LA-SUB--96-99-Pt. 1

Final Report
DOE Subcontract No. 63545L0014-31

***Ambient Monitoring of Volatile
Organic Compounds at Los Alamos
National Laboratory in
Technical Area 54, Areas G & L***

Prepared by:

***Radian Corporation
8501 Mo-Pac Boulevard
P.O. Box 201088
Austin, Texas 78720-1088***

Technical Collaboration:

***Dr. Erik L. Vold
CST-14 Solid Radioactive Waste Management
Los Alamos National Laboratory
Los Alamos, New Mexico 87545***

MASTER

RADIAN
INTERNATIONAL LLC

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

**Portions of this document may be illegible
in electronic image products. Images are
produced from the best available original
document.**

RCN 640-015-01-03
DCN 95-640-015-05

RADIAN
INTERNATIONAL LLC

(Mailing) P.O. Box 201088
Austin, TX 78720-1088
(Shipping) 8501 N. Mopac Blvd.
Austin, TX 78759
(512) 454-4797

**Ambient Monitoring of
Volatile Organic Compounds at
Los Alamos National Laboratory
in Technical Area 54, Areas G and L**

Final Report

DOE Contract No. 6355L0014-31

Prepared by:

**Steve Mischler/Eric Anderson
Radian Corporation
8501 Mo-Pac Boulevard
P.O. Box 201088
Austin, Texas 78720-1088**

Technical Collaboration:

**Dr. Erik L. Vold
CST-14 Solid Radioactive Waste Management
MS J595
Los Alamos National Laboratory
Los Alamos, New Mexico 87545**

March 15, 1994

TABLE OF CONTENTS

		Page
	Abstract	vi
1.0	INTRODUCTION	1-1
	1.1 Background	1-1
	1.2 Site Description	1-1
	1.3 Description of Task Objective	1-3
	1.4 Approach	1-3
2.0	TECHNICAL APPROACH	2-1
	2.1 Sampling Sites	2-1
	2.2 Sampling Frequency, Period, and Duration	2-1
	2.3 Sampling Equipment and Procedures	2-1
	2.4 Analytical Equipment and Procedures	2-5
	2.5 Quality Control Procedures	2-6
3.0	RESULTS	3-1
4.0	DISCUSSION OF RESULTS	4-1
	4.1 Meteorological Parameters and Air Quality	4-1
5.0	CONCLUSIONS AND RECOMMENDATIONS	5-1
	5.1 Conclusions	5-1
	5.2 Recommendations	5-2
6.0	REFERENCES	6-1

LIST OF FIGURES

		Page
2-1	Diagram Showing Sampling Locations around Area G and Area L	2-2
2-2	Location of Background Site at Bandelier National Monument	2-3
2-3	Diagram of VOC Sampling System	2-4
3-1	Wind Rose from June 16, 1994	3-17
3-2	Wind Rose from June 17, 1994	3-18
3-3	Wind Rose for June 29, 1994	3-19
3-4	Wind Rose for June 30, 1994	3-20
3-5	Wind Rose for July 28, 1994	3-21
3-6	Wind Rose for August 1, 1994	3-22
3-7	Wind Rose for August 2, 1994	3-23
3-8	Wind Rose for August 3, 1994	3-24
4-1	Diagram of Areas G and L Showing Wind Rose and VOC Concentrations for June 16, 1994.	4-2
4-2	Diagram of Areas G and L Showing Wind Rose and VOC Concentrations for June 17, 1994.	4-3
4-3	Diagram of Areas G and L Showing Wind Rose and VOC Concentrations for June 29, 1994.	4-4
4-4	Diagram of Areas G and L Showing Wind Rose and VOC Concentrations for June 30, 1994.	4-5

LIST OF FIGURES (Continued)

	Page
4-5 Diagram of Areas G and L Showing Wind Rose and VOC Concentrations for July 28, 1994.	4-6
4-6 Diagram of Areas G and L Showing Wind Rose and VOC Concentrations for August 1, 1994.	4-7
4-7 Diagram of Areas G and L Showing Wind Rose and VOC Concentrations for August 2, 1994	4-8
4-8 Diagram of Areas G and L Showing Wind Rose and VOC Concentrations for August 3, 1994	4-9
4-9 TNMHC Concentrations vs. Maximum Daily Temperature.	4-10
4-10 Maximum Observed Values as a Percent of Action Level (TWA/100)	4-18

LIST OF TABLES

	Page
3-1	VOC Ambient Air Concentrations at Point 1 3-2
3-2	VOC Ambient Air Concentrations at Point 2 3-5
3-3	VOC Ambient Air Concentrations at Point 4 3-8
3-4	VOC Ambient Air Concentrations at Point 5 3-11
3-5	VOC Ambient Air Concentrations at the Bandelier Site 3-14
4-1	Summary of Selected VOC Concentrations 4-11
4-2	Comparison of TNMHC Concentrations during Episode 1 and Episode 2. 4-13
4-3	Maximum TWAs/100 Concentrations at each Site Versus 4-14
4-4	Precision Estimate Results for VOC Measurements at LANL 4-19
5-1	Summary of Means and Confidence Intervals for Selected VOCs 5-2

Ambient Monitoring of Volatile Organic Compounds
at LANL in TA-54, Areas G & L

Abstract

Ambient air monitoring for volatile organic compounds (VOCs) was conducted at TA-54 to characterize non-radioactive air emissions to determine if the Laboratory's waste operations are releasing significant amounts of VOCs to the ambient environment. Samples were collected at four locations along the northern fenceline (dominant downwind side) of Areas G & L and at a background site located in Bandelier National Monument. Eight-hour integrated samples were collected in evacuated canisters during daylight hours on each of eight days during the summer of 1994, for a total of 40 samples. The samples were analyzed by gas chromatography following EPA Method TO-14 for a target list of 68 analytes.

In general, about two dozen volatile organic compounds (VOCs) were identified in each sample, including those collected at the background site, but the concentration levels were very low (e.g.; < 1 to 10 ppbv). The average total non-methane hydrocarbon (TNMHC) concentration ranged from 4.3 to 22.8 ppbv at the Area G and L sites as compared with an average of 4.2 ppbv at the background site. The measured concentrations were compared with action levels developed by the New Mexico Environment Department and were well below the action levels in all cases. Methanol and benzene were the only compounds that ever exceeded 1 % of the action level. The measured VOC concentrations were collected during the warmest months of the year and therefore should represent worst-case air impacts. Based on the results of this study, VOC emissions from Areas G and L have an insignificant impact on local air quality and pose no health risk to workers or nearby populations.

1.0 INTRODUCTION

Radian Corporation was contracted by Los Alamos National Laboratory (LANL) to conduct an ambient air monitoring study at Technical Area 54 (TA-54). Samples were collected from two sites within Area G, two sites around Area L, and one background site, located at LANL's background monitoring site in Bandelier National Park. A total of eight sample sets were collected, with four sets collected during June and four more collected the latter part of July and early August. Samples were collected in SUMMA[®] polished stainless steel canisters and analyzed for selected volatile organic compounds (VOCs). This report presents the results from the monitoring study.

1.1 Background

Los Alamos National Laboratory has operated a solid, low-level radioactive disposal facility in Area G of Technical Area 54, since 1957. A smaller adjacent disposal area, designated Area L, is used for the storage of low-level mixed waste. Various types of wastes have historically been disposed of in TA-54, including tritium waste, transuranic element (TRU) waste, volatile organic compounds such as solvents, and mixed waste. Currently, however, only low-level radioactive waste is disposed of in TA-54. The waste disposal practices in these areas are designed to contain the waste and prevent or minimize migration of contaminants via all pathways, including the air pathway.

Ambient monitoring data is currently taken by a network of fenceline monitors. These monitors are equipped to measure the ambient air for tritium, TRU,

and alpha, beta and isotopic gamma radiation. However, the current program is not equipped to measure VOCs which may be emitted. Therefore, this program is being conducted to determine VOC concentration levels at selected locations near the perimeters of Areas G and L, and at an additional background location at Bandelier National Monument.

This study was performed for the following reasons:

- Although not a regulatory requirement, there is a need to characterize non-radioactive air emissions and related off-site impacts to determine if the Laboratory's waste operations are releasing toxic amounts of air pollutants to the ambient environment.
- The Department of Energy (DOE) requires that all facilities follow Best Management Practices (BMP) with regards to all of their activities. Quantifying the off-site impacts of emitted pollutants, even though not required by regulators, is a BMP.

1.2 Site Description

An overview of the location and relevant features of Areas G and L is given below, followed by more detailed information about each area. The primary source of the information presented in this section is a recent report by Purtymun and Suazo¹. A more detailed description of the site and site activities can be found in the Quality Assurance Project Plan for

Ambient Monitoring of Volatile Organic Compounds².

1.2.1 Overview

Los Alamos National Laboratory (LANL) has operated a solid, low-level radioactive disposal area in Technical Area (TA) 54, designated Area G, since 1957. A smaller adjacent disposal area, designated Area L, is used for the disposal of low-level mixed waste. TA-54 occupies about 63 acres on the southern half of Mesita del Buey on the Pajarito Plateau. Mesita del Buey is a narrow mesa about 2 miles long that extends to the southeast. The elevation of the mesa is roughly 6900 ft. on the west and 6600 ft. at the eastern end. The mesa is bounded by Pajarito Canyon to the south and Canada del Buey to the north. The edges of the mesa have been cut to near vertical and vary in height from 50 to 100 ft. Areas G and L are located on Mesita del Buey approximately 4.5 miles southeast of the town of Los Alamos and one mile northwest of the subdivision of White Rock.

Summer days at the site are generally sunny with moderately warm days and cool nights. Maximum daytime temperatures are usually below 90°F and nighttime summer temperatures usually drop below 60°F. The surface winds are variable, but the most common meteorology is a moderate SW up-valley wind during the day and either a light NW to N drainage wind or a moderate SW wind at night. The average wind speed is 2.9 m/sec (6 mph), with the most prevalent wind direction being south to southwest. The LANL area is semi-arid. The area gets 18 in. of annual precipitation

with 40% occurring during July and August.

A variety of environmental monitoring is currently done at Areas G and L. The existing air monitoring program consists of biweekly samples analyzed for tritium, alpha, beta, and isotopic gamma radiation and samples analyzed quarterly for TRU (specifically, isotopic plutonium, americium-241, and total uranium). Additional monitoring is performed to examine concentration levels of various contaminants in the surface soils, vegetation, pore gas, and run-off.

1.2.2 Area G

Area G occupies over 60 acres at the southern end of Mesita del Buey. Historically, a wide variety of waste has been disposed of underground at Area G, including the following categories: polychlorinated biphenyls (PCBs), low-level radioactive waste, mixed waste, transuranic waste (TRU), animal tissue, and tritium waste. Currently, only low-level radioactive waste is disposed of in Area G. Low-level waste has been disposed of in 30 pits and 209 shafts.

1.2.3 Area L

Area L occupies several acres immediately west of Area G within TA-54. Waste has been stored underground at Area L; the waste is believed to include tritium waste and organic solvents. Most of Area L, however, has been paved and is now used for temporary above-ground storage of drums of mixed wastes and gas cylinders. Less information is available about subsurface wastes at Area L, but subsurface VOCs are known to be present

at the northern-most portion of the area and in the northeast quadrant of the area.

1.3 Description of Task Objective

The overall goal of this measurement program was to acquire a database to determine the impact of VOC emissions on the surrounding air quality. The resulting data can also serve as a baseline from which to assess the impacts of any future site activities. The specific objectives of this program were to:

- Measure VOC concentrations levels at selected locations near the perimeters of Areas G and L, and at an additional location in Bandelier National Monument, a minimum of four times;
- Determine whether the measured concentrations exceed state regulatory limits or might be hazardous to human health;
- Estimate the impacts of emissions from Areas G and L on the surrounding air quality by comparing fenceline concentrations levels with data collected at the background station at Bandelier National Monument.

1.4 Approach

The measurements were conducted using a sampling and analytical technique based on EPA's Method TO-14: "Determination of Volatile Organic Compounds in Ambient Air Using Summa® Passivated Canister Sampling and

Gas Chromatographic Analysis." This method involves collection of whole air samples in evacuated, passivated stainless steel canisters with subsequent analysis using a high resolution gas chromatograph (GC) coupled with one or more appropriate GC detectors. In this case, three detectors were used: (1) a flame ionization detector (FID) for primary identification and quantitation of non-halogenated VOCs, (2) a photoionization detector (PID) for confirmation non-halogenated VOC identifications, and (3) an electrolytic conductivity detector (ELCD) for identification and quantitation of halogenated VOCs. Specific details of the sampling and analytical approaches are given in Section 2 of this report.

Ambient VOC samples were collected at two sites in Area G, two sites at the fenceline of Area L and one background site located in Bandelier National Monument during eight sampling periods. Samples were collected over an integrated, approximate eight hour period (e.g. 8 a.m. to 4 p.m.), four times during each of the two sampling episodes.

Meteorological measurements were not be performed as part of this measurement program. However, meteorological data are collected at Area G by LANL and these data were used for interpretation of the VOC data in this report.

2.0 TECHNICAL APPROACH

This section describes the site locations; sampling period, frequency, and duration; sampling equipment and procedures; analytical equipment and procedures; and quality control procedures that were used throughout the measurement program.

2.1 Sampling Sites

Sampling was conducted at five fixed sites. Two of the sites (identified as Site 1 and Site 2) were located along the perimeter of Area G, two were located in Area L, and the fifth was a background site. The First Area G site (point 1) was oriented roughly parallel to the predominant wind vector, northeast of VOC Hot Spot #2 (Figure 2-1). The second site (point 2) within Area G was located due north of Pit 37 as indicated in Figure 2-1. The first Area L Site (Site 4) was located north of Area L, near the perimeter fence. The second Area L Site (Point 5) was located northwest of Area L along the perimeter fence. A background monitoring station (Site 3) was located at Bandelier National Monument, approximately two miles southwest of Areas G and L (Figure 2-2).

2.2 Sampling Frequency, Period, and Duration

Eight sample sets were collected during June, July and August of 1994. The first four sampling periods occurred on June 16 -17 and 29 -30 and coincided with the peak dry period for this area. The remaining samples were collected on July 28 and August 1 - 3 and coincided with the wet season. Samples were

collected over an approximate eight hour period, beginning at approximately 8:00 a.m. local time and ending at approximately 4:00 p.m. on the same day. In all, 40 samples, not counting blanks or duplicates, were collected during this period.

2.3 Sampling Equipment and Procedures

Whole air samples were collected using lightweight, portable sampling systems that do not require electrical power (Figure 2-3). The sampling systems consist primarily of a SUMMA® passivated stainless steel canister, a Milliflow® differential flow controller, and a five-foot vertical length of 1/4-inch o.d. stainless steel tubing to act as a sample inlet. Stainless steel in-line filters (7- μ m pore size) were used to prevent particulate matter from clogging the sample tube and flow controller.

During each sampling period, ambient air was drawn into the evacuated canister by the pressure differential force between the canister and ambient air. The flow controller was designed to maintain a constant air flow into the sample canister so long as the pressure differential between the canister and ambient air stays above about 10" Hg.

The flow controllers were preset (and checked during sample set-up) by the field operator to ensure that this minimum pressure differential is maintained throughout the sampling period. A flow rate of approximately 15 cc/min was used to achieve this objective.

Figure 2-1. Diagram Showing Sampling Locations around Area G and Area L

Figure 2-2. Location of Background Site at Bandelier National Monument

Figure 2-3. Diagram of VOC Sampling System.

The sample canisters were certified clean and evacuated at Radian's VOC Laboratory prior to each use. The certification criterion was a total non-methane hydrocarbon concentration of less than 10 ppb-v carbon using humidified nitrogen drawn into the canister. The same blank-certification criterion was also applied to the sample inlets, filters, and flow regulators.

Radian's field technician visited each site several time during the sampling episodes: once to set out canisters and start sample collection, one or two times during the sampling period to ensure proper flowrate, and finally to stop sample collection and retrieve the canisters. All of the activities that the field technician performed during sample set-up and retrieval are documented in a field log. More specific information on the sampling procedures, can be found in Section 4 of the Quality Assurance Project Plan (QAPP).

2.4 Analytical Equipment and Procedures

The analysis of volatile organic compounds (VOCs) contained in the evacuated canisters were performed using a gas chromatograph equipped with dual columns and multiple detectors (GC/MD). The detectors will include a flame ionization detector (FID), a photoionization detector (PID), and a electrolytic conductivity detector (ELCD).

Samples were analyzed within 14 days of collection. During the analysis, the canister sample were cryogenically focused in order to reconcentrate the sample and provide lower detection limits.

The cryogenic traps were then thermally desorbed onto capillary columns for compound separation. One column eluent was analyzed by the PID and FID detectors arranged in series configuration, and the eluent from the second column was analyzed by the ELCD. The FID/PID was used to quantitate the aromatic and aliphatic hydrocarbons while the ELCD was used to quantitate most halogenated hydrocarbon species.

Radian has three multiple detector GC systems that can be used to analyze ambient level samples. Whenever possible, all canister samples were analyzed on the same analytical system. The operating parameters for the three analytical systems are provided in Table 2-1. For more detailed information on laboratory objectives for precision and accuracy, and detection limits, refer to Section 5 of the QAPP² for ambient air monitoring of volatile organic compounds.

The gas chromatographic-multidetector data was collected with a Nelson 2600 data acquisition system. The raw data were printed as peak areas, retention times, and chromatograms for review. The data also were stored on magnetic media for further data manipulation and permanent storage. Radian software, RPIP (Radian Peak Identification Program), was used to process the multidetector data, assign peak identification, and calculate peak concentrations.

Identification of peaks was based on normalized retention times, detector responses, and individual responses from the daily calibration standard. The retention time of each peak on the FID

was calculated relative to the retention time of toluene (RRT). The PID data were scanned for any peaks that matched the FID retention times. The corresponding PID/FID response ratio was compared with the sample's PID/FID response for toluene to generate a toluene-normalized response (TNR) factor. Different compound classes and individual compounds produce characteristic TNRs. The RRT and TNR data were compared to target compound database parameters for potential matches. The potential matches were reviewed and validated by experienced personnel to ensure data quality. The quantitation of each target compound was based on individual response factors, which were calculated daily by analyzing a low-level standard containing all the target analytes.

2.5 Quality Control Procedures

The primary objective of the quality assurance and quality control efforts were to assure that the reported measurement data are of sufficient quality to achieve the overall goals of the measurement program. The program goals were met since the reported concentration levels were within about a factor of two from the true concentration levels (or within a few tenths of part-per-billion) and were representative of the ambient concentration levels in the general vicinities of the respective monitoring sites. The quality control procedures employed in this program are described in detail in the QAPP. During field sampling some basic QC checks were performed to assure sample reliability:

Duplicate Sampling -- Duplicate samples were collected for VOC samples to

estimate the sampling variability. Duplicate samples were collected on three of the sampling days. Sample collection of the duplicate pairs was achieved by placing the canisters in close proximity at the sampling site.

Canister Blank Check -- All canisters were blank - checked prior to shipment to the field by drawing humidified nitrogen into the canister and then drawing the gas back out and into the GC System. Any canister with a blank value greater than 10 ppbv - carbon was recleaned and rechecked prior to its shipment to the field.

Canister Flow Rate Checks -- To ensure a constant flow rate throughout the sampling episode, the sample flow rate was periodically checked. The sample flow rate does not affect sample or precision accuracy; however, a constant flow during the sampling period is necessary to obtain a true representative sample of VOC concentrations.

Sample handling and sample custody procedures were based on standard U.S. EPA procedures. Information related to field sampling activities was recorded in a bound notebook. Each entry was dated and signed or initialed. All samples were labeled and given a unique tracking number. A record of all samples was kept in a project master log. A chain-of-custody form was prepared in the field for each sample and accompanied the samples to the laboratory.

The Radian laboratory followed its own standard quality control program, as outlined in the QAPP. Elements of the program included instrument calibrations,

response factor checks, retention time checks, analytical blanks, spiked samples, and verification of canister cleanliness prior to use. Sampling and analytical precision associated with collection of VOC samples was evaluated through duplicate samples and replicate analyses (repeated laboratory analyses of the same samples). The analytical accuracy of the VOC measurements was evaluated by the analysis of internal laboratory standards.

3.0 RESULTS

The results for the eight ambient air sampling periods at each site are presented in Tables 3-1 through 3-5. Figures 3-1 through 3-8 are wind roses showing the joint wind frequency as a function of wind speed from each direction during each sampling period (8 a.m. to 5 p.m.). No precipitation data was available for this report.

The results are further reduced and discussed in Section 4.0.

Table 3-1
VOC Ambient Air Concentrations at Point 1

Compound	Ambient Concentrations (ppb)							
	6-16-94	6-17-94	6-29-94	6-30-94	7-28-94	8-01-94	8-02-94	8-03-94
Ethylene	0.3	0.2	0.6	0.3	0.6	0.3	0.5	0.4
Acetylene			0.4		0.5			
Ethane	0.8	1.3	2.4	1.4	1.8	3.4	1.9	3.2
Chlorodifluoromethane	0.2	0.3	1.6	0.5		0.8		
Propylene	0.3	0.2	0.3		0.3	0.2	0.3	0.4
Propane		0.6	1.0	0.5	1.0	2.1	0.8	1.9
Chloromethane	0.3	0.4	0.3	0.5		0.7		
Dichlorodifluoromethane	0.5	0.4	0.5	0.5	0.2	0.5	0.3	0.2
Isobutane			1.9				0.4	0.3
Isobutene + 1-Butene								
n-Butane			1.4	0.3		0.3	0.5	0.8
Methanol	1.0	32.1	62.9	12.3				
Isopentane	0.4	0.3	6.8	0.4	0.5	0.2	2.0	0.3
Acetone	0.7	1.3	6.4	0.9	3.4	1.2	2.9	3.2
Trichlorofluoromethane	0.2	0.2	1.0	0.05	0.09	0.3	0.2	0.2
2-Methyl-1-Butene			0.1					
n-Pentane	0.4	0.3	2.6	0.2	0.3	0.2	0.9	0.2
Isoprene			0.1		0.3			
t-2-Pentene								
1,1-Dichloroethylene								
c-2-Pentene								
Methylene Chloride			0.3			0.08		
2-Methyl-2-Butene								
Neohexane			0.1					
Freon 113	0.05	0.05		0.04		0.2	0.06	
Isobutyraldehyde			0.1					
Cyclopentene								
1,1-Dichloroethane								

**Table 3-1
(Continued)**

Compound	Ambient Concentrations (ppb)							
	6-16-94	6-17-94	6-29-94	6-30-94	7-28-94	8-01-94	8-02-94	8-03-94
Cyclopentane								
2,3-Dimethylbutane								
MTBE + Isohex + c-4-m-2-Pentene			1.1	0.3	0.3			
Butyraldehyde					0.7			
2-Butanone								
3-Methylpentane			0.8		0.2		0.3	
n-Hexane			1.1		0.2		0.3	
Chloroform								
Methylcyclopentane			0.4				0.2	
1,2-Dichloroethane								
2,4-Dimethylpentane								
1,1,1-Trichloroethane	0.4	0.3	2.5	0.2	0.1	1.0	0.8	0.04
Benzene	0.2	0.1	0.4	0.2	0.3	0.3	0.3	0.2
Carbon Tetrachloride	0.07	0.06	0.08		0.04	0.09	0.08	0.02
1-Butanol + Cyclohexane			0.4	0.3	0.2			
Isoheptane + 2,3-Dimethylpentane			0.4					
3-Methylhexane								
Trichloroethylene + BDCMethane								
1,4-Dioxane + 2,2,4-TMPentane			0.1					
n-Heptane			0.2					
Methylcyclohexane			0.1					
2,3,4-Trimethylpentane							0.1	
Toluene	0.3	0.2	1.7	0.2	0.5	0.2	1.7	0.2
Hexanal			0.4		0.4	0.2	0.2	
n-Octane								

**Table 3-1
(Continued)**

Compound	Ambient Concentrations (ppb)							
	6-16-94	6-17-94	6-29-94	6-30-94	7-28-94	8-01-94	8-02-94	8-03-94
Tetrachloroethylene								
Ethylbenzene			0.1					
p-Xylene + m-Xylene			0.3		0.1		0.2	0.2
Heptanal			0.2					
o-Xylene			0.1				0.1	
A-Pinene + Benzaldehyde			0.2		0.2			
m-Ethyltoluene								
p-Ethyltoluene								
1,3,5-Trimethylbenzene								
B-Pinene			0.06					
1,2,4-TMBenzene + T-Butylbenzene			0.1					
N-Decane + P-Dichlorobenzene			5.7					
n-Undecane			6.7				0.3	
Total Unidentified VOCs	0.3	0.4	19.9	0.4	1.3	1.0	2.1	1.6
Total Unidentified Halogenated VOCs			0.8	0.07		0.05		0.1
TNMHC	2.7	8.5	74.4	5.4	8.8	5.3	15.1	7.5

NOTE: Only compounds detected at least once are included in the table.

Table 3-2
VOC Ambient Air Concentrations at Point 2

Compound	Ambient Concentrations (ppb)							
	6-16-94	6-17-94	6-29-94	6-30-94	7-28-94	8-01-94	8-02-94	8-03-94
Ethylene	0.4	0.2	0.6	0.9	0.9	0.5	0.9	0.8
Acetylene			0.5	0.3	0.3			
Ethane	0.8	1.4	2.9	1.8	1.7	3.1	2.0	4.0
Chlorodifluoromethane				0.1		0.5		
Propylene	0.4	0.2	0.3	0.3	0.3	0.4	0.4	0.4
Propane		0.6	1.4	0.5	0.8	1.3	0.5	1.7
Chloromethane	0.3	0.3	0.2	0.5		0.6		
Dichlorodifluoromethane	0.4	0.4	0.3	0.3	0.2	0.3	0.06	0.3
Isobutane				0.6		0.2		0.4
Isobutene + 1-Butene								
n-Butane		0.2	1.1	1.0		0.4		1.0
Methanol		1.4	1.7	2.3	1.0			
Isopentane	0.6	0.2	1.4	5.4	0.2	0.4	0.5	1.5
Acetone	1.2	1.8	2.8	0.6	1.9	1.1	2.9	2.5
Trichlorofluoromethane	0.2	0.2	0.1	0.1	0.07	0.3	0.04	0.1
2-Methyl-1-Butene				0.2				
n-Pentane			0.9	3.2		0.2	0.2	0.8
Isoprene		0.3						
t-2-Pentene				0.4				
1,1-Dichloroethylene								
c-2-Pentene				0.2				
Methylene Chloride							0.1	
2-Methyl-2-Butene				0.4				
Neohexane								
Freon 113	0.04	0.03		0.05		0.1		
Isobutyraldehyde								
Cyclopentene								
1,1-Dichloroethane								

Table 3-2
(Continued)

Compound	Ambient Concentrations (ppb)							
	6-16-94	6-17-94	6-29-94	6-30-94	7-28-94	8-01-94	8-02-94	8-03-94
Cyclopentane				0.2				
2,3-Dimethylbutane				0.4				
MTBE + Isohex + c-4-m-2-Pentene	0.2		0.6	2.2				
Butyraldehyde		0.2	0.7					
2-Butanone								
3-Methylpentane			0.4	1.3				0.3
n-Hexane			0.4	1.7				0.3
Chloroform								
Methylcyclopentane			0.2	1.0				0.3
1,2-Dichloroethane								
2,4-Dimethylpentane				0.2				
1,1,1-Trichloroethane	0.09	0.07	0.1		0.05	0.2	0.06	
Benzene	0.2	0.1	0.4	1.2	0.2	0.4	0.2	0.5
Carbon Tetrachloride	0.06	0.05	0.05		0.03	0.09	0.05	0.06
1-Butanol + Cyclohexane		0.2		0.8				
Isoheptane + 2,3-Dimethylpentane			0.2	0.8				0.2
3-Methylhexane				0.5				
Trichloroethylene + BDCMethane								
1,4-Dioxane + 2,2,4-TMPentane								
n-Heptane				0.2				
Methylcyclohexane				0.2				
2,3,4-Trimethylpentane								
Toluene	0.3	0.1	0.7	2.4	0.2	0.2	0.8	0.7
Hexanal			0.3		0.2	0.2		
n-Octane								

Table 3-2
(Continued)

Compound	Ambient Concentrations (ppb)							
	6-16-94	6-17-94	6-29-94	6-30-94	7-28-94	8-01-94	8-02-94	8-03-94
Tetrachloroethylene						0.03		
Ethylbenzene				0.3				
p-Xylene + m-Xylene			0.2	0.6				0.4
Heptanal					0.2			
o-Xylene			0.1	0.2			0.1	0.1
A-Pinene + Benzaldehyde	0.2	0.1	0.2		0.1			
m-Ethyltoluene								
p-Ethyltoluene								
1,3,5-Trimethylbenzene								
B-Pinene								
1,2,4-TMBenzene + T-Butylbenzene								
N-Decane + P-Dichlorobenzene					0.1			
n-Undecane	0.2				0.3			
Total Unidentified VOCs	0.2	0.4	1.0	0.3		0.9	0.8	1.5
Total Unidentified Halogenated VOCs				0.06		0.1		0.03
TNMHC	3.3	4.1	12.1	26.9	4.6	5.5	5.3	11.6

NOTE: Only compounds detected at least once are included in the table.

Table 3-3
VOC Ambient Air Concentrations at Point 4

Compound	Ambient Concentrations (ppb)							
	6-16-94	6-17-94	6-29-94	6-30-94	7-29-94	8-01-94	8-02-94	8-03-94
Ethylene	0.3	0.3	0.4	0.4	0.6	0.6	0.6	1.1
Acetylene					0.2			1.6
Ethane	0.8	1.6	2.7	1.9	1.5	3.3	2.1	3.9
Chlorodifluoromethane	0.6	0.2	0.3	0.6				
Propylene	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.5
Propane		0.5	1.2	0.8	0.7	1.3	0.6	2.5
Chloromethane	0.3	0.3		0.6		0.3		
Dichlorodifluoromethane	0.4	0.4	0.4	0.4	0.3	0.4	0.06	0.07
Isobutane						0.4		0.5
Isobutene + 1-Butene								
n-Butane		0.3	0.7	0.3		0.6	0.2	0.8
Methanol		1.0	1.1	3.5	3.3	2.5		1.3
Isopentane	0.4	0.2	0.3	0.3	0.8	1.6	1.3	2.3
Acetone	1.1	2	2.5	0.9	2.5	4	2.4	3.5
Trichlorofluoromethane	0.2	0.2	0.1	0.1	0.1	0.2	0.05	0.03
2-Methyl-1-Butene								
n-Pentane			0.2	0.2	0.3	1.0	0.7	1.0
Isoprene	0.4	0.3	0.3			0.3		0.2
t-2-Pentene								
1,1-Dichloroethylene								
c-2-Pentene								
Methylene Chloride			0.3		0.2	0.09		
2-Methyl-2-Butene								
Neohexane								
Freon 113	0.04	0.05	0.03	0.06		0.06		
Isobutyraldehyde								
Cyclopentene								
1,1-Dichloroethane								

**Table 3-3
(Continued)**

Compound	Ambient Concentrations (ppb)							
	6-16-94	6-17-94	6-29-94	6-30-94	7-29-94	8-01-94	8-02-94	8-03-94
Cyclopentane								
2,3-Dimethylbutane								0.1
MTBE + Isohex + c-4-m-2-Pentene					0.2			
Butyraldehyde			0.9		0.6			
2-Butanone					0.4			
3-Methylpentane					0.1	0.3	0.3	0.6
n-Hexane					0.2	0.3	0.3	0.5
Chloroform								
Methylcyclopentane						0.2	0.2	0.3
1,2-Dichloroethane								
2,4-Dimethylpentane								
1,1,1-Trichloroethane	0.7	0.4	0.9	0.4	1.0	0.7	0.5	0.4
Benzene	0.2	0.1	0.2	0.2	0.2	0.4	0.4	0.6
Carbon Tetrachloride	0.1	0.06	0.06		0.06	0.07	0.05	0.08
1-Butanol + Cyclohexane				0.4	0.2	0.3		
Isoheptane + 2,3-Dimethylpentane						0.2	0.2	0.3
3-Methylhexane								
Trichloroethylene + BDCMethane		0.1	0.06		0.3	0.1	0.07	
1,4-Dioxane + 2,2,4-TMPentane					0.2			
n-Heptane								
Methylcyclohexane								
2,3,4-Trimethylpentane								
Toluene	0.2	0.1	0.2	0.2	0.4	1.0	0.8	0.9
Hexanal					0.4	0.4		0.3
n-Octane						0.1		
Tetrachloroethylene								

**Table 3-3
(Continued)**

Compound	Ambient Concentrations (ppb)							
	6-16-94	6-17-94	6-29-94	6-30-94	7-29-94	8-01-94	8-02-94	8-03-94
Ethylbenzene						0.2		
p-Xylene + m-Xylene					0.09	0.5	0.3	0.4
Heptanal					0.2			0.2
o-Xylene						0.3	0.1	0.2
A-Pinene + Benzaldehyde					0.1	0.2		0.1
m-Ethyltoluene						0.1		
p-Ethyltoluene						0.1		
1,3,5-Trimethylbenzene						0.1		
B-Pinene								0.2
1,2,4-TMBenzene + T-Butylbenzene						0.2		0.1
N-Decane + P-Dichlorobenzene					0.1	0.5		
n-Undecane					0.1	0.1		
Total Unidentified VOCs	0.4	0.3	0.8	0.3	1.6	3	1.9	2.2
Total Unidentified Halogenated VOCs				0.06				
TNMHC	2.9	3.9	6.3	4.1	9.1	17.2	9.2	17.4

NOTE: Only compounds detected at least once are included in the table.

Table 3-4
VOC Ambient Air Concentrations at Point 5

Compound	Ambient Concentrations (ppb)							
	6-16-94	6-17-94	6-29-94	6-30-94	7-28-94	8-01-94	8-02-94	8-03-94
Ethylene	0.3			0.5	0.4	0.6	0.3	0.3
Acetylene								
Ethane	0.8	1.4	2.6	1.7	1.6	3.2	1.8	3.1
Chlorodifluoromethane				0.1				
Propylene	0.3	0.3	0.2	0.2	0.2	0.4	0.3	0.2
Propane		0.6	1.3	1.9	1.0	1.3	1.1	1.8
Chloromethane	0.3	0.3		0.7		0.7		0.2
Dichlorodifluoromethane	0.5	0.3	0.3	0.4	0.2	0.4	0.06	0.4
Isobutane				0.8				
Isobutene + 1-Butene						0.3		
n-Butane		0.2	0.4	0.6		0.4		0.8
Methanol	1.5		27.1	5.4	6.2			1.3
Isopentane	0.3	0.2	0.4	1.2	0.5	0.3	0.3	2.3
Acetone	2.7	2.0	3.6	2.3	1.8	22.1	3.0	1.9
Trichlorofluoromethane	0.2	0.2	0.2	0.2	0.09	0.3	0.08	0.2
2-Methyl-1-Butene								
n-Pentane			0.3		0.3	0.2		0.2
Isoprene			0.3			0.4	0.4	0.3
t-2-Pentene								
1,1-Dichloroethylene	0.09							
c-2-Pentene								
Methylene Chloride	1.6	0.4	1.3	1.2	0.6	1.0	1.7	0.9
2-Methyl-2-Butene								
Neohexane			0.1					
Freon 113	0.2	0.1	0.1	0.3	0.07	0.4	0.2	
Isobutyraldehyde								
Cyclopentene								
1,1-Dichloroethane								
Cyclopentane								
2,3-Dimethylbutane								

Table 3-4
(Continued)

Compound	Ambient Concentrations (ppb)							
	6-16-94	6-17-94	6-29-94	6-30-94	7-28-94	8-01-94	8-02-94	8-03-94
MTBE + Isohex + c-4-m-2-Pentene			0.2	0.2	0.2			
Butyraldehyde			0.7	0.3	0.5			
2-Butanone			0.5		0.2			
3-Methylpentane					0.2			
n-Hexane					0.2	0.1		
Chloroform			0.03					
Methylcyclopentane								
1,2-Dichloroethane								
2,4-Dimethylpentane								
1,1,1-Trichloroethane	15.2	6.0	8.6	4.0	0.6	1.0	0.8	2.4
Benzene	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2
Carbon Tetrachloride		0.1		0.05	0.05	0.1		0.07
1-Butanol + Cyclohexane				0.3				
Isoheptane + 2,3-Dimethylpentane								
3-Methylhexane						0.6		
Trichloroethylene + BDCMethane		0.2	0.1	0.03	0.1		0.06	0.1
1,4-Dioxane + 2,2,4-TMPentane								
n-Heptane								
Methylcyclohexane								
2,3,4-Trimethylpentane								
Toluene	0.3	0.2	0.3	0.6	0.3	0.2	0.3	0.2
Hexanal					0.3			
n-Octane								
Tetrachloroethylene	0.05				0.04	0.09		
Ethylbenzene								
p-Xylene + m-Xylene			0.1	0.2	0.2	0.09	0.1	
Heptanal					0.3	0.4		
o-Xylene								

Table 3-4
(Continued)

Compound	Ambient Concentrations (ppb)							
	6-16-94	6-17-94	6-29-94	6-30-94	7-28-94	8-01-94	8-02-94	8-03-94
A-Pinene + Benzaldehyde					0.1	0.1		
m-Ethyltoluene								
p-Ethyltoluene								
1,3,5-Trimethylbenzene								
B-Pinene						0.2		
1,2,4-TMBenzene + T-Butylbenzene								
N-Déane + P-Dichlorobenzene				0.2				
n-Undecane					0.09			
Total Unidentified VOCs	7.1	0.03	0.4	0.9	1.1	3.0	1.2	1.6
Total Unidentified Halogenated VOCs				0.05		0.03		0.1
TNMHC	10.3	3.5	11.6	8.7	7.8	15.1	5.3	6.1

Table 3-5
VOC Ambient Air Concentrations at the Bandelier Site

Compound	Ambient Concentrations (ppb)							
	6-16-94	6-17-94	6-29-94	6-30-94	7-28-94	8-01-94	8-02-94	8-03-94
Ethylene	0.2	0.2	0.3		0.2	0.2		
Acetylene								
Ethane	0.8	1.1	2.2	2.5	1.3	2.9	1.5	2.8
Chlorodifluoromethane								
Propylene	0.2	0.2	0.2					0.2
Propane		0.4	0.9	1.0	0.7	1.2	0.5	1.6
Chloromethane		0.4		0.6				
Dichlorodifluoromethane	0.3	0.3	0.3	0.4	0.2	0.3		
Isobutane								
Isobutene + 1-Butene								
n-Butane		0.3	0.5	0.3		0.3		0.3
Methanol	1.1	1.1	773				3.4	
Isopentane		0.2	0.2	0.3		0.3		
Acetone	1.4	1.8	3.1		2.4	3.7	2.2	1.8
Trichlorofluoromethane	0.1	0.1	0.1	0.05	0.07	0.09	0.03	
2-Methyl-1-Butene								
n-Pentane						0.1		
Isoprene			0.9	1.7	0.2	0.6	0.2	0.3
t-2-Pentene								
1,1-Dichloroethylene								
c-2-Pentene								
Methylene Chloride								
2-Methyl-2-Butene								
Neohexane								
Freon 113				0.04			0.03	
Isobutyraldehyde								
Cyclopentene								
1,1-Dichloroethane								

**Table 3-5
(Continued)**

Compound	Ambient Concentrations (ppb)							
	6-16-94	6-17-94	6-29-94	6-30-94	7-28-94	8-01-94	8-02-94	8-03-94
Cyclopentane								
2,3-Dimethylbutane								
MTBE + Isohex + c-4-m-2-Pentene								
Butyraldehyde			0.4		0.3			
2-Butanone								
3-Methylpentane								
n-Hexane								
Chloroform								
Methylcyclopentane								
1,2-Dichloroethane								
2,4-Dimethylpentane								
1,1,1-Trichloroethane	0.1	0.1	0.08		0.04	0.03		
Benzene		0.2		0.2		0.1	0.1	0.2
Carbon Tetrachloride		0.05	0.04		0.04	0.03		
1-Butanol + Cyclohexane				0.3				
Isoheptane + 2,3-Dimethylpentane								
3-Methylhexane								
Trichloroethylene + BDCMethane		0.05						
1,4-Dioxane + 2,2,4-TMPentane								
n-Heptane								
Methylcyclohexane								
2,3,4-Trimethylpentane								
Toluene			0.1		0.1	0.1	0.2	0.1
Hexanal			0.2		0.3	0.2	0.2	
n-Octane								
Tetrachloroethylene								

**Table 3-5
(Continued)**

Compound	Ambient Concentrations (ppb)							
	6-16-94	6-17-94	6-29-94	6-30-94	7-28-94	8-01-94	8-02-94	8-03-94
Ethylbenzene								
p-Xylene + m-Xylene								
Heptanal								
o-Xylene						0.1		
A-Pinene + Benzaldehyde								
m-Ethyltoluene								
p-Ethyltoluene								
1,3,5-Trimethylbenzene								
B-Pinene						0.09		
1,2,4-TMBenzene + T-Butylbenzene								
N-Decane + P-Dichlorobenzene								
n-Undecane								
Total Unidentified VOCs		0.6	2.9			0.6	0.6	0.2
Total Unidentified Halogenated VOCs				0.06				0.1
TNMHC	1.5	3.3	137	3.6	3.0	6.1	3.8	3.8

NOTE: Only compounds detected at least once are included in the table.

Figure 3-1. Wind Rose from June 16, 1994

Figure 3-2. Wind Rose from June 17, 1994

Figure 3-3. Wind Rose for June 29, 1994.

Figure 3-4. Wind Rose for June 30, 1994.

Figure 3-5. Wind Rose for July 28, 1994.

Figure 3-6. Wind Rose for August 1, 1994.

Figure 3-7. Wind Rose for August 2, 1994.

Figure 3-8. Wind Rose for August 3, 1994.

4.0 DISCUSSION OF RESULTS

This section discusses the ambient results in association with meteorological parameters and the possible impacts of the measured concentrations.

4.1 Meteorological Parameters and Air Quality

Graphical presentations showing the five sampling points, the applicable 9-hour (e.g. 8:00 - 5:00) wind rose, and the corresponding concentrations of methylene chloride, 1,1,1-trichloroethane and total non-methane hydrocarbons (TNMHC) for the eight sampling periods are given in Figures 4-1 through 4-8. These figures illustrate the effect of wind direction on ambient concentrations. Table 4-1 presents tabular results for these three parameters. The concentrations are higher when the primary wind vector blows across a waste body and toward the sampling site. For example, Point 4 is north and northwest of mixed waste storage areas and highest concentrations are measured during days when the wind is blowing from the southeast.

One deviation from the above trend was noted. Point 1 shows the highest concentrations on June 29, 1994. From the location of Point 1, it is expected that higher VOC concentrations would be seen on days with a southwest wind. On this day, however, the primary wind vector was east northeast and the wind speed was higher than usual (10-24 mph). These meteorological conditions were expected to result in low concentrations at this site.

One explanation of these higher concentrations at Point 1 may be activities

in White Rock, which would be directly upwind under these conditions. Dispersion modeling runs show that receptor concentrations of benzene (for example) may be greater than 70 ppb from emissions of 1 g/sec (such as a gasoline station could produce) at a distance of 2000 meters. The air parcel at Point 1 moved over White Rock before being sampled. The high wind speed could have limited dispersion and diffusion.

High ambient temperatures may increase VOC concentrations at Area G and Area L by increasing volatilization. This could result in higher concentrations on days with higher maximum temperatures. Figure 4-9 presents TNMHC concentrations verses maximum daily temperature. From this figure there appears to be little correlation between temperature and VOC concentrations at any of the four sites in Areas G and L. The temperature data used for this analysis was obtained from the meteorological tower in Area G.

Table 4-2 contains the average TNMHC concentrations and the standard deviation for the first four periods and the second four periods. This table also has the average temperature during these runs. These data show little correlation between ambient temperature and VOC concentration. The temperature averaged 10°F higher during the first four periods, but no trend is apparent.

The potential risk from VOCs in the ambient air can be evaluated by comparing the measured ambient concentrations to health-based action levels. Table 4-3 compares the maximum concentration of each detected compound

Figure 4-1. Diagram of Areas G and L Showing Wind Rose and VOC Concentrations for June 16, 1994.

Figure 4-2. Diagram of Areas G and L Showing Wind Rose and VOC Concentrations for June 17, 1994.

Figure 4-3. Diagram of Areas G and L Showing Wind Rose and VOC Concentrations for June 29, 1994.

Figure 4-5. Diagram of Areas G and L Showing Wind Rose and VOC Concentrations for July 28, 1994.

Figure 4-6. Diagram of Areas G and L Showing Wind Rose and VOC Concentrations for August 1, 1994.

Figure 4-7. Diagram of Areas G and L Showing Wind Rose and VOC Concentrations for August 2, 1994.

Figure 4-8. Diagram of Areas G and L Showing Wind Rose and VOC Concentrations for August 3, 1994.

TNMHC concentration vs Maximum Daily Temperature

Figure 4-9. TNMHC Concentrations vs. Maximum Daily Temperature.

Table 4-1
Summary of Selected VOC Concentrations

Site	Methylene Chloride	TCA	TNMHC
June 16, 1994			
Site 1	ND	0.4	2.7
Site 2	ND	0.09	3.3
Site 3	ND	0.1	1.5
Site 4	ND	0.7	2.9
Site 5	1.6	15.2	10.3
June 17, 1994			
Site 1	ND	0.3	8.5
Site 2	ND	0.07	4.1
Site 3	ND	0.1	3.3
Site 4	ND	0.4	3.9
Site 5	0.4	6.0	3.5
June 29, 1994			
Site 1	0.3	2.5	74.4
Site 2	ND	0.1	12.1
Site 3	ND	0.08	8.2
Site 4	0.3	0.9	6.3
Site 5	1.3	8.6	11.6
June 30, 1994			
Site 1	ND	0.2	5.4
Site 2	ND	ND	26.9
Site 3	ND	ND	3.6
Site 4	ND	0.4	4.1
Site 5	1.2	4	8.7
July 28, 1994			
Site 1	ND	0.1	8.0
Site 2	ND	0.05	4.6
Site 3	ND	0.04	3.0
Site 4	0.2	1.0	9.1
Site 5	0.6	0.6	7.8

Table 4-1
(Continued)

Site	Methylene Chloride	TCA	TNMHC
August 1, 1994			
Site 1	0.08	1.0	5.3
Site 2	ND	0.2	5.5
Site 3	ND	0.03	6.1
Site 4	0.09	0.7	17.2
Site 5	1.0	1.0	15.0
August 2, 1994			
Site 1	ND	0.8	15.1
Site 2	0.1	0.06	5.3
Site 3	ND	ND	3.8
Site 4	ND	0.5	9.2
Site 5	1.7	0.8	5.3
August 3, 1994			
Site 1	ND	0.04	7.5
Site 2	ND	ND	11.6
Site 3	ND	ND	3.8
Site 4	ND	0.4	17.4
Site 5	0.9	2.4	6.1

TCA = 1,1,1-Trichloroethane

TMNHC = Total Non-Methane Hydrocarbon (based on a carbon number of 6).

Table 4-2
Comparison of TNMHC Concentrations during
Episode 1 and Episode 2.

Episode 1				Episode 2		
(June 16, 17, 29, 30)				(July 26, Aug 1-3)		
PT	Average Temperature	Average TNMHC (ppb)	STDev	Average Temperature	Average TNMHC (ppb)	STDev
1	89	22.8	30	80	9.2	3.6
2	89	11.6	9.5	80	6.8	2.8
4	89	4.3	1.2	80	13.2	4.1
5	89	8.5	3.1	80	8.6	3.7
3	89	4.2	2.5	80	4.2	1.2

Table 4-3
Maximum TWAs\100 Concentrations at each Site Versus

Compound	Maximum Concentrations (ppb)					TWA's/100 (ppb)
	point 1	point 2	point 4	point 5	Bandelier	
Ethylene	0.6	0.9	1.1	0.6	0.3	NA
Acetylene	0.5	0.5	1.6	ND	ND	NA
Ethane	3.4	4	3.9	3.4	2.9	NA
Chlorodifluoromethane	1.6	0.5	0.6	0.1	ND	10000
Propylene	0.4	0.4	0.5	0.4	0.2	NA
Propane	2.1	1.7	2.5	1.9	1.6	NA
Chloromethane	0.7	0.6	0.6	0.7	0.6	NA
Dichlorodifluoromethane	0.5	0.5	0.4	0.5	0.4	10000
Isobutane	1.9	0.6	0.5	0.8	ND	NA
Isobutene + 1-Butene	ND	ND	ND	0.3	ND	NA
n-Butane	1.4	1.1	0.8	0.8	0.5	8000
Methanol	62.9	2.3	3.5	27.1	3.4	2000
Isopentane	6.8	5.4	2.3	2.3	0.3	NA
Acetone	6.4	2.9	4	22.1	3.7	7500
Trichlorofluoromethane	1.0	0.3	0.2	0.3	0.1	10000
2-Methyl-1-Butene	0.1	0.2	ND	ND	ND	NA
n-Pentane	2.6	3.2	1.0	0.3	0.1	6000
Isoprene	0.3	0.3	0.4	0.6	1.7	NA
t-2-Pentene	ND	0.4	ND	ND	ND	NA
1,1-Dichloroethylene	ND	ND	ND	0.09	ND	50
c-2-Pentene	ND	0.2	ND	ND	ND	NA
Methylene Chloride	0.3	0.1	0.3	1.7	ND	500
2-Methyl-2-Butene	ND	0.4	ND	ND	ND	NA
Neohexane	0.1	ND	ND	0.1	ND	NA
Freon 113	0.2	0.1	0.06	0.4	0.04	NA
Isobutyraldehyde	0.1	ND	ND	ND	ND	NA

Table 4-3
(Continued)

Compound	Maximum Concentrations (ppb)					TWA's/100 (ppb)
	point 1	point 2	point 4	point 5	Bandelier	
Cyclopentene	ND	ND	ND	ND	ND	NA
1,1-Dichloroethane	ND	ND	ND	ND	ND	2000
Cyclopentane	ND	0.2	ND	ND	ND	6000
2,3-Dimethylbutane	ND	0.4	0.1	ND	ND	5000
MTBE + Isohex + c-4-m-2-Pentene	1.1	2.2	0.2	0.2	ND	NA
Butyraldehyde	0.7	0.7	0.9	0.7	0.4	NA
2-Butanone	ND	ND	0.4	0.5	ND	2000
3-Methylpentane	0.8	1.3	0.6	0.2	ND	NA
n-Hexane	1.1	1.7	0.5	0.2	ND	500
Chloroform	ND	ND	ND	0.03	ND	100
Methylcyclopentane	0.4	1	0.3	0	ND	NA
1,2-Dichloroethane	ND	ND	ND	0.07	ND	100
2,4-Dimethylpentane	ND	0.2	ND	ND	ND	NA
1,1,1-Trichloroethane	2.5	1.2	1.0	15.2	0.1	3500
Benzene	0.4	1.2	0.6	0.3	0.2	100
Carbon Tetrachloride	0.09	0.09	0.1	0.1	0.05	50
1-Butanol + Cyclohexane	0.4	0.8	0.4	0.3	0.3	NA
Isoheptane + 2,3-Dimethylpentane	0.4	0.8	0.2	ND	ND	NA
3-Methylhexane	ND	0.5	ND	0.6	ND	NA
Trichloroethylene + BDCMethane	ND	ND	0.3	0.2	0.05	NA
1,4-Dioxane + 2,2,4-TMPentane	0.1	ND	0.2	ND	ND	NA
n-Heptane	0.2	0.2	ND	ND	ND	4000
Methylcyclohexane	0.1	0.2	ND	ND	ND	4000

**Table 4-3
(Continued)**

Compound	Maximum Concentrations (ppb)					TWA's/100 (ppb)
	point 1	point 2	point 4	point 5	Bandelier	
2,3,4-Trimethylpentane	0.1	ND	ND	ND	ND	NA
Toluene	1.7	2.4	1.0	0.6	0.2	1000
Hexanal	0.4	0.3	0.4	0.3	0.3	NA
n-Octane	ND	ND	0.1	ND	ND	3000
Tetrachloroethylene	ND	0.03	ND	0.09	ND	500
Ethylbenzene	0.1	0.3	0.2	ND	ND	1000
p-Xylene + m-Xylene	0.3	0.6	0.5	0.2	ND	1000
Heptanal	0.2	0.2	0.2	0.4	ND	NA
o-Xylene	0.1	0.2	0.3	ND	0.1	1000
A-Pinene + Benzaldehyde	0.2	0.2	0.2	0.1	ND	NA
m-Ethyltoluene	ND	ND	0.1	ND	ND	NA
p-Ethyltoluene	ND	ND	0.1	ND	ND	NA
1,3,5-Trimethylbenzene	ND	ND	0.1	ND	ND	250
b-Pinene	0.06	ND	0.2	0.2	0.09	NA
1,2,4-TMBenzene + T-Butylbenzene	0.1	ND	0.2	ND	ND	NA
N-Decane + P-Dichlorobenzene	5.7	0.1	0.5	0.2	ND	NA
n-Undecane	6.7	0.3	0.1	0.09	ND	NA
Total Unidentified VOCs	19.9	1.5	3.0	7.1	2.9	NA
Total Unidentified Halogenated VOCs	0.8	0.1	0.06	0.1	0.1	NA
TNMHC	74.4	26.9	17.4	15.1	8.2	NA

NA - No applicable standard available.

ND - Not detected.

at each site with the occupational exposure limits divided by a safety factor of 100. The occupational exposure limits are the Time Weighted Averages (TWAs) published by the American Conference of Governmental Industrial Hygienists (ACGIH). TWAs are the levels to which nearly all workers can be repeatedly exposed for a normal 8-hour workday and 40-hour workweek without adverse effects. The value obtained by dividing the TWA by 100 is the value that the New Mexico Environment Department uses to represent the level that most (even sensitive) members of the public can be exposed to continuously without adverse effects. The comparison presented in Table 4-3 shows that the measured maximums of the pollutants are far below the TWA/100 limits. This is illustrated by the bar graph given as Figure 4-10 that shows the observed value for selected compounds as a percentage of the action level.

Standard quality control checks for ambient air monitoring studies were performed. The precision assessments for VOC data were obtained by collecting duplicate samples and analyzing them in duplicate to provide "nested" duplicate results. From the four analysis results, estimates of analytical and total (analytical + sampling) precision can be calculated. In this study, three duplicate samples were collected. Table 4-4 summarizes the precision data for the compounds which had detectable concentrations in all four analysis. The replicate analysis results indicated that precision estimate calculations for 18 out of the 19 compounds with detectable concentrations in all four analysis had a coefficient of variation (%CV) of less than 40%. Higher than expected variability was

indicated for 1,1,1-trichloroethane. The total %CV was 92%, however, the analytical %CV was 7%. This indicates that the analytical results are reliable and that most of the variability is a result of measurement variability. It should be noted that the mean concentration for 1,1,1-trichloroethane in these duplicate measurements is below 2 ppb and this supports the assumption that the measurement variability increases as the compound concentrations approach analytical detection limits. The contribution of both sampling and analysis to the total %CV suggests that the overall precision of the measurements is reasonable. The analytical %CV data show that the variability estimates partly depend on the mean analyte concentration.

The ambient sample collected at the Bandelier site on June 29 (Sample A440) had an anomalous result. The analysis showed ambient methanol concentrations to be 773 ppb. The next highest methanol concentration at this site was 3.4 ppb. It is believed this concentration is not reliable and does not represent true ambient levels. Methanol was used during the manufacturing process to clean parts. All canisters were thoroughly cleaned after receipt, many times. Due to a still unexplained phenomenon the methanol will show back up, even though canister blanking indicates no contamination. By removing this methanol value, the TNMHC concentration for that sample was reduced from 137 ppb to 8.2 ppb.

Maximum Observed Values as a Percent of the Action Level (TWA/100)

Only compounds with action levels are shown

Figure 4-10. Maximum Observed Values as a Percent of Action Level (TWA/100)

Table 4-4
Precision Estimate Results for VOC Measurements at LANL

Compound	Number of Nested Duplicates	Average Analytical CV(%)	Average Total CV(%)
Ethylene	3	8.2	27.8
Ethane	3	3.7	5.4
Propylene	3	11.5	20.0
Propane	3	6.4	6.2
n-Butane	3	11.5	20.9
Methanol	3	18.1	23.5
Isopentane	3	11.5	11.5
Acetone	3	20.3	27.1
Trichlorofluoromethane	3	19.6	17.8
Isoprene	3	14.4	19.9
Methylene Chloride	3	1.9	6.3
Freon 113	3	22.7	35.6
1,1,1-Trichloroethane	3	6.7	92.2
Benzene	3	0.0	38.5
Carbon Tetrachloride	3	30.7	27.3
Toluene	3	0.0	27.2
Unidentified VOCs	3	9.8	37.8
Unidentified Halogenated VOCs	3	14.4	14.4
TNMHC	3	13.4	17.0

5.0 CONCLUSIONS AND RECOMMENDATIONS

A series of measurements to determine ambient concentrations of volatile organic compounds (VOCs) were conducted at five sampling sites during the months of June, July, and August of 1994. Four of the sampling sites were oriented to measure VOC concentrations at the perimeter of Areas G and L and the fifth site was a background site located at Bandelier National Monument. The sites were selected to be downwind of Areas G and L during periods of southeast winds.

One way of assessing whether the background data are statistically different from the Area G and L values is to calculate the mean, standard error, and upper and lower 95% confidence interval around the mean and compare those values between sites. Table 5-1 shows number of samples with a detected analyte concentration (n), sample mean (based strictly on the number of times the analyte was detected), and upper and lower 95% confidence interval. These data are shown for 11 of the target compounds, including those most frequently detected. Of those 11 compounds, two (methylene chloride and p- & m-xylene) were not detected in any of the background site samples. The remaining nine compounds were detected at least once in the background samples. Generally, the upper and lower 95% confidence intervals for these nine samples overlapped to some degree. One exception was 1,1,1-trichloroethane at sites 4 and 5 (located adjacent to Area L. This indicates that, at least for eight of the eleven compounds, the differences between the background VOC concentrations and the Area G and L sites were not

statistically significant at the 95% confidence level. Evaluation of the data at lower confidence intervals (e.g., 90%) might show statistically significant differences between background and area VOC values. No single compound had concentrations higher than 4% of the action level set by the New Mexico Environment Department.

The conclusions arrived at for this study are given below followed by recommendations.

5.1 Conclusions

Several conclusions can be drawn from the data presented in this document:

- The sampling approach used in this study was successful in obtaining reliable and useful data.
- The VOC concentrations in the ambient air are well below action levels set by the New Mexico Environment Department.
- The measured VOC concentrations were collected during the warmest months of the year and therefore should represent worst-case air impacts.
- If the VOC concentrations remain at the measured levels, they would be expected to pose no health risk to workers or nearby populations.
- VOC emissions from Area G and Area L have an insignificant impact on local air quality.

Table 5-1
Summary of Means and Confidence Intervals for Selected VOCs

Compound	Site 1 (G-1)				Site 2 (G-2)				Site 4 (L-1)				Site 5 (L-2)				Background Site (B-1)			
	n	Mean	95% CI		n	Mean	95% CI		n	Mean	95% CI		n	Mean	95% CI		n	Mean	95% CI	
			Upper	Lower			Upper	Lower			Upper	Lower			Upper	Lower			Upper	Lower
Chloromethane	5	0.44	0.65	0.23	5	0.38	0.58	0.18	4	0.38	0.61	0.14	5	0.44	0.74	0.14	2	0.50	1.77	-0.77
Dichlorodifluoromethane	8	0.39	0.50	0.27	8	0.28	0.37	0.19	8	0.30	0.43	0.18	8	0.32	0.44	0.20	6	0.30	0.37	0.23
n-Pentane	8	0.64	1.33	-0.05	5	1.06	2.60	-0.48	6	0.57	0.97	0.16	4	0.25	0.34	0.16	1	0.10	NA	NA
Methylene Chloride	2	0.19	1.59	-1.21	1	0.10	0.10	0.10	3	0.20	0.46	-0.06	8	1.09	1.47	0.71	0	NA	NA	NA
Freon 113	5	0.08	0.16	0.00	4	0.06	0.10	0.01	5	0.05	0.06	0.03	7	0.20	0.31	0.08	2	0.04	0.10	-0.03
1,1,1-Trichloroethane	8	0.67	1.35	-0.01	6	0.10	0.15	0.04	8	0.63	0.82	0.43	8	4.83	9.04	0.61	5	0.07	0.11	0.03
Benzene	8	0.25	0.33	0.17	8	0.40	0.69	0.11	8	0.29	0.42	0.15	8	0.21	0.24	0.18	5	0.16	0.23	0.09
Carbon Tetrachloride	7	0.06	0.09	0.04	7	0.06	0.07	0.04	7	0.07	0.08	0.05	5	0.07	0.11	0.04	4	0.04	0.05	0.03
Toluene	8	0.63	1.19	0.06	8	0.68	1.30	0.05	8	0.48	0.78	0.17	8	0.30	0.41	0.19	5	0.12	0.18	0.06
p-Xylene + m-Xylene	4	0.20	0.33	0.07	3	0.40	0.90	-0.10	4	0.32	0.60	0.04	5	0.14	0.21	0.07	0	NA	NA	NA
TNMHC	8	15.96	35.90	-3.97	8	9.18	15.78	2.57	8	8.76	13.57	3.96	8	8.55	11.67	5.43	8	4.16	5.88	2.44

95% CI = 95% Confidence Interval.

n = Number of samples with a detectable concentration for a given analyte.

Note: All statistical evaluations based on actual detected values, not detects were not included or considered in the statistical evaluations.

5.2 Recommendations

Several recommendations merit consideration:

- Additional monitoring may be prudent if significant changes are made in the types of activities performed at TA-54 or if the types or amounts of organic compounds disposed of at TA-54 increases.
- A one-year, or longer, VOC monitoring program should be considered if it becomes necessary to prove to any regulatory agencies that air impacts from VOCs at TA-54 are negligible. Such a program typically would entail sampling either every 6th day or every 12th day. It would ensure that ambient levels remain below established action levels and serve to identify any long-term trends in VOC concentrations.

6.0 REFERENCES

1. Purtymun, W.F. and J.A. Suazo. "Site Description and Activities of Los Alamos National Laboratory: Technical Area 54, Area G." Draft Report. July 1990.
2. Radian Corporation, Quality Assurance Project Plan, "Ambient Monitoring of Volatile Organic Compounds at Los Alamos National Laboratory in Technical Area 54, Areas G and L," May 25, 1994.
3. New Mexico Environmental Improvement Board. Air Quality Control Regulation 201-Ambient Air Quality Standards. June 1981.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.