPERABLE UNIT 2
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JET PROPULSION LABORATORY
PASADENA, CALIFORNIA

Contract Number N68711-97-D-8702
Delivery Order No. 0048

Prepared for:

Department of the Navy,
Southwest Division
Naval Facilities Engineering Command
1220 Pacific Highway
San Diego, California 92132-5187

Prepared by:

GEOFON, INC.
22632 Golden Springs Drive, Suite 270
Diamond Bar, California 91765

GEOFON Project No. 04-4304.480 May 10, 2002

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Prepared by: Brad Shojaee 5/10/02

Brad Shojaee — Date
GEOFON, Inc.
Project Geologist

Approved by: [signature] 5/10/02

Asrar Faheem, R.E.A. — Date
GEOFON, Inc.
Project Manager

Approved by: Steve Mulligan 5-10-02

Steve Mulligan — Date
GEOFON, Inc.
Quality Assurance Officer

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LIST OF ACRONYMS AND ABBREVIATIONS

APCL:	Applied Physics and Chemistry Laboratory
cc:	cubic centimeter
COC:	chain-of-custody
DOHS:	Department of Health Services
DOT:	Department of Transportation
ELAP:	Environmental Laboratory Accreditation Program
FID:	flame ionization detector
FSP:	Field Sampling Plan
GAC:	granular activated carbon
GEOFON:	GEOFON, Incorporated
IDW:	investigation derived waste
JPL:	Jet Propulsion Laboratory
LCS/LCSD:	laboratory control sample/laboratory control sample duplicate
MS/MSD:	matrix spike/matrix spike duplicate
NASA:	National Aeronautics and Space Administration
NFESC:	Naval Facilities Engineering Service Center
OD:	outside diameter
OU-2:	Operable Unit 2
PVC:	polyvinyl chloride
QC:	quality control
ROI:	radius of influence
RWQCB:	Regional Water Quality Control Board
SVE:	soil vapor extraction
SWDIV:	Southwest Division Naval Facilities Command
USEPA:	United States Environmental Protection Agency
VOCs:	volatile organic compounds

A.1 INTRODUCTION

This revised Field Sampling Plan (FSP) describes sampling activities to be performed by GEOFON Incorporated (GEOFON) during an expanded soil vapor extraction (SVE) pilot test for Operable Unit 2 (OU-2) at the National Aeronautics and Space Administration's (NASA) Jet Propulsion Laboratory (JPL) in Pasadena, California. The location and boundaries of the JPL site are shown on Figure A-1. A map of the facility is provided as Figure A-2.

The original FSP was prepared in December of 2000, for the continued operation of a SVE system at pilot test well VE-01. This FSP has been revised to include additional work that will be performed in association with an expanded pilot test that will be performed for OU-2. The additional work will include the following tasks:

- Drilling and installation of three additional vapor extraction wells (VE-02 through VE-04),
- Disconnecting the existing SVE equipment at Location 1 (VE-01) and transporting the equipment to Location 2 (VE-02),
- Equipment and utility connections at Location 2,
- SVE system operation at Location 2 for up to six (6) months, and
- Continued soil vapor monitoring following an established sampling frequency protocol.

A.1.1 Objectives

The objective of this FSP is to provide field sampling procedures and data gathering methods, including the field quality control procedures that will be used to confirm that the goals of the project have been met. These goals include:

- Perform an expanded pilot test at OU-2 to confirm the feasibility of using in-situ soil vapor extraction and provide design criteria for implementing a full-scale SVE system at the site.
- Collection and disposal of liquids generated during the operation of the SVE pilot system.
- Collection of periodic soil vapor samples at 32 nested monitoring wells to monitor the horizontal and vertical distribution of VOC vapors in the vadose zone.

The sampling program is also designed to satisfy the requirements of the Navy, which will review and approve this FSP. This document is intended for use as a reference by field personnel during field sampling activities.

A.1.2 Background

Site location, background information and previous site investigation information is presented in the Work Plan for Soil Vapor Extraction Pilot Test in Operable Unit 2 (FWENC, 1998).

A.2 SAMPLING STRATEGY

Three new vapor extraction wells (VE-02, VE-03, and VE-04) will be installed as part of an expanded pilot test that will be conducted at OU-2. Proposed locations of the new vapor extraction wells are included in Figure A-3. Each well will consist of multiple discrete screened intervals (i.e., multiple separate casings in the same borehole) with a bentonite seal between screens. The screens will be designated, shallowest to deepest, as Screen A, Screen B, and Screen C, etc. The deepest casing in each well will extend to the lowest recorded water elevation at each location.

After the new vapor extraction wells have been completed, the existing SVE unit will be moved from Location 1 (well VE-01) and connected to the well screens at Location 2 (well VE-02). The SVE unit will be operated continuously at Location 2 until performance objectives (i.e., VOC concentration reduction, asymptotic mass removal, and cost effectiveness) have been achieved, or for approximately six (6) months (whichever occurs first). Data collection activities that will be performed during this period of operation will include SVE system field monitoring, air permit compliance sampling, facility-wide soil vapor monitoring, and sampling of the investigation-derived waste. The following sections provide a description of the data collection activities that will be performed during the expanded SVE pilot test.

A.2.1 Soil Sampling

At the request of the United States Environmental Protection Agency (USEPA) Region IX, soil samples will be collected for perchlorate analysis during the installation of the new vapor extraction wells. Grab samples of the continuous soil core at each drilling location will be collected at 20-foot intervals, at major changes in lithology (i.e., confining layers), and immediately above the observed groundwater table. All soil samples will be shipped to the project laboratory under proper chain-of-custody protocol. At a minimum, soil samples collected at depths of 20 feet bgs, and every 40-foot-interval thereafter, will be analyzed for perchlorate using USEPA Method 314. Additional soil samples collected above major changes in lithology and above the observed groundwater table will also be analyzed. The remaining soil samples will be archived for possible analysis, if deemed necessary based on the results of the initial perchlorate analyses.

A.2.2 Soil Vapor Extraction System

Field measurements that will be collected during the pilot test will be divided into the following three categories:

- Extraction Well Data
- Monitoring Well Data
- Periodic Soil Vapor Sampling

Extraction well data will be collected at VE-02. These measurements will include vacuum pressures, flow rates, and extracted vapor concentrations prior to carbon treatment (influent) and after carbon treatment (effluent). In addition, laboratory samples will be collected at a minimum once every two weeks for the duration of the pilot test. All laboratory samples will be analyzed for volatile organic compounds (VOCs) using USEPA Method TO-14.

Monitoring well data will consist of vacuum response readings at 32 nested monitoring wells that were previously installed at the site. Each well has a series of depth specific probes (5 to 10 probes per well) where measurements will be taken. Monitoring well locations are shown on Figure A-3.

In addition, periodic soil vapor monitoring will be performed at the 32 monitoring wells. The soil vapor sampling frequency for each vapor monitoring well will be determined by using the vapor sampling frequency flow chart (Figure A-4). Table A-1 presents the soil vapor sampling frequencies based on the most recent laboratory data. The samples collected during the periodic soil vapor monitoring program will be analyzed for VOCs by a mobile laboratory using USEPA Method 8021B.

Data collected from the extraction and monitoring wells will be used to estimate physical design parameters, such as SVE flow rate from the extraction well, radius of influence (ROI) of the extraction well, and permeability of the soil to air flow. The data will also be used to evaluate VOC concentrations in extracted vapor and in the vadose zone.

A.2.3 Investigation Derived Waste

Investigation derived waste (IDW) sampling will be conducted on the wastes generated during the drilling activities and the operation of the SVE system. Liquid waste will be generated during decontamination activities associated with the installation of the new SVE wells and liquid waste from the system's moisture separator. Solid waste will include the spent granular activated carbon (GAC) and soil cuttings generated during the drilling activities.

The liquid waste will be collected and temporarily stored in labeled Department of Transportation (DOT)-approved 55-gallon drums and stored on-site in a secure storage area. One sample from the liquid waste at the site will be collected and analyzed for metals and VOCs. After reviewing the analytical results, the waste will be classified, transportation and disposal

options will be evaluated. GEOFON will procure a licensed waste disposal contractor, prepare manifests, schedule removal of the waste, and acquire certificates of disposal or certificates of treatment. All manifests will be reviewed and signed by an authorized representative from JPL.

A sample of the spent carbon will be collected during the transfer process (when first transfer occurs) and delivered to the disposal facility for analysis. Based on the results, disposal approval forms will be prepared and submitted to JPL for review and signature. The signed forms will be returned to the GAC disposal facility and an approval number will be obtained. The equipment vendor will use this approval number, along with the carbon analysis data, to complete waste manifest forms. These forms will be provided to JPL for review and signature a minimum of five working days prior to scheduled transportation of the waste. After the waste manifest forms have been signed, the equipment vendor's subcontractor will transport the GAC to the disposal facility for recycling.

A.3 SAMPLE ANALYSES

Soil vapor samples collected from the SVE influent and effluent will be transported to Advanced Technology Laboratories in the City of Industry, California for analysis using USEPA Method TO-14. Advanced Technology Laboratories is accredited by the California Department of Health Services (DOHS) through the Environmental Laboratory Accreditation Program (ELAP). Soil vapor samples collected from monitoring wells during the facility-wide periodic sampling events will be analyzed by an on-site laboratory provided by HP Labs in Escondido, California. All soil vapor samples will be analyzed by USEPA Method 8021B in accordance with Regional Water Quality Control Board (RWQCB) protocols.

Perchlorate soil samples and aqueous samples will be transported to Applied Physics and Chemistry Laboratory (APCL) located in Chino, California. APCL has successfully completed the Naval Facilities Engineering Service Center (NFESC) Laboratory Evaluation Program and California DOHS through the ELAP. The soil samples will be analyzed for perchlorate using USEPA Method 314.

A.3.1 Sample Containers, Preservatives, and Holding Times

Requirements for sample containers, preservation, and holding times are presented in Table A-2.

A.3.2 Field Quality Control Samples

Field quality control (QC) samples will be collected and analyzed during the project to assess the consistency and performance of the sampling program. Field QC samples for this project will consist of field duplicates and method/equipment blanks.

Field duplicates will consist of two samples (an original and a duplicate) of the same matrix collected at the same time and location, to the extent possible, using the same sampling techniques. During the periodic soil vapor monitoring events, field duplicates will be prepared and analyzed at a frequency of 1 per every 10 field samples (10 percent). Field duplicates will receive unique sample numbers; therefore, the identity of the duplicate samples is "blind" to the analytical laboratory. Exact locations of duplicate samples and their identifications will be recorded in the field logbook.

A.3.3 Laboratory Quality Control Samples

Each type of laboratory-based QC sample (including method blanks) will be analyzed at a rate of 5 % or one per batch (a batch is a group of 20 samples analyzed together), whichever is more frequent. QC samples will consist of laboratory duplicates, laboratory blanks, matrix

spike/matrix spike duplicates (MS/MSDs), and laboratory control sample/laboratory control sample duplicate (LCS/LCSDs), whichever is applicable, and any other method-required QC samples.

A.4 FIELD METHODS AND SAMPLING PROCEDURES

The following sections present the procedures for sampling, decontamination, sample numbering, sample labeling, sample packaging and shipment, sample documentation and field documentation.

A.4.1 Sample Collection Procedures

Grab soil samples will be collected from the continuous core generated during drilling activities to screen for the presence of perchlorate in the vadose zone. Soil vapor samples collected from the SVE unit will be collected using an electric sampling pump in conjunction with a Vac-U-Chamber™ sampling chamber to collect each sample into a Tedlar® bag. Facility-wide periodic soil vapor samples will be collected using a sampling syringe. In addition, aqueous samples of the decontamination water generated during drilling activities and during the operation of the SVE system will be collected and analyzed for waste characterization and disposal purposes. Details of each type of sampling are provided in the following subsections.

A.4.1.1 Soil Sampling

Soil samples will be collected using a lined core barrel sampler, which allows for the collection of continuous soil cores. The first step will be to advance the inner drill pipe and core barrel sampler to the desired sampling interval. The inner drill pipe is always advanced in front of the outer drill pipe. Once the inner drill pipe is set, the outer drill pipe will be advanced down over the inner pipe to hold the borehole open. The inner pipe and core barrel sampler will then be mechanically lifted by the drill head to the surface for core sample recovery. Grab soil samples will then be collected from the core barrel at the specified depth. The samples will be transferred from the core barrel to pre-cleaned, 4-ounce glass jars and stored in an ice-filled cooler maintained at about 4°C.

A.4.1.2 Extraction Well Sampling

Extraction well sampling will be performed at each of the extraction well screens that are operating during the course of the pilot test (i.e., Screens A, B, C, and etc.). Two types of extraction well samples will be collected: laboratory samples and field samples. All samples collected for submission to the laboratory will be collected into 1-liter Tedlar® bags, labeled, stored on site in a closed container to prevent exposure to sunlight, and transported to the lab at the end of each day for analysis on the following day.

An electric sample pump will be used in conjunction with the sampling chamber to collect each sample into a clean, unused Tedlar® bag. The Tedlar® bag will be placed within the chamber and connected in series between a sample valve and purge valve that are integral to the wall of the chamber. The air in the Tedlar® bag and chamber can then be evacuated through the one-way purge valve via an electric pump. After evacuating the air within the chamber and Tedlar® bag, the vacuum within the box allows a sample to be collected through the sample valve without the need for a sample pump.

The vapor extraction system will be fitted with individual valves to be used for collecting extraction well samples from each screened interval and the total influent. Valve SP-A will correspond to screen A, valve SP-B will correspond to screen B, valve SP-C will correspond to screen C, and valve SP-D will correspond to screen D, where applicable. Effluent vapor samples will be collected from a sampling port located at the SVE exhaust stack. Soil vapor samples from the SVE influent and effluent sample ports will be collected at a frequency of once every two weeks through the duration of the pilot test.

In addition to collecting samples to be submitted to the laboratory for analysis, extraction well samples will also be collected for field analysis with a flame ionization detector (FID) in order to monitor organic vapors at the influent and effluent of the system. These samples will be collected via the electric pump and Vac-U-Chamber™ assembly into a Tedlar® bag designated specifically for field samples. The sample will then be analyzed with a FID to determine the concentration of organic vapors inside the bag. In between field FID samples, the Tedlar® bag will be purged with ambient air and emptied.

A.4.1.3 Monitoring Well Sampling

Laboratory samples and field monitoring samples will also be collected from the 32 nested monitoring wells at the site. Soil vapor samples for laboratory analysis will be withdrawn from the soil through the sampling tips and 1/8-inch-outside diameter (OD) Nylaflow® tubing using calibrated, gas-tight, 60-cubic centimeter (cc) sterile syringes fitted with a three-way, on-off valve. Prior to collecting the soil vapor sample, four volumes of the length of the tubing will be purged to flush the tubing and fill it with in-situ soil vapor. Since each foot of tubing has an internal volume of 1 cc, the total volume purged will be easily measured with the calibrated syringes. Following purging, a 60-cc soil vapor sample will be collected in the syringe, the valve turned to the off position, put in a light tight box, and transferred immediately to the on-site mobile laboratory for analysis. Because the purge and sample volumes will be small for the laboratory analysis, a vacuum pump will not be required to evacuate the tubing or to collect a soil vapor sample.

Monitoring well samples may also be collected for field analysis with an FID. The samples will be collected in a similar fashion as described in Section 4.1.2. A battery-powered pump will be utilized for this process in conjunction with a sample chamber as described earlier. Samples will be collected into a dedicated Tedlar® bag. Each of the monitoring points will have a dedicated Tedlar® bag to collect each sample. The bags will be purged with ambient air in between samples. Each bag will be properly labeled with the corresponding monitoring-point designation.

A.4.1.4 Compliance Sampling

Compliance sampling will be performed during the course of the expanded pilot test. The purpose of compliance sampling is to ensure that the emissions from the extraction system do not exceed the limits stipulated in the air permit. The effluent from each carbon vessel will be collected into a Tedlar® bag, analyzed with an FID, and the results recorded.

The effluent conduit of each primary carbon vessel has been fitted with a sample valve. Sample valve SP-103 will correspond to the effluent of primary carbon vessel No. 1, while sample valve SP-104 will correspond to the effluent of primary carbon vessel No. 2. Since the carbon vessels are located downstream of the blower, the pressure exerted by the blower can be utilized to collect samples directly into a Tedlar® bag without the use of the sample pump and Vac-U-Chamber™ apparatus.

A.4.1.5 Liquid Waste Sampling

Liquid samples for waste characterization will be collected using disposable bailers. A new disposable bailer will be lowered into the 55-gallon drum and allowed to fill. Water from the bailer will then be transferred to new, pre-cleaned bottle(s) with the appropriate preservative provided by the analytical laboratory. The samples will be labeled and packaged for laboratory submittal.

A.4.2 Sampling Equipment Decontamination Procedure

If non-disposable sample equipment is used, the following procedures for decontamination of sampling equipment will be performed:

1. Wash with non-phosphate detergent.
2. Rinse with tap-water.
3. Deionized/distilled water rinse.
4. Deionized/distilled water rinse (twice).

A.4.3 Sample Identification

All samples submitted to the analytical laboratory will be uniquely numbered. Samples collected from the SVE system during operation will be numbered according to the following format:

VEAA-B-CCC-DDD

Where AA is the vapor extraction well number, B denotes the screen interval or sample location, CCC is the week of operation; and DDD is a sequential number generated at the time of sample collection.

Samples collected from the soil vapor monitoring wells will be numbered according to the following format:

SVWAA-VPBB-CCC

Where AA is the monitoring well number, BB denotes the vapor probe designation, and CCC is a sequential number generated at the time of sample collection.

A complete description of the sample and sampling conditions will be recorded in the field logbook and referenced to the unique sample identification number.

A.4.4 Sample Labeling

Sample labels will be filled out with indelible, waterproof black ink, and will be affixed to each sample container that will be shipped to an off-site laboratory for analysis. Each sample container used for soil vapor sampling will be labeled at a minimum with the following information:

- Sample identification number;
- Sample collection date (month/day/year);
- Time of collection (24-hour clock);
- Site location;
- Project number;
- Sampler's initials; and
- Analyses to be performed.

The 60-cc syringes that will be used for soil vapor sampling of the vapor monitoring wells will be labeled with the following information:

- Sample identification number;

- Time of collection (24-hour clock); and
- Well purge volume.

A.4.5 Sample Packaging and Shipment

Soil samples collected during the installation of the vapor extraction wells will be placed in an ice-filled cooler maintained at about 4°C. Sufficient packing material will be placed between the sample jars to prevent damage during shipment. The samples will be hand-delivered to the project laboratory no later than 48 hours after collection.

Immediately after soil vapor sample collection, sample labels will be affixed to each sample container. The Tedlar® bags will be temporarily stored on-site in a closed container to prevent exposure to sunlight. The samples will be transported to the laboratory at the end of each day for analysis on the following day. Soil vapor samples will be analyzed within 72 hours of collection.

Soil vapor samples collected in the 60-cc sterile syringes will be placed in a closed container and immediately transferred to the on-site laboratory after collection. It is intended that analysis of the samples will begin within 15 minutes of collection.

A.4.6 Field Documentation

At a minimum, sampling information will be recorded on a chain-of-custody form and in the field logbook. Both documents will be completed in the field at the time of sample collection. All entries will be legible and will be recorded in indelible black ink.

A.4.6.1 Chain-of-Custody Documentation

Chain-of-custody (COC) documentation is required for each sample to track sample collection, shipment, laboratory receipt, custody, and disposal. The COC form will be used to record the samples taken and the analyses requested. Information recorded will include:

- Client name, address, telephone number, and fax number;
- Name of GEOFON contact;
- Name of analytical laboratory;
- Site name;
- Project name;
- Project number;
- Sample identification number;

- Time and date of sample collection;
- Container size and type;
- Type of sample (i.e., soil, water, vapor, etc.);
- Preservatives;
- Analyses requested;
- Sampler's signature; and
- Any other project-specific instructions to the laboratory.

The top two copies of the completed COC form will accompany the samples to the analytical laboratory, and the remaining copy will be kept for project files.

The COC form will be signed by each individual who has the samples in their possession. A sample is considered to be in one's custody if it is:

- In actual possession or in view of the person who collected the sample;
- Locked in a secure area; or
- Placed in an area restricted to authorized personnel.

If the samples are transported to an analytical laboratory by a commercial shipping company, the waybill or airbill number will be noted on the COC form. The waybill or airbill serves as an extension of the COC.

A.4.6.2 Field Logbook

Proper and accurate documentation in the field logbook is necessary to prevent misidentification of samples, and to facilitate interpretation of analytical results. A field logbook is bound with consecutively-numbered pages and is assigned to a specific person who is responsible for entry of information into the logbook. The logbook will be signed and dated by this person prior to initiation of fieldwork. All entries into the logbook will be executed by this designated person in indelible ink. Corrections to erroneous data will be made by crossing a line through the entry and entering the corrected information. The correction will be initialed and dated by the person making the entry. At the end of each workday, logbook pages will be signed and dated by the person. Unused portions of logbook pages will be crossed out, signed, and dated. A copy of the COC and the custody seal is included as Attachment A-1.

If it is necessary to transfer the logbook to another person during the course of field work, the person relinquishing the logbook will sign and date the logbook at the time it is transferred, and the person receiving the logbook will do likewise.

Information recorded in the logbook will include the following:

- Project name and location;
- Date and time;
- General weather information;
- Work performed;
- Field observations;
- Sampling performed; including specifics such as location, type of samples, type of analyses, and sample identification;
- Field analyses performed; including results, instrument checks, any problems, and calibration records for the field instrumentation;
- Descriptions of deviations from the FSP;
- Problems encountered and corrective actions taken;
- Identification of primary field and QC samples;
- QC activities; and
- Verbal or written instructions.

A.4.6.3 Document Correction

Changes or corrections on any project documentation will be made by crossing out the item with a single line, initialing, and dating next to the correction by the person performing the correction. The new information will be written above the crossed-out item. Corrections must be written clearly and legibly with indelible ink.

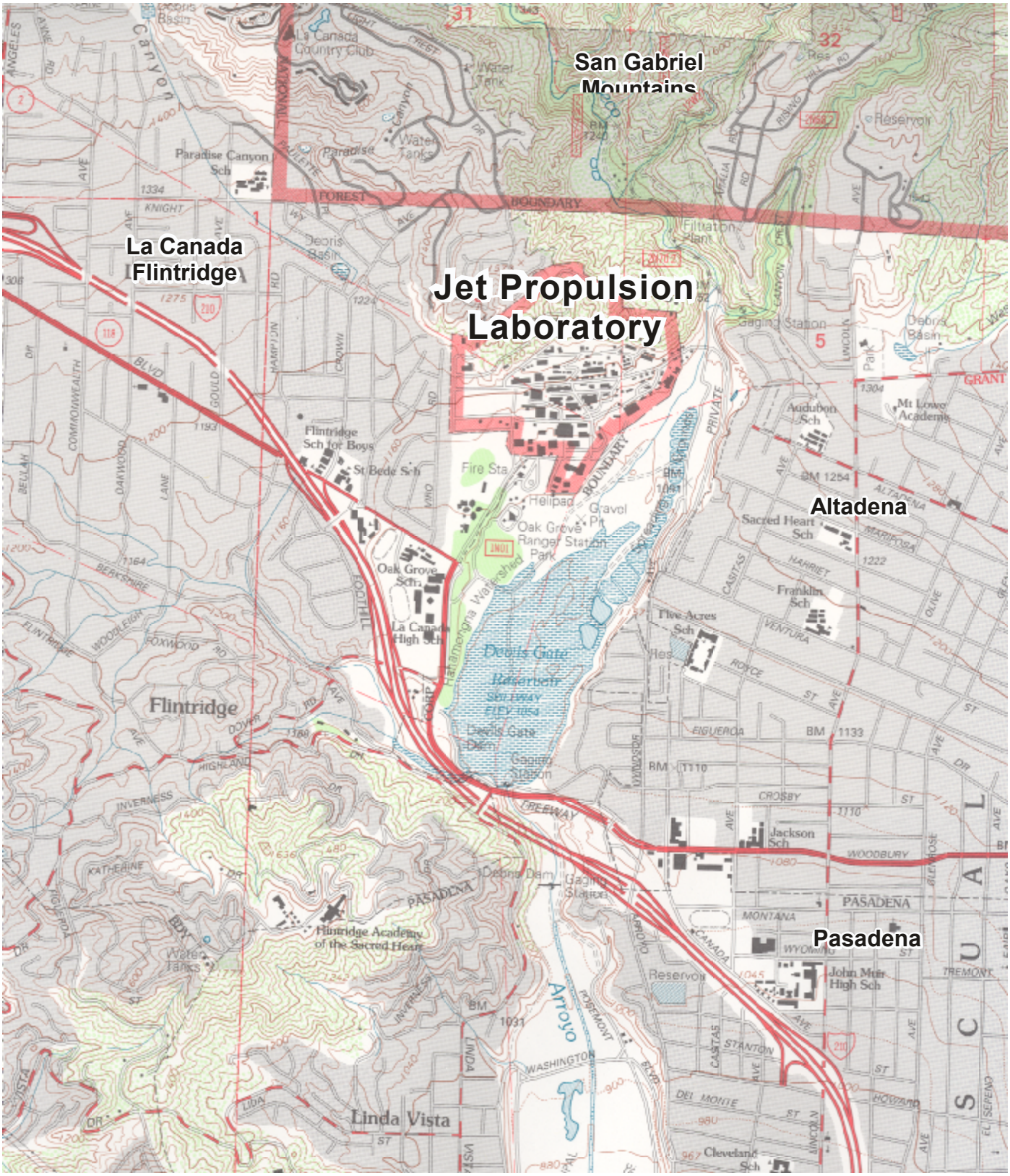
A.5 REFERENCES

Foster Wheeler, 1998. *Draft/Final Work Plan for the Soil Vapor Extraction Pilot Test in Operable Unit 2, National Aeronautics and Space Administration Jet Propulsion Laboratory, Pasadena, California*, May.

U.S. Environmental Protection Agency (USEPA), 1997. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods (SW-846) Update III*, June.

U.S. Navy/Marine Corps Installation Restoration Manual, August 2000.

FIGURES



Scale in Miles

0 0.5 1

N

SOURCE: USGS Pasadena 7 1/2-Minute Quad, 1995

SITE LOCATION MAP
FIGURE A-1

Jet Propulsion Laboratory
Pasadena, California

GEOFON

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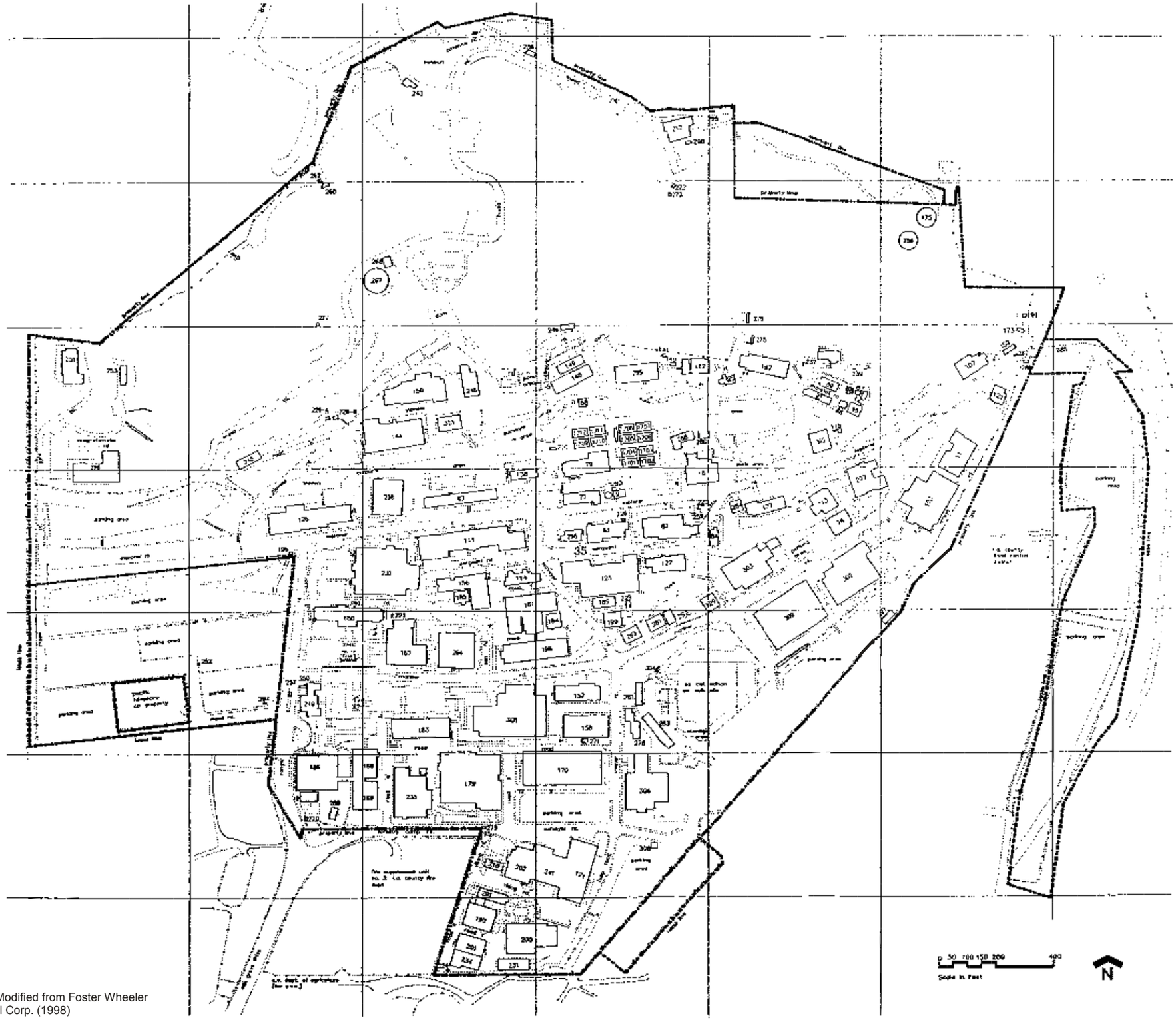

Note: Figure Modified from Foster Wheeler Environmental Corp. (1998)

SITE FACILITY MAP
FIGURE A-2

Jet Propulsion Laboratory
Pasadena, California

GEOFON

Date: May 2002
Contract No.: N68711-97-D-8702
DO No.: 0048

EXPLANATION

- ●[1] APPROXIMATE LOCATION OF SOIL VAPOR MONITORING WELL INSTALLED DURING RI INVESTIGATION
- ▲ VE-01 APPROXIMATE LOCATION OF EXISTING SOIL VAPOR EXTRACTION WELL
- ■ VE-02 PROPOSED LOCATION OF ADDITIONAL SOIL VAPOR EXTRACTION WELLS

Note: Figure Modified from Foster Wheeler Environmental Corp. (1998)

EXISTING AND PROPOSED SVE AND MONITORING WELL LOCATION MAP
FIGURE A-3

Jet Propulsion Laboratory
Pasadena, California

GEOFON

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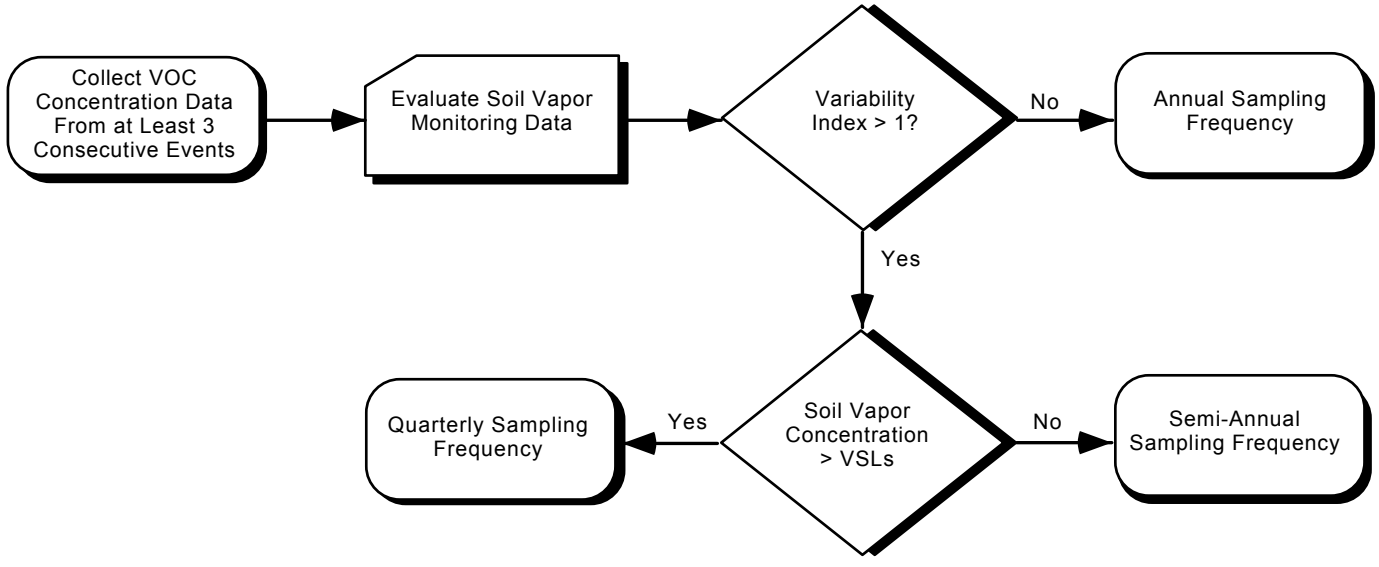

Variability Index

$$\text{Variability Index} = \frac{\text{Concentration Range Over the Past 3 or 4 Events}}{\text{Median Concentration}}$$

VAPOR SAMPLING FREQUENCY FLOW CHART

FIGURE A-4

Jet Propulsion Laboratory
Pasadena, California

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