

**NINTH PERIODIC SOIL VAPOR
SAMPLING RESULTS
FEBRUARY 2002**

AT THE

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JET PROPULSION LABORATORY
PASADENA, CALIFORNIA**

Contract No. 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**

Prepared by:

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

**NINTH PERIODIC SOIL VAPOR
SAMPLING RESULTS
FEBRUARY 2002**

AT THE

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JET PROPULSION LABORATORY
PASADENA, CALIFORNIA**

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

Prepared by: Anthony Ford 4/3/02
Anthony Ford Date
GEOFON, Inc.
Senior Geologist

Approved by: Asrar Faheem 4/3/02
Asrar Faheem, R.E.A. Date
GEOFON, Inc.
Project Manager

TABLE OF CONTENTS

	Page
LIST OF FIGURES	i
LIST OF TABLES	ii
LIST OF APPENDICES	ii
ACRONYMS AND ABBREVIATIONS	iii
1.0 INTRODUCTION.....	1-1
2.0 SOIL VAPOR SAMPLING PROCEDURES	2-1
3.0 ANALYTICAL RESULTS	3-1
4.0 CONCLUSIONS	4-1
5.0 QUALITY ASSURANCE AND QUALITY CONTROL	5-1
6.0 REFERENCES.....	6-1

LIST OF FIGURES

Figure 1-1	Locations of Soil Vapor Monitoring Wells Sampled
Figure 3-1	Carbon Tetrachloride Concentrations at Depth
Figure 3-2	Freon 113 Concentrations at Depth
Figure 3-3	Trichloroethene Concentrations at Depth
Figure 3-4	1,1-Dichloroethene Concentrations at Depth
Figure 3-5	Total VOC Concentrations at Depth

LIST OF TABLES

Table 1-1	Summary of Soil Vapor Sampling Frequency
Table 2-1	Summary of Construction Details for Soil Vapor Monitoring Wells
Table 2-2	Summary of Primary Target Compounds for Analyses Performed on Soil Vapor Samples
Table 3-1	Summary of Soil Vapor Results, Ninth Periodic Sampling Event
Table 4-1	Revised Summary of Soil Vapor Sampling Frequency

LIST OF APPENDICES

Appendix A	Soil Vapor Data Validation Report, Ninth Periodic Sampling Event
Appendix B	B-1 Results of Soil Vapor Analyses
	B-2 Chain-of-Custody Forms
	B-3 Initial Three-Point Calibration Data
	B-4 Daily Opening, Closing, and Continuing Calibration Verification Reports
Appendix C	Summary of Soil Vapor Results, All Periodic Sampling Events Completed to Date

ACRONYMS AND ABBREVIATIONS

Bgs:	below ground surface
cc:	cubic centimeter
CCl ₄ :	carbon tetrachloride
CDHS:	California Department of Health Services
CRWQCB:	California Regional Water Quality Control Board
%D:	percent difference
DCE:	dichloroethene
Freon 11:	trichlorofluoromethane
Freon 113:	1,1,2-trichloro-1,2,2-trifluoroethane
FWENC:	Foster Wheeler Environmental Corporation
GC:	gas chromatograph
GEOFON:	GEOFON, Incorporated
JPL:	Jet Propulsion Laboratory
NASA:	National Aeronautics and Space Administration
OD:	outside diameter
OU-2:	Operable Unit 2
PCE:	tetrachloroethene
QA/QC:	quality assurance/quality control
RI:	remedial investigation
TCA:	trichloroethane
TCE:	trichloroethene
µg/L:	micrograms per liter
VOC:	volatile organic compound

1.0 INTRODUCTION

Presented in this report are the results of the ninth periodic soil vapor sampling event completed as part of the periodic monitoring program being conducted at the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL) for Operable Unit 2 (OU-2) (on-facility soils). The purpose of this program is to monitor the horizontal and vertical distributions of volatile organic compound (VOC) vapors in the vadose zone beneath the JPL site. From February 11 through February 20, 2002, GEOFON, Inc. (GEOFON) personnel collected soil vapor samples from selected soil vapor monitoring probes in well Nos. 1 through 18, 26, 27, and 30 through 39. The locations of the soil vapor monitoring wells are shown in Figure 1-1. The set of soil vapor monitoring wells included in this sampling event is based on the soil vapor sampling frequency developed for the periodic monitoring program. A summary of the soil vapor sampling frequency is presented in Table 1-1.

All soil vapor samples collected during this event were analyzed for VOCs by HP Labs in an on-site laboratory that is certified by the California Department of Health Services (CDHS). The analyses were performed in accordance with EPA Method 8021 and the California Regional Water Quality Control Board, Los Angeles Region (CRWQCB), protocols and guidance.

Sampling procedures are described in Section 2.0, and a summary of all VOCs detected during this ninth periodic soil vapor sampling event, including locations and depths, is contained in Section 3.0. Conclusions are provided in Section 4.0. A soil vapor data validation report for all samples analyzed during this sampling event is included in Appendix A and summarized in Section 5.0. Cited references are listed in Section 6.0. Laboratory reports for all samples analyzed, along with chain-of-custody forms, are included in Appendix B. The initial three-point calibration data and the daily calibration verification standards for each day's sampling are also included in this appendix. Appendix C contains a summary of soil vapor sampling results from all events conducted during the periodic monitoring program.

2.0 SOIL VAPOR SAMPLING PROCEDURES

From February 11 through February 20, 2002, soil vapor samples were collected and analyzed from soil vapor monitoring well Nos. 1 through 12, 14, 15, 17, 26, 27, Nos. 30 through 33, and Nos. 35 through 39. All sampling ports were plugged in monitoring wells 13, 16, 18, and 34, preventing the collection of soil vapor samples during this sampling event. A description of the soil vapor well construction procedures was presented in the first long-term soil vapor sampling report prepared for OU-2 (FWENC, 2000a). Well construction details are summarized in Table 2-1 of this report. Ninety four (94) depth-specific vapor samples, including fifteen (15) duplicate samples, were collected and analyzed for 25 primary target VOC compounds in accordance with the CRWQCB (1997) guidance.

Soil vapor samples were 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 were 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 was easily measured with the calibrated syringes. Following purging, a 60-cc soil vapor sample was collected in the syringe, the valve was turned to the off position, and the sample was immediately transferred to the on-site mobile laboratory for analysis. During sampling, neither water vapor nor condensation was observed in the transparent sampling syringes. Because the purge and sample volumes were small, a vacuum pump was not required to evacuate the tubing or to collect a soil vapor sample. To demonstrate reproducibility of results, a duplicate soil vapor sample was collected and analyzed after every five environmental samples.

The samples were analyzed on-site in a mobile laboratory certified (Certification No. 1667) by the CDHS to perform analyses by EPA Method 8021 for the parameters listed in Table 2-2. The time between sample collection and analysis was, at most, only a few minutes.

3.0 ANALYTICAL RESULTS

The results from the previous remedial investigation (RI) for OU-2 (FWENC, 1999) indicated that four VOCs were more frequently detected in soil vapor samples at elevated concentrations relative to other VOCs. These four VOCs are carbon tetrachloride (CCl₄), 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113), trichloroethene (TCE), and 1,1-dichloroethene (1,1-DCE). Freon 113, CCl₄, and TCE were detected in most soil vapor samples, where VOCs were present, and were frequently the only VOCs present.

The VOCs most frequently detected during this ninth periodic sampling event were, as in the past, CCl₄, Freon 113, TCE, and 1,1-DCE. The CCl₄, Freon 113, TCE, and 1,1-DCE concentrations ranged from 1 to 7.3 micrograms per liter of vapor (µg/L-vapor), 1.1 to 9.5 µg/L-vapor, 1.2 to 8.9 µg/L-vapor, and 1.3 to 2 µg/L-vapor, respectively. In general, concentrations of CCl₄, TCE, and 1,1-DCE measured during this event are lower than those measured during the previous sampling event conducted in November 2001 (GEOFON, 2001c). Furthermore, many concentrations measured during this event are substantially lower than those measured during the OU-2 RI. Freon 113 was the only chemical that was detected at higher concentrations during this event, as compared to the November 2001 results. Freon 113 was detected at a concentration of 8.1 µg/L-vapor at a depth of 155 feet in well No. 32, as compared to the concentration of 4.1 µg/L-vapor that was reported at the same location during the November 2001 event.

Two other VOCs, 1,1,1-trichloroethane (1,1,1-TCA), and tetrachloroethene (PCE), were also detected during this sampling event. 1,1,1-TCA was detected in one well (No. 36) at a depth of 55 feet below ground surface (bgs), and PCE was detected in one well (No. 17) at a depth of 36 feet bgs. Concentrations of these compounds were generally low relative to those of other compounds detected (1,1,1-TCA: 4.3 µg/L-vapor, and PCE: 1.6 µg/L-vapor). Compared to the previous vapor sampling event (November 2001), 1,1,1-TCA and PCE concentrations decreased during this sampling event from 6.9 to 4.3 µg/L-vapor and from 2.9 to 1.6 µg/L-vapor, respectively. Chloroform and trichlorofluoromethane (Freon 11), which have been detected in prior events, were not detected during this event.

A summary of the analytical results for all samples collected during this sampling event is presented in Table 3-1, and the laboratory reports for each day's sampling are presented in Appendix B-1. Chain-of-custody forms are included in Appendix B-2. Data from all periodic monitoring events conducted to date are tabulated in Appendix C.

Locations of detections with depth for CCl₄, Freon 113, TCE, and 1,1-DCE are shown in Figures 3-1, 3-2, 3-3, and 3-4, respectively. Total VOC concentrations with depth are presented in Figure 3-5.

4.0 CONCLUSIONS

The following conclusions are based on the results of the soil vapor sample laboratory analyses and the site conditions at the time of the sampling:

- Nine soil vapor monitoring probes that were sampled during the November 2001 sampling event were plugged during this event. The locations of the newly plugged probes include well No. 2 (37 feet), well No. 6 (60 feet), well No. 26 (180 feet), well No. 31 (45 feet), well No. 34 (118 feet), well No. 35 (60 feet), and well No. 38 (25, 45, and 80 feet).
- The vapor monitoring probe located at a depth of 95 feet in well No. 38 was reported to be plugged during previous sampling events. However, the probe was open during this event, and a soil vapor sample was collected.
- The VOCs (i.e., CCl_4 , TCE, 1,1-DCE, and 1,1,1-TCA) detected during this ninth periodic sampling event were generally lower than those measured during the prior sampling events and those measured during the OU-2 RI.
- In addition to the above VOCs, PCE was also detected at a depth of 36 feet bgs in one soil vapor monitoring well (No.17) at a low concentration of 1.6 $\mu\text{g/L}$ -vapor.
- VOCs were not detected above the laboratory method detection limit in soil vapor monitoring well Nos. 1 through 3, 5 through 8, 11 through 16, 27, 30, 31, and 38.
- Based on the results of soil vapor samples collected during this sampling event, VOC concentrations generally continue to decline throughout the site. However, a slight increase of Freon 113 was reported at a depth of 100 feet bgs at soil vapor monitoring well No. 39. Compared to the previous vapor sampling event (November 2001), the Freon 113 concentrations increased during this sampling event from 4.1 to 8.1 $\mu\text{g/L}$ -vapor in well No. 32.
- This sampling event represents the third consecutive quarter that soil vapor samples have been collected from monitoring well Nos. 1 through 17, 30, and 31. The data collected during the last three quarters was evaluated using the vapor sample frequency flow chart

presented in the technical memorandum for implementation of soil vapor extraction at JPL (Battelle, 2001). Based on the results of the data evaluation, GEOFON recommends conducting one additional quarterly sampling event at well Nos. 2, 4, 10, and 17. The results of the data evaluation are summarized in Table 4-1.

5.0 QUALITY ASSURANCE AND QUALITY CONTROL

This section briefly summarizes the quality assurance and quality control (QA/QC) procedures followed during the ninth periodic soil vapor sampling event. Analytical data reports for all soil vapor samples were sent to Laboratory Data Consultants, located in San Diego, California, for independent data evaluation. All data were usable as qualified. The validated data reports are presented in Appendix A, Soil Vapor Data Validation Report.

All sample analyses were performed using an external, three-point standard calibration method (Appendix B-3). For most target analytes, both detectors on the gas chromatograph (GC) were calibrated over a range equivalent to 5 to 200 µg/L analyte in soil vapor. Analytical system performance was verified at the beginning of each analytical day with an "opening standard" and a "closing standard" after the last environmental sample analysis for the day. A "continuing standard" was analyzed after the tenth environmental sample run that day. If ten or fewer samples were analyzed during the day, the closing standard substituted for the continuing standard. Results of the daily opening, closing, and continuing (if applicable) standards are presented in Appendix B-4.

During, each analytical day, the environmental sample analyses were bracketed by check standards, which verified acceptable system performance for the analytes listed in the daily calibration data summary tables (Appendix B-4). The percent difference (%D) of calibration factors in continuing standard mixtures were less than or equal to 20 percent for selected compounds and less than or equal to 15 percent for all other compounds (see Appendix B-4).

Field blanks of ambient air from inside the field laboratory trailer were analyzed immediately after the opening verification standard and were clean in all cases. No matrix spikes or laboratory replicates were required.

Two surrogate compounds (1,4-difluorobenzene and 4-bromofluorobenzene) were injected into the GC along with the environmental samples as a QA/QC check on recovery limits. In accordance with RWQCB (1997) protocols, surrogate recoveries should be in the range of 75 to 125 percent. All surrogate recoveries obtained during this sampling event satisfied this criteria by a wide margin, usually within a recovery range of 85 to 115 percent.

No sample analysis data obtained during this sampling event were rejected as unusable. Overall, the assessment of soil vapor and corresponding control sample data indicate that data quality objectives were achieved in terms of precision, accuracy, representativeness, comparability, and completeness for all analytes sampled.

6.0 REFERENCES

- Battelle. 2001. *Technical Memorandum, Design, Construction, Operation, Optimization, and Monitoring Recommendations for the Soil Vapor Extraction (SVE) System, Operable Unit 2 (OU-2), Jet Propulsion Laboratory*. October
- FWENC (Foster Wheeler Environmental Corporation). 1999. *Final Remedial Investigation Report for Operable Unit 2: Potential On-Site Contaminant Source Areas*. Volume 1. November.
- FWENC (Foster Wheeler Environmental Corporation). 2000a. *First Long-Term Soil Vapor Sampling Results, October 1998*. February.
- FWENC (Foster Wheeler Environmental Corporation). 2000b. *Second Long-Term Soil Vapor Sampling Results, October 1998*. February.
- FWENC (Foster Wheeler Environmental Corporation). 2000c. *Third Long-Term Soil Vapor Sampling Results, October 1998*. March.
- FWENC (Foster Wheeler Environmental Corporation). 2000d. *Fourth Long-Term Soil Vapor Sampling Results, January 2000*. April.
- FWENC (Foster Wheeler Environmental Corporation). 2000e. *Fifth Long-Term Soil Vapor Sampling Results, June 2000*. September.
- GEOFON (GEOFON, Inc.). 2001a. *Sixth Long-Term Soil Vapor Sampling Results, January 2001*. February.
- GEOFON (GEOFON, Inc.). 2001b. *Seventh Periodic Soil Vapor Sampling Results, July 2001*. November
- GEOFON (GEOFON, Inc.). 2001c. *Eighth Periodic Soil Vapor Sampling Results, November 2001*. January
- CRWQCB (California Regional Water Quality Control Board, Los Angeles Region). 1997. *Interim Guidance for Active Soil Gas Investigation*. February 25.