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Naval Facilities Engineering Command
Contracts Department
1220 Pacific Highway
San Diego, California 92132-5190

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MCAS EL TORO
SSIC NO. 5090.3

Contract No. N68711-92-D-4670

**COMPREHENSIVE LONG-TERM ENVIRONMENTAL
ACTION NAVY
CLEAN II**

**FINAL
TECHNICAL MEMORANDUM
RISK EVALUATION FOR AN OFF-STATION
AGRICULTURAL WORKER
EL TORO, CALIFORNIA**

**CTO-0164/0309
July 2002**

Prepared by:

BECHTEL NATIONAL, INC.
1230 Columbia Street, Suite 400
San Diego, California 92101-8502



Signature: Andrea Temeshy
Andrea Temeshy, Ph.D., Risk Assessment Manager

Date: July 1, 02



CLEAN II Program
Bechtel Job No. 22214
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IN REPLY REFERENCE: CTO-0164/0309

July 31, 2002

Contracting Officer
Naval Facilities Engineering Command
Southwest Division
Ms. Karen Rooney, Code 02R1.KR
1220 Pacific Highway
San Diego, CA 92132-5190

Subject: Final Technical Memorandum – Risk Evaluation for an Off-Station
Agricultural Worker, Dated July 2002
MCAS El Toro, CA

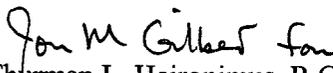
Dear Ms. Rooney:

It is our pleasure to submit this copy of the Final Technical Memorandum – Risk Evaluation for an Off-Station Agricultural Worker – for the Marine Corps Air Station (MCAS) El Toro, California. This document was prepared under Contract Task Order (CTO) 0164 and Contract No. N68711-92-D-4670 in support of the Record of Decision for Sites 18 and 24.

This technical memorandum evaluates the risk to an agricultural worker from exposure to groundwater in the off-Station portion of the VOC groundwater plume and incorporates comments submitted by U.S. EPA, DTSC, and RWQCB on the draft technical memorandum on the same subject. Responses to regulatory agency comments are being submitted under separate cover. The risk assessment confirms that the risks to the agricultural worker are within the range considered unconditionally acceptable by the U.S. EPA.

We appreciate the opportunity to be of service to you on this project. If you have any questions or would like further information, please contact John Scholfield at (619) 744-3093, or me at (619) 744-3004.

Sincerely,


Thurman L. Heironimus, R.G.
Project Manager

TLH/sp
Enclosure

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BECHTEL NATIONAL, INC.

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TO: Contracting Officer
Naval Facilities Engineering Command
Southwest Division
Ms. Karen Rooney, Code 02R1.KR
1220 Pacific Highway
San Diego, CA 92132-5190

DATE: July 31, 2002
CTO #: 0164
LOCATION: MCAS El Toro, CA

FROM: Thurman L. Heironimus, Project Manager

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- 2 RISK ASSESSMENT RESULTS**
- 3 PUBLIC HEALTH RISK ASSESSMENT FOR THE OCWD/IRWD PROPOSED TRICHLOROETHYLENE CONTAINMENT PROGRAM, IRVINE, CALIFORNIA**

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ACRONYMS/ABBREVIATIONS

bgs	below ground surface
Cal/EPA	California Environmental Protection Agency
CCl ₄	carbon tetrachloride
COPC	chemical of potential concern
CSF	cancer slope factor
DCE	dichloroethene
EPC	exposure-point concentration
HEAST	Health Effects Assessment Summary Tables
IRIS	Integrated Risk Information System
µg/L	micrograms per liter
MCAS	Marine Corps Air Station
mg/kg-day	milligrams per kilogram per day
mg/m ³	milligrams per cubic meter
m ³ /hour	cubic meters per hour
OCWD	Orange County Water District
OEHHA	Office of Environmental Health Hazard Assessment
PCE	tetrachloroethene
PRG	preliminary remediation goal
RfD	reference dose
RME	reasonable maximum exposure
Station	MCAS El Toro
TCE	trichloroethene
TDS	total dissolved solids
U.S. EPA	United States Environmental Protection Agency
VOC	volatile organic compound

Final Technical Memorandum
RISK EVALUATION FOR AN OFF-STATION
AGRICULTURAL WORKER

1 INTRODUCTION

Groundwater from the principal aquifer in the vicinity of Marine Corps Air Station (MCAS) El Toro (Station) is used primarily for agriculture and to a lesser extent as a secondary source of local municipal water supply. Currently only one well, 18_ET1, is screened within the principal aquifer groundwater plume. Groundwater from this well is treated using air stripping prior to agricultural use. Groundwater in the shallow groundwater plume is not used for agricultural purposes, nor is such use likely due to high total dissolved solids (TDS) and nitrate concentrations and to the relatively low yield.

In 1989, Orange County Water District (OCWD) performed a risk assessment to evaluate the risk to an agricultural worker from groundwater extracted from areas within the volatile organic compound (VOC) plume in the principal aquifer (Med-Tox 1989). A copy of this assessment is attached. The OCWD assessment concluded that the excess cancer risk to the agricultural worker is on the order of 6.37×10^{-15} to 3.185×10^{-14} and that the noncancer risk is on the order of 2.45×10^{-10} to 1.23×10^{-9} . The assessment was based on a maximum trichloroethene (TCE) concentration of 40 micrograms per liter ($\mu\text{g/L}$).

This risk assessment is being performed to confirm the results of the OCWD risk assessment and assist in determining whether institutional controls prohibiting use of untreated groundwater from the groundwater plume for agricultural purposes are necessary. To be conservative, concentrations of VOCs from well 18_MCAS03 were used in the risk assessment. This well is located within the off-Station portion of the shallow groundwater unit in an area with TCE concentrations ($140 \mu\text{g/L}$) over two times greater than the maximum concentration of TCE reported anywhere in the principal aquifer ($61 \mu\text{g/L}$).

This memorandum presents the methodology used in the human-health risk assessment and tabulates the risk estimate results.

2 HUMAN-HEALTH EVALUATION METHODOLOGY

The risk assessment was conducted in accordance with guidelines published by the United States Environmental Protection Agency (U.S. EPA) in the Risk Assessment Guidance for Superfund: Part A (U.S. EPA 1989) and Part B (U.S. EPA 1991) and supporting documents and guidelines published by the California Environmental Protection Agency (Cal/EPA) (1992). Exposure conditions used in the estimation of risk are chosen to represent "reasonable maximum exposure" (RME) conditions. Use of these exposure conditions tends to overestimate risk. This overestimation of risk is deliberate; it provides risk managers with a margin of safety when making risk-management decisions.

3 EVALUATION OF ANALYTICAL RESULTS

Well 18_MCAS03 is located in the shallow groundwater unit in the area with the highest off-Station concentrations of TCE (Figure 1). Therefore, the agricultural scenario risk evaluation was based on exposure to all the VOCs reported at this well. The analytical data associated with 18_MCAS03 is presented in Tables 1 and 2.

To address potential exposure to groundwater VOCs at well 18_MCAS03 the maximum concentration was used in the risk assessment. All VOCs reported above the laboratory detection limit were identified as chemicals of potential concern (COPCs). Table 3 presents the VOCs and their maximum reported groundwater concentration.

4 EXPOSURE ASSESSMENT

The agricultural worker was assumed to be exposed to VOCs in the shallow groundwater unit, at well 18_MCAS03, through inhalation of vapors released from the groundwater as it is being used for agricultural purposes. Groundwater is assumed to be pumped to the surface and diverted throughout the agricultural fields via irrigation ditches.

The following exposure settings were considered in this assessment:

- agricultural scenario where the worker performs moderate activities
- agricultural scenario where the worker performs heavy activities

4.1 Quantification of Exposure

The final step in the exposure assessment is to quantify the exposure for the inhalation of vapors released from the groundwater that accumulated in the ditches. Exposure quantification is a two-step process. Step 1 entails estimating exposure-point concentrations (EPCs), and step 2 entails estimating dose rates.

4.1.1 ESTIMATING EXPOSURE-POINT CONCENTRATIONS

The concentrations of chemical vapors released from groundwater were calculated based on the highest reported concentration. Groundwater pumped to the surface is assumed to collect in the irrigation ditches as semistagnant water. The predominant exposure scenario at the agricultural fields is assumed to be inhalation of VOCs emitted from the water collected in the irrigation ditches. The U.S. EPA "lagoon model" (U.S. EPA 1988) was used to estimate vapor emissions from the irrigation ditches and the "box model" (Cal/EPA 1994) was used subsequently to predict air concentrations associated with the estimated vapor emissions. Attachment 1 presents the equations and Table 3 the resultant vapor-phase concentrations.

4.1.2 ESTIMATING DOSE

Dose rate is the amount of chemical to which a receptor is exposed per unit of body weight and time. Dose rates were estimated by integrating intake variables such as inhalation rate, body weight, and exposure duration with the contaminant concentration. Exposure assumptions describe the rate of contact that the receptors could have with the

Final Technical Memorandum Risk Evaluation for an Off-Station Agricultural Worker

vapor phase. U.S. EPA guidelines on upper-bound exposure assumptions are designed to address conservatively the behavior or activity patterns of more than 90 to 95 percent of the receptor populations. The intent is to estimate an RME.

Exposure parameters for evaluating agricultural exposures have not been promulgated by U.S. EPA and Cal/EPA. Hence, in order to estimate an RME for this scenario, conservative assumptions were implemented in the risk assessment. This deliberate attempt to overestimate dose is made in the interest of public protection. This approach is designed so that there is high confidence that the actual risk is not underestimated.

The exposure assumptions for a hypothetical agricultural receptor exposed to VOCs released from the groundwater during agricultural activities are as follows.

Agricultural Worker – Moderate Activity Level

- Exposure by an adult was assumed to occur 8 hours a day, 250 days a year for a total of 25 years.
- Inhalation of vapors was assumed to occur at a moderate activity rate of 1.6 cubic meters per hour (m³/hour).

Agricultural Worker – Strenuous Activity Level

- Exposure by an adult was assumed to occur 8 hours a day, 250 days a year for a total of 25 years.
- Inhalation of vapors was assumed to occur at a demanding activity rate of 2.5 m³/hour.

The dose equation for inhalation of vapors is as follows.

Inhalation of Airborne Chemical Vapors

$$D_v = (C_a \times IR_a \times ET \times EF \times ED) / (BW \times AT)$$

where

- D_v = dose resulting from inhalation of chemical vapors (mg/kg-day)
- C_a = chemical concentration in air (mg/m³) (predicted based on modeling)
- IR_a = air intake rate by inhalation (m³/hour)
- ET = exposure time (hours/day)
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- BW = body weight (kilogram)
- AT = averaging time (day)

The values assigned to the parameters in the dose formula are presented in Table 4.

5 TOXICITY CRITERIA

The toxicity values used in the risk assessment consist of cancer slope factors (CSFs) for carcinogenic effects and reference doses (RfDs) for chronic exposures associated with the noncarcinogenic effects. The health criteria were obtained from the table of preliminary

Final Technical Memorandum Risk Evaluation for an Off-Station Agricultural Worker

remediation goals (PRGs) published by U.S. EPA Region 9 (U.S. EPA 2000) and confirmed by a review of the U.S. EPA Integrated Risk Information System (IRIS) database and the U.S. EPA Health Effects Assessment Summary Tables [HEAST] (U.S. EPA 2002 and U.S. EPA 1997, respectively). The IRIS database and HEAST were also searched for toxicity criteria for chemicals not listed in the table of PRGs. Table 5 lists the U.S. EPA toxicity values used in the risk characterization.

CSFs developed by the Cal/EPA were also implemented in the risk assessment. The Cal/EPA CSFs are listed in the Office of Environmental Health Hazard Assessment (OEHHA) toxicity database (Cal/EPA 2002). Use of Cal/EPA toxicity values in addition to the U.S. EPA CSFs permits dual tracking of the cancer risk. Dual tracking of the risk consists of a risk assessment evaluation solely using U.S. EPA toxicity values and a separate risk assessment evaluation using California toxicity values. Table 5 lists the Cal/EPA toxicity values used in the risk characterization.

6 RISK CHARACTERIZATION RESULTS

Results for moderate and strenuous activity by a hypothetical agricultural worker are described below.

6.1 Shallow Groundwater Unit – Hypothetical Agricultural Worker at a Moderate Activity Level

The estimated cancer risk for the hypothetical agricultural worker exposed to VOCs generated from the groundwater as it is being used in agricultural fields for 250 days per year over a course of 25 years is quantified at 1.1×10^{-8} (U.S. EPA) and 3.4×10^{-8} (Cal/EPA). This estimated risk level is considered unconditionally acceptable under U.S. EPA and Cal/EPA guidance.

The estimated hazard index for this scenario is 0.00079. A hazard index value of less than 1 indicates that there is not a potential for adverse noncancer health effects under the scenario evaluated, even among the most chemically sensitive individuals. Cancer risk and hazard index are summarized in Table 6. Attachment 2 presents the risk estimates associated with each VOC evaluated in the risk assessment.

It should be noted that the results associated with this hypothetical scenario are considered conservative estimates of exposure and risk. This risk assessment considered a groundwater-to-air modeling approach with minimal dispersion. Hence, the resultant concentrations in the vapor phase are not overly attenuated by climatic conditions and would be higher than concentrations derived by use of a dispersion model. In addition, it is unlikely that an agricultural worker will remain at the same location for the 25-year period considered in this assessment. Lower exposure duration would lead to lower risks than those estimated. In addition, concentrations of TCE at well 18_MCAS03 are over two times greater than the maximum concentration of TCE reported anywhere in the principal aquifer.

6.2 Shallow Groundwater Unit – Hypothetical Agricultural Worker at a Strenuous Activity Level

The estimated cancer risk for a hypothetical agricultural worker from the inhalation of VOCs released from groundwater over a course of 25 years is quantified at 1.7×10^{-8} (U.S. EPA) and 5.2×10^{-8} (Cal/EPA). The estimated cancer risk is considered unconditionally acceptable under U.S. EPA and Cal/EPA guidance. The hazard index is quantified at 0.0012, indicating that systemic toxicity is unlikely. Attachment 2 presents the risk estimates associated with each VOC evaluated in the risk assessment.

As previously discussed, the risk estimates associated with the agricultural scenario are considered conservative estimates of the actual risk because they are based on upper-bound assumptions and exposure values. Thus, the risks quantified in this assessment are considered overestimates of the agricultural scenario.

7 REFERENCES

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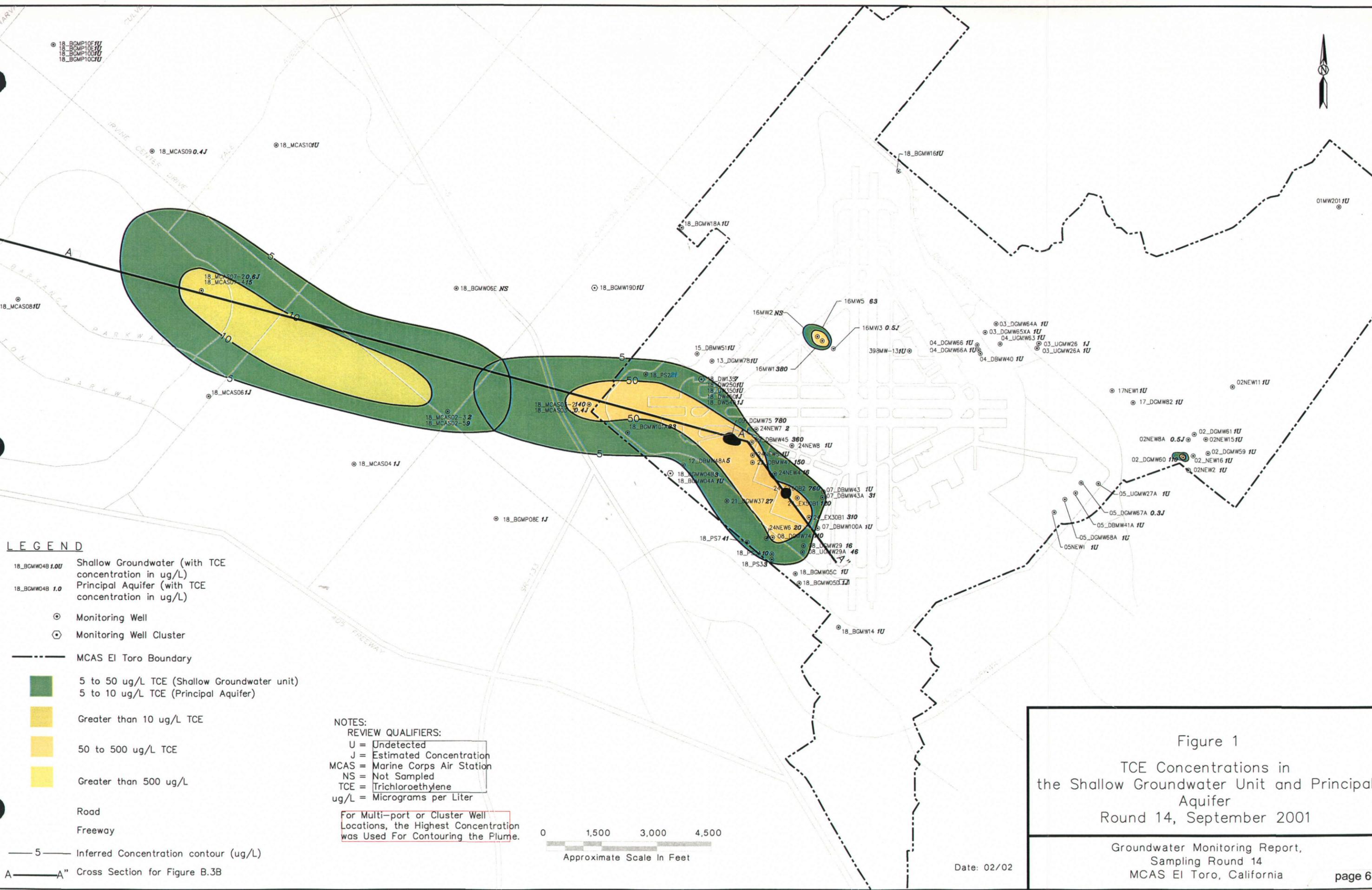
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U.S. EPA. *See* United States Environmental Protection Agency.

FIGURES

FINAL TECHNICAL MEMORANDUM RISK EVALUATION FOR AN OFF-STATION AGRICULTURAL WORKER

DATED 01 JULY 2002



LEGEND

- 18_BGMW04B 1.0U Shallow Groundwater (with TCE concentration in ug/L)
- 18_BGMW04B 1.0 Principal Aquifer (with TCE concentration in ug/L)
- Monitoring Well
- Monitoring Well Cluster
- MCAS El Toro Boundary
- 5 to 50 ug/L TCE (Shallow Groundwater unit)
- 5 to 10 ug/L TCE (Principal Aquifer)
- Greater than 10 ug/L TCE
- 50 to 500 ug/L TCE
- Greater than 500 ug/L
- Road
- Freeway
- 5 Inferred Concentration contour (ug/L)
- A-A Cross Section for Figure B.3B

NOTES:
 REVIEW QUALIFIERS:
 U = Undetected
 J = Estimated Concentration
 MCAS = Marine Corps Air Station
 NS = Not Sampled
 TCE = Trichloroethylene
 ug/L = Micrograms per Liter

For Multi-port or Cluster Well Locations, the Highest Concentration was Used For Contouring the Plume.

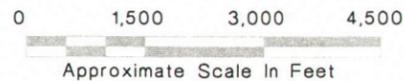


Figure 1
 TCE Concentrations in
 the Shallow Groundwater Unit and Principal
 Aquifer
 Round 14, September 2001

Groundwater Monitoring Report,
 Sampling Round 14
 MCAS El Toro, California

Date: 02/02

page 6

TABLES

FINAL TECHNICAL MEMORANDUM RISK
EVALUATION FOR AN OFF-STATION
AGRICULTURAL WORKER

DATED 01 JULY 2002

Table 1
Detected Volatile Organic Compounds in Groundwater at Well 18_MCAS03, 170 feet bgs Base Screen
MCAS El Toro

Station ID	Base Screen (ft. bgs)	Sample Date	Primary VOCs Detected and Regulatory Standards Concentrations in µg/L								Other Compounds Detected	Result
			TCE	PCE	CCI ₄	1,1-DCE	1,2-DCE (Total)	Chloroform	Benzene			
			5	5	0.5	6	6	100	1			
18_MCAS03-2	170	12-Jun-88	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.7	0.5 U			
		6-Dec-88	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.7	0.5 U			
		30-Jan-89	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 J	0.5 U			
		13-Apr-89	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 J	0.5 U			
		10-Oct-89	4.6	0.5 U	0.5 U	0.5 U	0.5 U	1	0.5 U			
		9-Feb-90	14.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5	0.5 U			
		13-Mar-90	18.1	0.5 J	0.5 U	0.5 U	0.5 U	0.5 J	0.5 U			
		17-May-90	7.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 J	0.5 U			
		2-Sep-90	14.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5	0.5 U			
		11-Sep-90	15.7	0.7	0.5 U	0.5 U	0.5 U	0.7	0.5 U			
		9-Nov-90	15.7	0.7	0.5 U	0.5 U	0.5 U	0.7	0.5 U			
		4-Apr-91	23.4	1.1	0.5 U	0.5 U	0.5 U	2.7	0.5 U			
		18-Jul-91	20.6	1	0.5 U	0.5 U	0.5 U	0.5 J	0.5 U			
		18-Oct-91	49.3	2.2	0.5 U	0.5 U	0.5 U	1.2	0.5 U			
		14-May-92	42.2	1.6	0.5 U	0.5 U	1.3	0.5 J	0.5 U			
		15-Sep-92	23.7	0.7	0.5 U	0.5 U	0.8	0.6	0.5 U			
		6-Feb-93	41.1	1.4	0.5 U	0.5 U	1.6	0.6	0.5 U			
		10-Jun-93	41.1	1.4	0.5 U	0.5 U		0.6	0.5 U			
		2-Jun-93	44.7	1.6	0.5 U	0.5 U		0.6	0.5 U			
		10-Jun-93	52.4	1.8	0.5 U	0.5 U		0.6	0.5 U			
		19-Nov-93	52.4	1.8	1 U	1 U	1 U	1 U	1 U			
		16-Jun-94	30.7	ND	ND	ND	ND	Trace	ND			
		20-Dec-95	76	1.8	ND	ND	0.8	Trace	ND			
		6-Feb-96	33	1	1 U	1 U	1 U	1 U	1 U			
		15-Jun-96	84.6	1.8	ND	ND	1.1	Trace	ND			
		6-Nov-96	115	2	1 U	1 U	4	1 U	1 U			
		11-Mar-97	107	5 U	5 U	5 U	4 J	5 U	5 U			
		4-Apr-97	64	1.5	ND	ND	5.7	0.8	ND			
		1-Jul-97	88	1	1 U	1 U	4	1 U	1 U			
		14-Oct-97	71	0.6 J	1 U	1 U	4 J	0.3 J	1 U	Vinyl Chloride	7J	
14-Oct-97	72	0.6 J	1 U	1 U	4 J	1 U	1 U	Methylene Chloride	1			
8-Oct-98	130	0.9 J	1 U	1 U	7	0.5 J	1 U	Toluene	1.4			
13-Jul-99	140	0.78	1 U	1 U	8.5	1 U	1 U					
13-Jul-99	140	0.94	1 U	1 U	9.2	1 U	1 U					
22-Feb-01	110	50 U	50 U	50 U	5 J	50 U	50 U					
11-Sep-01	140	5 U	5 U	5 UJ	9	5 U	5 U					

Table 2
Detected Volatile Organic Compounds in Groundwater at Well 18_MCAS03, Base Screen 230 feet bgs
MCAS EI Toro

Station ID	Base Screen (ft. bgs)	Sample Date	Primary VOCs Detected and Regulatory Standards Concentrations in µg/L								Other Compounds Detected	Result
			TCE	PCE	CCl4	1,1-DCE	1,2-DCE (Total)	Chloroform	Benzene			
			5	5	0.5	6	6	100	1			
18_MCAS03-3	230	12-Jun-88	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U		
		6-Dec-88	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U		
		30-Jan-89	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U		
		13-Apr-89	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U		
		10-Sep-89	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U		
		9-Oct-89	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U		
		9-Feb-90	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U		
		13-Mar-90	0.5 U	0.5 U	0.3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U		
		17-May-90	0.5 U	0.5 U	0.4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U		
		2-Sep-90	0.5 U	0.5 U	1 J	1 U	0.5 U	0.5 U	0.5 U	0.5 U		
		11-Sep-90	0.5 U	0.5 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U		
		9-Nov-90	0.5 U	0.5 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U		
		4-Apr-91	0.5 U	0.5 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U		
		18-Jul-91	0.5 U	0.5 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U		
		18-Oct-91	0.5 U	0.5 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U		
		14-May-92	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U		
		15-Sep-92	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U		
		6-Feb-93	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		
		2-Jun-93	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		
		10-Jun-93	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		
		6-Oct-93	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U		
		19-Nov-93	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U		
		16-Jun-94	ND	ND	1 U	1 U	ND	ND	ND	ND		
		20-Dec-95	ND	Trace	1 U	1 U	ND	ND	ND	ND		
		6-Feb-96	1 U	1 U	1 U	0.6 J	1 U	1 U	1 U	1 U		
		15-Jun-96	ND	Trace	ND	ND	ND	ND	ND	ND		
		6-Nov-96	1 U	1 U	0.5 U		1 U	1 U	1 U	1 U		
		11-Mar-97	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U		
		4-Apr-97	ND	Trace	1 U	1 U	ND	ND	ND	ND		
		1-Jul-97	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U		
		14-Oct-97	0.3 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	Methylene Chloride	0.4 J
		8-Oct-98	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	Acetone	1.7 J
		8-Oct-98			1 U	1 U					Carbon Disulfide	1.7
		12-Jul-99	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U		
		22-Feb-01	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U		
		11-Sep-01	0.4 J	0.4 J	1 U	1 UJ	1 UJ	1 U	1 U	1 U		

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Table 3
Well 18_MCAS03 Groundwater and Associated Vapor-Phase Concentrations

CAS Number	Analyte	Groundwater Concentration (mg/L)	Vapor-Phase Concentration (mg/m ³)
67-64-1	Acetone	1.70E-03	3.92E-07
75-15-0	Carbon disulfide	1.70E-02	3.87E-06
56-23-5	Carbon tetrachloride	1.00E-03	1.62E-07
67-66-3	Chloroform	8.00E-03	1.45E-07
540-59-0	1,2-Dichloroethene	9.20E-03	1.85E-06
75-35-4	1,1-Dichloroethene	6.00E-04	1.21E-07
75-09-2	Methylene chloride	1.00E-03	2.15E-07
127-18-4	Tetrachloroethene	1.80E-03	2.74E-07
108-88-3	Toluene	1.40E-03	2.9E-07
79-01-6	Trichloroethene	1.40E-01	2.44E-05
75-01-4	Vinyl chloride	7.00E-03	1.75E-06

Acronyms/Abbreviations:
 CAS – Chemical Abstracts Service
 mg/L – milligrams per liter
 mg/m³ – milligrams per cubic meter

Table 4
Shallow Groundwater Unit
Values Assigned to Dose Equation Parameters

Equation Parameter	Unit	Agricultural Worker at a Moderate Activity Level	Agricultural Worker at a Strenuous Activity Level
Inhalation of Vapors			
Inhalation rate	m ³ /hour	1.6	2.5
Exposure time	hours/day	8	8
Exposure frequency	days/year	250	250
Exposure duration	years	25	25
Body weight	kilograms	70	70
Averaging time (cancer)	days	25,550	25,550
Averaging time (noncancer)	days	ED × 365	ED × 365

Acronyms/Abbreviations:
 ED – exposure duration
 m³/hour – cubic meters per hour

**Table 5
Toxicity Values**

CAS Number	Analyte	U.S. EPA Inhalation CSF ^a	Ref ^b	U.S. EPA Inhalation RfD ^c	Ref ^b	Cal/EPA Inhalation CSF ^a	Ref ^b
67-64-1	Acetone	NA		1.00E-01	R	NA	
75-15-0	Carbon disulfide	NA		2.00E-01	I	NA	
56-23-5	Carbon tetrachloride	5.25E-02	I	7.00E-04	R	1.50E-01	O
67-66-3	Chloroform	8.05E-02	I	8.60E-05	N	1.90E-02	O
540-59-0	1,2-Dichloroethene	NA		9.00E-03	R	NA	
75-35-4	1,1-Dichloroethene	1.75E-01	I	9.00E-03	R	NA	
75-09-2	Methylene chloride	1.65E-03	I	8.57E-01	H	3.50E-03	O
127-18-4	Tetrachloroethene	2.03E-03	N	1.14E-01	N	2.10E-02	O
108-88-3	Toluene	NA		1.10E-01	I	NA	
79-01-6	Trichloroethene	6.00E-03	N	6.00E-03	R	1.00E-02	O
75-01-4	Vinyl chloride	3.10E-02	I	2.86E-02	I	2.70E-01	O

Notes:

^a units in inverse of milligrams per kilograms per day

^b Reference:

I – Integrated Risk Information System

N – National Center for Environmental Assessment, formerly known as Environmental Criteria and Assessment Office

O – Office of Environmental Health Hazard Assessment

R – route-to-route extrapolation

^c units in milligrams per kilograms per day

Acronyms/Abbreviations:

CAS – Chemical Abstracts Service

CSF – cancer slope factor

NA – not available

Ref – reference

RfD – reference dose

U.S. EPA – United States Environmental Protection Agency

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Table 6
Summary of Lifetime Cancer Risk and Hazard Index by Pathway
Agricultural Receptors

Receptor	Cancer Risk U.S. EPA ^a	Cancer Risk State ^b	Hazard Index
Agricultural Worker at a Moderate Activity Level			
Vapor Inhalation Risk	1.1E-08	3.4E-08	0.00079
Agricultural Worker at a Strenuous Activity Level			
Vapor Inhalation Risk	1.7E-08	5.2E-08	0.0012

Notes:

- ^a risk was calculated using U.S. EPA toxicity values
- ^b risk was calculated using Cal/EPA toxicity values

Acronyms/Abbreviations:

- Cal/EPA – California Environmental Protection Agency
- U.S. EPA – United States Environmental Protection Agency

ATTACHMENT 1

AIR MODELING METHODOLOGY

Attachment 1 AIR MODELING METHODOLOGY

The United States Environmental Protection Agency (U.S. EPA)-approved "lagoon model" (described in the Superfund Exposure Assessment Manual [U.S. EPA 1988]) was used to estimate vapor emissions from semistagnant water contained in irrigation ditches. Current maximum observed groundwater concentrations were used for model input concentrations (CDM 2002). The model was originally developed by Mackay and Leinonen (1975) for estimating volatilization releases from water bodies such as hazardous waste lagoons. The following is a list of the model assumptions:

- No constant addition of contaminants occurs.
- Diffusion is liquid-state controlled; it occurs from a well-mixed water phase to a well-mixed air phase across a stagnant water/air interface.
- Atmospheric background levels of the contaminants of concern are negligible.

The emission rate for a chemical from a water body takes the following form:

$$E_i = K_i C_s$$

where

- E_i = emission rate (g/cm²-sec)
 K_i = overall mass transfer coefficient (cm/sec) (chemical specific)
 C_s = contaminant liquid-phase concentration (g/cm³)

The overall mass transfer coefficient (K_i) is calculated via the following relationship:

$$\frac{1}{K_i} = \frac{1}{k_{iL}} + \frac{RT}{H_i k_{iG}}$$

where

- K_i = overall mass transfer coefficient (cm/sec)
 k_{iL} = liquid-phase mass transfer coefficient (cm/sec)
 R = ideal gas law constant (8.2×10^{-5} atm-m³/mol-°K)
 T = temperature (°K)
 H_i = Henry's law constant of compound i, (atm-m³/mol)
 k_{iG} = gas-phase mass transfer coefficient (cm/sec)

Attachment 1 Air Modeling Methodology

The following table summarizes the input parameters for the overall mass transfer coefficients (K_i):

Chemical	K_{iL}^a (cm/sec)	R^b (atm-m ³ /mol-K)	T (K)	H^c (atm-m ³ /mol)	K_{iG}^d (cm/sec)	$1/K_i$ (1/cm/sec)	K_i (cm/sec)
Trichloroethene	6.69E-05	8.20E-05	289	1.03E-02	0.35	1.50E+04	6.69E-05
Tetrachloroethene	5.85E-05	8.20E-05	289	1.84E-02	0.32	1.71E+04	5.85E-05
1,2-Dichloroethene ^e	7.74E-05	8.20E-05	289	4.07E-03	0.39	1.29E+04	7.73E-05
Chloroform	6.96E-05	8.20E-05	289	3.66E-03	0.36	1.44E+04	6.95E-05
Vinyl chloride	9.61E-05	8.20E-05	289	2.71E-02	0.45	1.04E+04	9.61E-05
Methylene chloride	8.27E-05	8.20E-05	289	2.19E-03	0.41	1.21E+04	8.25E-05
Toluene	7.95E-05	8.20E-05	289	6.63E-03	0.40	1.26E+04	7.94E-05
Carbon tetrachloride	6.23E-05	8.20E-05	289	3.05E-02	0.34	1.61E+04	6.23E-05
1,1-Dichloroethene	7.74E-05	8.20E-05	289	5.61E-03	0.39	1.29E+04	7.74E-05
Acetone	1.00E-04	8.20E-05	289	3.88E-05	0.46	1.13E+04	8.85E-05
Carbon disulfide	8.75E-05	8.20E-05	289	3.02E-02	0.42	1.14E+04	8.75E-05

The following footnotes are noted for the K_i summary table above:

- ^a Calculation of chemical-specific liquid-phase mass transfer coefficient (K_{iL}) is:

$$K_{iL} = (MWO_2/MW_i)^{0.5} \times (T/298) \times k_{L,O_2}$$

This equation is described in further detail below.

- ^b Source for ideal gas law constant (R): U.S. EPA 1988. Superfund Exposure Assessment Manual.
- ^c Source for Henry's law values (H): U.S. EPA 1998. User's Guide to the Johnson and Ettinger Model.
- ^d Calculation of chemical-specific gas-phase mass transfer coefficient (K_{iG}) is:

$$K_{iG} = (MWO_2/MW_i)0.33 \times (T/298)^{1.005} \times (k_{G,O_2})$$

where

- MWO₂ is the molecular weight of oxygen
- MW_i is the molecular weight of the chemical
- T is the temperature of the chemical
- K_{G,O₂} is the gas-phase mass transfer coefficient for oxygen at 25 degrees Celsius (°C) (Smith et al. 1983)

- ^e Use Henry's constant for cis-1,2-dichloroethene

Hwang (1982) provides a method for determining a compound's liquid-phase mass transfer coefficient (k_{iL}) for use in the above equation. To estimate k_{iL} , the following equation is used:

$$k_{iL} = \left(\frac{MW_{O_2}}{MW_i} \right)^{0.5} \left(\frac{T}{298} \right) (k_{L,O_2})$$

Attachment 1 Air Modeling Methodology

where

- k_{iL} = liquid-phase mass transfer coefficient (cm/sec)
- MW_{O_2} = molecular weight of oxygen
- MW_i = molecular weight of compound i
- T = temperature (°K)
- k_{L,O_2} = liquid-phase mass transfer coefficient for oxygen at 25 °C (cm/sec)

The gas-phase mass transfer coefficient can be calculated in an analogous fashion using the gas-phase mass transfer coefficient for oxygen (however, the exponent value is changed to 0.33). Liquid- and gas-phase mass transfer coefficients for oxygen (0.00014 and 0.583 cm/sec, respectively) were obtained from Mackay et al. (1985) and Smith et al. (1983).

In order to estimate exposure-point concentrations (EPCs) associated with predicted vapor emission rates for the chemicals of potential concern (COPCs), a simple California Environmental Protection Agency (Cal/EPA)-approved air dispersion model (the "box model") was used (Cal/EPA 1994). The model takes the form of the following equation:

$$C_a = \frac{E_i \times A}{LS \times V \times MH}$$

where

- C_a = air concentration (mg/m³)
- E_i = emission rate over the irrigation ditch (mg/m²-sec)
- A = area of irrigation ditch (m²)
- LS = length dimension perpendicular to the wind (m)
- V = average wind speed with the mixing zone (m/sec)
- MH = mixing height (m) (approximate height of breathing zone)

Cal/EPA default values for average wind speed and mixing height are 2.25 meters per second (m/sec) and 2 meters (m), respectively. However, the values used for this evaluation were 5.76 m/sec for wind speed and 1.5 m for mixing height. The wind speed value of 5.76 m/sec represents an average of five site-specific wind speeds provided in the 1989 Risk Assessment (Med-Tox 1989). The mixing height was reduced to 1.5 m to keep the model conservative. The irrigation ditch is assumed to be 2 m wide. The worker is assumed to be exposed to VOCs that have volatilized along an approximately 3-m upwind stretch of the ditch.

Attachment 1 Air Modeling Methodology

The table below is a summary of final air concentrations:

Chemical	Emission Rate (mg/m ² -sec)	Area of Ditch (m ²)	Dimension Perpendicular to Wind (m)	Mixing Height (m)	Wind Speed (m/sec)	Air Concentration (mg/m ³)
Trichloroethene	9.36E-05	6	2	1.5	5.76	3.25E-05
Tetrachloroethene	1.05E-06	6	2	1.5	5.76	3.65E-07
1,2-Dichloroethene	7.11E-06	6	2	1.5	5.76	2.47E-06
Chloroform	5.56E-07	6	2	1.5	5.76	1.93E-07
Vinyl chloride	6.72E-06	6	2	1.5	5.76	2.33E-06
Methylene chloride	8.25E-07	6	2	1.5	5.76	2.87E-07
Toluene	1.11E-06	6	2	1.5	5.76	3.86E-07
Carbon tetrachloride	6.23E-07	6	2	1.5	5.76	2.16E-07
1,1-Dichloroethene	4.64E-07	6	2	1.5	5.76	1.61E-07
Acetone	1.50E-06	6	2	1.5	5.76	5.22E-07
Carbon disulfide	1.49E-05	6	2	1.5	5.76	5.16E-06

Acronyms/Abbreviations:

- m – meter
- m² – square meter
- mg/m²-sec – milligrams per square meter per second
- mg/m³ – milligrams per cubic meter

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Attachment 1 Air Modeling Methodology

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ATTACHMENT 2

RISK ASSESSMENT RESULTS

Attachment 2 Table 1
EI Toro CTO 164
Summary of U.S. EPA Total Lifetime Cancer Risks for the Agricultural Worker with a Moderate Activity Level
Cross Pathway Sum by Chemical

Chemical Name	CAS	Chemical Type	Medium	Exposure Point Concentration	Exposure Route	Dose (mg/kg-day)	Lifetime Cancer Risk
Carbon tetrachloride	56-23-5	V	Air Volatiles	2.2E-07 mg/m3	Inhalation	9.7E-09 <i>Air Volatiles</i> Carbon tetrachloride	5.1E-10 5.1E-10 5.1E-10
Chloroform	67-66-3	V	Air Volatiles	1.9E-07 mg/m3	Inhalation	8.6E-09 <i>Air Volatiles</i> Chloroform	7.0E-10 7.0E-10 7.0E-10
Dichloroethylene-1,1	75-35-4	V	Air Volatiles	1.6E-07 mg/m3	Inhalation	7.2E-09 <i>Air Volatiles</i> Dichloroethylene-1,1	1.3E-09 1.3E-09 1.3E-09
Methylene chloride	75-09-2	V	Air Volatiles	2.9E-07 mg/m3	Inhalation	1.3E-08 <i>Air Volatiles</i> Methylene chloride	2.1E-11 2.1E-11 2.1E-11
Tetrachloroethylene (PCE)	127-18-4	V	Air Volatiles	3.7E-07 mg/m3	Inhalation	1.6E-08 <i>Air Volatiles</i> Tetrachloroethylene (PCE)	3.3E-11 3.3E-11 3.3E-11
Trichloroethylene (TCE)	79-01-6	V	Air Volatiles	3.2E-05 mg/m3	Inhalation	1.5E-06 <i>Air Volatiles</i> Trichloroethylene (TCE)	8.7E-09 8.7E-09 8.7E-09
Vinyl chloride	75-01-4	V	Air Volatiles	2.3E-06 mg/m3	Inhalation	1.0E-07 <i>Air Volatiles</i> Vinyl chloride	3.2E-09 3.2E-09 3.2E-09

Notes:

- CAS - chemical abstract service number
- mg/kg-day - milligrams per kilograms-day
- mg/m³ - milligrams per meter cube

**Attachment 2 Table 2
 El Toro CTO 164
 Summary of State Total Lifetime Cancer Risks for the Agricultural Worker with a Moderate Activity Level
 Cross Pathway Sum by Chemical**

Chemical Name	CAS	Chemical Type	Medium	Exposure Point Concentration	Exposure Route	Dose (mg/kg-day)	Lifetime Cancer Risk
Carbon tetrachloride	56-23-5	V	Air Volatiles	2.2E-07 mg/m3	Inhalation	9.7E-09 <i>Air Volatiles</i> Carbon tetrachloride	1.5E-09 1.5E-09 1.5E-09
Chloroform	67-66-3	V	Air Volatiles	1.9E-07 mg/m3	Inhalation	8.6E-09 <i>Air Volatiles</i> Chloroform	1.6E-10 1.6E-10 1.6E-10
Methylene chloride	75-09-2	V	Air Volatiles	2.9E-07 mg/m3	Inhalation	1.3E-08 <i>Air Volatiles</i> Methylene chloride	4.5E-11 4.5E-11 4.5E-11
Tetrachloroethylene (PCE)	127-18-4	V	Air Volatiles	3.7E-07 mg/m3	Inhalation	1.6E-08 <i>Air Volatiles</i> Tetrachloroethylene (PCE)	3.4E-10 3.4E-10 3.4E-10
Trichloroethylene (TCE)	79-01-6	V	Air Volatiles	3.2E-05 mg/m3	Inhalation	1.5E-06 <i>Air Volatiles</i> Trichloroethylene (TCE)	1.5E-08 1.5E-08 1.5E-08
Vinyl chloride	75-01-4	V	Air Volatiles	2.3E-06 mg/m3	Inhalation	1.0E-07 <i>Air Volatiles</i> Vinyl chloride	2.8E-08 2.8E-08 2.8E-08

Notes:

- CAS - chemical abstract service number
- mg/kg-day - milligrams per kilograms-day
- mg/m³ - milligrams per meter cube

**Attachment 2 Table 3
 EI Toro CTO 164
 Summary of Chronic Hazard Index for the Agricultural Worker with a Moderate Activity Level
 Cross Pathway Sum by Chemical**

Chemical Name	CAS	Chemical Type	Medium	Exposure Point Concentration	Exposure Route	Dose (mg/kg-day)	Hazard Index
Acetone	67-64-1	V	Air Volatiles	5.2E-07 mg/m3	Inhalation	6.5E-08 <i>Air Volatiles</i> Acetone	6.5E-07 6.5E-07 6.5E-07
Carbon disulfide	75-15-0	V	Air Volatiles	5.2E-06 mg/m3	Inhalation	6.5E-07 <i>Air Volatiles</i> Carbon disulfide	3.2E-06 3.2E-06 3.2E-06
Carbon tetrachloride	56-23-5	V	Air Volatiles	2.2E-07 mg/m3	Inhalation	2.7E-08 <i>Air Volatiles</i> Carbon tetrachloride	3.9E-05 3.9E-05 3.9E-05
Chloroform	67-66-3	V	Air Volatiles	1.9E-07 mg/m3	Inhalation	2.4E-08 <i>Air Volatiles</i> Chloroform	2.8E-04 2.8E-04 2.8E-04
Dichloroethylene (mixture)-1,2	540-59-0	V	Air Volatiles	2.5E-06 mg/m3	Inhalation	3.1E-07 <i>Air Volatiles</i> Dichloroethylene (mixture)-1,2	3.4E-05 3.4E-05 3.4E-05
Dichloroethylene-1,1	75-35-4	V	Air Volatiles	1.6E-07 mg/m3	Inhalation	2.0E-08 <i>Air Volatiles</i> Dichloroethylene-1,1	2.2E-06 2.2E-06 2.2E-06
Methylene chloride	75-09-2	V	Air Volatiles	2.9E-07 mg/m3	Inhalation	3.6E-08 <i>Air Volatiles</i> Methylene chloride	4.2E-08 4.2E-08 4.2E-08
Tetrachloroethylene (PCE)	127-18-4	V	Air Volatiles	3.7E-07 mg/m3	Inhalation	4.6E-08 <i>Air Volatiles</i> Tetrachloroethylene (PCE)	4.0E-07 4.0E-07 4.0E-07

Attachment 2 Table 3 (continued)

Chemical Name	CAS	Chemical Type	Medium	Exposure Point Concentration	Exposure Route	Dose (mg/kg-day)	Hazard Index
Toluene	108-88-3	V	Air Volatiles	3.9E-07 mg/m3	Inhalation	4.8E-08 <i>Air Volatiles</i> Toluene	4.4E-07 4.4E-07 4.4E-07
Trichloroethylene (TCE)	79-01-6	V	Air Volatiles	3.2E-05 mg/m3	Inhalation	4.1E-06 <i>Air Volatiles</i> Trichloroethylene (TCE)	6.8E-04 6.8E-04 6.8E-04
Vinyl chloride	75-01-4	V	Air Volatiles	2.3E-06 mg/m3	Inhalation	2.9E-07 <i>Air Volatiles</i> Vinyl chloride	1.0E-05 1.0E-05 1.0E-05

Notes:

- CAS - chemical abstract service number
- mg/kg-day - milligrams per kilograms-day
- mg/m³ - milligrams per meter cube

**Attachment 2 Table 4
 El Toro CTO 164
 Summary of U.S. EPA Total Lifetime Cancer Risks for the Agricultural Worker with a Strenuous Activity Level
 Cross Pathway Sum by Chemical**

Chemical Name	CAS	Chemical Type	Medium	Exposure Point Concentration	Exposure Route	Dose (mg/kg-day)	Lifetime Cancer Risk
Carbon tetrachloride	56-23-5	V	Air Volatiles	2.2E-07 mg/m3	Inhalation	1.5E-08	7.9E-10
						<i>Air Volatiles</i> Carbon tetrachloride	7.9E-10 7.9E-10
Chloroform	67-66-3	V	Air Volatiles	1.9E-07 mg/m3	Inhalation	1.3E-08	1.1E-09
						<i>Air Volatiles</i> Chloroform	1.1E-09 1.1E-09
Dichloroethylene-1,1	75-35-4	V	Air Volatiles	1.6E-07 mg/m3	Inhalation	1.1E-08	2.0E-09
						<i>Air Volatiles</i> Dichloroethylene-1,1	2.0E-09 2.0E-09
Methylene chloride	75-09-2	V	Air Volatiles	2.9E-07 mg/m3	Inhalation	2.0E-08	3.3E-11
						<i>Air Volatiles</i> Methylene chloride	3.3E-11 3.3E-11
Tetrachloroethylene (PCE)	127-18-4	V	Air Volatiles	3.7E-07 mg/m3	Inhalation	2.6E-08	5.2E-11
						<i>Air Volatiles</i> Tetrachloroethylene (PCE)	5.2E-11 5.2E-11
Trichloroethylene (TCE)	79-01-6	V	Air Volatiles	3.2E-05 mg/m3	Inhalation	2.3E-06	1.4E-08
						<i>Air Volatiles</i> Trichloroethylene (TCE)	1.4E-08 1.4E-08
Vinyl chloride	75-01-4	V	Air Volatiles	2.3E-06 mg/m3	Inhalation	1.6E-07	5.1E-09
						<i>Air Volatiles</i> Vinyl chloride	5.1E-09 5.1E-09

Notes:

- CAS - chemical abstract service number
- mg/kg-day - milligrams per kilograms-day
- mg/m³ - milligrams per meter cube

**Attachment 2 Table 5
 El Toro CTO 164
 Summary of State Total Lifetime Cancer Risks for the Agricultural Worker with a Strenuous Activity Level
 Cross Pathway Sum by Chemical**

Chemical Name	CAS	Chemical Type	Medium	Exposure Point Concentration	Exposure Route	Dose (mg/kg-day)	Lifetime Cancer Risk
Carbon tetrachloride	56-23-5	V	Air Volatiles	2.2E-07 mg/m3	Inhalation	1.5E-08	2.3E-09
						<i>Air Volatiles</i>	<i>2.3E-09</i>
						Carbon tetrachloride	2.3E-09
Chloroform	67-66-3	V	Air Volatiles	1.9E-07 mg/m3	Inhalation	1.3E-08	2.6E-10
						<i>Air Volatiles</i>	<i>2.6E-10</i>
						Chloroform	2.6E-10
Methylene chloride	75-09-2	V	Air Volatiles	2.9E-07 mg/m3	Inhalation	2.0E-08	7.0E-11
						<i>Air Volatiles</i>	<i>7.0E-11</i>
						Methylene chloride	7.0E-11
Tetrachloroethylene (PCE)	127-18-4	V	Air Volatiles	3.7E-07 mg/m3	Inhalation	2.6E-08	5.4E-10
						<i>Air Volatiles</i>	<i>5.4E-10</i>
						Tetrachloroethylene (PCE)	5.4E-10
Trichloroethylene (TCE)	79-01-6	V	Air Volatiles	3.2E-05 mg/m3	Inhalation	2.3E-06	2.3E-08
						<i>Air Volatiles</i>	<i>2.3E-08</i>
						Trichloroethylene (TCE)	2.3E-08
Vinyl chloride	75-01-4	V	Air Volatiles	2.3E-06 mg/m3	Inhalation	1.6E-07	4.4E-08
						<i>Air Volatiles</i>	<i>4.4E-08</i>
						Vinyl chloride	4.4E-08

Notes:

- CAS - chemical abstract service number
- mg/kg-day - milligrams per kilograms-day
- mg/m³ - milligrams per meter cube

**Attachment 2 Table 6
 EI Toro CTO 164
 Summary of Chronic Hazard Index for the Agricultural Worker with a Strenuous Activity Level
 Cross Pathway Sum by Chemical**

Chemical Name	CAS	Chemical Type	Medium	Exposure Point Concentration	Exposure Route	Dose (mg/kg-day)	Hazard Index
Acetone	67-64-1	V	Air Volatiles	5.2E-07 mg/m3	Inhalation	1.0E-07	1.0E-06
						<i>Air Volatiles</i>	1.0E-06
						Acetone	1.0E-06
Carbon disulfide	75-15-0	V	Air Volatiles	5.2E-06 mg/m3	Inhalation	1.0E-06	5.1E-06
						<i>Air Volatiles</i>	5.1E-06
						Carbon disulfide	5.1E-06
Carbon tetrachloride	56-23-5	V	Air Volatiles	2.2E-07 mg/m3	Inhalation	4.2E-08	6.0E-05
						<i>Air Volatiles</i>	6.0E-05
						Carbon tetrachloride	6.0E-05
Chloroform	67-66-3	V	Air Volatiles	1.9E-07 mg/m3	Inhalation	3.8E-08	4.4E-04
						<i>Air Volatiles</i>	4.4E-04
						Chloroform	4.4E-04
Dichloroethylene (mixture)-1,2	540-59-0	V	Air Volatiles	2.5E-06 mg/m3	Inhalation	4.8E-07	5.4E-05
						<i>Air Volatiles</i>	5.4E-05
						Dichloroethylene (mixture)-1,2	5.4E-05
Dichloroethylene-1,1	75-35-4	V	Air Volatiles	1.6E-07 mg/m3	Inhalation	3.2E-08	3.5E-06
						<i>Air Volatiles</i>	3.5E-06
						Dichloroethylene-1,1	3.5E-06
Methylene chloride	75-09-2	V	Air Volatiles	2.9E-07 mg/m3	Inhalation	5.6E-08	6.5E-08
						<i>Air Volatiles</i>	6.5E-08
						Methylene chloride	6.5E-08
Tetrachloroethylene (PCE)	127-18-4	V	Air Volatiles	3.7E-07 mg/m3	Inhalation	7.2E-08	6.3E-07
						<i>Air Volatiles</i>	6.3E-07
						Tetrachloroethylene (PCE)	6.3E-07

Attachment 2 Table 6 (continued)

Chemical Name	CAS	Chemical Type	Medium	Exposure Point Concentration	Exposure Route	Dose (mg/kg-day)	Hazard Index
Toluene	108-88-3	V	Air Volatiles	3.9E-07 mg/m3	Inhalation	7.6E-08 <i>Air Volatiles</i> Toluene	6.9E-07 6.9E-07 6.9E-07
Trichloroethylene (TCE)	79-01-6	V	Air Volatiles	3.2E-05 mg/m3	Inhalation	6.4E-06 <i>Air Volatiles</i> Trichloroethylene (TCE)	1.1E-03 1.1E-03 1.1E-03
Vinyl chloride	75-01-4	V	Air Volatiles	2.3E-06 mg/m3	Inhalation	4.6E-07 <i>Air Volatiles</i> Vinyl chloride	1.6E-05 1.6E-05 1.6E-05

Notes:

- CAS - chemical abstract service number
- mg/kg-day - milligrams per kilograms-day
- mg/m³ - milligrams per meter cube

ATTACHMENT 3

**PUBLIC HEALTH RISK ASSESSMENT
FOR THE OCWD/IRWD PROPOSED
TRICHLOROETHYLENE CONTAINMENT PROGRAM,
IRVINE, CALIFORNIA**

**PUBLIC HEALTH RISK ASSESSMENT
FOR THE OCWD/IRWD PROPOSED
TRICHLOROETHYLENE CONTAINMENT PROGRAM
IRVINE, CALIFORNIA**

SUBMITTED TO:

**ORANGE COUNTY WATER DISTRICT
10500 ELLIS AVENUE
FOUNTAIN VALLEY, CALIFORNIA**

PREPARED BY:

**MED-TOX ASSOCIATES, INC.
1431 WARNER AVENUE
TUSTIN, CALIFORNIA**

JUNE, 1989

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EXECUTIVE SUMMARY**INTRODUCTION**

The Orange County Water District (OCWD) has discovered that groundwater underlying portions of the City of Irvine is contaminated with trichloroethylene. Hydrogeological studies performed by the Orange County Water District and other parties have revealed that a plume of trichloroethylene contaminated groundwater is migrating westward and poses a threat to drinking groundwater aquifers in the County of Orange. To help contain the westerly migration of this contaminated groundwater plume, the Orange County Water District and the Irvine Ranch Water District propose to pump the contaminated groundwater from the western end of the plume and use it for irrigation of agricultural fields and greenbelts. The pumping program would be operated jointly by the Orange County Water District and the Irvine Ranch Water District.

The purpose of this risk assessment is to evaluate the magnitude and probability of public health risks associated with potential trichloroethylene emissions from trichloroethylene contaminated water used for irrigation.

PROJECT AND SITE DESCRIPTION

In 1985, as a part of the District's ongoing water quality monitoring program, the Orange County Water District detected trichloroethylene in three Irvine area irrigation wells. Initial water quality tests revealed elevated trichloroethylene levels in an irrigation well located on the El Toro Marine Corps Air Station and in two wells located west of the air station. These westerly wells are considered to be down gradient with respect to regional groundwater flow from the contaminated well located at the air station.

To characterize the magnitude of the trichloroethylene contamination in the aforementioned wells, the Orange County Water District and the El Toro Marine Corps Air Station initiated a program of additional groundwater testing. This additional testing revealed evidence of both groundwater contamination at the base and up to three miles down gradient. The groundwater contamination was discovered to extend to a depth of approximately 200 to 450 feet below the surface and is estimated to impact 150,000 acre-feet of

groundwater. Furthermore, the Orange County Water District study suggested that the trichloroethylene contamination discovered on the El Toro Marine Corps Air Station may be contiguous with the off-base contamination plume¹.

The westward migration of the trichloroethylene contaminated plume poses a significant threat to domestic wells located west of Newport Boulevard which are used as drinking water sources². Water quality tests performed during 1985 to the present time have revealed that the concentrations of trichloroethylene in wells monitored have ranged from "trace" to 90 ug/L. State of California and Federal drinking water quality standards mandate that drinking water should not contain trichloroethylene in excess of 5 ug/L.

The Orange County Water District and the Irvine Ranch Water District have proposed a plan to contain the westward migration of this trichloroethylene contaminated groundwater plume. They propose to pump trichloroethylene contaminated groundwater at a rate of 700 gallons per minute into the existing Irvine Ranch Water District's reclaimed water distribution system. This mixed water will be used for drip and sprinkler irrigation of agricultural fields and greenbelt areas in the City of Irvine.

A well and pumping station will be developed near the intersection of Jeffrey Road and Irvine Center Drive in the City of Irvine. The agricultural field where irrigation will occur is bounded by Irvine Center Drive to the north, Jeffrey Road to the east, the San Diego Freeway to the south and Culver Boulevard to the west. The proposed well will be located at the western edge of the existing trichloroethylene contaminated plume near two existing wells, TIC 35 and 47. Trichloroethylene contaminated groundwater has been pumped and used for sprinkler and drip irrigation in agricultural fields since at least 1985 and probably longer from these two wells.

¹Phase I Report Investigation of TCE contamination in the vicinity of the El Toro Marine Air Corp. Station by Roy L. Herndon and James F. Reilly, OCWD, March 29, 1989.

²Orange County Water District: Results of an investigation of the TCE removed during sprinkler and drip irrigation in the Irvine area, March 1989.

RISK ASSESSMENT APPROACH

Risk assessment has four basic elements: hazard identification, dose-response assessment, exposure assessment, and risk characterization. Hazard identification involves identifying the types of health and environmental risks that are associated with the chemicals of concern. Once the potential hazards are identified, the amount of exposure or dose necessary to produce adverse effects is evaluated. Since all chemicals are toxic at some dose, this step provides a preliminary assessment of the types of toxic effects that would be anticipated from exposure to a chemical at a given dose. Exposure assessment identifies which populations are potentially exposed, delineates the potential exposure routes and quantifies the potential level of exposure at each identified receptor site. Risk characterization is the process of defining the probability or risk that adverse health effect will occur in the exposed population.

The risk assessment process is targeted to identify the potential exposure pathways that have the greatest probability of adversely impacting public health and the environment. Conservatism is incorporated into the risk assessment process. Conservative assumptions are used in predicting exposures and dose-response relations. Therefore, the predicted risks likely overestimate actual risks.

Two conservative exposure scenarios are used to estimate the dose or amount of trichloroethylene exposure that community residents and on-site workers might receive from trichloroethylene emissions associated with sprinkler and drip irrigation. One exposure scenario, the worst case scenario, assumes that pumped trichloroethylene containing groundwater will not be mixed with reclaimed water in the Irvine Ranch Water District's delivery system. Another conservative exposure scenario, the plausible exposure scenario, assumes that the trichloroethylene contaminated pumped groundwater is mixed with reclaimed water to be twenty percent of the original concentration.

The operational plan for pumping water anticipates that there will be diurnal and seasonal variations in water consumption demands. In this risk assessment, to be conservative it is assumed that the contaminated groundwater will be continually applied at the maximal usage rate to the smallest area thereby producing the greatest release potential of trichloroethylene. Both the worst case and plausible exposure scenarios assume that trichloroethylene will not be degraded after volatilization. Both exposure scenarios conservatively assume that community residents will be exposed twenty-four hours daily for seventy years and on-site workers will be exposed five days a week, eight hours a day for forty years. Both scenarios assume that 100% of the emitted trichloroethylene will be absorbed by breathing.

The risk characterization process is designed to prudently avoid underestimation of risk since the factors used to determine the potency of a chemical to induce chronic toxicity or carcinogenicity are conservative. In the case of carcinogens, a multistage, non-threshold, linearized model is used to extrapolate potential cancer risks from high dose to low dose. This multistage, non-threshold, linearized model assumes that any exposure is associated with some cancer risk even though other scientific models might not predict such risks. Cancer potency factors that have been developed to predict human cancer risk assume that humans are as sensitive as the most sensitive animal species.

CONCLUSIONS

Populations at risk from potential trichloroethylene exposure include on-site workers and nearby community residents. Both populations are at risk from potential air emissions of trichloroethylene vapors since trichloroethylene is readily volatilized from applied water. Fugitive dust emissions of soil contaminated with trichloroethylene are judged not to be significant. Empirical data do not provide any evidence of residual trichloroethylene soil contamination even though such soils have been irrigated with trichloroethylene contaminated water since at least 1985 and probably longer. Groundwater is not used as a drinking water source and therefore does not present a direct human health risk from ingestion at present.

The exposure assessment reveals that using the assumptions in the worst case scenario the incremental project related annual average trichloroethylene concentrations in the impacted area will be $3-4 \times 10^{-8}$ ug/m³. The total amount of trichloroethylene applied to the project area daily will be 57.2 gm. Trichloroethylene is a chemical routinely found in the South Coast Air Basin. Air quality tests during 1986-1987 performed by the South Coast Air Quality Management District and California Air Resources Board have revealed a trichloroethylene annual average of 1.07 ug/m³ in the Irvine Regional Park area. Therefore, the project-related incremental concentration of trichloroethylene release is de minimus in comparison to background trichloroethylene exposure levels found in the south coast air basin.

The potential public health risks from exposures to released trichloroethylene associated with this project are insignificant or de minimus. Using the conservative assumptions in both the plausible and worst case exposure scenarios, potential cancer risks from project related emissions range from 6.37×10^{-15} to 1.486×10^{-13} for both nearby community and on-site workers. Therefore, even if the entire Orange County population of over two million persons

were to be exposed to trichloroethylene from the project, 24 hours a day for lifetime, not even one excess cancer case from the project-related trichloroethylene emissions would be expected. The potential cancer risks for all potentially exposed person are well below the one-in-one-million (1×10^{-6}) risk commonly considered to be insignificant by regulatory agencies and scientific bodies.

There is no evidence that any potentially exposed persons would be at significant risk for developing any other adverse health effects. The Hazard Index is used to assess potential risks for non-carcinogenic effects. It should be emphasized that the Hazard Index is not a mathematical predictor of the incidence or severity of toxic effects but rather is an indicator of the degree to which acceptable levels of a contaminant are exceeded. If the Hazard Index exceeds unity, the public health concern is the same as if the individual chemical exposure exceeded the acceptable level by the same proportion. Using the assumptions in both the worst case and plausible exposure scenarios, the Hazard Index associated with potential project-related trichloroethylene emissions ranged from 2.45×10^{-10} to 5.7×10^{-9} for on-site workers and nearby community residents.

If unchecked, the trichloroethylene contaminated groundwater plume will move westward and within 3 to 5 years reach County of Orange drinking groundwater aquifers. The health risks associated with ingestion of groundwater contaminated with 8 ppb trichloroethylene for lifetime greatly exceed the risks associated with lifetime inhalation of trichloroethylene released from applied water using the assumptions in the plausible exposure scenario. Furthermore, if the County of Orange drinking groundwater sources become contaminated with trichloroethylene, the risks associated with this contamination could not be mitigated solely by relying on another available drinking water source since there would still be associated health risks from trichloroethylene inhalation associated with non-drinking domestic water use activities such as showering.

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CHAPTER ONE

INTRODUCTION

1.1 Environmental Chronology of the Project

The objective of this risk assessment is to evaluate the potential human health risks associated with the proposed use of trichloroethylene (TCE) contaminated groundwater in drip and sprinkler irrigation of agricultural fields and greenbelt areas in the City of Irvine. Risk assessments are designed to evaluate the magnitude and probability of potential public health risks posed by chemical contaminants found in the environment. Health risk information can then be used by risk managers in evaluating the risks associated with a planned project.

The Orange County Water District (OCWD) was established in 1933 to manage and protect the common groundwater supplies of the northwestern portion of Orange County, California. The mission of District is being guided by its adopted Groundwater Quality Protection Policy which directs the District to 1) maintain a groundwater supply of suitable quality for all existing and potential beneficial uses, 2) prevent degradation of the quality of the groundwater supply, and 3) assist, insofar as possible, the responsible regulatory agencies in identifying sources of pollution to assure cleanup by the responsible party(s) (OCWD, 1987).

The groundwater underlying part of the El Toro Marine Corps Air Station (MCAS) and a portion of the City of Irvine was discovered to be contaminated with trichloroethylene in 1985 by the Orange County Water District. Extensive studies have been conducted by the Orange County Water District and the El Toro Marine Corps Air Station to determine the source(s) and the extent of this contamination (OCWD, 1989a, 1989b). These studies have revealed extensive trichloroethylene groundwater contamination. The trichloroethylene contamination currently extends approximately three miles west of the air station at depths ranging from 200 to 450 feet below ground surface. It underlies approximately 2,900 acres and impacts as much as 150,000 acre-feet of groundwater. The trichloroethylene laden water body is migrating westward at an estimated rate of one to four feet a day.

The spreading of trichloroethylene contaminated water poses a significant threat to County of Orange drinking water supplies. Given the rate of current migration, it is estimated that downgradient drinking water sources will be contaminated in approximately 3 to 5 years. To protect the quality of County of Orange drinking water sources, the Orange County Water District has proposed a trichloroethylene containment program. The program will

remove the trichloroethylene contaminated water by pumping the water to the ground so that it can be used for greenbelt and agricultural irrigation in the City of Irvine. Groundwater containing trichloroethylene will be connected to the Irvine Ranch Water District (IRWD) reclaimed water system and used for sprinkler and drip irrigation over an estimated area of 205 acres (IRWD, 1989).

1.2 Guidance Documents

A standard format for preparing risk assessments has not been defined by regulatory agencies or professional societies. However, guidance has been provided by regulatory agencies concerning how risk assessments should be performed for assessing human health and environmental risks of chemical exposures. The principal guidance documents used in preparing this risk assessment include:

- o The California Site Mitigation Decision Tree Manual. Department of Health Services, State of California, 1986 (DHS, 1986).
- o The Endangerment Assessment Handbook. US EPA Office of Waste Programs Enforcement, draft dated August 1985 (ICAIR, 1985a).
- o Superfund Public Health Evaluation Manual. Washington, D.C.: US EPA, Office of Emergency and Remedial Response. Contract No. 68-01-7090 Task 7, EPA 540/1-86/060, October 1986 and EPA, 1989. (EPA, 1986f, 1989).
- o Guidance on Feasibility Studies under CERCLA. Chapter 5, "Evaluate Protection of Public Health Requirements", U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio; and Office of Solid Waste Programs Enforcement; and Office of Solid Waste and Emergency Response. Washington, D.C., June, 1985. (EPA, 1985b).

Other risk assessment guidance documents, health risk assessment reports, and references consulted and used in the preparation of this risk assessment, include the following:

- o Toxicology Handbook: Principles Related to Hazardous Waste Site Investigations. (ICAIR, Life Systems, Inc., 1985b),
- o "Guideline for Carcinogen Risk Assessment", (EPA, 1986a),
- o "Guideline for Estimating Exposure", (EPA, 1986b),
- o "Guideline for Mutagenicity Risk Assessment", (EPA, 1986c),
- o "Guideline for Health Risk Assessment of Chemical Mixtures", (EPA, 1986d),
- o "Guidelines for the Health Risk Assessment of Suspect Developmental Toxicants", (EPA, 1986e),
- o "Toxic Air Pollutant Source Assessment Manual for California Air Pollution Control District Permits", (CAPCOA, 1987),
- o Drinking Water and Health, Volumes 1 - 6, (NRC, 1977, 1980, 1982, 1983, 1986),

1.3 Format of the Risk Assessment Report

Typically, a risk assessment contains four basic elements. These are: 1) hazard identification, 2) dose-response assessment, 3) exposure assessment and 4) risk characterization.

Hazard Identification characterizes the threat to human health and the environment posed by the intrinsic toxicological and chemical properties of the detected contaminants. A qualitative assessment is made of the toxicological significance of the chemical constituents identified. For example, the detected chemicals may be identified as carcinogens, neurotoxins or reproductive toxins. Trichloroethylene is the chemical evaluated in this risk assessment. Chapter 2 presents the toxicological properties, environmental fate and transport characteristics of trichloroethylene.

Dose-Response Assessment is the critical examination of toxicological data used to determine the relationship between the exposure or dose levels and the predicted response of a receptor. Major strengths and uncertainties of the animal or epidemiological data are identified. For example, in assessing risks

to humans, human epidemiological data is preferred over estimates derived from animal toxicology data. Other factors examined in the dose-response assessment include: the choice of the mathematical extrapolation model used for extrapolating from high (administered doses) to low (environmental doses); the overall weight of evidence for carcinogenicity of a particular chemical; and the accuracy of interspecies comparisons (i.e., adjustment by the investigators using standardized scaling factors to account for the differences between humans and experimental test animals).

Absorption rates for dermal, inhalation and ingestion exposures are examined in light of the matrix in which the chemical is found. For example, a chlorinated solvent bound in a soil matrix will likely absorb more slowly through the human gastrointestinal tract than it would if ingested as a laboratory grade liquid. Dose-response assessment is contained in both Chapters 2 and 3, but not as a separate topic.

Exposure Assessment evaluates the plausibility and importance, relative to public health and environmental considerations, of possible exposure pathways. The environmental concentrations of site contaminants at the receptor locations are predicted and the receptor's potential exposure is quantified. An assessment of pathway "completeness" is made. In other words, is there a complete (ie. unbroken) exposure pathway for the chemical to travel from the source to a receptor? And, is there a suitable receptor in the exposure pathway? If no complete pathway is present, probable pathways are hypothesized and receptors are identified. Chapter 3 contains the exposure assessment.

Risk Characterization estimates the incidence or probability of an adverse health or environmental effect occurring under the exposure conditions defined in the exposure assessment. The risk characterization process integrates exposure information such as ambient air concentration data to determine the amount of net chemical intake by the receptor.

The net amount of chemical intake by a receptor is called the effective dose. An associated risk is predicted from the effective dose. The risk characterization process provides quantitative

carcinogenic and non-carcinogenic risk estimates that can be used by policy makers to reach decisions regarding the planned project. Risk characterization is presented in Chapter 4.

The process of risk assessment includes conservative assumptions which are likely to overestimate risk. The nature and limitations of the predicted risks are discussed in Chapter 5. The implications of introducing assumptions into the risk assessment and how such assumptions lead to uncertainties are also discussed.

CHAPTER TWO

HAZARD IDENTIFICATION

2.1 Project Background Information

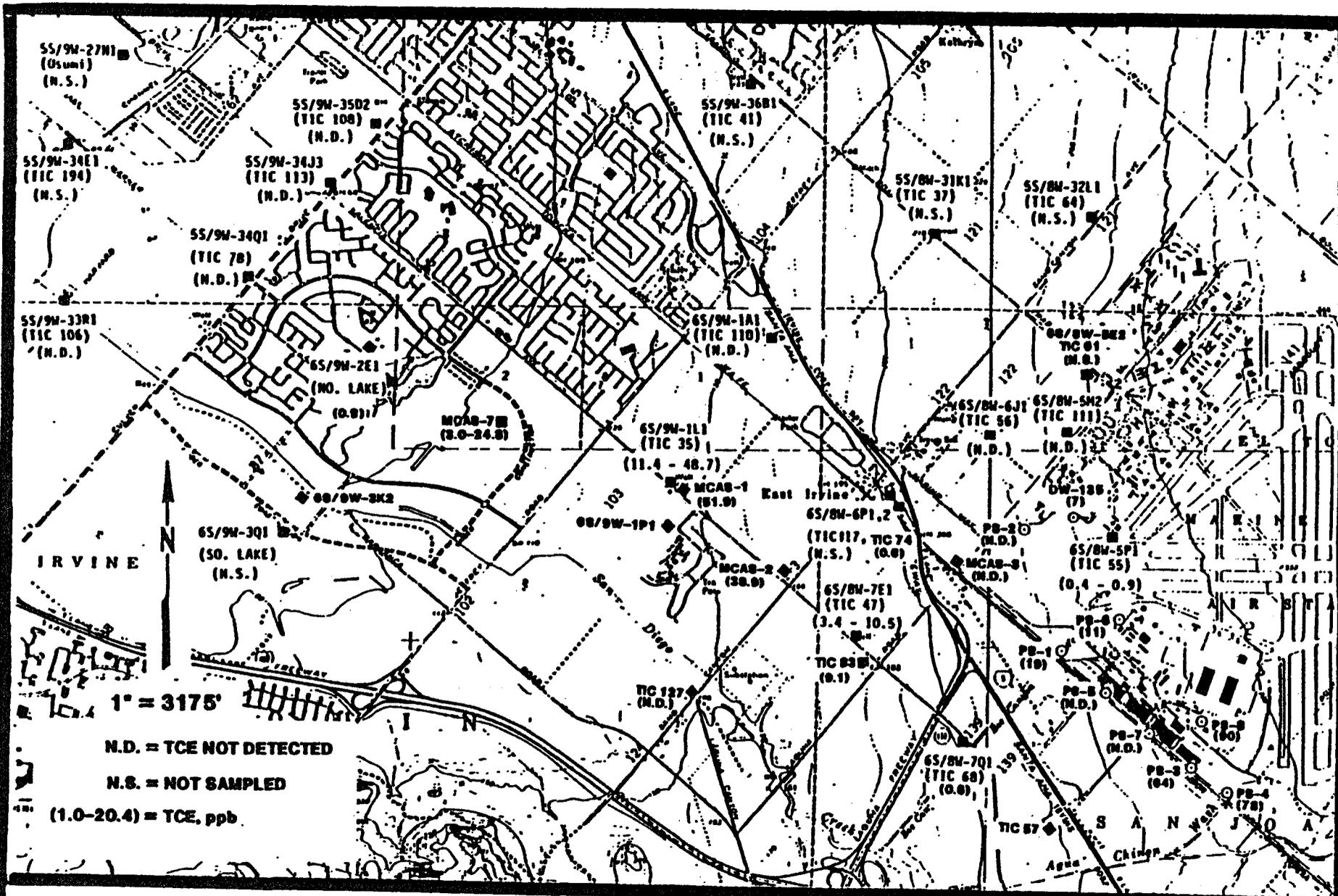
In 1985, during the course of a routine basinwide groundwater monitoring of all active production wells, the Orange County Water District discovered, for the first time, trichloroethylene in three Irvine area irrigation wells located west of the El Toro Marine Corps Air Station. Detected trichloroethylene water concentrations ranged from trace to 50 $\mu\text{g/L}$ (OCWD, 1989a).

Immediately after the discovery of trichloroethylene, the Orange County Water District and the El Toro Marine Corps Air Station conducted hydrogeological studies to determine the extent and possible sources of the trichloroethylene groundwater contamination. New monitoring wells as well as active and inactive irrigation wells in the Irvine area were incorporated in the water quality monitoring programs. The location of these wells is presented in Figure 2.1. Sampling at 13 off-base wells conducted between 1985 and 1987 revealed the presence of trichloroethylene in 4 wells: TIC 35 (11.4-48.7 $\mu\text{g/L}$), TIC 74 (not detected - 0.6 $\mu\text{g/L}$) TIC 47 (3.4-10.5 $\mu\text{g/L}$) and TIC 68 (not detected - 0.8 $\mu\text{g/L}$) (Figure 2.1).

Groundwater studies at the El Toro Marine Corps Air Station have revealed the presence of trichloroethylene contaminated groundwater below the base. Trichloroethylene was detected in seven base wells at concentrations ranging from "not detected" in wells PS-5 and PS-7 to 90 $\mu\text{g/L}$ in well PS-8 which is located near the southwest base property line. Trichloroethylene was found in the following base wells: PS-1 (19 ppb); PS-3 (64 ppb); PS-4 (78 ppb); PS-6 (11 ppb); PS-8 (90 ppb); DW-135 (7 ppb); and TIC 55 (0.9 ppb).

The Orange County Water District studies have provided an estimate of the boundaries of the trichloroethylene contamination and these are illustrated in Figure 2.2 (OCWD 1989 a,b). The southern boundary of the trichloroethylene plume is estimated to approach San Diego Creek and the Agua Chion Wash which is a probable groundwater recharge source for the margin of the basin. The northern boundary of the trichloroethylene plume appears to be fairly well defined by non-detectable trichloroethylene concentrations in wells TIC 111, TIC 110, and TIC 113 (Figure 2.1). The westerly extent of trichloroethylene contamination appears to lie between the Woodbridge North Lake well, TIC 78 on Culver Drive and well TIC 106 (OCWD, 1989 a,b).

Figure 2.1



TCE CONCENTRATIONS IN WELLS SAMPLED IN THE IRVINE AREA

Figure 2.2

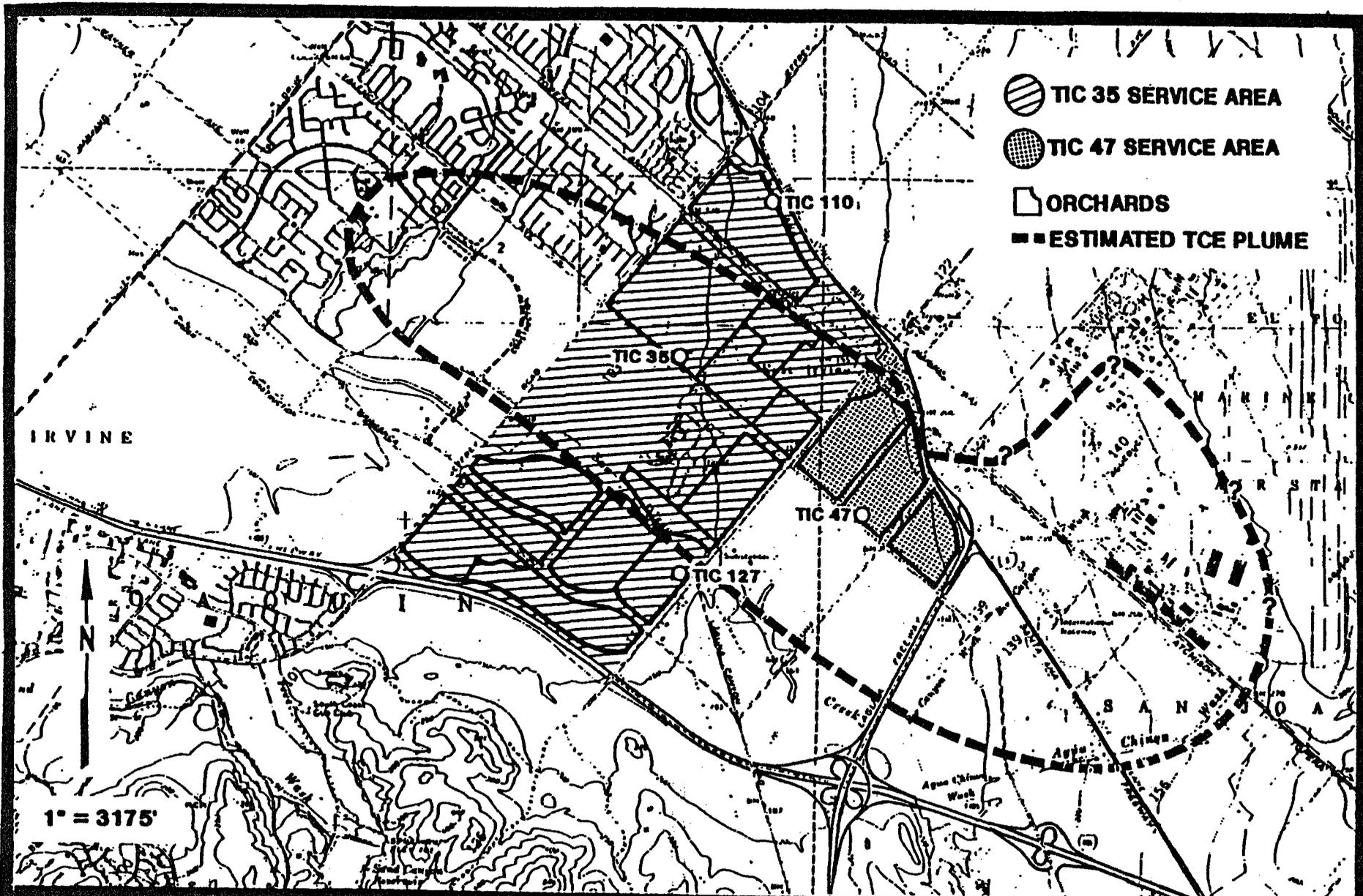


FIG 2.2

PRESENT TIC 35 AND TIC 47 SERVICE AREAS (CURRENTLY ALL DRIP IRRIGATION)

The vertical distribution of the trichloroethylene plume has been delineated by cluster wells near the TIC 55 well on the Marine Corps Air Station and at four MP monitoring wells (Figure 2.1). In wells MCAS-1, MCAS-2 and MCAS-7, trichloroethylene contaminated groundwater was found at depths between 200 and 450 feet. The highest concentration was present below 300 feet. Trichloroethylene was detected in cluster wells DW-135, DW-450, and DW-540 at the El Toro Marine Corps Air Station at depths of 135, 450, and 540 feet, respectively (OCWD, 1989a).

Trichloroethylene was not detected in the MP monitoring wells at shallow depths above 200 feet, discounting the possibility that the trichloroethylene groundwater contamination was due to superficial contamination sources at these locations. Trichloroethylene was not detected in MP monitoring wells below depths of 450 feet. A reason for the lack of trichloroethylene groundwater contamination at depths below 450 feet is the relative immobility of groundwater at this depth. It is estimated that the trichloroethylene-contaminated groundwater aquifer is at least 200-feet thick, covers 2,900 acres and impacts as much as 150,000 acre-feet (OCWD 1989b).

In November 1988, the monitoring well named "North Lake" located in Woodbridge Village was discovered to be contaminated with 0.9 ppb trichloroethylene for the first time. Prior water quality tests for trichloroethylene had been negative in this well. The presence of trichloroethylene in this well provided evidence to suggest that the trichloroethylene plume is migrating westward. The Orange County Water District has estimated this migration to be in the range of one to four feet per day (OCWD 1989b).

2.2 Description of the Proposed TCE Containment Project

The Orange County Water District has proposed a plan to immediately contain the westerly migration of the aforementioned trichloroethylene plume by pumping the contaminated groundwater so that it can be used for irrigation. Pumped groundwater will be connected to existing or future Irvine Ranch Water District reclaimed water distribution lines and used for irrigation. The water will be distributed to greenbelt areas by a sprinkler system and to agricultural fields by drip irrigation system.

This project calls for the installation of a pumping station near the intersection of Jeffrey Road and Irvine Center Drive in the City of Irvine. The proposed main pumping station will be located on the western end of existing contaminated plume and near the existing wells TIC 35 and 47 (Figure 2.2).

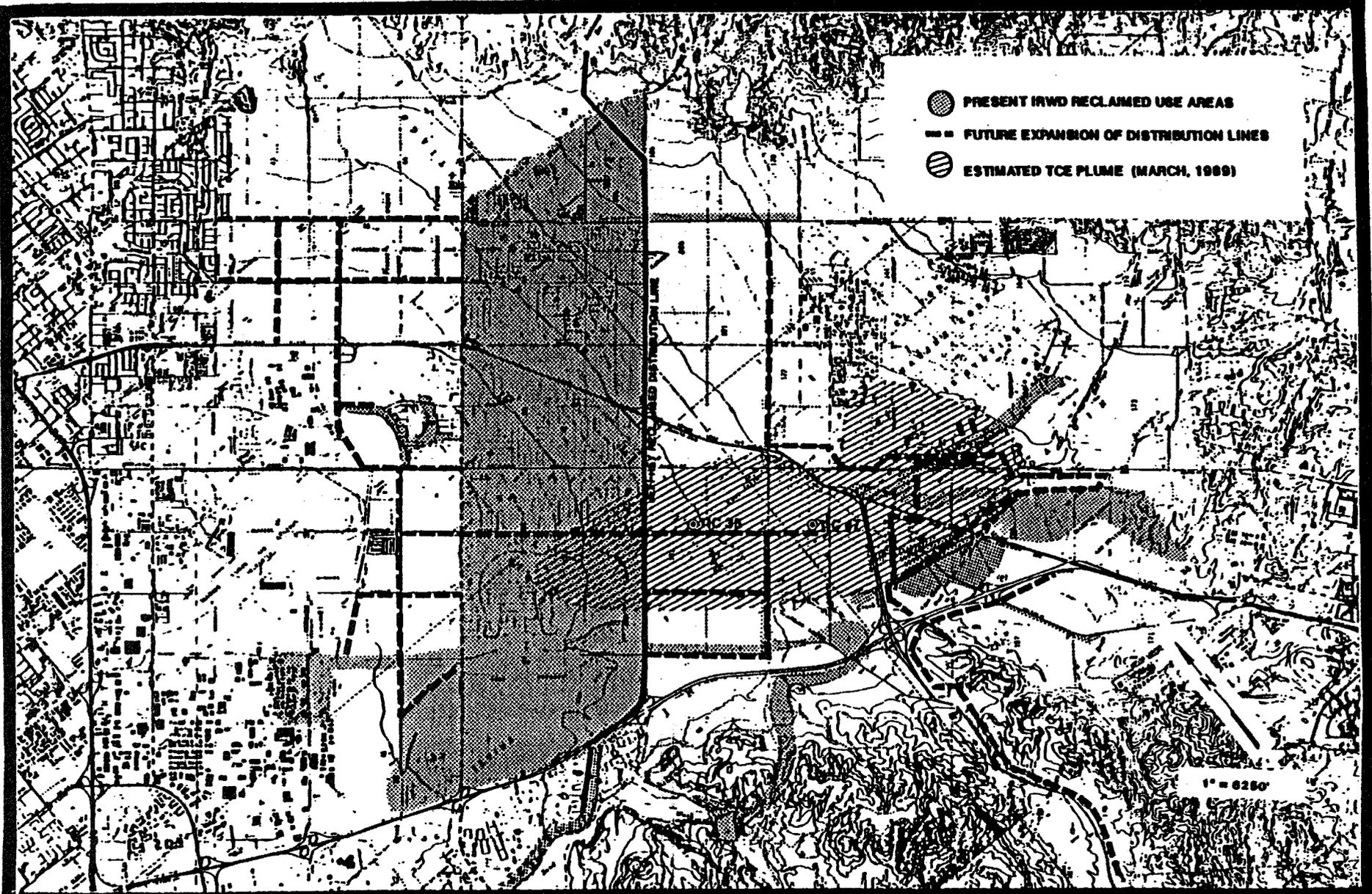
Irrigation wells TIC 35 and 47 have been in service since at least 1985 and probably longer. Studies have shown that inflow into these wells is almost exclusively derived from the contaminated trichloroethylene zones (OCWD, 1989b). Pumping these wells along with proposed pumping from the new well will serve as an effective measure to control trichloroethylene migration.

The project, if approved, will be jointly operated by the Orange County Water District and Irvine Ranch Water District. This project will pump trichloroethylene containing water at a rate of 700 gallons per minute to the existing Irvine Ranch Water District reclaimed water distribution system and be used for irrigating agricultural lands and greenbelt areas. Every day between hours 9 PM and 6 AM the pumped out water will be mixed with reclaimed IRWD water and used for drip and sprinkler irrigation.

IRWD has evaluated five operation scenarios to determine the potential flow, distribution and dilution of pumped trichloroethylene contaminated groundwater. The five scenarios are based upon historical diurnal and seasonal water consumption demands of the entire supply system in the region (IRWD, 1989). The five scenarios include maximum day/peak hour, average day/peak hour, average day/minimum hour, minimum day/peak hour, minimum day/minimum hour usage patterns. During the maximum day/peak hour times, water usage is approximately 9 times greater than usage rates in the average day use scenario.

The operational plan calls for trichloroethylene contaminated water to flow north to the Rattlesnake Reservoir during non-irrigation hours of 6 AM to 9 PM and to flow south during the irrigation period (9 PM to 6 AM). The trichloroethylene water entering the proposed system at Jeffrey Road and Irvine Center Drive will be immediately mixed with water coming down from the Rattlesnake Reservoir and other sources. This mixed water will then be distributed to the irrigation system as indicated in Figure 2.3. The Irvine Ranch Water District estimates the mixed water will contain 8 ppb of trichloroethylene.

Figure 2.3



IRWD RECLAIMED WATER DISTRIBUTION AREAS

To be conservative this risk assessment assumes that irrigation of agricultural fields and greenbelt areas will be at the maximum day/peak hour flow rates. (section 3.1). For purposes of this risk assessment the exposure models are based on the assumption that local water demand on the pumped out water will be the greatest and sprayed over the smallest area (approximately 205 acres). This water use scenario predicts the highest concentrations of airborne trichloroethylene since the largest quantity is being applied to the smallest area of land.

2.3 Toxicology of Trichloroethylene

2.3.1 Pharmacokinetics and Metabolism

The pharmacokinetics and metabolism of trichloroethylene have been studied in man and animals. Trichloroethylene is well absorbed by the inhalation and oral routes but dermal adsorption appears to be poor (EPA 1985f). Trichloroethylene is extensively metabolized to trichloroethanol, trichloroethanol glucuronide, trichloroacetic acid and other minor metabolites in both humans and animals (Powell, 1945).

Human metabolism occurs principally in the liver but extrahepatic metabolism has been described in the kidney and lungs. Metabolism has been reported to be saturated with high levels of exposure. The biological half life of trichloroethylene has been reported to be between 1.75 to 2.25 hours in blood, however elimination from the fat is longer. In humans the majority of an absorbed dose is excreted in the urine, however a small amount is exhaled through the lungs. (Stott et al., 1982).

2.3.2 Toxicological Aspects in Man and Animals

2.3.2.1 Central Nervous System

Inhalation studies in humans reveal that trichloroethylene produces central nervous system effects characterized by narcosis (Nomiyama and Nomiyama, 1977). Trichloroethylene was used in the past as an anesthetic gas. Case reports have revealed that short term high level exposures have produced central nervous symptoms including dizziness, headaches, confusion, and at very high levels unconsciousness (EPA, 1985f). Animal inhalation studies have also revealed behavioral changes and other central nervous system effects.

Long term or chronic exposure has been associated with central nervous symptoms including memory loss, vertigo and other symptoms (Grand Jean et al, 1955). However, the absence of adequate exposure data in published studies makes the interpretation of any dose-response relationship difficult. Other effects attributed to long term exposure include trigeminal neuralgia, decreased appetite and sleep disturbances. Although behavioral effects and impaired psychomotor performance have been reported at exposure levels of 200 ppm and greater in both experimentally exposed humans and in some epidemiological studies, there is no data to suggest that impairment of the central nervous system would occur from chronic low level exposures (EPA, 1985f).

2.3.2.2 Hepatic

Trichloroethylene has been reported to produce hepatic or liver injury in man and animals. Although case reports have linked acute occupational exposures with hepatic injury, no quantitative exposure data is available, from these case reports. Trichloroethylene was not observed to induce liver injury in 250 neurosurgical patients undergoing prolonged anesthesia with trichloroethylene (Brittain, 1948).

Acute and intermediate duration inhalation exposures in animals have produced some evidence of liver injury. Hepatic effects that have been observed include an increase in liver weight. However in many of these studies liver histology was not examined. One study involving several mice strains exposed to trichloroethylene for 30 days at 150 ppm biochemical indices of possible liver damage and also some histopathological changes were observed (Kjellstrand et al, 1983). Male mice appear to be the most sensitive species. There was no evidence of any hepatic injury with low level trichloroethylene exposures.

2.3.2.3 Kidney

There is little evidence that trichloroethylene induces renal or kidney disease in humans. There have been some case reports linking trichloroethylene exposure and renal injury after high level occupational exposures or intentional exposures (EPA, 1985f). No quantitative data describing the extent of exposures was presented in these case reports.

Animal studies have demonstrated that inhalation and oral exposures have produced renal damage (Nomiyama, et al., 1986). Renal toxic effects that have been reported include kidney enlargement with acute and intermediate duration inhalation and oral feeding exposures in rodents. Chronic oral and inhalation exposures have produced histological changes compatible with renal tubular injury or toxic nephropathy in mice and rats. In rodents, renal effects occur less frequently than hepatic changes and there is little information regarding the mechanism of injury. A chronic inhalation study of mice exposed to 100 ppm was reported as not demonstrating any adverse renal effects; however there was a decrease in overall survival at this dose. (Kjellstrand et al 1981). There is no evidence that low level trichloroethylene exposures would produce any adverse renal effects.

2.3.2.4. Hematological System

There is no evidence that trichloroethylene has induced hematological abnormalities in exposed humans (EPA, 1985f). Animal exposure studies have revealed several hematological changes including a reduction of amino levulinic acid dehydratase activity in rat liver and bone marrow cells as well as dose related changes in hemoglobin, reticulocyte count, hematocrit, and leukocyte counts. The significance of these findings is unclear to human exposures since there is no evidence of hematological abnormalities in exposed humans.

2.3.2.5. Immunological System

Although little data is available concerning the immunotoxic potential of trichloroethylene, like other chlorinated hydrocarbons it has been reported to produce evidence suggestive of immune depression in rodents. Rats exposed to 800 ppm for 12 weeks were reported to have increased thymus weights but such changes were not seen in rats exposed to 50 and 200ppm (Nomiyama et al., 1986). Male and female CD-I mice administered trichloroethylene in drinking water for four to six months showed abnormalities in immune function (Sanders et al., 1982). Humoral and cell mediated responses to sheep erythrocytes, and bone marrow stem cells were reported to have been depressed. Some of these immunological changes have been observed at doses of 17 to 19 mg/kg/day. Bone marrow stem cell colonization has been reported to be an early indicator of immune injury. The lowest dose producing any disturbance of bone marrow stem cell colonization was 18 mg/kg/day in CD-I mice exposed to trichloroethylene containing water for four to six months.

2.3.2.6. Reproductive Toxicity

Reproductive toxicity refers to adverse effects of the reproductive system. This type of toxicity can occur as a result of damage to the reproductive organs or to the endocrine glands involved in the reproductive cycle. Manifestations of this type of toxicity can be varied and include alterations in sexual behavior, fertility and pregnancy outcome.

A review of the literature reveals that there have been no studies that have thoroughly evaluated the reproductive effects of trichloroethylene exposure in humans. Animal studies have revealed an effect on sperm morphology but no evidence of impaired sperm function. A significant increase in morphological abnormalities was reported in mice exposed to 2,000 ppm, four hours daily for 5 days (EPA 1985f). This data provides suggestive evidence that high concentration of trichloroethylene can cause damage of the spermatocytes.

Studies involving chronic oral feeding have demonstrated decreased testicular and epididymal weights in rodents with chronic dietary exposures of trichloroethylene exceeding 0.15% of the diet by weight. At 0.06% no effects on the reproductive system including histology, fertilization or other reproductive performance parameters were observed in male or female rats (NTP, 1982). Mating behavior is effected at doses of 1,000 mg/kg/day but these may be related to the narcotic properties of trichloroethylene and not to any effect on the reproductive system.

2.3.2.7. Developmental Toxicity

Developmental toxicity refers to an adverse effects of a chemical on a developing organism that results from exposure prior to conception, prenatally and postnatally to the time of sexual maturity. Developmental toxic effects include several distinct types of toxic effects including embryotoxicity, fetotoxicity and teratogenicity. Embryotoxicity and fetotoxicity refer to toxic effects on the fetus as a result of prenatal exposure to the chemical.

They are distinguished by what stage of development a chemical exerts its action. Teratogenicity refers to a chemicals ability to produce a structural damage to a developing fetus or what is commonly regarded as a birth defect.

There is inconclusive evidence that trichloroethylene produces developmental toxic effects in humans. One study reported an increase of miscarriages in nurses exposed to trichloroethylene and other anesthetics in operating rooms (Corbett et al., 1974). However, since the nurses in this study were exposed to other anesthetics and possibly other chemicals, it is not possible to causally link trichloroethylene to any of the reported abnormalities. Lagakos (1986) reported a statistical association between the ingestion of well water contaminated with chlorinated hydrocarbons including trichloroethylene and eye, ear and central nervous system congenital anomalies. Well water pollutants reported in this study, included, trichloroethylene at concentrations of 0.61 ppb, tetrachloroethylene at 21 ppb and 32 other hydrocarbons at various other concentrations. The significance of this data is unclear since the health surveys used by Lagakos to collect birth defects data were biased and his grouping of diagnoses has been considered to be meaningless (MacMahon, 1986). Therefore any reported association between ingestion of well water contaminated with several chlorinated hydrocarbons including trichloroethylene and the aforementioned birth defects could be due to chance alone.

Inhalation studies provide some evidence that trichloroethylene is fetotoxic but not teratogenic. Reported effects consistent with delayed development observed in Wistar rats exposed to 130 ppm on day 8 to 21 gestation include, decreased fetal weights but no anomalies (Healy et al., 1982). However, in this study there was no determination as to whether the doses that produced fetotoxic effects also produced maternal toxicity. Other inhalation studies in mice and rats have not demonstrated any evidence of developmental toxicity at levels that do not adversely affect maternal well being. These studies provide evidence that trichloroethylene is not toxic to the fetus at doses that do not cause maternal toxicity (EPA, 1985f).

The absence of any developmental toxic effects at doses that are not maternally toxic is significant since many teratologists believe that any chemical administered at some dose or route of exposure can cause some disturbance in embryonic development in some species (Karnofsky, 1965). For a chemical to be considered a developmental toxicant

it should produce disturbances in embryonic development at exposure levels that do not produce toxicity in the mother. Therefore if a chemical disturbs embryonic development at a dose that produces maternal toxicity it does not indicate that the chemical produces selective or unique developmental toxic effects.

There is no data to prove that trichloroethylene is a teratogen. A single inhalation study involving rats exposed to 500 ppm demonstrated a statistically insignificant increase in a rare anomaly, external hydrocephalus (Beliles et al., 1980). EPA has evaluated this study and determined that the observed external hydrocephalus "was not dose dependent and the significance of this finding could not be assessed from this study" (EPA, 1985a).

2.3.3. Carcinogenicity

There is insufficient human epidemiological data to ascertain if trichloroethylene is carcinogenic in chronically exposed humans. Three studies of workers exposed to trichloroethylene at concentrations greater than would be anticipated from environmental exposures did not demonstrate any measurable excess cancer risk. (Axelson et al., 1978; Tola et al., 1980; Malek et al., 1979; Shindell and Urlich, 1985). However, since these studies had several limitations including small sample sizes, and lack of analysis by tumor site they do not prove that trichloroethylene is not a human carcinogen (Axelson et al., 1978).

Trichloroethylene has been found to be carcinogenic in rodents (NCI, 1976; NTP 1982, 1986). Chronic inhalation of trichloroethylene has produced an increased incidence of lung tumors in mice (Fukuda et al., 1983), as well as testicular Leydig cell tumors in rats (Maltoni et al, 1986). Chronic feeding studies have produced an increased incidence of hepatocellular carcinomas in mice and a marginal increase incidence of renal adenocarcinomas in rats (NTP 1982, 1986).

The EPA Carcinogen Assessment Group has classified trichloroethylene as a Group B2 - probable human carcinogen (EPA, 1985f). The International Agency for Research on Cancer (IARC) classifies trichloroethylene as a Group 3 Chemical - not classifiable as to carcinogenicity in

humans. At the time of the IARC evaluation in 1982 the available animal toxicological data was limited and the Maltoni and Fukuda data had not yet been published. The cancer slope factor for trichloroethylene inhalation is 1.3×10^{-2} (mg dose/kg/day), and the unit risk is 1.3×10^{-6} per $\mu\text{g}/\text{m}^3$ (EPA, 1985f). This cancer potency slope factor is derived from the chronic feeding studies data (NTP, 1982).

EPA has proposed lowering the cancer potency factor for trichloroethylene in light of new lung tumor incidence data from the inhalation exposure studies (Maldoni et al., 1986, Fukuda et al., 1983) to 1.7×10^{-2} (mg dose/kg/day)⁻¹ with a new unit risk 1.7×10^{-6} $\mu\text{g}/\text{m}^3$.

2.3.4 Summary of Trichloroethylene Toxicity

The pharmacokinetics, metabolism and toxicity of trichloroethylene have been studied in man and animals. Trichloroethylene is well absorbed following inhalation and oral ingestion.

Evidence from animal toxicity studies, experimental human exposure studies and clinical data from exposed persons suggests that for effects other than carcinogenicity "long-term exposure of humans to environmental (ambient) levels of trichloroethylene is not likely to represent a health concern" (EPA, 1985f).

Occupational exposure to very high levels of airborne trichloroethylene has produced central nervous systems effects but little or no evidenced damage to other organs including the liver or kidneys. Trichloroethylene was previously used as an anesthetic gas. Chronic inhalation and oral exposure studies have demonstrated adverse hepatic and renal effects in rodents.

Trichloroethylene should be considered to be a probable human carcinogen. Trichloroethylene has been reported to cause cancer in mice, in both sexes, at two sites, by two routes of administration in four separate experiments. Although epidemiological studies of occupationally exposed workers do not show an increased cancer risks from exposures, these studies have limitations and cannot be used to detract from the evidence of carcinogenicity in rodent.

Available studies do not provide any evidence that trichloroethylene is toxic to the fetus at levels below maternally toxic doses and maternal toxicity would not be expected from typical environmental exposures.

Developmental toxic effects including teratogenicity provide data to suggest that the conceptus is not uniquely susceptible and "animal studies suggest that at low ambient levels that do not cause maternal toxicity - trichloroethylene would not pose a significant hazard to a developing conceptus" (EPA, 1985).

2.4 Environmental Fate and Transport of TCE

Trichloroethylene is known to be ubiquitous in the environment. Trichloroethylene has been detected in drinking water (EPA, 1975a,b,c), in marine water, in rain water, food, human tissues (Pearson and McConnell 1975; McConnell et al., 1975), in the atmosphere (Pearson and McConnell 1975; McConnell et al., 1975; Singh et al., 1978), and in marine organisms (Pearson and McConnell, 1975).

Humans are environmentally exposed to trichloroethylene by inhaling outdoor air contaminated with trichloroethylene or ingesting contaminated groundwater. Trichloroethylene released into the environment has many sources including emissions from plants manufacturing paints and coatings, incineration of municipal waste and from waste disposal. Products containing trichloroethylene can include typewriter correction fluids, paint remover, paints, and other solvents.

2.4.1 Factors Affect the Fate and Transport of a Chemical

The mobility or the fate and transport of a chemical in the environment is dependent upon its physical and chemical properties. The major physical and chemical parameters affecting a chemical's environmental fate and transport are described below.

Water Solubility is the maximum concentration of a chemical that dissolves in pure water at a specific temperature and pH. It is a critical property affecting environmental fate and transport. Chemicals with high water solubility will tend to dissolve in water and be transported from soil to groundwater or surface water rather than remaining in soil.

Vapor Pressure is a measure of the volatility of a chemical in its pure state and is an important determinant of the rate of volatilization. Values of this parameter, in units of mm Hg, are given for a temperature range of 20 to 30°C. Constituents with a high vapor pressure are more likely to migrate from soils and be transported into air via evaporation. Also they are more likely to volatilize from groundwater and migrate through soil into ambient air.

Henry's Law Constant is a parameter important in assessing chemical volatility. Values for Henry's Law Constant (H) are calculated using the following equation:

$$H \text{ (atm-m}^3\text{/mole)} = \frac{\text{vapor pressure (atm)} \times \text{molecular weight (g/mole)}}{\text{water solubility (g/m}^3\text{)}}$$

Organic Carbon Partition Coefficient (K_{oc}) is a measure of the tendency for an organic chemical to be adsorbed to soil and sediment and is expressed as:

$$K_{oc} = \frac{\text{mg chemical adsorbed/kg organic carbon in matrix}}{\text{mg chemical dissolved/liter of solution}}$$

The K_{oc} is chemical specific and is largely independent of soil properties. The higher the K_{oc} value the more adsorbable the compound. The K_{oc} generally decreases with symmetry and polarity of the compound.

Octanol-Water Partition Coefficient (K_{ow}) is defined as the ratio of a chemical's concentration in the octanol phase to its concentration in the aqueous phase of a two-phase octanol-water system. K_{ow} is a measure of how a chemical is distributed at equilibrium between octanol and water. K_{ow} is an important parameter and is often used in the assessment of environmental fate and transport of organic chemicals.

High K_{ow} values are generally indicative of a chemical's ability to accumulate in fatty tissues and therefore bioaccumulate in the food chain. The K_{ow} also helps to characterize a chemical's movement from an organic matrix to water. Additionally, K_{ow} is a key variable used in the estimation of skin permeability. The K_{ow} generally decreases with symmetry and polarity of the compound.

Bioconcentration Factor (BCF) as used in this risk assessment is a measure of the tendency for a chemical in water to accumulate in fish tissue. The concentration of a chemical in the edible portion of fish tissue can be estimated by multiplying the concentration of the chemical in surface water by the fish bioconcentration factor for that chemical. This parameter is therefore an important determinant for human intakes via the aquatic food ingestion route. This is also important for other fish eating species, such as, larger fish, birds, and larger carnivorous mammals.

Chemical Half-Lives are used as a measure of persistence, or the length of time a chemical will remain in various environmental media.

2.4.2 Physical and Chemical Properties of TCE

The general physical and chemical properties of trichloroethylene are compiled below.

Molecular weight	131.39 g/mole	(Weast 1977)
Melting point	-73°C	(Weast 1977)
Boiling point at at 760 torr	87°C	(Weast 1977)
Vapor pressure at 20°C	57.9 torr	(Pearson and McConnell 1975)
Solubility in water at 20°C	1100 mg/L	(Pearson and McConnell 1975)
Log octanol/water partition coefficient	2.29	(Leo et al. 1971)
Specific Gravity at 20C	1.4642	(EPA, 1986f)
Vapor Pressure at 20°C	60mm Hg	(EPA, 1986f)
Vapor Density	4.53	(EPA, 1986f)
Henry's Law constant (atm-m ³ /mol)	9.1 x 10 ⁻³	(EPA, 1986f)
K _{oc} (ml/g)	126	(EPA, 1986f)
Fish BCF (l/kg)	10.6	(EPA, 1986f)

2.4.3 Probable Fate of Trichloroethylene in the Environment

Trichloroethylene contaminated groundwater which is used for irrigation and may undergo a variety of chemical and physical reactions. This section describes the probable mechanisms affecting the fate of trichloroethylene in the environment.

1. Volatilization

Volatile organics like trichloroethylene have been observed to vaporize readily from water. The volatilization of trichloroethylene from water has been found to be strongly dependent on its vapor pressure and solubility in water, although other factors such as the molecular diffusion coefficient will also influence volatilization (Dilling, 1977).

Once trichloroethylene enters the troposphere, hydroxyl radicals attack the double bond resulting in the subsequent formation of dichloroacetyl chloride and phosgene as the principal initial products. The tropospheric lifetime (time for reduction to 1/2 of initial concentration) of trichloroethylene based on its rate of reaction with hydroxyl radicals is reported to be 3.7 days (Dilling et al., 1981). Due to the reactivity of trichloroethylene with hydroxyl radicals in the troposphere, it is unlikely that unreacted trichloroethylene will diffuse upward to the stratosphere. The photooxidation products of trichloroethylene are readily hydrolyzed (Dilling et al., 1981).

2. Photolysis and Photoxidation

Based on the available literature, it does not appear that direct photodissociation of carbon-carbon or carbon-chlorine bonds contributes to the fate of trichloroethylene in the aquatic or the atmospheric environment. This is a result of the relatively rapid volatilization from aquatic systems and the rapid rate of hydroxyl radical attack in the troposphere (EPA, 1985f).

Little information is available about the specific rate of direct photolysis of trichloroethylene in the aqueous environment under ambient conditions (Jensen and Rosenbert, 1979; Jaffe and Orchin, 1962)

3. Oxidation

Oxidation in the aquatic environment does not appear to be a significant fate process, although there is evidence of some oxidation of trichloroethylene in aqueous, closed systems in the presence of sunlight (EPA, 1975c.) Hydrolysis, probably does not occur at a sufficient rate to be an important fate pathway for trichloroethylene (EPA,

1975c). There is, however, some evidence that trichloroethylene is metabolized by higher organisms leading to chlorinated acetic acid products (EPA, 1975c). Chlorinated acetic acids, in turn, have been shown to be susceptible to degradation by microorganisms in seawater (EPA, 1975c).

4. Bioaccumulation

There is some evidence of bioaccumulation of trichloroethylene in marine organisms but no evidence for biomagnification in aquatic food chains. In addition, no evidence was found of selective concentrations of trichloroethylene in marine sediments, thus indicating that adsorption may not be an important transport process (EPA, 1985f).

5. Sorption

Several researchers have investigated the mechanics of adsorption of trichloroethylene in a soil (Pearson and McConnell, 1975; McConnell et al., 1975; Dilling, et al., 1975). Once trichloroethylene is applied to the soil matrix, adsorption has the effect of retarding the transport of trichloroethylene as it moves through the soil. Dilling et al (1975) found that the adsorption of trichloroethylene in soil occurs primarily with the solid organic matter present in the porous medium. At the soil grain or soil an organic surface, an immobile layer of water exists which the organic chemical like trichloroethylene must diffuse through before adsorption can occur. Likewise, the immobile region must also be crossed for desorption to take place (Pearson and McConnell, 1975).

It is generally agreed that the amount of trichloroethylene that is absorbed to the soil matrix is to be proportional to the trichloroethylene concentration in the water phase. The greater the concentration in the water phase the greater the trichloroethylene concentration on the solid phase or mass absorbed. If the trichloroethylene concentration in the water decreases, the desorption of trichloroethylene may occur (McConnell et al., 1975)

6. Biotransformation and Biodegradation

There is limited and in part conflicting information on the microbial biodegradation of compounds such as trichloroethylene. Most researchers report that low molecular weight chloroaliphatics are not metabolized (Pearson and McConnell 1975; McConnell et al., 1975). In

mammals, the metabolic pathways of trichloroethylene lead to chlorinated acetic acids, either directly or via chloroethanols. Chlorinated acetic acids have all been shown to be susceptible to further degradation by microorganisms in seawater (Pearson and McConnell 1975). McConnell et al., (1975) concluded that the simple chloroaliphatic compounds are not particularly persistent, and that their degradation products are simple species commonly found in the environment.

7. Fate and Transport Data Summary

Table 2.1 summarizes the aquatic fate information discussed above. The oxidation rate presented is a photooxidation rate and refers to the rate of reaction of trichloroethylene with hydroxyl radicals in the troposphere.

Due to the relatively high vapor pressure of trichloroethylene, volatilization from the aquatic system to the atmosphere is quite rapid. Once in the troposphere, hydroxyl radicals attack the double bond, resulting in the subsequent formation of dichloroacetyl chloride and phosgene as the principal products. The tropospheric lifetime of trichloroethylene based on its rate of reaction

with hydroxyl radicals is reported to be 3.7×10^5 seconds, corresponding to a lifetime of approximately 4 days. Due to the relatively high reactivity of trichloroethylene with hydroxyl radicals in the troposphere, it is unlikely that unreacted trichloroethylene will reach the stratosphere.

2.5 Trichloroethylene Water and Air Quality Standards or Recommendations

Table 2.2 describes both Federal and State of California water and air quality standards for trichloroethylene.

Table 2.1

Table 2.1
Summary of Aquatic Fate of Trichloroethylene

<u>Environmental Process</u>	<u>Summary Statement</u>	<u>Rate</u>	<u>Half-Life (t1/2)</u>	<u>Confidence of Data</u>
Photolysis	Probably does not occur since photo-oxidation destroys trichloroethylene before it can reach the stratosphere, which is the region above the ozone layer where direct photolysis could occur.	-	-	High
Oxidation ^a	Photooxidation in the troposphere appears to be the predominant fate of this compound; photooxidation in the aquatic environment occurs at a slow rate; direct oxidation at ambient conditions does not occur in the aquatic or atmospheric environment.	$3 \times 10^{12} \text{ cm}^3 \text{ sec}^{-1}$	-4 days ^b	High
Hydrolysis	Probably occurs too slowly to be a significant fate process.	$0.065 \text{ months}^{-1}$ ^c	10.7 months	High
Volatilization	The primary transport process.	-	-20 minutes ^d	High
Sorption	Probably not important	-	-	Medium

Bioaccumulation	There is evidence of some bioaccumulation by marine organisms, but there is no evidence of biomagnification up the food chain.	Medium
Biotransformation/	There is evidence that metabolic	Medium
Biodegradation	of trichloroethylene from higher organisms can be biodegraded by microorganisms in sea water.	

-
- a. The predominant environmental process which is thought to determine the fate of the compound.
 - b. Reported as a lifetime of -3.7×10^5 seconds, corresponding to a lifetime of about 4 days.
 - c. Hydrolysis rate is probably a maximum rate.
 - d. Half-lives are on the order of several minutes to a few days, depending on the degree of agitation, the value presented was determined under conditions of continuous mechanical stirring at 200 rpm.

Table 2.2

Table 2.2 Applicable Air and Water Quality Standards for Trichloroethylene

California State Applied Action Level ¹ (water)	7.0	ug/L
California State Applied Action Level (air)	7.0	ug/m ³
EPA Suggested No-Adverse-Response Level ² (SNARL)	75.0	ug/L
EPA One-in-a-million Cancer Risk Level ³ (water)	3.0	ug/L
EPA One-in-a-million Cancer Risk Level ³ (air)	0.8	ug/m ³
Maximum Contaminant Level (MCL) for Drinking Water ⁴	5.0	ug/L
Ambient Water Quality Criteria (WQC) to Protect Freshwater Aquatic Life, Acute Toxicity	45.0	mg/L
Ambient Water Quality Criteria (WQC) to Protect Saltwater Aquatic Life, Acute Toxicity	2.0	mg/L

¹ Applied Action Level is developed for the protection of human health and welfare (Dec. 15, 1988 version)

² SNARL is established for water quality objective for the protection of human receptors.

³ Source of data: Integrated Risk Information System, USEPA.

⁴ Public Health Risk Evaluation Database (PHRED), EPA, 1988.

CHAPTER THREE

EXPOSURE ASSESSMENT

3.1 Exposure Pathway

The risk assessment process includes an evaluation of all known and/or potential exposure pathways associated with potential receptors. This Chapter provides a quantitative assessment of the exposure pathways by which human receptors may come into contact with trichloroethylene emissions from the proposed project. For human receptors, potential pathways of exposure are defined. The significance of each pathway is assessed. This chapter also describes the assumptions, models and methods that are used to determine trichloroethylene concentrations at the receptor points.

In order to establish an exposure pathway, four elements are required to be present:

- o Demonstration of a chemical release source
- o Demonstration of a transport medium
- o Demonstration of a receptor
- o Demonstration of route(s) of exposure for receptor

The potential risk associated with each exposure pathway is discussed in Chapter 4.

3.1.1 Exposure Scenario

As stated in section 2.2, to illustrate the maximum potential risks associated with exposure to project related trichloroethylene emissions, two conservative exposure assumptions are used.

The worst case exposure scenario assumes irrigation with undiluted trichloroethylene contaminated water year round, at maximum day/peak hour demand flow rates that would only be anticipated to be present during the summer months (i.e. the greatest demand of water supply), 100% evaporation of irrigation water containing trichloroethylene, and no degradation. These are conservative estimates because they assume no dilution of contaminated water in the irrigation system.

Persons potentially exposed to trichloroethylene contaminated groundwater include on-site workers and nearby community residents. Workers are assumed to be exposed 8 hours a day, 5 days a week for 40 years. Nearby community residents are assumed to be exposed 24 hours daily for 70 years.

The plausible exposure scenario provides a more realistic and still conservative estimate of risk. This scenario assumes year round irrigation with trichloroethylene contaminated water that has been mixed with IRWD water. This model also assumes that water will be applied year round at maximum day/peak hour demands normally only observed in summer months. The same conservative assumptions regarding duration of exposure for on-site and community residents are used as in the worst exposure scenario.

Both the plausible and worst case exposure scenarios provide a conservative estimate of the actual range of possible exposures.

3.2 Receptor Definition

The receptor(s) defines the population at risk of potential exposure from project related trichloroethylene emissions. The receptor(s) are defined after analyzing the following factors:

- o Identification of potentially exposed populations;
- o Characterization of populations; and
- o Analyses of population activities.

The first step requires comparing data on distribution and potential mobility of trichloroethylene contaminated groundwater with population data in order to identify and enumerate the potentially exposed human population. Population characterization involves identifying those groups within the exposed population which may experience a greater risk than the average population such as infants, the elderly, and women of child-bearing age.

3.3 Human Receptor

The agricultural field where the contaminated groundwater will be used and nearby residential and industrial areas superimposed by 1/4 mile and 1/2 mile radii to 2 mile from the site are described in Figure 3.1. The proposed site is bordered by the Irvine Center Drive to the north; Jeffrey Road to the east; San Diego Freeway to the south; Culver Blvd. to the west (Fig. 3.1).

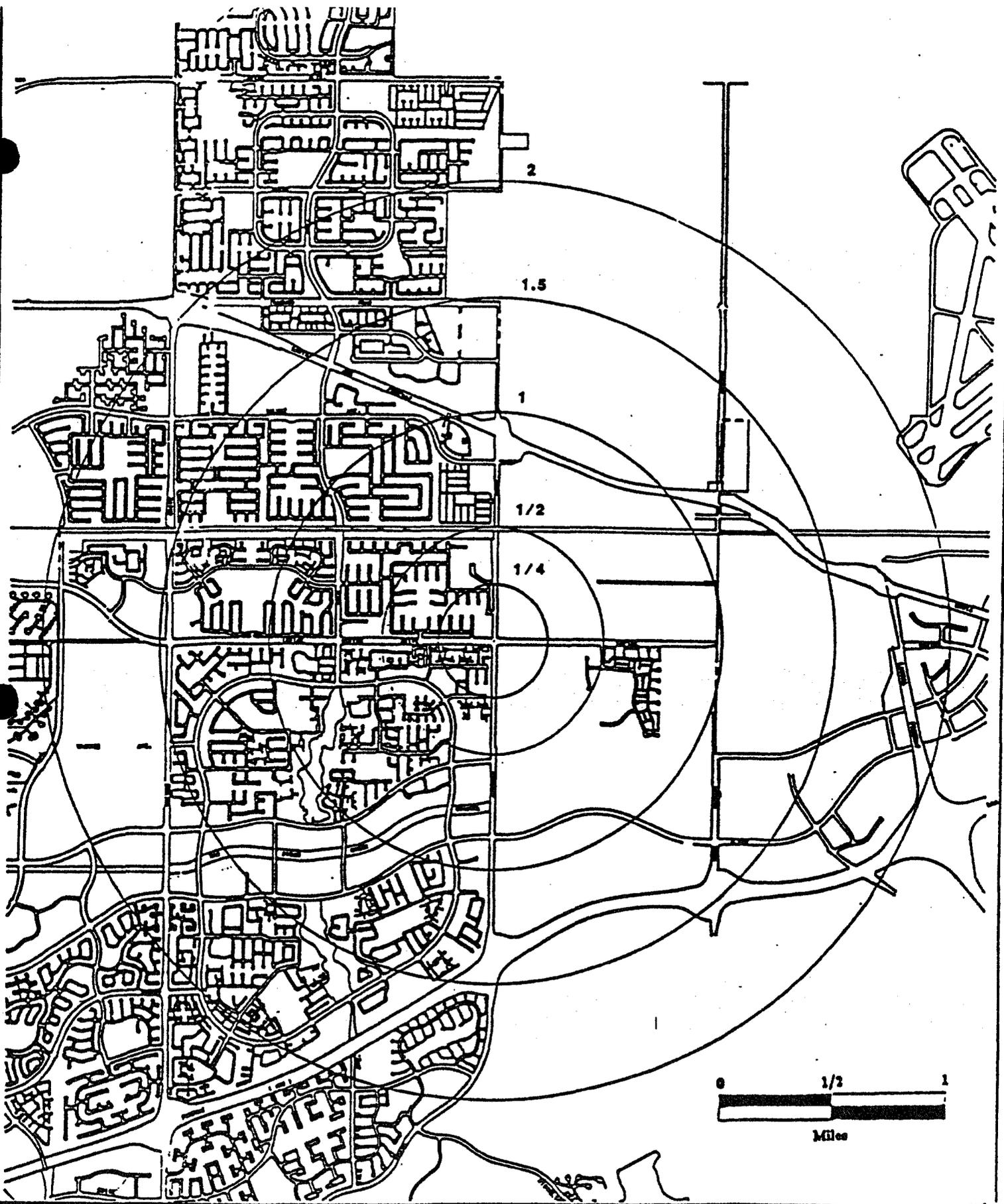
In characterizing the current nearby human receptor population, the following two assumptions were employed:

- o The 1980 census data (Appendix A) with an annual population growth rate of 2% is representative of the present population characteristics and distribution in the study area. The 2% annual rate of population growth was obtained from the Health Care Agency (HCA) of Orange County. According to HCA, the County has experienced an annual growth rate of 2% in population growth since 1980 census survey (USDC, 1982, 1983).
- o Census tracts which intersect radial zones (Fig. 3.1) in portions were assigned a percent occupancy within that zone. The total population in the particular census tract was multiplied by the percent occupancy within the radial zone to arrive at an estimated representative population in the radial zone (Table 3.1).

After a thorough review of site specific data, information pertinent to receptor definition can be summarized as follows:

- o No schools were identified in the 2.5 mile radius emanating from Jeffrey Road and Irvine Center Drive. The Irvine Unified School District indicated that schools are not located along the flight patterns of the Tustin Marine Corps Air Station and the El Toro Marine Corps Air Station (IUSD, 1989). These two air stations are located west and east of the outer fringes of the 2.5 mile radius.

Figure 3.1



MED-TOX ASSOCIATES, INC.
 ENVIRONMENTAL & GEOTECHNICAL
 SERVICES
 PROJECT NUMBER: IG 3850

Irvine Center Drive & Jeffry Blvd.
 1/4 mile and 1/2 mile Radii to 2 mile



Table 3.1

Table 3.1
Census Tract Data

Zone (Radius From Site in Miles)	Census tract number	1980 Total Census Tract Population (a)	Percent of track population in zone (b)	Population < 5 yrs.	Distribution (a) > 5 to 64 65 and over	1980 Total Estimated Population (a)	1980 Total Estimated Population (c)	Total 1989
0.25	525.06	2016	12.5	21	335	8	354	426
	525.08	8562	5	34	364	10	426	500
	525.10	1086	3	1	31	1	33	39
0.50	525.06	2916	33	55	886	21	962	1125
	525.08	8562	10	69	768	20	857	1003
	525.10	1086	7	2	73	2	77	90
1.0	524.05	4546	5	52	336	0	388	454
	525.05	4653	60	266	2298	175	2728	3192
	525.06	2916	100	168	2684	64	2916	3412
	525.07	3135	33	81	932	22	1035	1211
	525.08	8562	33	226	2534	66	2826	3306
	525.10	1086	40	9	571	10	435	509
1.5	524.05	4546	33	146	1258	96	1500	1755
	525.04	4340	50	187	1942	41	2170	2539
	525.05	4653	100	313	3925	415	4653	5444
	525.06	2916	100	168	2684	64	2916	3412
	525.07	3135	95	233	2582	64	2979	3455
	525.08	8562	55	377	4223	198	4709	5509
	525.10	1086	55	12	571	14	497	698
	525.12	1086	55	12	571	14	497	698
2.0	524.04	7760	5	52	336	0	388	454
	524.05	4546	60	266	2287	175	2728	3192
	524.06	3180	10	25	286	5	317	371
	525.03	4943	40	149	1794	35	1978	2314
	525.04	4340	95	354	3689	78	4123	4824
	525.05	4653	100	313	3925	415	4653	5444
	525.06	2916	100	168	2684	64	2916	3412
	525.07	3135	100	245	2823	67	3135	3668
	525.08	8562	85	582	6525	169	7277	8514
	525.09	1712	33	33	524	8	555	661
	525.10	1086	75	17	779	19	815	954
	526.04	4025	5	6	160	35	201	235
	526.12	5998	33	105	2039	165	2309	2701
	2.0	524.24	7760	20	207	1343	1	1551
524.05		4546	90	398	3430	263	4091	4786
424.06		3180	40	99	1143	24	1266	1481
525.01		1670	10	8	159	0	167	195
525.02		6322	5	19	283	14	316	370
525.03		4943	67	249	3004	68	3311	3874
525.04		4340	100	375	3883	82	4340	5078
525.05		4653	100	313	3925	415	4653	5444
525.06		2916	100	168	2684	64	2916	3412
525.07		3135	100	245	2923	67	3135	3668
525.08		8562	100	685	7678	199	8562	10018
525.09		1712	55	55	873	14	942	1102
525.10		1086	85	19	883	21	923	1080
526.04		4025	15	19	479	106	604	706
526.12		6998	55	178	3399	275	3849	4503
526.18		5766	15	67	922	37	1016	1189
526.21		3355	10	21	287	87	335	302

TOTAL

49,113

- (a): 1980 Census Report Volume 3A, Selected Population Characteristics - Orange County
 (b): Estimated percent of total census tract population for these tracks intersected by the particular zone. Estimated based on the proportion of residential areas in each radial shown in Figure 2.1.
 (c): 1989 population estimates are calculated using the Orange County Annual growth rate estimated to be 2%. (Multiply 1980 figures by 1.208)

- o Under present conditions, the potential worker population is limited to authorized personnel working at the site and surrounding orchard. The total number of workers is estimated to be less than 100 people.
- o The total current population in the one-quarter mile zone is principally comprised of occupational and residential populations. This population is estimated to be 965 people. There are no day-care centers, schools, hospitals or elderly care centers in the area
- o Based on the 1980 census data, the maximum current residential population estimated to reside within a one-half mile radius of the site is 2218 (Table 3.1). This estimated population, based on the above census data, is expected to be comprised of 126 children under 5 years and 43 adults over 65 years (Table 3.1).
- o An estimated total residential population of 12,974 is currently located within one mile distance from the proposed site.
- o An estimated total population of 22,842; 36,744 and 49,133 persons are currently located within the 1.5, 2.0, and 2.5 mile radial zone, respectively.
- o Most housing in the site vicinity is occupied year-round.
- o There is no consumption of underlying groundwater in the subject area. All drinking water is provided by the Irvine Ranch Water District municipal water supply system that derives its supply from clean sources. Therefore, exposure from contaminated drinking water will not be considered in this assessment.

3.4 Potential Exposure Pathways and Scenarios

All potential exposure pathways by which human receptors may be exposed to trichloroethylene are identified in Table 3.2. The pathways investigated include inhalation of vapors or resuspended soil particulates, dermal contact with soil, ingestion of soil, and ingestion of water and contaminated food.

According to the proposed trichloroethylene containment plan, human receptors working at the proposed project site or living in the immediate vicinity of the site may be exposed to vaporized trichloroethylene from pumped out groundwater via inhalation (Table 3.2).

Other exposure routes are incomplete and/or highly unlikely. They are listed for evaluation because the purpose of the exposure assessment is to determine which are complete pathways with the potential to produce human health effects (Table 3.2).

3.4.1 Ambient Air Exposure Pathway

The potential ambient air exposure pathway was assessed using methods described in the Superfund Exposure Assessment Manual (EPA, 1986f). The volatilization of trichloroethylene from pumped out water and from contaminated soil into ambient air as well as the release of trichloroethylene via respirable dust particles are the major release mechanisms considered in the air exposure route evaluation (Table 3.2).

There is a potential for inhaling trichloroethylene released from the contaminated groundwater that has been applied to soil due to the high volatility of trichloroethylene. Potential human exposure via inhalation of volatilized trichloroethylene from irrigated water is the most significant exposure pathway (Table 3.2).

Exposure of human receptors to trichloroethylene from fugitive dust or vapor emissions from residual trichloroethylene in the soil is considered highly unlikely. The reason for this is that trichloroethylene does not appear to accumulate in

Table 3.2

**Table 3.2 Potential Air Exposure Pathways
(El Toro TCE Pumpout Project)**

Transport/ Exposure Medium	Potential Receptor Exposure Point(s)	Potential Exposure Route(s)	Comments
Air	Chemicals emanating from contaminated soils.	Inhalation of volatiles.	Pathway does not exist. Soil samples collected from the proposed project area do not contain TCE. The detection limit used was one part per billion (ppb).
Air	Chemicals absorbed to particles and become airborne	Inhalation of particulates	Pathway does not exist. Soil samples collected from the proposed project area do not contain TCE. The detection limit used was one part per billion (ppb).

**Table 3.2 (Continued) Soil Dermal Contact and Soil Ingestion Exposure Scenarios
(El Toro TCE Pumpout Project)**

Transport/ Exposure Medium	Potential Receptor Exposure Point(s)	Potential Exposure Route(s)	Comments
Soil (on-site)	Site occupational or community exposure scenario	Soil ingestion and dermal contact.	Exposure to TCE via direct dermal contact and soil ingestion by on-site workers or nearby residents is not likely because the surface soils in the proposed site location is not conta- minated with TCE.

Table 3.2 (Continued) Groundwater Exposure Scenarios
(El Toro TCE Pumpout Project)

Transport/ Exposure Medium	Potential Receptor Exposure Point(s)	Potential Exposure Route(s)	Comments
Groundwater (on-site)	None exists.	Ingestion (drinking water and/or food) and dermal absorption	Under current conditions no use is made of <u>on-site</u> direct consumption. Consequently this exposure scenario will not be viable and is not quantified in the exposure assessment.
Groundwater (off-site)	None exists.	Ingestion (drinking water and/or food) and dermal absorption.	Under current conditions no use is made of <u>off-site</u> direct consumption. Consequently this exposure scenario will not be viable and is not quantified in the exposure assessment.
Groundwater (on-site)	TCE released into ambient air during pumpout and irrigation processes.	Inhalation of volatilized TCE	Chemical emission rates and receptor exposure point concentrations are estimated according to methods outlined in the California decision tree method and EPA <u>Superfund Exposure Assessment Manual</u>

soil. A total of ten soil samples were collected from the proposed project site area on May 15, 1989. Soil samples were analyzed for volatile organic hydrocarbons according to EPA method 8010 (Appendix B). Results indicated that after at least 5 years and probably longer of continual irrigation with trichloroethylene contaminated water from the TIC 35 and TIC 47 wells there was no residual trichloroethylene detected in the soils where this water was applied. The detection limit was one part per billion (ppb).

3.4.2 Soil Ingestion and Dermal Contact Exposure Pathways

Exposure to trichloroethylene via ingestion of soil (and dust) could potentially occur by inadvertent consumption of soils found on hands, tools or other objects; from nail biting or consumption of soil itself. Ingestion of abnormally large amounts of soil, a pathological condition known as pica can also occur. Trichloroethylene exposure from ingestion of or dermal contact with on-site soils by human receptors is not likely, since no residual trichloroethylene was detected in surface soils presently undergoing irrigation with trichloroethylene contaminated water from TIC 35 and TIC 47.

3.4.3 Groundwater Exposure Pathway

Current uses of groundwater at the subject site were examined to ascertain if they presented a potential health risk (Table 3.2). Presently, the underlying groundwater is used solely for irrigation and there is no reported domestic household use (drinking, bathing, showering, etc.). Thus, direct contact with groundwater for domestic use is not likely and is not quantified in this exposure assessment.

3.5 Trichloroethylene Emission Rate From Irrigated Water

Trichloroethylene emission rates and receptor exposure point concentrations in the potential impacted areas are estimated according to the methods outlined in the California Site Mitigation Decision Tree (DHS, 1986) and EPA Superfund Exposure Assessment Manual (EPA, 1986f).

Parameters and assumptions used in the emission rate calculations are presented in Table 3.3. The concept of worst case and plausible exposure scenarios are used in inhalation exposure pathway analyses to provide information on the quantitative range of possible exposure concentrations to on-site workers and nearby community residents.

The trichloroethylene containment project will withdraw 700 gallons of water per minute from the underlying aquifer. The pumped water will be connected to the IRWD reclaimed water system and be mixed with clean water from other sources for irrigation use. On a daily basis, blended water will be used for landscape (sprinkler) and agricultural (drip) irrigation between 9 PM and 6 AM. The pumped water will be stored in the Rattlesnake Reservoir during the remaining hours (6 AM to 9 PM) (IRWD, 1989).

IRWD has estimated the maximum trichloroethylene concentration under such conditions will not exceed 40 ppb by hydraulic modeling using the proposed design of the system. The maximum concentration of trichloroethylene in the mixed water which will be used for irrigation will be 8 ppb. (IRWD, 1989).

Using the assumption in the worst case exposure scenario, the daily amount of trichloroethylene emitted into the ambient air from pumped out water can be estimated according to the following equation:

$$E = FR \times D \times CF \times C$$

Where

E = emission mass (g)
 FR = pumpout flow rate (gallon/min)
 D = irrigation duration on a daily basis (min)
 CF = conversion factor (3.785L/gallon)
 C = concentration of trichloroethylene in water (g/L)

Assuming no blending with reclaimed IRWD water and 100% volatilization of trichloroethylene into the ambient air, the amount of daily trichloroethylene emission can then be calculated.

Table 3.3

Table 3.3 Parameters Used in Estimating Ambient TCE Concentrations From Pumped Out Water and On-site Receptor's Effective Dose, El Toro TCE Pumpout Project

Parameter	Plausible Case	Worst Case Scenario
1. Mode of Release	Volatilization	Volatilization
2. Degree of Vaporization	100%	100%
3. Duration of Irrigation per day	9 hours	9 hours
4. Pumping Rate	700 gallons per minute	700 gallons per minute
5. Concentration of Contaminant	8 ppb	40 ppb
6. Size of Irrigation Area (m ²)	8.296 x 10 ⁵	8.296 x 10 ⁵
7. Dispersion Model	ISCST	ISCST
8. Meteorological Data	SCAQMD El Toro Station (1981)	SCAQMD ET Station (1981)
9. Inhalation Rate	10 m ³ /day	10 m ³ /day
10. Body Weight	70 kg	70 kg
11. Exposure Duration	40 years	40 years
12. Absorption Factor	100%	100%
13. Age Range	18 - 65	18 - 65
14. Daily Exposure Duration	8 hours	8 hours

Table 3.3 (Continued) Parameters Used In Estimating Ambient TCE Concentrations Released From Pumped Out Water and Off-site Receptor's Effective Dose, El Toro TCE Pumpout Project

Parameter	Plausible Case	Worst Case Scenario
1. Mode of Release	Volatilization	Volatilization
2. Degree of Vaporization	100%	100%
3. Duration of Irrigation per day	9 hours	9 hours
4. Pumping Rate	700 gallons per minute	700 gallons per minute
5. Concentration of Contaminant	8 ppb	40 ppb
6. Size of Irrigation Area (m ²)	8.296 x 10 ⁵	8.296 x 10 ⁵
7. Dispersion Model	ISCST	ISCST
8. Meteorological Data	SCAQMD El Toro Station (1981)	SCAQMD E T Station (1981)
9. Inhalation Rate	20 m ³ /day	20 m ³ /day
10. Body Weight	70 kg	70 kg
11. Exposure Duration	70 years	70 years
12. Absorption Factor	100%	100%
13. Daily Exposure Duration	24 hours	24 hours

$$\begin{aligned}
 E &= 700 \text{ gallon/min} \times 540 \text{ min} \times 3.785 \\
 &\quad \text{L/gallon} \times (40 \times 10^{-6} \text{ g/L}) \\
 &= 57.2292 \text{ g}
 \end{aligned}$$

Thus under the worst case community exposure scenario, 57.2292 grams of trichloroethylene will be emitted from an estimated 205 irrigated acres during 9 hours of irrigation. The emission rate of trichloroethylene is

$$\begin{aligned}
 &(57.2292 \text{ g}) / (540 \text{ min}) / (205 \text{ acres}) \\
 &= 2 \times 10^{-9} \text{ g/sec/m}^2
 \end{aligned}$$

Using the assumptions in the plausible exposure scenario, the emission rate of trichloroethylene will be $0.4 \times 10^{-9} \text{ g/sec/m}^2$.

3.6 Receptor's Exposure Point Concentration

A Gaussian dispersion model, the Industrial Source Complex Short Term (ISCST) (EPA, 1986g, 1987) was employed to estimate the incremental annual average concentrations of trichloroethylene at 99 on-site and off-site receptor locations using assumptions in the worst case exposure scenario (Table 3.4).

The ISCST model assumes a normal distribution of gas emissions about a plume centerline directly downwind from a point source (Holzworth, 1972, Shen, 1981, Turner, 1970). Additional major assumptions underlying this dispersion study include:

- o there are no chemical reactions in the atmosphere
- o flat terrain exists between source and receptor
- o continuous emissions at a steady concentration

The summary data of the ISCST model under the worst case exposure scenario is contained in Appendix C.

The incremental annual average concentration is the estimated value by which background trichloroethylene concentrations will be increased from the proposed project emissions. Site specific meteorological data

Table 3.4

Table 3.4 Summary of Predicted On-site and Off-site Incremental Annual TCE Average Concentration (ng/m³)
Under the Worst Case Exposure Scenario

Y-AXIS / (METERS) /	X-AXIS (METERS)								
	-1610.0	-1207.5	-805.0	-402.5	.0	402.5	805.0	1207.5	1610.0
2500.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003
2000.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003
1500.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003
1000.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003
500.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00004
.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00004
-500.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00004	.00004
-1000.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00004	.00004	.00004
-1500.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00004	.00004	.00004
-2000.0 /	.00003	.00003	.00003	.00003	.00003	.00004	.00004	.00004	.00004
-2500.0 /	.00003	.00003	.00003	.00003	.00004	.00004	.00004	.00004	.00004

Note: The origin (0 m, 0 m) is located at the crosssection of Jeffrey Road and Irvine Center Drive.

collected by the South Coast Air Quality Management District (SCAQMD) at the SCAQMD El Toro monitoring station in 1981 were used in the estimation of the incremental trichloroethylene concentration.

The size of the air dispersion study covers a 3.2 km by 5.0 km (2.0 miles x 3.1 miles) area, with the proposed pumpout station located at the center of the plot (Appendix C). Use of site specific meteorological data provides the best estimation of the long term incremental trichloroethylene concentrations at receptor points surrounding the proposed site.

Using the assumptions in the worst case exposure scenario (i.e., no mixing of contaminated water), the incremental annual average trichloroethylene concentration related to the proposed project is estimated to range from 3×10^{-8} to 4×10^{-8} ug/m³ over the entire study area (Table 3.4). This should be considered to be the maximum exposure level for both on-site workers and community residents. This level is insignificant when compared to existing background annual average air trichloroethylene concentrations in the Los Angeles Air Basin (1.66 ug/m³) and in Irvine Park (1.07 ug/m³) (Table 3.5) (SCAQMD, 1988).

3.7 Ambient Air Sampling

Ambient air sampling was performed by Med-Tox on May 15, 1989 at ten locations at and in the vicinity of the proposed project site. Three sets of air samples were collected from each of the following test points: TIC 35, TIC 47 and the crossroad of Jeffrey Road and Irvine Center Drive. In addition, one air sample was collected approximately 1 mile east of TIC 47 serving as field control (Appendix B).

Air samples were collected using personal sampling pumps operating at 0.20 liters per minute, with 2 liter Tedlar bags. Trichloroethylene analysis of the samples was performed by Environmental Analytical Services, Inc. of San Luis Obispo, California.

The South Coast Air Quality Management District performs similar sampling for volatile hydrocarbons in Anaheim, Azusa, Burbank, and Hawthorne, Maywood,

Table 3.5

Table 3.5 Comparison of Predicted Project-related Incremental and Measured Background Airborne TCE Concentrations

	<u>Trichloroethylene</u> (ug/m3)
CARB (1986-1987) annual average (Los Angeles basin)	1.66
CARB (1986-1987) annual average (Irvine Park)	1.07
On-site air sampling (Average value of all samples)	0.807
ISCST modeling maximum conc. over an area of 3220m x 5000m (Worst case incremental value)	4E-8

Bell Gardens, Gardena, Rancho Dominguez, Yorba Linda, and Irvine Park (Table 3.6). The California Air Resources Board (CARB) also performs routine sampling for volatile hydrocarbons at El Monte, Long Beach, Los Angeles, Rubidoux, and Upland (SCAQMD, 1988).

Trichloroethylene air concentrations measured in the agricultural field where irrigation water from this project will be used, revealed a trichloroethylene levels that are higher than the annual average concentrations reported by the South Coast Air Quality Management District throughout the basin. In addition, the airborne trichloroethylene concentrations are higher than the airborne levels measured by the California Air Resources Board measurements at the Irvine Regional Park. Moreover, the airborne trichloroethylene concentrations detected at a site distant from the agricultural field are higher than the average concentrations measured at the Irvine Regional Park.

There are several reasons for the ambient trichloroethylene air levels that were measured in this study. First the field samples are short term samples and therefore may not be indicative of average or long term values. Furthermore, at the time of sampling other possible releases of airborne trichloroethylene that might have temporarily increased the background concentration such, as off-site industrial releases could not be excluded. In addition, laboratory test variability could have been a contributing factor. However, even though the measured levels are higher than average levels reported by SCAQMD and California Air Resources Board the measured levels did not differ by more than an order of magnitude. The projected incremental trichloroethylene concentrations that would be emitted by irrigated water would be several orders of magnitude less.

The measured airborne trichloroethylene in the ambient air cannot be attributed solely to irrigation with trichloroethylene contaminated water from TIC 35 and TIC 47 wells. Water samples collected at TIC-35 and TIC 47 well heads at the time of the air monitoring study contained 7 ppb trichloroethylene. The total pumping rate of trichloroethylene containing water at these two wells was 1,300 gallons per minute during the air monitoring period (OCWD unpublished data). Using the worst case assumptions including complete

TABLE 3.6
AVERAGE AMBIENT CONCENTRATIONS OF TCE
DURING THE MATES¹ PERIOD (1986-1987)
(CONCENTRATIONS IN ppb)

	SCAGMD - NETWORK				ARB				
	ANAHEIM	AZUSA	BURBANK	HAWTHORNE	El Monte	LONG BEACH	L.A.	RUBIDOUX	UPLAND
Ave. Conc.	.3-.5	.6-.7	.7-.8	.2-.4	.173	.210	.250	.124	.496
Std. Dev.	.5	.7	.6	.5	.082	.092	.083	.070	.572
Detection Limit	.2	.2	.2	.2	.005	.005	.005	.005	.005
Sample Size/<#DL	31/17	32/10	26/4	29/22	10/0	28/0	31/0	27/0	31/0
Data Category	B	B	B	B	A	A	A	A	A

	SCAGMD - NETWORK				ARB					
	L.A SCHOOL DIST.	MAYWOOD	BELLGARDENS	AT&T HAWTHORNE	GARDENA	RANCHO DOMINGUEZ	YORDA LINDA	IRVINE PARK	L.A. FIRE DEPT.	BURBANK POLICE
Ave. Conc.	.4-.5	.3-.4	.1-.3	.1-.3	.0-.3	.1-.3	1.3	.1-.3	.1-.3	.3-.5
Std. Dev.	.4	.9	.4	.5	.2	.2	*	.3	*	.4
Detection Limit	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
Sample Size/<#DL	30/11	31/21	29/21	30/26	30/27	31/23	31/30	29/24	32/29	31/14
Data Category	B	B	B	B	B	B	C	B	C	B

Note: a - Data category codes: A - Most of the data above detection limits (>90%), C - Very few of the data points are above detection limits (<10%), and B - Several data points fall above and below detection limits.

b - standard deviation not calculated for Data Category C.

(1) Multiple Air Toxic Study, AQMD

<#DL - Number of samples reported below the detection limit

use of pumped water within the test area (500 m by 1000 m), 100% trichloroethylene evaporation from applied water, and rapid mixing of the released trichloroethylene up to 10 m height in the ambient air, the amount of trichloroethylene released from irrigation water during the 10-minute air sampling period was 4.095×10^{-4} g. This amount of trichloroethylene release would result in a 1.53×10^{-5} ppb incremental trichloroethylene concentration to the existing air quality. The measured trichloroethylene concentration was more than five orders of magnitude greater than the amount that could be contributed by TIC 35 and TIC 47 wells.

The predicted incremental trichloroethylene concentration from the proposed project is too low to be distinguished from ambient background measurement. Therefore, for the purpose of this exposure assessment, field monitoring results have suggested that airborne trichloroethylene found in the air at the proposed site area are attributable to the regional air quality issue. Future air monitoring tests will be performed in conjunction with this project. Potential emissions of trichloroethylene from irrigation water are insignificant or de minimum when compared to background trichloroethylene concentrations. The health risks from such exposures are assessed in Chapter 4.

CHAPTER FOUR

RISK CHARACTERIZATION

4.1 Risk Assessment Methodology

This chapter describes the potential risks associated with the potential project related trichloroethylene emissions utilizing the methodology described in Sections 4.1 - 4.3. Potential human health risks are described for each exposure pathway identified in Chapter 3.

Table 3.2 describes the potential inhalation exposure pathway. Table 3.3 describes the assumptions used in the calculations of potential exposure levels for the worst case and plausible scenarios for on-site workers and residential populations. The potential human health risks for nearby residents or on-site workers are determined by comparing the effective dose (in terms of exposure concentrations and duration) to appropriate health criteria. If the effective dose of trichloroethylene is below the pertinent toxicity level (threshold in the case of non-cancer effects and "acceptable" in the case of cancer risks for carcinogens), actual risk will be negligible.

4.1.1 Evaluation Parameters

Two different evaluation parameters (carcinogenic and non-carcinogenic) are used to evaluate the risk from trichloroethylene exposures. The individual lifetime incremental cancer risk is used for carcinogenic effects and the Hazard Index for non-carcinogenic effects.

4.1.1.1 Carcinogenic Risk

EPA, in developing the cancer potency factors (CPF's) for carcinogens, has required that the linearized multistage non-threshold model using data that represents the 95% upper confidence limit be used to evaluate carcinogen dose-response relationships. The cancer potency slope expresses the probability of a human developing cancer from daily 24 hour exposure over a 70-year lifetime. This quantification of cancer potency is expressed as 1/(mg/kg/day) and is often route-specific. The inhalation and oral cancer potency slope factor of trichloroethylene is 1.3×10^{-2} mg/kg/d and 1.1×10^{-2} mg/kg/d, respectively (EPA, 1989).

Since a cancer risk is considered to be present if exposure occurs at any level above zero (non-threshold), cancer risks are stated in terms of additional (incremental) cancer risk attributed to the exposure from the suspected carcinogen at the estimated effective dose.

For example, a 1×10^{-6} cancer risk would be equivalent to one additional cancer case expected in an exposed population of one million as compared to the cancer probability of the same size in an unexposed population.

4.1.1.2 Non-Carcinogenic Risk

Current risk assessment methodology for non-carcinogens is based on the derivation of a chemical exposure level which is not anticipated to cause significant adverse effects from a lifetime of exposure. These values are derived from either human epidemiological or animal toxicity studies. If no human epidemiological data is available upon which a safe exposure level can be based, conservative assumptions incorporating safety factors are used to extrapolate safe human exposure levels from animal study data.

Safe human exposure levels are expressed in several ways including maximum exposure level (MEL), acceptable daily intake (ADI), acceptable intake chronic (AIC), reference dose (RfD) or an applied action level (AAL) (DHS, 1987). The MELs, ADIs and RfDs are estimates of long term daily exposure of the general population to a substance which would not produce any deleterious effects. Safety factors are incorporated in the development of these intake levels.

Since an inhalation RfD of trichloroethylene has not been developed by the EPA, for this risk assessment an acceptable intake chronic (AIC) or (ADI) was derived from the air Applied Action Level established by California Department of Health Services.

The Applied Action Level (air) for trichloroethylene is 7 ug/m^3 (Table 2.2). That means an adult receptor can receive up to 140 micrograms of trichloroethylene daily without significant risk of developing long-term non-carcinogenic effects. The daily allowable level (AL) of trichloroethylene for such receptor is equivalent to 2 ug/kg/d.

Characterizing risks from non-carcinogenic effects involves comparing the expected exposure level (EL) to the allowable level (AL). The resultant ratio, or Hazard Index (HI), is a numerical indicator of the transition between acceptable and unacceptable exposure levels.

The hazard index is a numerical indication of the degree to which acceptable levels are exceeded. As the hazard index approaches unity, concern for the potential hazard posed by the chemical increases. If the hazard index exceeds unity, the public health concern is the same as if an individual chemical exposure exceeded the acceptable level by the same proportion.

In using the hazard index system, it should be noted that the U.S. EPA (EPA, 1986f) has emphasized that the hazard index is not a mathematical prediction of incidence or severity of effects. It is simply a numerical indicator to help identify potential exposure problems. Similarly, in the development of allowable daily intakes (ADIs) or other acceptable standards (which are used in this study) for non-carcinogenic effects of trichloroethylene, AAL levels established by California DHS were used. .

4.2 Characterization of Potential Risk

The approach taken throughout this assessment is very conservative and includes many health protective assumptions that will likely overestimate actual risks were used in the process. For example:

- o On-site receptors are assumed to be exposed to predicted concentrations for 8 hours/day, 5 days/week over an average lifetime of 40 years.
- o Off-site receptors are assumed to be exposed to predicted concentration for 24 hours daily for an average lifetime of 70 years.
- o 100% of the dissolved trichloroethylene in water is assumed to be emitted to the ambient air by vaporization with no reduction factor taken into account.
- o The risks quantified based on EPA cancer potency factors are the 95% upper-bound estimate of risk.

The adoption of all these assumptions is designed to be prudently conservative so as to not underestimate the potential risk. Predicted risks can be assumed to be upper limit estimates (i.e. the actual risks will be lower than predicted).

4.2.1 Ambient Air Exposure Pathway

The ambient air pathway was assessed using methods described in Sections 3.5 and 3.6. The ISCST Air Pollution Dispersion Model was used to determine the incremental annual concentration for trichloroethylene both on-site and at the nearest residential areas under the worst case scenario (Appendix C). Table 3.4 summarizes the predicted incremental annual average trichloroethylene levels on-site and the surrounding residential area for the worst case exposure scenario. The origin of this table (0 m, 0 m) is the proposed location of pumping station at the intersection of Jeffrey Road and Irvine Center Drive. The predicted projected related incremented trichloroethylene concentration in the southeastern quadrant of the study area is slightly higher than the rest of areas primarily due to the predominant local meteorological conditions such as wind direction.

For the plausible exposure scenario established in this study, the only different assumptions used (as compared to the worst case scenario) is the concentration of contaminant (Table 3.3). The resultant ambient trichloroethylene concentration using assumptions in the plausible exposure scenario is 20% of the predicted incremented exposure levels to the worst case scenario.

4.2.1.1 Carcinogenic Risk, Ambient Air

Cancer risk is calculated by multiplying chronic daily chemical intake by the route specific cancer potency slope of the chemical. The risks are predicted based on conservative exposure and toxicological assumptions.

Table 4.1 describes the potential cancer risks associated with the ambient trichloroethylene exposure pathway for both on-site and surrounding residential areas utilizing the conservative worst case and the plausible exposure scenarios.

The estimated incremental cancer risks associated with on-site and off-site human exposures using the conservative assumption in both exposure scenarios are at least seven order of magnitude less than the 1×10^{-6} probability, a risk level commonly accepted as an insignificant cancer risk (Table 4.1).

4.2.1.2 Non-Cancer Risk, Ambient Air

Table 4.2 presents the Hazard Index for on-site and off-site receptors and includes the most plausible and worst case exposure scenarios. Under both exposure scenarios, the trichloroethylene released from the proposed project does not present an unacceptable non-cancer risk to the on-site workers and nearby residents. The predicted risks are at least 8 orders of magnitude less than the unity.

4.3 Risk Characterization Summary

The risk characterization process reveals that the potential public health risks from possible trichloroethylene emissions from the OCWD/IRWD proposed trichloroethylene pumpout project are judged as acceptable using health protective criteria developed by regulatory agencies. The potential cancer risks for on-site workers and nearby community residents will not exceed the one-in-one-million risk commonly considered to be acceptable.

The Hazard Index is used to assess potential non-carcinogenic risk from exposure to trichloroethylene. The Hazard Index for inhalation of released trichloroethylene vapors does not exceed unity using the assumptions under the worst case and plausible exposure scenarios for both on-site and off-site human receptors.

The purpose of this risk assessment is to provide an estimate of the potential public health impact of the released trichloroethylene with the proposed project. One of the principle purposes of risk assessment is to identify which exposure pathways have the greatest potential to adversely impact human health. Extreme conservatism is incorporated into both the plausible and worst case scenarios in an effort to identify which exposure pathways have the greatest potential to produce an adverse impact rather than to determine what actual risks are likely to be. Public health is best protected by utilizing such a conservative process even though it overestimates potential risks.

Table 4.1

Table 4.1: Potential Receptor's Cancer Risk Associated With Inhalation of TCE Emitted From The Proposed OCMD/IRMD Pumpout Project

	Off-site Plausible	Off-site Worst Case	On-site Plausible	On-site Worst Case
Annual incremental TCE conc. (ug/m ³) in the ambient air	0.8 x 10 ⁻⁸	4 x 10 ⁻⁸	0.6 x 10 ⁻⁸	3 x 10 ⁻⁸
Inhalation rate (m ³ /day)	20	20	10	10
Exposure duration (yr)	70	70	40	40
Body weight (kg)	70	70	70	70
Effective dose (ug/kg/day)	2.29 x 10 ⁻⁹	1.14 x 10 ⁻⁸	4.9 x 10 ⁻¹⁰	2.45 x 10 ⁻⁹
Cancer Potency Factor (1/ug/kg/d)	1.3 x 10 ⁻⁵	1.3 x 10 ⁻⁵	1.3 x 10 ⁻⁵	1.3 x 10 ⁻⁵
Total Risk	2.97 x 10⁻¹⁴	1.486 x 10⁻¹³	6.37 x 10⁻¹⁵	3.185 x 10⁻¹⁴

Table 4.2

Table 4.2: Potential Receptor's Non-Cancer Risk Associated With Inhalation of TCE Emitted From The Proposed OCMD/IRMD Pumpout Project

	Off-site Plausible	Off-site Worst Case	On-site Plausible	On-site Worst Case
Annual incremental TCE conc. (ug/m ³) in the ambient air	0.8 x 10 ⁻⁸	4 x 10 ⁻⁸	0.6 x 10 ⁻⁸	3 x 10 ⁻⁸
Inhalation rate (m ³ /day)	20	20	10	10
Exposure duration (yr)	70	70	40	40
Body weight (kg)	70	70	70	70
Effective dose (ug/kg/day)	2.29 x 10 ⁻⁹	1.14 x 10 ⁻⁸	4.9 x 10 ⁻¹⁰	2.45 x 10 ⁻⁹
Allowable level ^a (ug/kg/d)	2	2	2	2
Ratio of dose to allowable level	1.145 x 10 ⁻⁹	5.7 x 10 ⁻⁹	2.45 x 10 ⁻¹⁰	1.23 x 10 ⁻⁹

CHAPTER FIVE

ASSUMPTIONS AND LIMITATIONS OF ESTIMATED RISKS

5.1 Introduction of Uncertainties

Potential public health risks associated with this proposed pumpout project have been estimated in this risk assessment. The risk assessment process has some inherent uncertainties and require the risk assessor to make assumptions and use professional judgement in this process.

Uncertainties inherent in the risk assessment process include:

- o possible errors from sampling and chemical analysis of trichloroethylene in various media,
- o comprehensiveness of a sampling program,
- o projections of chemical concentrations at exposure points,
- o estimates of human intake levels, and
- o extrapolation of dose response data from animals to humans.

In risk assessments it is important that all sources of uncertainty associated with final risk estimates are documented and understood (Slovic, 1987; Wilson and Crouch, 1987; USEPA, 1986c).

The following factors, although not all inclusive, are nevertheless representative of the factors that may overestimate and/or underestimate health risks.

5.2 Uncertainties Which Could Overestimate Risk

a. Dose-Response Relationship

- o Cancer potency factors developed by the EPA were used in this study. These levels are developed based on a 95 percent upper-bound limit. Therefore, the actual risk will most likely not be higher and is likely to be considerably lower.

- o In the absence of human data, the EPA assumes a linear dose response model for extrapolating health effects observed at higher doses or exposures in animals to low dose human exposure. The cancer potency factors used to predict cancer incidence from low exposure are based upon the most potent dose-response animal study data. Humans are assumed to be as sensitive as the most sensitive animal species tested.
- o EPA uses a non-threshold, linearized multistage model for extrapolating responses observed at high doses to low doses. Carcinogens are assumed to cause some risk at any exposure level. Other dose-response models may assume that there is a threshold for carcinogenic effects and therefore there may be an exposure level that is without adverse effect.
- o The lung absorption rate is estimated using health protective assumptions. For example, 100% absorption efficiency is assumed for the inhalation route even though human experimental evidence or animal toxicological data may not reveal complete absorption.
- o This risk assessment assumes that trichloroethylene is 100% bioavailable to the receptor or target organ.
- b. Environmental and Exposure Aspects
 - o Exposure to trichloroethylene is assumed to remain constant over a lifetime, i.e., the on-site worker is assumed to be exposed to project related ambient pollutant concentrations 8 hours a day for 40 years, while off-site receptors are assumed to be exposed 24 hours daily for a lifetime (70 years). In reality, lifestyle changes due to age and actual residence time will reduce exposure duration. Thus, the actual effective dose may be much lower than the dose used in this analysis and therefore the health risk would be less.
 - o Using assumptions in the worst case exposure scenario trichloroethylene contaminated water is assumed to be undiluted and uniformly distributed in the proposed irrigation system.

In actuality, trichloroethylene will not be evenly distributed in the entire proposed system. The actual trichloroethylene concentration at any given node of the system is a function of its relative distance from the main pumpout station and the operation scenarios identified in section 2.2. The assumption that the irrigated water will be uniformly contaminated with the maximum concentration possible throughout the proposed irrigation system produces a significant overestimation of the exposure risk.

- o The exposure to and concentration of trichloroethylene at the exposure points is held constant over a 70-year lifetime. In reality, trichloroethylene fate and transport mechanisms will alter the concentration of trichloroethylene in the environment.

5.3 Uncertainties Which Could Underestimate Risk

- o There is a possibility that people who have been previously exposed to airborne pollutants at injurious concentrations, or who are chronically ill may have an increased risk of adverse health effects from exposure to pollutants.
- o Biochemical individualism indicates that there may be high susceptibility for some population groups because of metabolic differences and/or their inherent differences in their response to the effects of carcinogens.

5.4 Interrisk Comparisons

In this risk assessment, the human receptor's quantitative potential carcinogenic risks associated with exposures to trichloroethylene potentially released from the proposed pumpout station is estimated. An interrisk comparison is provided herein to put the predicted health risks into perspective. An interrisk comparison compares the incremental cancer risks from exposure to an environmental contaminant to other commonplace activities which also have incremental cancer risks or increases in the chance of death or a reduced life expectancy (Hutt, 1984; Slovic, 1987).

Cancer is the second leading cause of death in the U.S. The national risk of death due to cancer (all causes) over a 70 year lifespan is very high, and is estimated at 2.7×10^{-1} , or a chance of approximately one in four. The 2.7×10^{-1} cancer risk is the baseline situation or background incidence of cancer.

As a point of reference, the cancer risk associated with lifetime exposure from air pollutants commonly found in the Los Angeles basin exceeds the one in one million (1×10^{-6}) risk level generally accepted as insignificant by most agencies. For example, the lifetime risk associated with trichloroethylene inhalation exposure at background concentrations found in the Los Angeles basin (1.66 ug/m^3) and Irvine Park (1.07 ug/m^3) all exceed one-in-a-million cancer risk from a lifetime of exposure. A one-in-one million risk occurs with a lifetime of exposure at (0.8 ug/m^3). In comparison, the project-related incremental annual trichloroethylene average concentration ($4.0\text{E-}8 \text{ ug/m}^3$) is an equivalent of a $5.0\text{E-}14$ incremental cancer risk.

An incremental cancer risk of 1×10^{-6} (ie. one incremental lifetime cancer risk per one million population) is selected as the "acceptable" level in this study. Interrisk comparisons provide perspective to the meaning of a 1×10^{-6} cancer risk by relating this incremental level of risk to commonly experienced or practiced daily activities. A discussion of what has been deemed an "acceptable" level of risk in managing hazardous waste contaminated sites by various regulatory agencies is also provided (Crouch and Wilson, 1984; Wilson, 1979).

In the field of hazardous waste management or environmental risk associated with new projects, there is no one universally agreed to level of acceptable incremental cancer risk. The EPA has not promulgated any standard value that constitutes an acceptable, allowable or appropriate incremental cancer risk level. As a general rule, an incremental cancer risk ranges between 1×10^{-4} and 1×10^{-7} have been deemed "acceptable" by several regulatory agencies (EPA, 1985d).

U.S. Courts recognize the legal doctrine referred to as de minimus non curat lex, or simply de minimus. This maxim holds that the law does not concern itself with trifling matters and that courts should be reluctant to apply the literal terms of a statute to mandate pointless results (FDA, 1985). Courts have upheld this principle in their interpretations of the Food Additives Amendment, the Clean Air Act, the polychlorinated biphenyl provisions in the Toxic Substances Control Act, and the Occupational Safety and Health Act (FDA, 1985; Hutt, 1984; OSHA, 1985). Several judicial decisions have defined an "acceptable", de minimus or "insignificant" risk as 1×10^{-6} (ie. one incremental lifetime cancer risk per one million population). California's Proposition 65 uses a 1×10^{-5} risk value as an "allowable" risk value. Therefore, potential cancer risk from this project is insignificant or de minimus.

The Department of Health Services (DHS), State of California (DHS) has performed many risk analysis concerning the release of hazardous air toxics to the environment. DHS has stated that if a project related incremental pollution concentration or incremental risk is 100 times lower than the corresponding value for regional levels, a facility's emission and its associated risks are deemed de minimus (DHS, 1988). Therefore, the risk associated with this project should be considered as de minimus.

A one-in-a-million lifetime risk (1×10^{-6}) is an increment, or addition to the 2.7×10^{-1} baseline risk of getting cancer (an increase from 0.27 to 0.270001). From an epidemiological perspective, the baseline cancer risk is so high that incremental risks less than perhaps 1×10^{-4} (or one case in a population of ten thousand) are not likely to be measurable. The risk associated with this proposed project cannot be measured using epidemiological techniques.

The purpose of the risk assessment is to provide risk data that will be useful in making decisions about the hazards associate with the project. It is important to gain some perspective about the meaning of the magnitude of the risk. Comparisons can be useful in this context. Table 5.1 shows a variety of risks expressed in a similar manner, as

Table 5.1

TABLE 5.1

EXAMPLES OF ONE IN A MILLION RISKS IN EATING AND DRINKING

- 40 DIET SODAS (SACCHARIN)
- 6 POUNDS OF PEANUT BUTTER (AFLATOXIN)
- 180 PINTS OF MILK (AFLATOXIN)
- 200 GALLONS OF DRINKING WATER FROM
NEW ORLEANS OR MIAMI
- 90 POUNDS OF BROILED STEAK

an average annual incremental risk and an incremental lifetime risk assuming 70 years (Crouch and Wilson 1984; Wilson, 1979; and Wilson and Crouch, 1987). Wilson (1979) cites other common activities estimated to increase the chances of death in any given year by 0.000001 (one-in-a-million or 1×10^{-6}). These are given in Table 5.2.

By comparing measures of risk due to activities of everyday life with similar measures of risk from chemicals, it is evident that the lifetime risk of cancer or death associated with many activities in the U.S. is relatively high when compared to "acceptable" risks for the general population, or a one-in-a-million incremental risk. Furthermore, the risk associated with this project are estimated to be 100 times less than a one-in-one-million cancer risk.

5.5 Risk Associated With No Action Remedial Alternative

One of the viable remedial alternatives in dealing with current trichloroethylene groundwater contamination in the El Toro and Irvine areas is the "no action" plan. Under such an alternative option, the plume of trichloroethylene containing water will continually migrate westwardly at a rate of one to four feet daily toward one of the major drinking water supply sources in Orange County (OCWD, 1989a).

Following the exposure assessment methods presented in Chapter 3, it can be estimated that the predicted worst case project-related incremental cancer risk from inhalation of volatilized trichloroethylene (1.486×10^{-13}) is less than the risk of a person consuming two liters of water daily for a lifetime containing 4.458×10^{-7} ug/L of trichloroethylene.

Another way to provide basis of comparison is to compare the predicted worst case off-site receptor's cancer risk (1.486×10^{-13}) with the potential risks associated with "no action" plan. If an adult consumes two liters of a day containing 8 ppb trichloroethylene (the value used in the plausible exposure scenario), he will have a 2.667×10^{-6} lifetime cancer risk, a level exceed the

Table 5.2

TABLE 5.2

EXAMPLES OF ONE IN A MILLION RISKS

Time to Accumulate one in a million risk of death
in the occupational indicated:

- o Manufacturing 4.5 Days
- o Service and Government 3.5 Days
- o Transportation and Public Utilities 1.0 Day
- o Agriculture 1.5 Hours
- o Construction 14 Hours
- o Mining and Quarrying 9 Hours

TABLE 5.2 (Continued)
EXAMPLES OF ONE IN A MILLION RISKS

Time to Accumulate One in One Million Risk of Death
from the Cause Indicated

○	DROWNING	10 DAYS
○	FIRES	13 DAYS
○	FIREARMS	36 DAYS
○	ELECTROCUTION	2 DAYS
○	TORNADOES	20 MONTHS
○	FLOODS	20 MONTHS
○	LIGHTNING	2 YEARS
○	ANIMAL BITE OR STING	4 YEARS

insignificant risk value. If the worst case trichloroethylene concentration (40 ppb) is used, the lifetime cancer risk for the same individual will increase to 1.3×10^{-5} .

Such analysis indicates that under "no action" plan, the continual westerly migration of the trichloroethylene plume poses a potential significant health threat to the population that use this aquifer as a source of drinking water. In addition, residents who would rely on contaminated water for drinking and household purposes would also be a risk from inhalation of trichloroethylene contaminated water from other domestic use activities. Trichloroethylene can volatilize into the atmosphere from activities such as bathing, showering, dishwashing, laundering, cooking, toilet flushing and other activities. This risk assessment does not quantify the inhalation risks from these trichloroethylene exposures. Therefore, if the drinking water aquifers were to be contaminated with trichloroethylene in the County of Orange, community resident's health risks could not be eliminated by solely using an alternate drinking water source since they would likely continue to use trichloroethylene contaminated water for other daily activities.

CHAPTER SIX

REFERENCES

6.0 REFERENCES

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Appendix A

1980 CENSUS DATA, ORANGE COUNTY TRACT

TABLE 2: POPULATION BY AGE AND SEX FOR ENTIRE CENSUS TRACTS

TRACT: (0-SUPPRESSED)	423. 12	423. 13	423. 14	324. 04	324. 05	324. 064	324. 078	324. 08	324. 09
AGE BY SEX (1)									
TOTAL MALES	2318	2648	2790	3368	2268	1593	2919	3190	4102
UNDER 1 YEAR	54	42	37	124	49	23	61	39	64
1 AND 2 YEARS	87	57	70	223	103	47	111	111	130
3 AND 4 YEARS	74	37	60	133	82	54	93	114	141
5 YEARS	34	21	24	54	47	39	64	37	39
6 YEARS	31	19	34	33	40	30	31	60	74
7 TO 9 YEARS	115	90	119	155	92	123	143	232	285
10 TO 13 YEARS	142	73	173	123	133	138	192	303	434
14 YEARS	32	23	40	14	23	29	34	70	88
15 YEARS	27	23	30	30	21	23	32	49	94
16 YEARS	32	27	49	17	31	30	32	38	103
17 YEARS	37	37	67	35	21	29	40	54	91
18 YEARS	33	44	33	306	24	23	43	34	81
19 YEARS	24	41	38	700	19	18	33	42	57
20 YEARS	30	91	41	725	18	17	28	23	34
21 YEARS	40	93	42	543	14	20	31	27	47
22 TO 24 YEARS	138	330	103	971	68	31	131	62	111
25 TO 29 YEARS	323	491	242	431	200	97	384	192	255
30 TO 34 YEARS	231	339	292	245	338	192	444	430	439
35 TO 44 YEARS	234	243	440	164	327	322	334	644	811
45 TO 54 YEARS	194	198	309	43	241	172	209	294	429
55 TO 59 YEARS	84	103	141	6	120	61	73	107	122
60 AND 61 YEARS	31	37	44	0	43	20	23	29	23
62 TO 64 YEARS	34	49	69	2	30	8	23	34	36
65 TO 74 YEARS	121	100	134	0	113	18	33	43	60
75 TO 84 YEARS	34	42	39	1	18	9	11	11	11
85 YEARS AND OLDER	10	14	10	0	3	0	0	1	1
UNDER 5 YEARS	217	134	167	504	234	124	243	244	333
5 - 17 YEARS	430	277	340	483	410	443	608	903	1230
18 - 64 YEARS	1444	2079	1838	4380	1484	1001	2002	1944	2443
65 AND OVER	183	154	183	1	138	27	44	33	72
MEDIAN AGE (2)	28.1	28.0	32.2	21.0	32.0	30.1	28.9	30.3	27.7
TOTAL FEMALES									
UNDER 1 YEAR	44	30	33	133	49	31	53	34	62
1 AND 2 YEARS	83	38	54	209	73	34	120	108	109
3 AND 4 YEARS	63	43	72	171	83	37	111	124	132
5 YEARS	32	14	28	74	33	32	62	63	73
6 YEARS	41	10	33	33	31	33	33	74	77
7 TO 9 YEARS	108	57	118	148	109	84	184	219	262
10 TO 13 YEARS	147	83	134	110	116	131	138	280	392
14 YEARS	39	28	34	30	13	29	34	69	77
15 YEARS	22	22	42	23	27	28	38	63	99
16 YEARS	33	27	67	21	23	39	28	49	117
17 YEARS	19	31	49	38	18	24	24	34	68
18 YEARS	32	44	34	34	19	24	21	34	82
19 YEARS	41	41	32	104	30	24	24	38	47
20 YEARS	43	84	44	118	13	19	31	29	39
21 YEARS	33	97	47	123	24	17	34	37	42
22 TO 24 YEARS	141	293	109	322	94	39	143	97	121
25 TO 29 YEARS	314	343	243	324	294	134	437	248	314
30 TO 34 YEARS	243	237	289	143	323	217	499	341	343
35 TO 44 YEARS	270	198	447	114	277	298	383	370	791
45 TO 54 YEARS	214	193	334	23	238	198	137	238	338
55 TO 59 YEARS	130	98	181	3	113	31	34	100	101
60 AND 61 YEARS	34	30	49	0	34	11	14	27	22
62 TO 64 YEARS	33	41	68	2	34	12	14	28	31
65 TO 74 YEARS	133	121	144	3	128	20	34	40	64
75 TO 84 YEARS	37	74	52	1	19	12	7	11	23
85 YEARS AND OLDER	14	17	9	0	7	1	3	3	11
UNDER 5 YEARS	194	131	141	333	209	124	284	288	303
5 - 17 YEARS	441	272	331	497	372	404	383	873	1143
18 - 64 YEARS	1392	1747	1901	1338	1343	1008	1819	2027	2313
65 AND OVER	228	214	227	4	134	33	44	34	102
MEDIAN AGE (2)	29.2	27.7	33.0	20.1	31.2	29.8	27.8	29.2	28.3
TOTAL POPULATION	4733	5012	5590	7740	4544	3180	5433	6434	8187
POPULATION BY AGE (1)									
UNDER 5 YEARS	411	247	328	1037	443	248	349	334	438
5 - 17 YEARS	891	349	1111	980	782	849	1193	1778	2393
18 - 64 YEARS	3038	3824	3739	3738	3039	2009	3821	3993	4980
65 AND OVER	413	370	412	3	292	60	90	111	174
SUPPRESSED	0	0	0	0	0	14	2	0	0
MEDIAN AGE (2)	28.7	27.9	32.4	20.8	31.4	30.0	28.3	29.8	28.1

TABLE 2: POPULATION BY AGE AND SEX FOR ENTIRE CENSUS TRACTS

TRACT. (0=SUPPRESSED)	524.10	524.11	525.010	525.02	525.03	525.04	525.05	525.06	525.07
AGE BY SEX (1)									
TOTAL MALES	2384	2223	1310	3056	2443	2152	2211	1451	1534
UNDER 1 YEAR	38	29	4	39	33	41	30	15	26
1 AND 2 YEARS	62	69	9	71	72	69	58	34	50
3 AND 4 YEARS	63	54	17	81	71	78	55	34	48
5 YEARS	27	32	8	29	50	42	33	21	27
6 YEARS	27	41	13	62	62	39	37	26	23
7 TO 9 YEARS	100	144	34	209	200	153	88	93	110
10 TO 13 YEARS	141	209	29	317	300	173	133	167	149
14 YEARS	34	50	3	74	54	52	23	39	24
15 YEARS	43	54	8	83	57	41	34	33	21
16 YEARS	27	61	3	74	60	35	43	47	24
17 YEARS	29	47	3	73	61	24	32	30	21
18 YEARS	32	43	97	51	48	34	25	24	23
19 YEARS	16	50	244	43	30	28	31	29	13
20 YEARS	29	39	268	54	29	18	19	14	15
21 YEARS	24	33	191	29	30	34	33	24	14
22 TO 24 YEARS	67	88	189	84	47	87	139	42	45
25 TO 29 YEARS	200	161	82	144	72	187	304	58	124
30 TO 34 YEARS	292	196	64	248	234	315	263	129	212
35 TO 44 YEARS	337	363	39	384	376	407	326	307	323
45 TO 54 YEARS	210	245	3	349	238	167	174	174	150
55 TO 59 YEARS	119	85	0	122	64	49	71	53	44
60 AND 61 YEARS	44	22	0	39	9	15	25	10	9
62 TO 64 YEARS	76	29	0	38	10	28	34	10	17
65 TO 74 YEARS	242	52	0	85	23	19	127	19	13
75 TO 84 YEARS	84	21	0	31	9	11	43	10	6
85 YEARS AND OLDER	19	6	0	3	2	2	9	1	1
UNDER 5 YEARS	169	152	30	191	174	188	143	87	124
5 - 17 YEARS	428	638	103	917	846	561	443	436	401
18 - 64 YEARS	1446	1354	1177	1827	1387	1371	1444	878	987
65 AND OVER	343	79	0	121	34	32	179	30	20
MEDIAN AGE (2)	34.0	27.1	20.7	30.3	26.0	28.3	29.4	28.9	30.2
TOTAL FEMALES									
UNDER 1 YEAR	37	26	4	44	42	37	48	19	20
1 AND 2 YEARS	52	61	20	68	65	72	70	28	34
3 AND 4 YEARS	61	74	24	69	89	78	52	34	45
5 YEARS	24	34	7	40	59	37	34	18	24
6 YEARS	21	34	18	39	48	40	23	27	29
7 TO 9 YEARS	101	127	44	190	185	140	87	111	98
10 TO 13 YEARS	134	212	32	354	288	160	158	146	114
14 YEARS	38	42	12	62	68	37	32	42	35
15 YEARS	37	62	4	74	67	49	30	37	29
16 YEARS	35	65	4	69	67	47	34	37	24
17 YEARS	33	51	1	67	53	50	35	34	16
18 YEARS	30	51	7	43	40	27	29	35	17
19 YEARS	23	32	12	60	31	31	37	19	12
20 YEARS	33	31	16	31	17	14	47	22	16
21 YEARS	29	36	5	24	18	21	38	12	13
22 TO 24 YEARS	112	101	14	76	37	98	172	37	59
25 TO 29 YEARS	248	174	49	208	140	244	305	74	153
30 TO 34 YEARS	307	261	51	385	343	329	264	183	277
35 TO 44 YEARS	275	387	28	634	333	373	319	312	324
45 TO 54 YEARS	227	205	2	352	177	141	190	132	117
55 TO 59 YEARS	138	73	1	124	54	50	111	50	48
60 AND 61 YEARS	47	36	0	34	8	23	34	9	14
62 TO 64 YEARS	106	25	1	45	18	18	57	13	12
65 TO 74 YEARS	304	55	0	101	35	34	178	25	31
75 TO 84 YEARS	106	24	1	54	13	12	50	6	9
85 YEARS AND OLDER	29	3	0	11	9	2	8	3	11
UNDER 5 YEARS	150	161	48	181	196	187	170	81	121
5 - 17 YEARS	443	627	122	893	835	556	433	452	369
18 - 64 YEARS	1593	1412	186	2022	1416	1393	1603	898	1064
65 AND OVER	439	82	1	168	53	50	236	34	47
MEDIAN AGE (2)	34.0	27.9	19.1	31.5	27.7	28.0	29.8	30.0	30.7
TOTAL POPULATION									
	3011	4505	1670	6322	4943	4340	4653	2916	3135
POPULATION BY AGE (1)									
UNDER 5 YEARS	313	313	78	372	372	375	313	168	245
5 - 17 YEARS	871	1265	225	1812	1481	1117	878	908	770
18 - 64 YEARS	3041	2766	1363	3849	2803	2766	3047	1776	2053
65 AND OVER	784	161	1	289	87	82	415	64	67
SUPPRESSED	0	0	3	0	0	0	0	0	0
MEDIAN AGE (2)	34.0	27.9	20.6	31.0	27.1	28.1	29.6	29.5	30.5

TABLE 2: POPULATION BY AGE AND SEX FOR ENTIRE CENSUS TRACTS

TRACT: (0-SUPPRESSED)	323. 08	323. 09	323. 10	626. 04	626. 05	626. 07	626. 08	626. 10	626. 11
AGE BY SEX (1)									
TOTAL MALES	4199	867	322	1938	1625	2865	3012	23	1568
UNDER 1 YEAR	77	10	6	19	18	32	4	0	15
1 AND 2 YEARS	138	17	2	17	23	49	4	1	23
3 AND 4 YEARS	132	14	3	23	9	40	2	0	26
5 YEARS	59	19	0	13	6	15	0	0	13
6 YEARS	67	13	3	15	5	22	1	0	14
7 TO 9 YEARS	189	57	10	48	27	78	4	0	37
10 TO 13 YEARS	260	97	6	107	36	132	1	0	64
14 YEARS	73	20	1	18	10	32	1	0	10
15 YEARS	46	26	4	29	22	38	0	1	14
16 YEARS	52	20	3	30	18	35	1	0	12
17 YEARS	34	30	0	32	19	29	5	0	19
18 YEARS	67	23	4	29	23	40	1	0	18
19 YEARS	49	24	4	25	15	32	13	0	27
20 YEARS	53	14	5	29	27	37	27	0	46
21 YEARS	47	14	12	26	23	44	21	1	31
22 TO 24 YEARS	215	43	77	93	134	125	73	3	145
25 TO 29 YEARS	367	50	159	184	237	249	67	7	244
30 TO 34 YEARS	648	84	77	189	234	289	45	7	202
35 TO 44 YEARS	709	154	67	265	235	398	41	0	217
45 TO 54 YEARS	388	86	37	247	141	294	32	1	179
55 TO 59 YEARS	149	26	14	131	70	159	42	2	61
60 AND 61 YEARS	66	3	10	49	33	75	25	0	19
62 TO 64 YEARS	44	6	9	68	30	115	54	0	24
65 TO 74 YEARS	72	9	8	165	103	324	748	0	57
75 TO 84 YEARS	13	3	1	86	62	158	1405	0	8
85 YEARS AND OLDER	3	1	0	21	26	24	395	0	3
UNDER 5 YEARS	347	43	11	99	69	121	10	1	64
5 - 17 YEARS	780	282	27	292	163	381	13	1	203
18 - 64 YEARS	2982	529	475	1335	1222	1857	441	21	1233
65 AND OVER	90	13	9	272	191	506	2548	0	68
MEDIAN AGE (2)	30.0	24.2	28.8	37.0	33.0	37.9	77.1	28.6	29.7
TOTAL FEMALES									
TOTAL FEMALES	4363	845	564	2067	1847	3046	6015	8	1744
UNDER 1 YEAR	74	5	1	22	15	35	3	0	17
1 AND 2 YEARS	123	25	6	33	15	35	1	0	13
3 AND 4 YEARS	141	27	4	15	16	32	1	1	25
5 YEARS	71	15	2	9	8	18	3	0	10
6 YEARS	37	16	0	6	4	22	1	0	16
7 TO 9 YEARS	173	59	5	32	37	76	2	0	43
10 TO 13 YEARS	247	81	8	101	46	136	7	0	70
14 YEARS	64	24	0	23	15	26	0	0	16
15 YEARS	30	24	2	34	11	27	2	0	22
16 YEARS	69	22	0	31	15	30	0	0	21
17 YEARS	56	27	3	28	23	40	4	0	20
18 YEARS	40	13	11	23	22	31	14	0	26
19 YEARS	60	18	8	27	20	32	22	1	46
20 YEARS	44	12	9	22	25	33	22	0	43
21 YEARS	52	7	17	16	36	30	20	0	68
22 TO 24 YEARS	306	27	98	86	131	121	68	1	172
25 TO 29 YEARS	640	67	139	160	229	251	60	0	261
30 TO 34 YEARS	709	91	77	163	188	236	34	1	230
35 TO 44 YEARS	644	172	68	264	167	354	37	0	216
45 TO 54 YEARS	369	67	30	235	136	292	65	2	172
55 TO 59 YEARS	160	21	27	147	80	204	117	2	60
60 AND 61 YEARS	32	4	7	56	39	93	84	0	14
62 TO 64 YEARS	33	9	6	80	32	135	183	0	30
65 TO 74 YEARS	83	7	11	244	241	465	1927	0	79
75 TO 84 YEARS	20	4	5	154	202	246	2630	0	31
85 YEARS AND OLDER	6	1	0	36	74	46	708	0	3
UNDER 5 YEARS	338	57	11	70	66	102	5	1	55
5 - 17 YEARS	767	268	20	284	159	375	19	0	218
18 - 64 YEARS	3149	508	517	1279	1125	1812	726	7	1358
65 AND OVER	109	12	16	434	517	757	3263	0	113
MEDIAN AGE (2)	29.4	26.5	28.9	41.9	39.0	43.8	76.3	35.0	29.7
TOTAL POPULATION	8562	1712	1086	4005	3472	5911	9027	31	3312
POPULATION BY AGE (1)									
UNDER 5 YEARS	685	100	22	129	95	223	15	2	119
5 - 17 YEARS	1547	550	47	576	322	756	32	1	421
18 - 64 YEARS	6131	1037	992	2614	2347	3669	1167	28	2591
65 AND OVER	199	25	25	706	708	1263	7813	0	181
SUPPRESSED	0	0	0	0	0	0	0	0	0
MEDIAN AGE (2)	29.6	25.4	28.8	39.4	34.7	40.7	76.3	29.3	29.7

TABLE 2 POPULATION BY AGE AND SEX FOR ENTIRE CENSUS TRACTS

TRACT (8-SUPPRESSED)	626.12	626.13	626.14	626.150	626.16	626.17	626.18	626.19	626.20
AGE BY SEX (1)									
TOTAL MALES	3389	0	1979	0	3368	1967	3290	2137	2920
UNDER 1 YEAR	27	0	24	0	29	11	34	22	29
1 AND 2 YEARS	72	0	27	0	80	21	71	25	39
3 AND 4 YEARS	65	0	26	0	74	32	81	30	27
5 YEARS	44	0	6	0	49	18	44	14	21
6 YEARS	35	0	15	0	43	17	33	19	18
7 TO 9 YEARS	169	0	14	0	174	59	176	56	65
10 TO 13 YEARS	263	0	26	0	302	132	278	118	103
14 YEARS	65	0	2	0	49	33	78	25	20
15 YEARS	61	0	3	0	66	45	77	31	35
16 YEARS	91	0	3	0	73	55	83	37	28
17 YEARS	81	0	5	0	76	60	81	38	30
18 YEARS	74	0	191	0	61	37	65	30	28
19 YEARS	64	0	265	0	55	29	56	36	26
20 YEARS	38	0	221	0	55	24	45	22	28
21 YEARS	30	0	147	0	31	17	40	29	39
22 TO 24 YEARS	106	0	201	0	87	49	82	92	126
25 TO 29 YEARS	191	0	282	0	165	52	99	235	271
30 TO 34 YEARS	296	0	89	0	273	74	237	225	385
35 TO 44 YEARS	372	0	22	0	717	297	643	418	538
45 TO 54 YEARS	448	0	4	0	475	360	313	258	288
55 TO 59 YEARS	248	0	1	0	196	201	180	105	116
60 AND 61 YEARS	68	0	0	0	56	62	43	44	24
62 TO 64 YEARS	64	0	0	0	50	70	49	64	55
65 TO 74 YEARS	131	0	1	0	89	134	94	108	114
75 TO 84 YEARS	49	0	0	0	21	43	21	50	49
85 YEARS AND OLDER	11	0	0	0	0	13	7	6	16
UNDER 5 YEARS	164	0	77	0	183	64	186	77	95
5 - 17 YEARS	829	0	74	0	834	419	890	338	322
18 - 64 YEARS	2181	0	1423	0	2241	1274	2052	1558	1924
65 AND OVER	211	0	1	0	110	210	122	164	179
MEDIAN AGE (2)	33.7	0.0	20.8	0.0	33.9	42.3	33.4	34.7	34.2
TOTAL FEMALES	3613	0	1423	0	3400	2016	3428	2103	2277
UNDER 1 YEAR	39	0	19	0	27	11	37	12	15
1 AND 2 YEARS	32	0	27	0	83	25	70	33	47
3 AND 4 YEARS	62	0	20	0	84	29	67	28	30
5 YEARS	32	0	5	0	47	13	43	9	16
6 YEARS	41	0	5	0	31	10	41	17	19
7 TO 9 YEARS	139	0	16	0	194	63	180	45	60
10 TO 13 YEARS	258	0	28	0	269	126	268	129	91
14 YEARS	66	0	1	0	67	26	68	30	23
15 YEARS	63	0	1	0	79	41	63	33	22
16 YEARS	62	0	2	0	73	52	86	17	30
17 YEARS	75	0	12	0	70	56	79	43	25
18 YEARS	60	0	223	0	58	44	56	31	18
19 YEARS	32	0	313	0	60	26	43	36	39
20 YEARS	35	0	188	0	38	13	46	21	36
21 YEARS	36	0	95	0	30	25	33	31	26
22 TO 24 YEARS	130	0	169	0	95	47	93	92	112
25 TO 29 YEARS	221	0	193	0	186	64	160	180	231
30 TO 34 YEARS	367	0	72	0	375	103	339	210	322
35 TO 44 YEARS	697	0	24	0	718	354	719	382	378
45 TO 54 YEARS	468	0	7	0	398	368	461	228	214
55 TO 59 YEARS	222	0	1	0	168	198	178	121	101
60 AND 61 YEARS	61	0	0	0	47	52	39	33	39
62 TO 64 YEARS	85	0	0	0	46	74	53	49	45
65 TO 74 YEARS	197	0	0	0	104	134	94	142	169
75 TO 84 YEARS	82	0	0	0	24	50	63	107	115
85 YEARS AND OLDER	11	0	0	0	9	10	21	24	44
UNDER 5 YEARS	133	0	66	0	194	65	174	73	92
5 - 17 YEARS	736	0	70	0	830	389	852	333	286
18 - 64 YEARS	2434	0	1287	0	2219	1368	2222	1434	1571
65 AND OVER	290	0	0	0	137	194	180	273	328
MEDIAN AGE (2)	33.2	0.0	20.2	0.0	32.9	41.6	33.8	36.4	34.9
TOTAL POPULATION	6998	0	2998	2	6768	3983	6718	4240	4797
POPULATION BY AGE (1)									
UNDER 5 YEARS	317	0	143	0	377	129	360	150	187
5 - 17 YEARS	1363	0	144	0	1684	808	1742	661	608
18 - 64 YEARS	4613	0	2710	0	4460	2642	4274	2992	3495
65 AND OVER	301	0	1	0	247	404	302	437	507
SUPPRESSED	0	0	0	2	0	0	0	0	0
MEDIAN AGE (2)	34.9	0.0	20.9	0.0	32.9	41.9	33.6	35.9	34.3

TABLE 2: POPULATION BY AGE AND SEX FOR ENTIRE CENSUS TRACTS

TRACT (0-SUPPRESSED)	626.21	626.22	626.23	627.00	628.00	629.00	630.01	630.04	630.05
AGE BY SEX (1)									
TOTAL MALES	1611	1513	2081	3360	2396	980	3803	2412	811
UNDER 1 YEAR	24	0	0	30	19	7	22	3	2
1 AND 2 YEARS	37	0	0	43	32	13	32	8	1
3 AND 4 YEARS	35	1	1	29	29	8	43	11	9
5 YEARS	24	0	0	14	14	15	22	3	1
6 YEARS	19	0	0	20	10	3	14	3	3
7 TO 9 YEARS	79	0	0	84	44	31	92	31	11
10 TO 13 YEARS	87	0	0	134	78	32	201	67	30
14 YEARS	15	0	0	40	27	18	63	24	7
15 YEARS	15	0	0	41	29	14	62	23	9
16 YEARS	19	0	0	42	37	20	67	33	11
17 YEARS	21	0	0	33	44	20	78	41	16
18 YEARS	18	0	1	29	42	14	63	42	7
19 YEARS	12	0	0	44	44	23	44	34	9
20 YEARS	22	1	0	38	78	12	64	26	10
21 YEARS	13	0	0	37	67	21	63	28	7
22 TO 24 YEARS	90	1	2	233	233	33	210	94	33
25 TO 29 YEARS	203	4	1	484	384	38	294	162	37
30 TO 34 YEARS	233	8	3	384	274	41	243	158	39
35 TO 44 YEARS	188	13	3	320	283	124	304	273	138
45 TO 54 YEARS	118	23	11	333	281	140	430	399	141
55 TO 59 YEARS	47	37	44	348	139	94	341	239	78
60 AND 61 YEARS	18	20	34	80	44	40	112	89	23
62 TO 64 YEARS	22	62	120	104	64	48	132	134	24
65 TO 74 YEARS	133	343	1021	244	138	87	244	311	64
75 TO 84 YEARS	101	433	709	123	63	29	92	120	11
85 YEARS AND OLDER	10	121	127	33	21	7	29	22	2
UNDER 5 YEARS	98	1	1	102	80	28	97	24	12
5 - 17 YEARS	279	0	0	432	287	173	399	231	88
18 - 64 YEARS	988	173	223	2384	2003	634	2744	1704	432
65 AND OVER	244	1339	1837	422	224	123	343	433	79
MEDIAN AGE (2)	31.4	73.3	73.0	34.4	31.0	43.1	39.0	48.3	42.7
TOTAL FEMALES									
UNDER 1 YEAR	19	0	1	28	19	3	20	7	3
1 AND 2 YEARS	42	0	1	42	20	10	29	7	2
3 AND 4 YEARS	32	0	0	38	13	4	31	9	4
5 YEARS	17	1	0	27	18	4	17	3	3
6 YEARS	23	0	0	14	9	11	26	3	4
7 TO 9 YEARS	70	1	0	87	44	29	102	37	12
10 TO 13 YEARS	89	1	0	129	87	31	176	67	21
14 YEARS	18	0	0	44	24	9	63	24	3
15 YEARS	19	0	0	33	14	14	38	29	8
16 YEARS	17	0	0	40	37	20	84	34	13
17 YEARS	18	0	0	33	30	17	74	32	10
18 YEARS	17	0	0	44	31	21	33	34	7
19 YEARS	19	0	2	49	47	18	44	32	8
20 YEARS	17	0	0	34	48	19	64	32	8
21 YEARS	22	0	0	63	44	22	60	32	7
22 TO 24 YEARS	102	3	2	349	233	31	137	87	39
25 TO 29 YEARS	234	9	4	333	343	38	214	182	83
30 TO 34 YEARS	183	1	2	393	198	37	221	139	70
35 TO 44 YEARS	179	12	12	494	242	141	313	400	133
45 TO 54 YEARS	118	31	42	410	300	198	431	489	134
55 TO 59 YEARS	32	84	141	298	182	113	319	323	64
60 AND 61 YEARS	22	30	91	107	38	39	84	117	22
62 TO 64 YEARS	44	127	242	121	49	44	132	141	30
65 TO 74 YEARS	203	1181	1492	337	194	94	318	409	41
75 TO 84 YEARS	110	1140	1098	218	138	38	130	224	18
85 YEARS AND OLDER	14	190	204	77	49	11	41	38	9
UNDER 5 YEARS	113	0	2	108	34	19	80	23	13
5 - 17 YEARS	271	3	0	431	283	137	402	237	78
18 - 64 YEARS	1033	317	338	2941	1837	743	2320	2030	432
65 AND OVER	327	2311	2994	432	283	143	309	471	88
MEDIAN AGE (2)	31.3	74.3	72.3	34.9	33.9	43.9	41.9	50.4	40.8
TOTAL POPULATION	3333	4344	3617	7492	5133	2062	7316	3393	1622
POPULATION BY AGE (1)									
UNDER 5 YEARS	211	1	3	210	134	47	177	47	23
5 - 17 YEARS	330	3	0	903	332	332	1201	448	144
18 - 64 YEARS	2021	490	741	3323	3842	1397	3264	3734	1264
65 AND OVER	373	3830	4833	1034	607	284	874	1124	147
SUPPRESSED	0	0	0	0	0	0	0	0	0
MEDIAN AGE (2)	31.3	74.4	72.3	34.7	32.1	44.8	40.3	49.3	41.7

TABLE 2 POPULATION BY AGE AND SEX FOR ENTIRE CENSUS TRACTS

TRACT: (0-SUPPRESSED)	630.06	630.07	630.08	631.019	631.02	631.03	632.01	632.02	633.00
AGE BY SEX (1)									
TOTAL MALES	1647	1491	48	1297	2317	1334	1677	1531	2891
UNDER 1 YEAR	4	12	0	13	31	17	31	24	48
1 AND 2 YEARS	17	19	0	13	74	25	41	29	69
3 AND 4 YEARS	10	20	0	12	46	24	32	38	45
5 YEARS	7	10	0	7	18	17	13	14	31
6 YEARS	8	10	0	9	21	13	21	10	26
7 TO 9 YEARS	45	62	0	33	78	46	51	49	69
10 TO 13 YEARS	71	111	0	42	92	100	75	58	96
14 YEARS	17	42	0	17	25	24	12	20	21
15 YEARS	19	42	0	19	27	21	16	19	23
16 YEARS	18	44	0	17	36	32	12	16	33
17 YEARS	21	38	0	14	32	40	24	24	41
18 YEARS	27	22	0	20	22	35	21	24	40
19 YEARS	31	41	0	20	43	27	37	32	62
20 YEARS	42	31	0	31	44	26	32	33	57
21 YEARS	72	25	0	38	58	34	47	29	71
22 TO 24 YEARS	172	28	2	106	266	82	141	136	268
25 TO 29 YEARS	202	41	1	233	473	119	303	222	412
30 TO 34 YEARS	139	45	0	134	310	93	177	171	318
35 TO 44 YEARS	175	212	1	159	272	157	196	198	308
45 TO 54 YEARS	174	259	1	163	203	198	146	137	241
55 TO 59 YEARS	97	162	10	87	99	80	65	72	148
60 AND 61 YEARS	23	36	1	26	45	24	28	33	51
62 TO 64 YEARS	46	49	5	33	53	28	25	44	90
65 TO 74 YEARS	128	99	15	68	91	63	86	75	217
75 TO 84 YEARS	53	26	12	11	43	23	33	48	85
85 YEARS AND OLDER	7	3	0	10	15	6	12	16	21
UNDER 5 YEARS	33	51	0	38	131	66	104	91	162
5 - 17 YEARS	206	359	0	158	329	293	224	210	340
18 - 64 YEARS	1220	951	21	1032	1888	903	1218	1091	2066
65 AND OVER	188	130	27	69	149	92	131	139	323
MEDIAN AGE (2)	30.7	39.8	67.0	30.1	28.6	29.8	28.8	29.7	30.3
TOTAL FEMALES									
UNDER 1 YEAR	8	10	0	14	41	13	24	25	42
1 AND 2 YEARS	15	21	0	18	66	22	36	29	68
3 AND 4 YEARS	11	26	0	20	48	31	39	38	50
5 YEARS	6	7	0	6	25	13	11	8	20
6 YEARS	7	12	0	7	22	13	12	12	30
7 TO 9 YEARS	23	46	0	24	67	47	43	45	97
10 TO 13 YEARS	68	122	0	55	92	86	80	61	108
14 YEARS	21	33	0	7	23	29	12	13	30
15 YEARS	25	36	0	12	38	24	26	22	26
16 YEARS	20	24	0	18	32	18	18	19	43
17 YEARS	27	43	0	15	35	19	18	17	33
18 YEARS	37	23	0	23	43	21	22	31	47
19 YEARS	64	28	0	42	57	22	32	33	72
20 YEARS	89	14	0	30	81	35	49	29	76
21 YEARS	116	14	0	41	67	26	63	38	56
22 TO 24 YEARS	259	42	0	142	331	82	165	135	281
25 TO 29 YEARS	248	34	1	190	375	147	245	217	394
30 TO 34 YEARS	166	90	0	104	266	114	144	129	269
35 TO 44 YEARS	182	279	0	151	281	175	194	167	301
45 TO 54 YEARS	169	276	7	155	244	189	157	146	282
55 TO 59 YEARS	123	138	12	87	125	84	77	100	212
60 AND 61 YEARS	48	38	1	28	45	34	25	35	52
62 TO 64 YEARS	59	43	5	33	47	24	46	31	122
65 TO 74 YEARS	165	87	24	63	134	84	94	145	326
75 TO 84 YEARS	105	29	13	28	91	38	46	87	195
85 YEARS AND OLDER	18	3	0	20	71	11	31	33	63
UNDER 5 YEARS	34	57	0	52	155	66	121	92	140
5 - 17 YEARS	199	323	0	144	334	249	220	197	387
18 - 64 YEARS	1562	1019	26	998	1962	953	1179	1111	2164
65 AND OVER	288	119	37	111	296	133	171	263	584
MEDIAN AGE (2)	29.9	39.8	67.3	29.7	29.1	32.3	28.3	32.3	33.4
TOTAL POPULATION	3730	3009	111	2611	5264	2755	3368	3194	6166
POPULATION BY AGE (1)									
UNDER 5 YEARS	67	108	0	90	306	132	225	183	302
5 - 17 YEARS	405	652	0	302	663	542	444	407	727
18 - 64 YEARS	2782	1970	47	2030	3830	1856	2377	2202	4230
65 AND OVER	476	249	64	180	445	225	302	402	907
SUPPRESSED	0	0	0	9	0	0	0	0	0
MEDIAN AGE (2)	30.2	39.8	67.2	29.9	28.8	31.1	28.7	30.8	31.9

Appendix B

REPORT ON THE SOIL AND AIR TESTINGS

AT THE PROPOSED TCE-CONTAINING WATER PUMPOUT SITE

INTRODUCTION

On May 15, 1989, surface soil and ambient air samples were collected at and adjacent to the proposed Orange County Water District Irvine Ranch Water District (OCWD/IRWD) proposed trichloroethylene water pumpout station which will be located at the cross-section of Jeffrey Road and Irvine Center Drive in the City of Irvine, California. The objectives of this survey were 1) to determine if there is residual trichloroethylene concentration in the top layer of soils which have been irrigated with trichloroethylene-containing water for at least 5 years and probably longer and 2) to document the airborne concentrations of trichloroethylene at and in the immediate vicinity of the site while the drip irrigation was in service in order to provide reference measurements as to the pre-construction existing trichloroethylene concentration in the area.

PROJECT AND SITE BACKGROUND INFORMATION

In 1985, during the course of a routine basinwide groundwater monitoring of all active wells, the OCWD detected trichloroethylene for the first time in three Irvine area irrigation wells. Further investigations revealed that trichloroethylene groundwater contamination had extended as far as approximately three miles west of the El Toro Marine Corps Air Station (MCAS) at depths ranging from 200 to 450 feet below ground level. It underlines approximately 2,900 acres and impacts as much as 150,000 acre-feet of groundwater. Further, the trichloroethylene laden water body is migrating westward at an estimated rate of 1 to 4 feet per day.

In order to protect the Orange County water supply sources that are located downgradient, OCWD has proposed a trichloroethylene containment program to slow and curtail the westerly migration of the trichloroethylene plume. The program will install a pumping station that withdraws 700 gallons of trichloroethylene contaminated water per minute for irrigation use. The proposed pumping station is on the west side of the trichloroethylene plume and located at the cross-section of Jeffrey Road and Irvine Center Drive. The pumped out trichloroethylene water will be connected to the existing IRWD reclaimed water delivery system, blended with trichloroethylene-free water from other sources, and then used in drip and sprinkler irrigation in the City of Irvine.

Concurrent with pumping station design, OCWD is in the process of preparing a health risk assessment to determine the probability and magnitude of potential health risks that may associate with the proposed trichloroethylene water containment program. Preliminary findings indicate that inhalation is the significant exposure pathway by which emitted trichloroethylene may reach to potential impacted human receptors. Volatilization of dissolved

trichloroethylene is the major mechanism of potential trichloroethylene release. This study was therefore designed and executed to determine the existing trichloroethylene concentrations in the soils and ambient air in the proposed project area.

At the present time, the proposed project area is an orange orchard. It has received water from The Irvine Company's (TIC) irrigation wells #35 and #47 since 1985. TIC-35 and TIC-47 draw water from the same aquifer as the proposed plan but at different depths. Soil and air samples were collected in this study at and in the immediate vicinity of the proposed pumping station as well as TIC 35 and TIC 47 wells to document pre-construction trichloroethylene concentrations in the soils and ambient air.

Due to the short duration of the sampling, the measurements reported here are indicative of air quality in the study area and serve to provide a reference point to determine the project-related incremental risks of potential trichloroethylene emissions. The findings of this study are not meant to be definitive as trichloroethylene emissions from the site but rather correlative. This study also serves as the start of a long-term air quality and soil testing which would offer more definitive assessment to trichloroethylene emissions from the proposed project.

SUMMARY OF SAMPLING AND ANALYTICAL METHODS

a. Air Sampling

Ambient air samples were collected using SKC personal sampling pumps calibrated to flowrates of 0.20 liters of air per minute. Air was collected to a 2 liter Tedlar bag attached to the pump by 1 inch of tygon tubing at 0.20 liter per minute for 10 minutes. Samples were then sealed and placed in light resistant polyurethane bags. Bags were containerized and transported to the laboratory with chain of custody for trichloroethylene analysis with a detection limit of 0.03 part per billion (ppb).

A total of 9 samples were collected on-site concurrent with 1 off-site sample serving as site control. Figure 1 identifies the locations of monitoring stations. Specifically, three samples were collected at distances of 20, 200 and 500 meters north of each of the following three reference points:

Reference Pt. 1 - Intersection of Jeffrey Road
and Irvine Center Drive (JICD)

Pt. 2 - Tic 35 Well Head (35)

Pt. 3 - Tic 47 Well Head (47)

The following nine samples were collected from the site:

Reference Pt. 1 - MY0515-JICD/20 A
MY0515-JICD/200 A
MY0515-JICD/500 A

Reference Pt. 2 - MY0515-35/20 A
MY0515-35/200 A
MY0515-35/500 A

Reference Pt. 3 - MY0515-47/20 A
MY0515-47/200 A
MY0515-47/500 A

Sample identification was designated by the reference point and its corresponding distance from the reference point. For example, sample MY0515-JICD/20m A indicating the air (A) sample was collected on May 15 at 20 m north of the cross-section of Jeffrey Road and Irvine Center Drive (JICD). Sample MY0515-BKGD was taken at a location approximately 1 mile east from TIC 47 to serve as site control. It was bagged and sent with the rest of the samples. All air samples were collected 4 ft. above ground.

Air samples were analyzed for trichloroethylene by Environmental Analytical Services (EAS), Inc. of San Luis Obispo, CA according to EPA method TO14 with gas chromatograph/electron capture detector method.

b. Soil Sampling

Soil samples were collected on the same date at the same 9 preselected locations as the air samples. The only difference being the soil samples were taken at the first orange tree to the east of the intersection of the reference point. The soils were collected below the surface between 4 to 6 inches at the first outlet of the drip irrigation of the corresponding orange tree. At the time of sampling, soil samples were saturated with water due to irrigation. Soil samples were then labeled and placed in 8 oz. Mason jars and sealed with teflon lids. Samples were then delivered to Chemical Research Laboratories (CRL) at Garden Grove, CA where trichloroethylene analysis was performed according to EPA method 8010 at a detection level of 1 part per billion (ppb).

Nine soil (S) samples collected are as follow:

Reference Pt. 1 - MY0515 - JICD/20 m S
MY0515 - JICD/200 m S
MY0515 - JICD/500 m S

Reference Pt. 2 - MY0515 - 35/20 m S
MY0515 - 35/200 m S
MY0515 - 35/500 m S

Reference Pt. 3 - MY0515 - 47/20 m S
MY0515 - 47/200 m S
MY0515 - 47/500 m S

RESULTS AND DISCUSSIONS

A copy of the laboratory reports on air and soil analysis is attached at the end of this report for reference.

trichloroethylene was measured in all 9 on-site air samples and one off-site sample. Airborne trichloroethylene concentrations detected on the site ranged from 0.32 to 1.20 ppb and one sample of the site MY0515-BKGD was measured at 0.25 ppb (EAS report).

All nine detected trichloroethylene concentrations at the site were higher than the 1986-1987 annual average trichloroethylene concentration reported by the South Coast Air Quality Management District and California Air Resources Board¹ measured at the Irvine Regional Park (0.2 ppb) (Table 1). The airborne trichloroethylene concentration (0.25 ppb) detected at the location which served as site control (sample MY051589-BKGD) was also higher than the 1986-1987 annual average measured at the Irvine Regional Park.

Because both on-site and off-site locations all detected higher trichloroethylene concentrations than the 1986-1987 annual average trichloroethylene concentration measured in the same region, the observed higher trichloroethylene concentrations may serve as an indicator of a trend indicating airborne trichloroethylene in the study area. Furthermore, due to the characteristics of short-term nature of collected samples, the possibility of some still-to-be-determined off-site trichloroethylene releases during the time of air monitoring could not be ruled out.

The possible sources of airborne trichloroethylene cannot be determined at present time with certainty. The detected trichloroethylene concentration at the site may result from off-site industrial or household releases¹, on-site irrigation of trichloroethylene containing water, and the levels are near the regional background concentration as reported by the SCAQMD and CARB¹. They could also be affected by laboratory analysis validity or potential error.

¹ 1985 Annual Average Ambient Air Concentrations of various Toxic Organic Gases in the South Coast Air Basin.

The detected trichloroethylene is believed not to be solely from the irrigated water based on the following calculations:

Water samples collected at TIC-35 and TIC-47 well heads at the time of air monitoring contained 7 ppb trichloroethylene. Total pumping rate of trichloroethylene containing water at these two wells was 1,300 gallons per minute during the air monitoring period (OCWD unpublished data). Under the worst case scenario which assumes complete use of pumped water within the test area (500 m by 1000 m), 100% trichloroethylene evaporation from applied water, and rapid mixing of the released trichloroethylene up to 10 m height in the ambient air, the amount of trichloroethylene released from irrigation water during the 10-minute air sampling period was 4.095×10^{-4} g. This amount of trichloroethylene release would result in a 1.53×10^{-5} ppb measured trichloroethylene concentration to the existing air quality. The calculated trichloroethylene incremental concentration was more than five orders of magnitude greater than the amount that could be contributed by TIC-35 and TIC-47 wells. The contribution of trichloroethylene released from drip irrigation operation was therefore determined de minimus as compared to the existing trichloroethylene concentrations in the region.

It is evident that at the time of sampling there was a trichloroethylene concentration variation throughout the sampling area which measured approximately 500 m by 1000 m in size A. Close examination of the measured trichloroethylene concentrations on-site reveals that there is no apparent correlation between trichloroethylene concentrations and the locations of monitoring stations and the location drip irrigation head. This conclusion is based on the examination of relative distance between location of the monitoring stations and well heads. The nine monitoring stations wells basically located on three parallel "lines" all running northeast to southwest with the TIC-35 "line" being at the center (Figure 1). The detected airborne trichloroethylene concentrations at TIC-35 "line" were between 1.1 to 1.2 ppb comparing to 0.77 to 0.94 ppb at JICD "line" and 0.32 to 0.83 ppb at TIC-47 "line". JICD "line" and TIC-47 "line" is located approximately 250 m northwest and 750 m southeast of TIC-35 "line", respectively. Samples taken from TIC-35 "line" consistently had higher trichloroethylene concentrations than the ones collected from JICD "line" in spite of longer delivery distance (up to 500 m from the well head as compared to approximately 250 m).

None of the 9 soil samples collected contained trichloroethylene at more than 1 ug/kg (CRL report). This finding is significant with respect to future risk assessment since the soils were sampled from an area that has been receiving trichloroethylene contaminated water for irrigation for more than five years. Such results suggested that after the application of contaminated water, trichloroethylene is very likely quickly evaporated into ambient

air and there is no detectable amount of trichloroethylene remains
in the surface soil as a residual.

TABLE 1
AVERAGE AMBIENT CONCENTRATIONS OF TCE
DURING THE MATES PERIOD (1986-1987)
(CONCENTRATIONS IN ppb)

	SCAQMD - NETWORK				ARB				
	ANAHEIM	AZUSA	BURBANK	HAWTHORNE	El Monte	LONG BEACH	L.A.	RUBIDOUX	UPLAND
Ave. Conc.	.3-.5	.6-.7	.7-.8	.2-.4	.173	.210	.250	.124	.496
Std. Dev.	.5	.7	.6	.5	.082	.092	.083	.070	.572
Detection Limit	.2	.2	.2	.2	.005	.005	.005	.005	.005
Sample Size/<#DL	31/17	32/10	26/4	29/22	10/0	28/0	31/0	27/0	31/0
Data Category	B	B	B	B	A	A	A	A	A

	SCAQMD - NETWORK				ARB					
	L.A SCHOOL DIST.	MAYWOOD	BELLGARDENS	AT&T HAWTHORNE	GARDENA	RANCHO DOMINGUEZ	YORDA LINDA	IRVINE PARK	L.A. FIRE DEPT.	BURBANK POLICE
Ave. Conc.	.4-.5	.3-.4	.1-.3	.1-.3	.0-.3	.1-.3	1.3	.1-.3	.1-.3	.3-.5
Std. Dev.	.4	.9	.4	.5	.2	.2	*	.3	*	.4
Detection Limit	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
Sample Size/<#DL	30/11	31/21	29/21	30/26	30/27	31/23	31/30	29/24	32/29	31/14
Data Category	B	B	B	B	B	B	C	B	C	B

Note: a - Data category codes: A - Most of the data above detection limits (>90%), C - Very few of the data points are above detection limits (<10%), and B - Several data points fall above and below detection limits.

b - standard deviation not calculated for Data Category C.

(1) Multiple Air Toxic Study, AQMD

<#DL - Number of samples reported below the detection limit

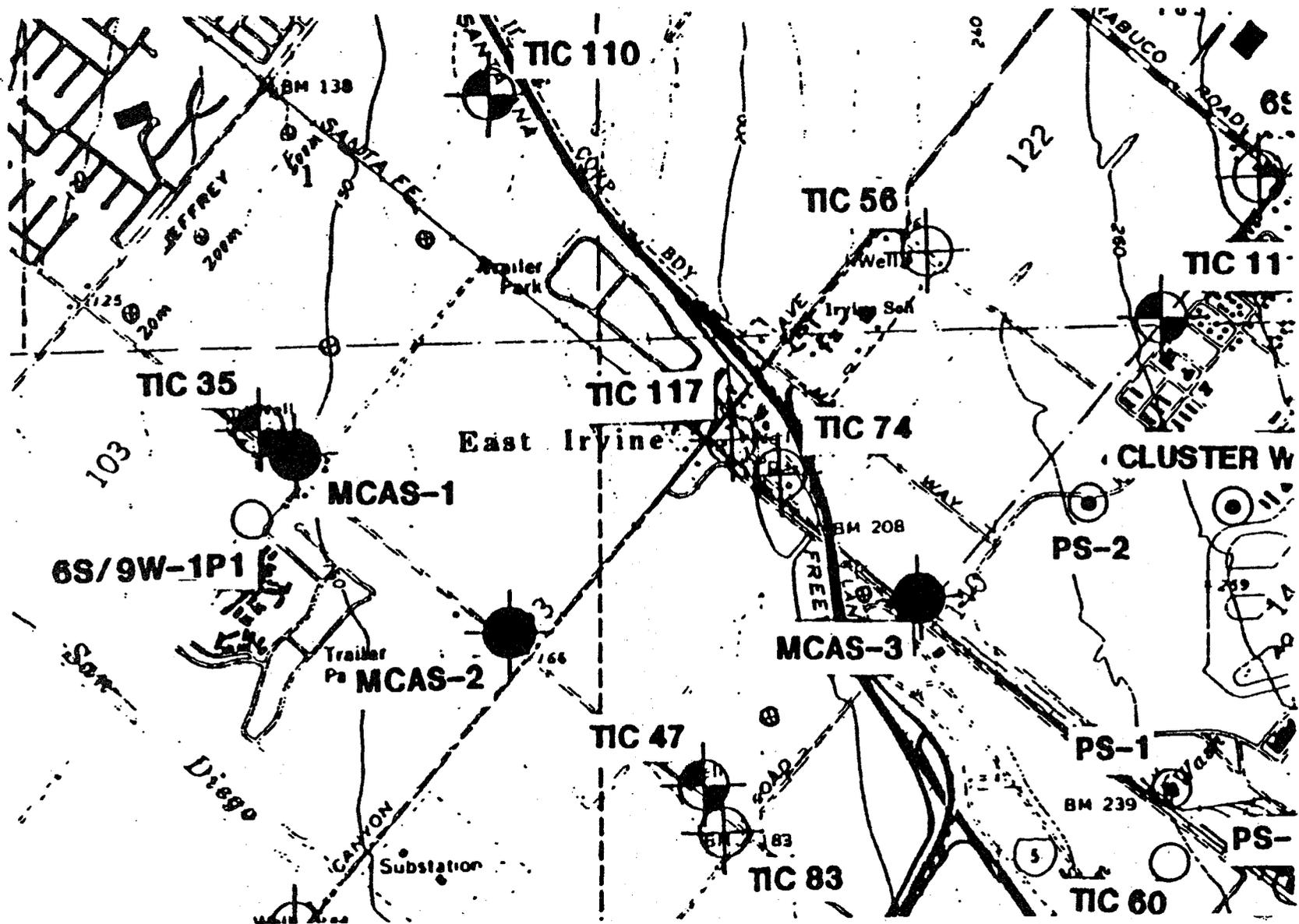


Figure 1: Locations of Soil and Air Sampling Stations

COPY OF SOIL ANALYTICAL RESULTS

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May 18, 1989

MED-TOX ASSOC INC
1431 Warner Avenue
Suite A
Tustin, CA 92680
Attn: Mr. Michael Yang

Analysis No: G-8913512-001/009
Date Sampled: 15-MAY-1989
Date Sample Rec'd: 16-MAY-1989
Project: MY051589

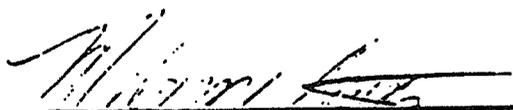
Enclosed with this letter is the report on the chemical and physical analyses on the samples from ANALYSIS NO: G-8913512-001/009 shown above.

The samples were received by CRL in a chilled state, intact and with the chain-of-custody record attached.

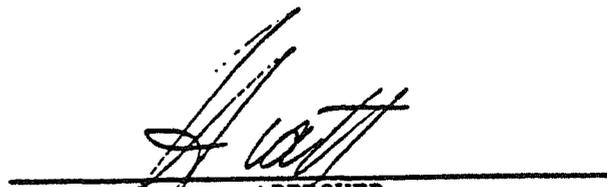
Please note that ND() means not detected at the detection limit expressed within the parentheses.

Solid samples are reported on "as received" basis.

Preliminary data were provided on May 17, 1989 at 2:00 P.M. to Mr. Michael Yang.



REVIEWED



APPROVED

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Laboratory Report

MED-TOX ASSOC INC
 1431 WARNER AVENUE
 SUITE A
 TUSTIN, CA 92680
 ATTN: MR. MICHAEL YANG
 Project: MY051589
 Sample ID: MY051589-#35-20M

Analysis No.: G-8913512-001
 Date Sampled: 15-MAY-1989
 Date Sample Rec'd: 15-MAY-1989
 Date Analyzed: 16-MAY-1989
 Sample Type: SOLID

Halogenated Volatile Organics (EPA 8010)

Units: ug/kg

Parameter	Result	Blank	Detection Limit
Chloromethane	ND	ND	1
Bromomethane	ND	ND	1
Vinyl Chloride	ND	ND	1
Chloroethane	ND	ND	1
Methylene Chloride	ND	ND	1
Trichlorofluoromethane	ND	ND	1
1,1-Dichloroethene	ND	ND	1
1,1-Dichloroethane	ND	ND	1
trans-1,2-Dichloroethene	ND	ND	1
Chloroform	ND	ND	1
1,2-Dichloroethane	ND	ND	1
1,1,1-Trichloroethane	ND	ND	1
Carbon Tetrachloride	ND	ND	1
Bromodichloromethane	ND	ND	1
1,2-Dichloropropane	ND	ND	1
trans-1,3-Dichloropropene	ND	ND	1
Trichloroethene	ND	ND	1
Dibromochloromethane	ND	ND	1
1,1,2-Trichloroethane	ND	ND	1
cis-1,3-Dichloropropene	ND	ND	1
2-Chloroethylvinyl ether	ND	ND	1
Bromoform	ND	ND	1
Tetrachloroethene	ND	ND	1
1,1,2,2-Tetrachloroethane	ND	ND	1
Chlorobenzene	ND	ND	1
1,2-Dichlorobenzene	ND	ND	1
1,3-Dichlorobenzene	ND	ND	1
1,4-Dichlorobenzene	ND	ND	1

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MED-TOX ASSOC INC
 1431 WARNER AVENUE
 SUITE A
 TUSTIN, CA 92680
 ATTN: MR. MICHAEL YANG

Analysis No.: G-8913512-002
 Date Sampled: 15-MAY-1989
 Date Sample Rec'd: 15-MAY-1989
 Date Analyzed: 16-MAY-1989
 Sample Type: SOLID

Project: MY051589
 Sample ID: MY051589-#35-200M

Halogenated Volatile Organics (EPA 8010)

Units: ug/kg

Parameter	Result	Blank	Detection Limit
Chloromethane	ND	ND	1
Bromomethane	ND	ND	1
Vinyl Chloride	ND	ND	1
Chloroethane	ND	ND	1
Methylene Chloride	ND	ND	1
Trichlorofluoromethane	ND	ND	1
1,1-Dichloroethene	ND	ND	1
1,1-Dichloroethane	ND	ND	1
trans-1,2-Dichloroethene	ND	ND	1
Chloroform	ND	ND	1
1,2-Dichloroethane	ND	ND	1
1,1,1-Trichloroethane	ND	ND	1
Carbon Tetrachloride	ND	ND	1
Bromodichloromethane	ND	ND	1
1,2-Dichloropropane	ND	ND	1
trans-1,3-Dichloropropene	ND	ND	1
Trichloroethene	ND	ND	1
Dibromochloromethane	ND	ND	1
1,1,2-Trichloroethane	ND	ND	1
cis-1,3-Dichloropropene	ND	ND	1
2-Chloroethylvinyl ether	ND	ND	1
Bromoform	ND	ND	1
Tetrachloroethene	ND	ND	1
1,1,2,2-Tetrachloroethane	ND	ND	1
Chlorobenzene	ND	ND	1
1,2-Dichlorobenzene	ND	ND	1
1,3-Dichlorobenzene	ND	ND	1
1,4-Dichlorobenzene	ND	ND	1

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MED-TOX ASSOC INC
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 SUITE A
 TUSTIN, CA 92680
 ATTN: MR. MICHAEL YANG

Analysis No.: G-8913512-003
 Date Sampled: 15-MAY-1989
 Date Sample Rec'd: 15-MAY-1989
 Date Analyzed: 16-MAY-1989
 Sample Type: SOLID

Project: MY051589
 Sample ID: MY051589-#35-500M

Halogenated Volatile Organics (EPA 8010)

Units: ug/kg

Parameter	Result	Blank	Detection Limit
Chloromethane	ND	ND	1
Bromomethane	ND	ND	1
Vinyl Chloride	ND	ND	1
Chloroethane	ND	ND	1
Methylene Chloride	ND	ND	1
Trichlorofluoromethane	ND	ND	1
1,1-Dichloroethane	ND	ND	1
1,1-Dichloroethane	ND	ND	1
trans-1,2-Dichloroethane	ND	ND	1
Chloroform	ND	ND	1
1,2-Dichloroethane	ND	ND	1
1,1,1-Trichloroethane	ND	ND	1
Carbon Tetrachloride	ND	ND	1
Bromodichloromethane	ND	ND	1
1,2-Dichloropropane	ND	ND	1
trans-1,3-Dichloropropene	ND	ND	1
Trichloroethene	ND	ND	1
Dibromochloromethane	ND	ND	1
1,1,2-Trichloroethane	ND	ND	1
cis-1,3-Dichloropropene	ND	ND	1
2-Chloroethylvinyl ether	ND	ND	1
Bromoform	ND	ND	1
Tetrachloroethene	ND	ND	1
1,1,2,2-Tetrachloroethane	ND	ND	1
Chlorobenzene	ND	ND	1
1,2-Dichlorobenzene	ND	ND	1
1,3-Dichlorobenzene	ND	ND	1
1,4-Dichlorobenzene	ND	ND	1

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 SUITE A
 TUSTIN, CA 92680
 ATTN: MR. MICHAEL YANG

Analysis No.: G-8913512-004
 Date Sampled: 15-MAY-1989
 Date Sample Rec'd: 15-MAY-1989
 Date Analyzed: 16-MAY-1989
 Sample Type: SOLID

Project: MY051589
 Sample ID: MY051589-#47-20M

Halogenated Volatile Organics (EPA 8010)

Units: ug/kg

Parameter	Result	Blank	Detection Limit
Chloromethane	ND	ND	1
Bromomethane	ND	ND	1
Vinyl Chloride	ND	ND	1
Chloroethane	ND	ND	1
Methylene Chloride	ND	ND	1
Trichlorofluoromethane	ND	ND	1
1,1-Dichloroethene	ND	ND	1
1,1-Dichloroethane	ND	ND	1
trans-1,2-Dichloroethene	ND	ND	1
Chloroform	ND	ND	1
1,2-Dichloroethane	ND	ND	1
1,1,1-Trichloroethane	ND	ND	1
Carbon Tetrachloride	ND	ND	1
Bromodichloromethane	ND	ND	1
1,2-Dichloropropane	ND	ND	1
trans-1,3-Dichloropropene	ND	ND	1
Trichloroethene	ND	ND	1
Dibromochloromethane	ND	ND	1
1,1,2-Trichloroethane	ND	ND	1
cis-1,3-Dichloropropene	ND	ND	1
2-Chloroethylvinyl ether	ND	ND	1
Bromoform	ND	ND	1
Tetrachloroethene	ND	ND	1
1,1,2,2-Tetrachloroethane	ND	ND	1
Chlorobenzene	ND	ND	1
1,2-Dichlorobenzene	ND	ND	1
1,3-Dichlorobenzene	ND	ND	1
1,4-Dichlorobenzene	ND	ND	1

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Laboratory Report

MED-TOX ASSOC INC
 1431 WARNER AVENUE
 SUITE A
 TUSTIN, CA 92680
 ATTN: MR. MICHAEL YANG
 Project: MY051589
 Sample ID: MY051589-#47-200M

Analysis No.: G-8913512-005
 Date Sampled: 15-MAY-1989
 Date Sample Rec'd: 15-MAY-1989
 Date Analyzed: 16-MAY-1989
 Sample Type: SOLID

Halogenated Volatile Organics (EPA 8010)

Units: ug/kg

Parameter	Result	Blank	Detection Limit
Chloromethane	ND	ND	1
Bromomethane	ND	ND	1
Vinyl Chloride	ND	ND	1
Chloroethane	ND	ND	1
Methylene Chloride	ND	ND	1
Trichlorofluoromethane	ND	ND	1
1,1-Dichloroethene	ND	ND	1
1,1-Dichloroethane	ND	ND	1
trans-1,2-Dichloroethene	ND	ND	1
Chloroform	ND	ND	1
1,2-Dichloroethane	ND	ND	1
1,1,1-Trichloroethane	ND	ND	1
Carbon Tetrachloride	ND	ND	1
Bromodichloromethane	ND	ND	1
1,2-Dichloropropane	ND	ND	1
trans-1,3-Dichloropropene	ND	ND	1
Trichloroethene	ND	ND	1
Dibromochloromethane	ND	ND	1
1,1,2-Trichloroethane	ND	ND	1
cis-1,3-Dichloropropene	ND	ND	1
2-Chloroethylvinyl ether	ND	ND	1
Bromoform	ND	ND	1
Tetrachloroethene	ND	ND	1
1,1,2,2-Tetrachloroethane	ND	ND	1
Chlorobenzene	ND	ND	1
1,2-Dichlorobenzene	ND	ND	1
1,3-Dichlorobenzene	ND	ND	1
1,4-Dichlorobenzene	ND	ND	1

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 SUITE A
 TUSTIN, CA 92680
 ATTN: MR. MICHAEL YANG
 Project: MY051589
 Sample ID: MY051589-#47-500M

Analysis No.: G-8913512-006
 Date Sampled: 15-MAY-1989
 Date Sample Rec'd: 15-MAY-1989
 Date Analyzed: 17-MAY-1989
 Sample Type: SOLID

Halogenated Volatile Organics (EPA 8010)

Units: ug/kg

Parameter	Result	Blank	Detection Limit
Chloromethane	ND	ND	1
Bromomethane	ND	ND	1
Vinyl Chloride	ND	ND	1
Chloroethane	ND	ND	1
Methylene Chloride	6.	ND	1
Trichlorofluoromethane	ND	ND	1
1,1-Dichloroethene	ND	ND	1
1,1-Dichloroethane	ND	ND	1
trans-1,2-Dichloroethene	ND	ND	1
Chloroform	ND	ND	1
1,2-Dichloroethane	ND	ND	1
1,1,1-Trichloroethane	ND	ND	1
Carbon Tetrachloride	ND	ND	1
Bromodichloromethane	ND	ND	1
1,2-Dichloropropane	ND	ND	1
trans-1,3-Dichloropropene	ND	ND	1
Trichloroethene	ND	ND	1
Dibromochloromethane	ND	ND	1
1,1,2-Trichloroethane	ND	ND	1
cis-1,3-Dichloropropene	ND	ND	1
2-Chloroethylvinyl ether	ND	ND	1
Bromoform	ND	ND	1
Tetrachloroethene	ND	ND	1
1,1,2,2-Tetrachloroethane	ND	ND	1
Chlorobenzene	ND	ND	1
1,2-Dichlorobenzene	ND	ND	1
1,3-Dichlorobenzene	ND	ND	1
1,4-Dichlorobenzene	ND	ND	1

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 1431 WARNER AVENUE
 SUITE A
 TUSTIN, CA 92680
 ATTN: MR. MICHAEL YANG
 Project: MY051589
 Sample ID: MY051589-JICO-20M

Analysis No.: G-8913512-007
 Date Sampled: 15-MAY-1989
 Date Sample Rec'd: 15-MAY-1989
 Date Analyzed: 16-MAY-1989
 Sample Type: SOLID

Halogenated Volatile Organics (EPA 8010)

Units: ug/kg

Parameter	Result	Blank	Detection Limit
Chloromethane	ND	ND	1
Bromomethane	ND	ND	1
Vinyl Chloride	ND	ND	1
Chloroethane	ND	ND	1
Methylene Chloride	ND	ND	1
Trichlorofluoromethane	ND	ND	1
1,1-Dichloroethane	ND	ND	1
1,1-Dichloroethane	ND	ND	1
trans-1,2-Dichloroethene	ND	ND	1
Chloroform	ND	ND	1
1,2-Dichloroethane	ND	ND	1
1,1,1-Trichloroethane	ND	ND	1
Carbon Tetrachloride	ND	ND	1
Bromodichloromethane	ND	ND	1
1,2-Dichloropropane	ND	ND	1
trans-1,3-Dichloropropene	ND	ND	1
Trichloroethene	ND	ND	1
Dibromochloromethane	ND	ND	1
1,1,2-Trichloroethane	ND	ND	1
cis-1,3-Dichloropropene	ND	ND	1
2-Chloroethylvinyl ether	ND	ND	1
Bromoform	ND	ND	1
Tetrachloroethene	ND	ND	1
1,1,2,2-Tetrachloroethane	ND	ND	1
Chlorobenzene	ND	ND	1
1,2-Dichlorobenzene	ND	ND	1
1,3-Dichlorobenzene	ND	ND	1
1,4-Dichlorobenzene	ND	ND	1

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Laboratory Report

MED-TOX ASSOC INC
 1431 WARNER AVENUE
 SUITE A
 TUSTIN, CA 92680
 ATTN: MR. MICHAEL YANG
 Project: MY051589
 Sample ID: MY051589-JICO-200M

Analysis No.: G-8913512-008
 Date Sampled: 15-MAY-1989
 Date Sample Rec'd: 15-MAY-1989
 Date Analyzed: 16-MAY-1989
 Sample Type: SOLID

Halogenated Volatile Organics (EPA 8010)

Units: ug/kg

Parameter	Result	Blank	Detection Limit
Chloromethane	ND	ND	1
Bromomethane	ND	ND	1
Vinyl Chloride	ND	ND	1
Chloroethane	ND	ND	1
Methylene Chloride	ND	ND	1
Trichlorofluoromethane	ND	ND	1
1,1-Dichloroethane	ND	ND	1
1,1-Dichloroethane	ND	ND	1
trans-1,2-Dichloroethane	ND	ND	1
Chloroform	ND	ND	1
1,2-Dichloroethane	ND	ND	1
1,1,1-Trichloroethane	ND	ND	1
Carbon Tetrachloride	ND	ND	1
Bromodichloromethane	ND	ND	1
1,2-Dichloropropane	ND	ND	1
trans-1,3-Dichloropropene	ND	ND	1
Trichloroethane	ND	ND	1
Dibromochloromethane	ND	ND	1
1,1,2-Trichloroethane	ND	ND	1
cis-1,3-Dichloropropene	ND	ND	1
2-Chloroethylvinyl ether	ND	ND	1
Bromoform	ND	ND	1
Tetrachloroethane	ND	ND	1
1,1,2,2-Tetrachloroethane	ND	ND	1
Chlorobenzene	ND	ND	1
1,2-Dichlorobenzene	ND	ND	1
1,3-Dichlorobenzene	ND	ND	1
1,4-Dichlorobenzene	ND	ND	1

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Laboratory Report

MED-TOX ASSOC INC
 1431 WARNER AVENUE
 SUITE A
 TUSTIN, CA 92680
 ATTN: MR. MICHAEL YANG

Analysis No.: G-8913512-009
 Date Sampled: 15-MAY-1989
 Date Sample Rec'd: 15-MAY-1989
 Date Analyzed: 16-MAY-1989
 Sample Type: SOLID

Project: MY051589
 Sample ID: MY051589-JICO-500M

Halogenated Volatile Organics (EPA 8010)

Units: ug/kg

Parameter	Result	Blank	Detection Limit
Chloromethane	ND	ND	1
Bromomethane	ND	ND	1
Vinyl Chloride	ND	ND	1
Chloroethane	ND	ND	1
Methylene Chloride	ND	ND	1
Trichlorofluoromethane	ND	ND	1
1,1-Dichloroethene	ND	ND	1
1,1-Dichloroethane	ND	ND	1
trans-1,2-Dichloroethene	ND	ND	1
Chloroform	ND	ND	1
1,2-Dichloroethane	ND	ND	1
1,1,1-Trichloroethane	ND	ND	1
Carbon Tetrachloride	ND	ND	1
Bromodichloromethane	ND	ND	1
1,2-Dichloropropane	ND	ND	1
trans-1,3-Dichloropropene	ND	ND	1
Trichloroethene	ND	ND	1
Dibromochloromethane	ND	ND	1
1,1,2-Trichloroethane	ND	ND	1
cis-1,3-Dichloropropene	ND	ND	1
2-Chloroethylvinyl ether	ND	ND	1
Bromoform	ND	ND	1
Tetrachloroethene	ND	ND	1
1,1,2,2-Tetrachloroethane	ND	ND	1
Chlorobenzene	ND	ND	1
1,2-Dichlorobenzene	ND	ND	1
1,3-Dichlorobenzene	ND	ND	1
1,4-Dichlorobenzene	ND	ND	1

The Report Cover Letter is an integral part of this report.

This report pertains only to the samples investigated and does not necessarily apply to other apparently identical or similar materials. This report is submitted for the exclusive

Enseco - CRL / South Coast

7440 Lincoln Way • Garden Grove, CA 92641
(714) 898-6370 • (213) 598-0458 • (800) LAB-1-CRL
FAX: (714) 891-5917

Laboratory Report

MED-TOX ASSOC INC
1431 WARNER AVENUE
SUITE A
TUSTIN, CA 92680
ATTN: MR. MICHAEL YANG
Project: MY051589

Analysis No.: G-8913512-001/009
Date Sampled: 15-MAY-1989
Date Sample Rec'd: 15-MAY-1989
Sample Type: SOLID

QA/QC Summary

Date	Parameter (Method)	Average Spike Recovery	Acceptable Range	Relative Percent Difference	Acceptable Range
16-MAY-1989	1,1-DICHLOROETHENE (EPA 8010)	80	60-120	5.	40
16-MAY-1989	TRICHLOROETHENE (EPA 8010)	93	60-120	5.	40
16-MAY-1989	CHLOROBENZENE (EPA 8010)	72	60-120	13.	40

The Report Cover Letter is an integral part of this report.

This report pertains only to the samples investigated and does not necessarily apply to other apparently identical or similar materials. This report is submitted for the exclusive

COPY OF AIR ANALYTICAL RESULTS

Environmental Analytical Service, Inc.

3576 EMPLEO ST. SUITE 5 SAN LUIS OBISPO, CALIFORNIA 93401

(905) 841-3555

ANALYTICAL RESULTS

Trichloroethylene Analysis by GC/ECD

Date Sampled: 5/15/89

Date Analyzed: 5/19/89

Lab Number	Client Number	MDL ppbv	Result ppbv
90829	HY051589-35/20A	0.03	1.2
90830	HY051589-35/200A	0.03	1.1
90831	HY051589-35/500A	0.03	1.1
90832	HY051589-47/20A	0.03	0.77
90833	HY051589-47/200A	0.03	0.83
90834	HY051589-47/500A	0.03	0.32
90835	HY051589-JICD/20A	0.03	0.79
90836	HY051589-JICD/200A	0.03	0.84
90837	HY051589-JICD/500A	0.03	0.77
90838	HY051589-BKGD	0.03	0.25

Appendix C

PRINTOUTS OF ISCST MODEL

ISCST (DATED 88207)
AN AIR QUALITY DISPERSION MODEL IN
SECTION 1. GUIDELINE MODELS
IN UNAMAP (VERSION 6) JUNE 88.
SOURCE: UNAMAP FILE ON EPA'S UNIVAC AT RTP, NC.

IBM-PC VERSION (1.62)

*** EL TORO TCE EMISSION STUDY WITH SCAQMD EL TORO MET DATA ***

CALCULATE (CONCENTRATION=1,DEPOSITION=2)	ISW(1) = 1
RECEPTOR GRID SYSTEM (RECTANGULAR=1 OR 3, POLAR=2 OR 4)	ISW(2) = 3
DISCRETE RECEPTOR SYSTEM (RECTANGULAR=1,POLAR=2)	ISW(3) = 1
TERRAIN ELEVATIONS ARE READ (YES=1,NO=0)	ISW(4) = 0
CALCULATIONS ARE WRITTEN TO TAPE (YES=1,NO=0)	ISW(5) = 0
LIST ALL INPUT DATA (NO=0,YES=1,MET DATA ALSO=2)	ISW(6) = 1
COMPUTE AVERAGE CONCENTRATION (OR TOTAL DEPOSITION) WITH THE FOLLOWING TIME PERIODS:	
HOURLY (YES=1,NO=0)	ISW(7) = 0
2-HOUR (YES=1,NO=0)	ISW(8) = 0
3-HOUR (YES=1,NO=0)	ISW(9) = 0
4-HOUR (YES=1,NO=0)	ISW(10) = 0
6-HOUR (YES=1,NO=0)	ISW(11) = 0
8-HOUR (YES=1,NO=0)	ISW(12) = 0
12-HOUR (YES=1,NO=0)	ISW(13) = 0
24-HOUR (YES=1,NO=0)	ISW(14) = 0
PRINT 'N'-DAY TABLE(S) (YES=1,NO=0)	ISW(15) = 1
PRINT THE FOLLOWING TYPES OF TABLES WHOSE TIME PERIODS ARE SPECIFIED BY ISW(7) THROUGH ISW(14):	
DAILY TABLES (YES=1,NO=0)	ISW(16) = 0
HIGHEST & SECOND HIGHEST TABLES (YES=1,NO=0)	ISW(17) = 0
MAXIMUM 50 TABLES (YES=1,NO=0)	ISW(18) = 0
METEOROLOGICAL DATA INPUT METHOD (PRE-PROCESSED=1,CARD=2)	ISW(19) = 1
RURAL-URBAN OPTION (RU.=0,UR. MODE 1=1,UR. MODE 2=2,UR. MODE 3=3)	ISW(20) = 3
WIND PROFILE EXPONENT VALUES (DEFAULTS=1,USER ENTERS=2,3)	ISW(21) = 1
VERTICAL POT. TEMP. GRADIENT VALUES (DEFAULTS=1,USER ENTERS=2,3)	ISW(22) = 1
SCALE EMISSION RATES FOR ALL SOURCES (NO=0,YES>0)	ISW(23) = 0
PROGRAM CALCULATES FINAL PLUME RISE ONLY (YES=1,NO=2)	ISW(24) = 2
PROGRAM ADJUSTS ALL STACK HEIGHTS FOR DOWNWASH (YES=2,NO=1)	ISW(25) = 1
PROGRAM USES BUOYANCY INDUCED DISPERSION (YES=1,NO=2)	ISW(26) = 2
CONCENTRATIONS DURING CALM PERIODS SET = 0 (YES=1,NO=2)	ISW(27) = 1
REG. DEFAULT OPTION CHOSEN (YES=1,NO=2)	ISW(28) = 2
TYPE OF POLLUTANT TO BE MODELLED (1=SO2,2=OTHER)	ISW(29) = 2
DEBUG OPTION CHOSEN (YES=1,NO=2)	ISW(30) = 2
ABOVE GROUND (FLAGPOLE) RECEPTORS USED (YES=1,NO=0)	ISW(31) = 1
NUMBER OF INPUT SOURCES	NSOURC = 1
NUMBER OF SOURCE GROUPS (=0,ALL SOURCES)	NGROUP = 0
TIME PERIOD INTERVAL TO BE PRINTED (=0,ALL INTERVALS)	IPERD = 0
NUMBER OF X (RANGE) GRID VALUES	NXPNTS = 9
NUMBER OF Y (THETA) GRID VALUES	NYPNTS = 11
NUMBER OF DISCRETE RECEPTORS	NDWYPT = 0
SOURCE EMISSION RATE UNITS CONVERSION FACTOR	TK = .10000E+07
HEIGHT ABOVE GROUND AT WHICH WIND SPEED WAS MEASURED	ZR = 10.00 METERS
LOGICAL UNIT NUMBER OF METEOROLOGICAL DATA	INMET = 9
DECAY COEFFICIENT FOR PHYSICAL OR CHEMICAL DEPLETION	DECAY = .000000E+00
SURFACE STATION NO.	ISS = 53128
YEAR OF SURFACE DATA	ISY = 81
UPPER AIR STATION NO.	IUS = 91919
YEAR OF UPPER AIR DATA	IUY = 81
ALLOCATED DATA STORAGE	LIMIT = 43500 WORDS
REQUIRED DATA STORAGE FOR THIS PROBLEM RUN	MINIT = 703 WORDS

*** EL TORO TCE EMISSION STUDY WITH SCAQMD EL TORO MET DATA ***

* ABOVE GROUND RECEPTOR HEIGHTS IN METERS *
* FOR THE RECEPTOR GRID *

Y-AXIS / (METERS) /	X-AXIS (METERS)								
	-1610.0	-1207.5	-805.0	-402.5	.0	402.5	805.0	1207.5	1610.0
2500.0 /	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000
2000.0 /	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000
1500.0 /	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000
1000.0 /	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000
500.0 /	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000
.0 /	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000
-500.0 /	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000
-1000.0 /	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000
-1500.0 /	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000
-2000.0 /	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000
-2500.0 /	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000	1.50000

*** EL TORO TCE EMISSION STUDY WITH SCAQMD EL TORO MET DATA ***

*** SOURCE DATA ***

SOURCE NUMBER	PK	PART.	E CATS.	EMISSION RATE		X	Y	BASE ELEV.	HEIGHT	TEMP. (DEG.K)	EXIT VEL.		BLDG. HEIGHT	BLDG. LENGTH	BLDG. WIDTH
				TYPE=0,1 (GRAMS/SEC)	TYPE=2 (GRAMS/SEC)						TYPE=0 (M/SEC)	TYPE=0 (M/SEC)			
NUMBER	E	E	CATS.	*PER METER**2	(METERS)	(METERS)	(METERS)	(METERS)	(METERS)	(METERS)	TYPE=1	TYPE=1,2	TYPE=0	TYPE=0	TYPE=0
1	2	0	0	.20000E-08	427915.0	726695.0	.0	.00	.00	911.00	.00	.00	.00	.00	.00

CALN HOURS (=1) FOR DAY 350 *	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	1
CALN HOURS (=1) FOR DAY 351 *	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0
CALN HOURS (=1) FOR DAY 352 *	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	1	1	1	1
CALN HOURS (=1) FOR DAY 353 *	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	0	1	1
CALN HOURS (=1) FOR DAY 354 *	1	1	1	0	1	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0
CALN HOURS (=1) FOR DAY 355 *	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
CALN HOURS (=1) FOR DAY 356 *	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
CALN HOURS (=1) FOR DAY 357 *	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1
CALN HOURS (=1) FOR DAY 358 *	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
CALN HOURS (=1) FOR DAY 359 *	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	1	0	0	1	1	1
CALN HOURS (=1) FOR DAY 360 *	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
CALN HOURS (=1) FOR DAY 361 *	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CALN HOURS (=1) FOR DAY 362 *	1	1	0	0	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1
CALN HOURS (=1) FOR DAY 363 *	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1
CALN HOURS (=1) FOR DAY 364 *	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0
CALN HOURS (=1) FOR DAY 365 *	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

'N'-DAY
365 DAYS
SGROUP# 1

*** EL TORO TCE EMISSION STUDY WITH SCAQMD EL TORO MET DATA ***

* 365-DAY AVERAGE CONCENTRATION (NANOGRAMS/CUBIC METER)

* FROM ALL SOURCES *
* FOR THE RECEPTOR GRID *

* MAXIMUM VALUE EQUALS .00004 AND OCCURRED AT (1610.0, -2500.0) *

Y-AXIS / (METERS) /	X-AXIS (METERS)								
	-1610.0	-1207.5	-805.0	-402.5	.0	402.5	805.0	1207.5	1610.0
2500.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003
2000.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003
1500.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003
1000.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003
500.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00004
.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00004
-500.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00004
-1000.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00004	.00004
-1500.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00003	.00004	.00004
-2000.0 /	.00003	.00003	.00003	.00003	.00003	.00003	.00004	.00004	.00004
-2500.0 /	.00003	.00003	.00003	.00003	.00004	.00004	.00004	.00004	.00004