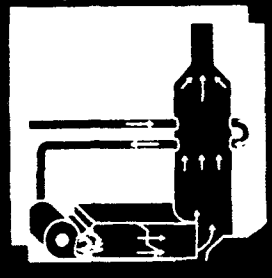
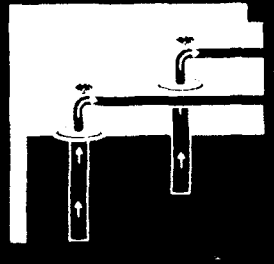
BASEWIDE ENGINEERING EVALUATION-COST ANALYSIS FOR SOIL VAPOR EXTRACTION

SITE SPECIFIC DOCUMENT IC 7





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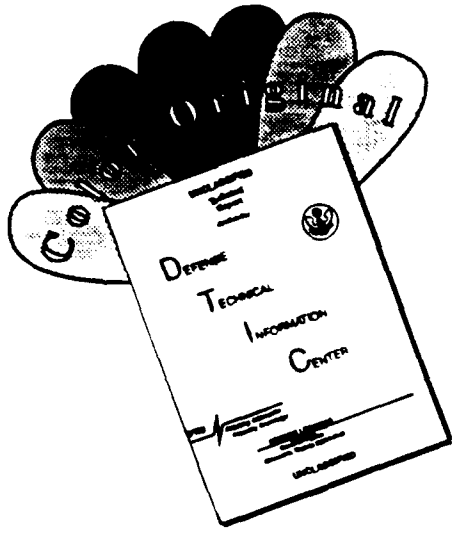

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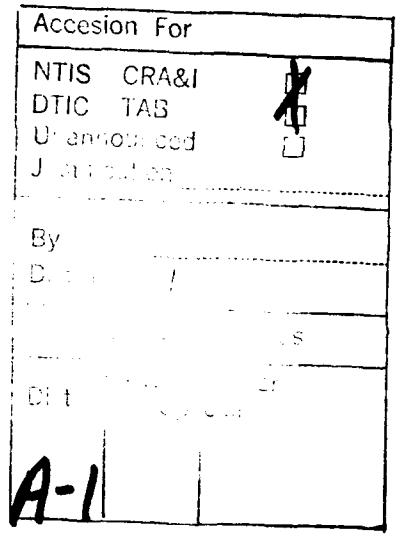


Statement A per telecon
Gerry Spyles SM-ALC/EMR-RPM
MC Clellan AFB, CA 95652-1036

NWW 12/8/93

McClellan Air Force Base

November 1993
Final

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES

LIST OF TABLES

Section 1
INTRODUCTION

This document supports the use of soil vapor extraction (SVE) as the non-time critical removal action for selected areas with high levels of volatile organic compound (VOC) contamination in Investigation Cluster 7 (IC 7), which is located near the center of Operable Unit B (OU B). This SVE removal action is part of the initial basewide SVE removal action at McClellan Air Force Base (McAFB). The principal objective of basewide SVE removal actions is to achieve early risk reduction by removing a significant quantity of VOCs from soils in the vadose zone, intercepting an exposure pathway, or preventing additional voc flux to groundwater.

This document is a companion to the Basewide Engineering Evaluation-Cost Analysis (EE/CA) General Evaluation Document. The General Evaluation Document provides the long-term plan to standardize and streamline the use of SVE removal actions at McAFB by establishing SVE as the presumptive remedy for McAFB; outlining a site selection methodology for SVE removal actions; and providing a general SVE system configuration and cost estimate.

The site-specific EE/CA for IC 7 focuses on information to supplement the General Evaluation Document in support of the SVE removal action at IC 7. In particular, this document demonstrates that IC 7 satisfies the criteria listed in the site selection methodology of the General Evaluation Document. Since the General Evaluation Document establishes the case for treating SVE as the presumptive remedy, this document contains no evaluation of alternatives.

Section 2
SITE CHARACTERIZATION

Overview

IC 7 covers an area of 15.5 acres and contains six Potential Release Locations (PRLs) and four Study Areas (SAs): PRL L-5B, PRL L-6, PRL P-9, PRL S-5, PRL S-34, PRL S-35, SA 7, SA 11, SA 14, and SA 18 (also identified as OT162, OT163, SD085, WP090, SD119, SD120, SD185, ST189, SD192, and SS196, respectively). Information about the location of these sites and the industrial activities that occurred at them is summarized in figures 2-1 and 2-2, and in table 2-1. Significant geological, soil, and soil gas chemical data have been collected in recent site characterization efforts that cover about 10 acres. The geologic and soil gas chemical data have been analyzed to identify sources of contamination in IC 7 and to model the subsurface geology and dispersion of contamination in order to identify candidate sites for SVE removal actions.

An effort to identify various sources was initiated with visual inspection of raw data and contoured representation of chemical information. Areas with adequate data and significant chemical concentrations were selected for developing detailed models of the distribution of contamination. These efforts led to the identification of the following zones of contamination, or contamination spreading centers:

- The washrack plume near the northwest corner of Building 652 (PRL S-34)
- The Industrial Wastewater Line (IWL) plume near the northeast corner of Building 652 (PRL S-34)
- A VOC spreading center south-southeast of Building 654 (PRL S-35)
- Two small local zones of elevated VOC contamination

The washrack and IWL plumes will be included in the action EE/CA removal action, and they will be described in detail in subsequent sections (see figure 2-9).

Data from recent soil borings were used to develop geologic models, which are needed to generate estimates of VOC mass in soil and to assist in the design of the extraction system. Four silt and three sand bodies were identified throughout most of the contaminated area. The soil borings also provided information on the concentration of contaminants. Soil gas data are used in preference to direct soil measurements of VOCs, as outlined in McAFB's Soil Gas Consensus Statement (1992). The geologic model was integrated with the contaminant plume model to estimate the mass of contaminants, relying on the assumption that the gas, liquid, and solid phases are in equilibrium. As stated in the Soil Gas Consensus Statement, the accuracy of estimating soil VOC concentrations using soil gas data has not

Section 2

PRL S-34

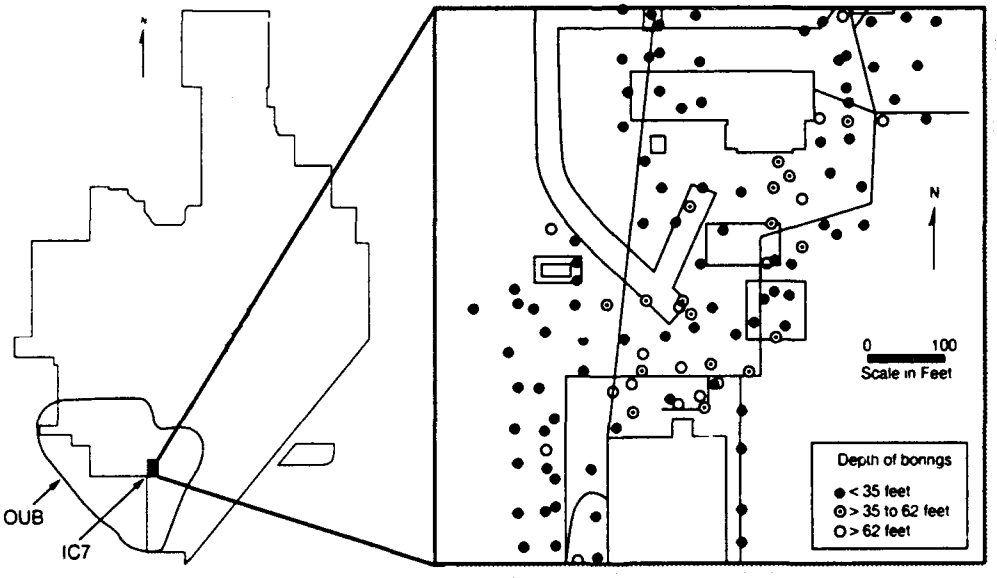


Figure 2-1
IC 7 Location Maps and Site Photographs

Section 2

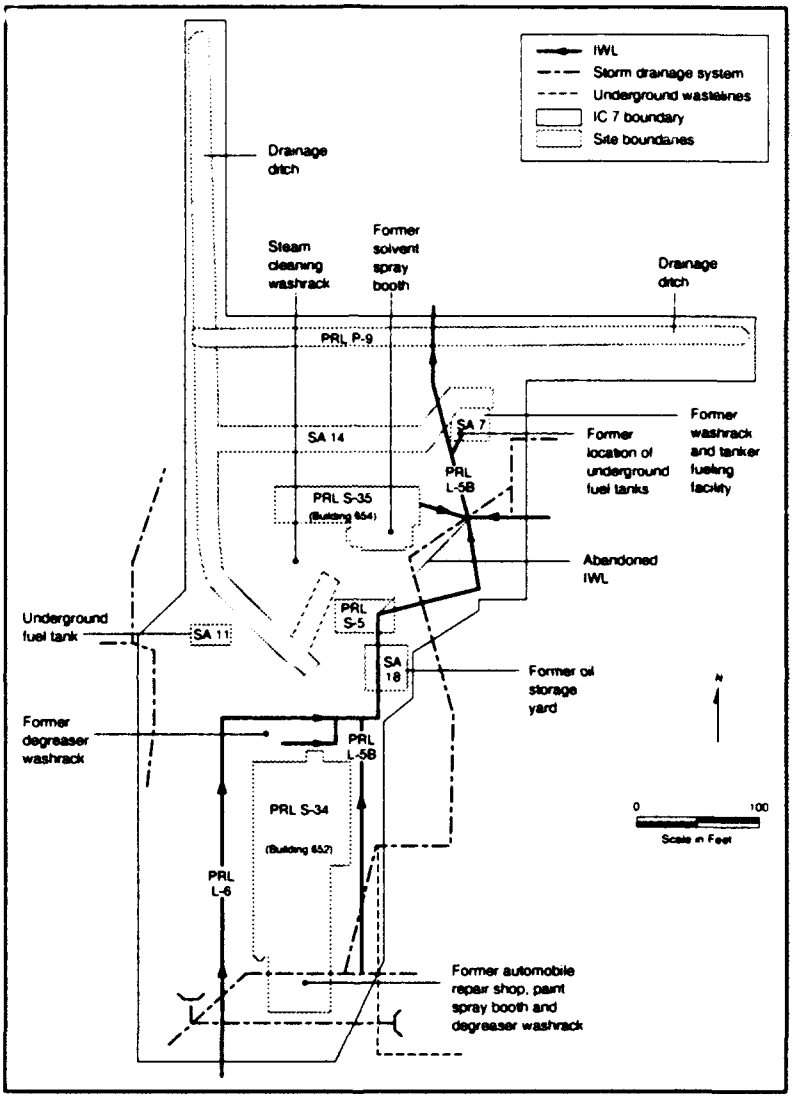


Figure 2-2
IC 7 Detailed Site Location Map

been verified. McAFB has initiated limited studies to compare collocated soil gas and soil samples that are specially preserved in the field. Results from these studies may require modifications to the equilibrium-based approach to mass estimating being used at this time. It is known that this type of equilibrium-based mass calculation underestimates the mass in the zones where there is free product, and it appears to overestimate the mass in vapor-dominated zones.

Geostatistical analysis was applied to develop models for the first three contaminant spreading centers listed on page 2. All three spreading centers

Section 2

Site ID	Alternative Designation	Historical Usage	Chemicals of Concern	Current Status
PRL-L-5B	Industrial Wastewater Line (IWL)	Received wastewater from painting, paint removal, solvent cleaning and other operations (1953-present)	Paint, paint remover, solvent	Active
PRL-L-6	IWL	Received wastewater from chemical laboratory, degreaser and spray paint booth, and a washrack for steam cleaning air conditioners	Paint Solvents	Active
PRL-L-9	Drainage ditch	Received treated wastewater from IWTP No. 4 (1957-mid 1960's)	VOCs?	
PRL-S-5	IWTP No. 2	In operation from 1956-1976	Paint residues, oils, solvents, and metals	All the above-ground structures have been dismantled and the area w/surrounding locations have been covered w/asphalt pavement.
PRL-S-34	A portion of the site is Building 652	Vehicle repair, degreaser and paint booth, washrack steam cleaning operations	TCE, methylene chloride, fuel, and motor oils, hydraulic fluids, paint waste	Building 652 is being refurbished, the degreaser is no longer in use, the paint spray booth and exterior washracks have been removed.
PRL-S-35	Building 654	Park airplanes and tractor trailers (1946-1949), house antifreeze, diesel fuel, and oil tanks (1971), solvent spray booth (1965-1981)	VOCs	
SA-7	Building 650	Tanker fueling, underground JP-4 and JP-5 tanks, washracks, hazardous materials, staging area	Fuels	Hazardous materials staging area
SA-11		Underground gasoline storage tank	Fuels?	Storage tank was emptied in 1986
SA-14	Drainage ditch	Received effluent from ITWPs No. 2 & No. 4, Building 654, and others	VOCs	Now covered w/asphalt pavement
SA-18		Fenced-in oil storage yard		Now covered w/asphalt pavement

References: Radian 1990a, 1990b, 1990c, and 1990d

Table 2-1 *Background Information for Sites at IC 7*

Section 2

appear to contain a core of contamination that reaches the water table, and in at least the washrack and the IWL plumes, there may be core zones of dissolved VOCs and free product VOCs. Surrounding these core zones are vapor-dominated plumes that apparently spread outward by diffusion and are now commingled and overlapping. Contaminant mass in the spreading center at Building 654 is much smaller than at the other two areas and a core zone of very high contamination may not exist.

- Existing extraction wells near the core zone of the washrack and IWL plumes at building 652 (PRL S-34) will be used for SVE removal of VOCs.

- Additional testing and operation using existing extraction wells will focus on the dispersed portion of these plumes outside the core zone.

- No additional extraction wells will be installed to remove contaminants from the plume near Building 654 (PRL S-35). Operation of the other extraction wells in the vicinity could result in collateral removal of contaminants.

Investigation Results

Pre-1990 investigations in the general area of IC 7 were not directed towards VOC characterization; rather they consisted of a search for a scrap metal burial pit and an investigation of the integrity of the IWL. In 1990, 148 shallow soil gas samples (depths less than 10 feet) were collected within the boundaries of IC 7. Follow-up work during 1992 and 1993 consisted of 135 borings from which 249 soil gas samples were extracted and analyzed.

The 249 soil gas sampling locations and soil VOC analyses (concentrated in about 10 acres) define the nature and extent of contamination in the 15.5 acres that constitute IC 7. Of the soil gas samples, 63 percent were collected at depths less than 35 feet, 25 percent were between 35 and 62 feet, and 12 percent were from below 62 feet to the water table.

In the vicinity of IC 7, there are six groundwater monitor wells that are in the general downgradient direction from IC 7. It is likely that contamination reported from these wells is derived from both IC 7 and IC 1, but because of the complex pattern of groundwater movement (historic pumping) and the proximity of these two areas to each other, the contributions from the two areas must be assessed together.

Groundwater is contaminated primarily by trichloroethene (TCE), tetrachloroethene (PCE), and chloroform. Based on data collected since 1986, the A zone aquifer concentrations have ranged from not detected to 3,500 µg/L

Section 2

for TCE, not detected to 370 µg/L for PCE, and not detected to 1.8 µg/L for chloroform. A Hydropunch sample collected near one of the suspected sources contained 19,000 µg/L TCE and 2,900 µg/L PCE. In the B zone, TCE was reported once at the detection limit of 0.2 µg/L, and in the C zone, TCE, PCE, and chloroform were all reported at less than 1 µg/L from one round of sampling.

The nearest upgradient monitor wells are located about 700 feet north-northwest of IC 7. Groundwater from these wells primarily contains TCE (not detected to 7.1 µg/L) and DCE12C (not detected to 4.9 µg/L) in the A, B, and C zones. High soil gas contaminant concentrations in the vadose zone are present to the water table at IC 7. Therefore, it is likely that the washrack and IWL plumes, and the plume emanating from Building 654 (PRL S-35) are sources contributing to groundwater contamination beneath OU B.

Soil gas permeability tests were performed in OU B (IC 1 and IC 7) (Radian, 1993a). Information obtained will be used to support the design for the SVE system. Results of the soil gas permeability test follow:

- The mean permeability is 40 darcies for all piezometer nests using VW-4 as the pumping well (near the IWL source) and assuming a stratum thickness of about 80 feet.

- The mean permeability is 42 darcies for all piezometer nests using VW-5 as the pumping well (near washrack source).

- There is little apparent difference in permeability between silts and sands.

- The average radius of influence is 201 feet for well VW-4 and 211 feet for well VW-5.

Soil gas samples were quantitatively analyzed by several methods, including FPID (field gas chromatography [GC] using a photo ionization detector), FECD (field GC using an electron capture detector), SGVOC (field GC using both detectors), and EPA method TO-14 (GC/MS off-site laboratory full scan). Not all samples were analyzed by the same methods nor were they analyzed for all the constituents identified in table 2-2 (includes data from both phase I and II field efforts). Method TO-14 was used to investigate the most complete spectrum of compounds in 22 samples collected throughout IC 7 and was used on duplicate samples to validate the other methods.

The results of the soil gas sampling from 1992 and 1993 indicate that of the 48 compounds looked for, 23 were never detected (analyzed for by TO-14 only), 10 were detected occasionally (defined as being observed in less than

Section 2

Table 2-3a
Commonly Detected Analytes (ppbv)

Analyte	Method TO-14				Method FPID				Method FECD				Method SGVOC			
	Max	Min	Obs	Det	Max	Min	Obs	Det	Max	Min	Obs	Det	Max	Min	Obs	Det
TCE	1,400,000	17,000	22	20					2,900,000	13	207	199	1,600,000	5.3	113	107
PCE	2,300,000	670	22	15					6,000,000	11	207	141	830,000	6.0	113	96
DCE12C	430,000	330	22	18	1,000,000	10	206	183					1,000,000	23	106	38
UNK					3,300,000	60	483	63	300,000	100	483	109				
DCE11	5,300	420	22	5	6,400	10	171	156								
FC113	280,000	420	22	10					390,000	25	178	117	230,000	130	101	8
VC					220,000	39	206	131					110,000	86,000	101	2
DCE12T					1,000	11	206	126					12,000	11	101	2
BZ	2,400	2,400	22	1	2,500	12	206	122					76,000	310	101	4
BZME	19,000	17,000	22	2	6,900	10	206	48					220,000	14	102	14
FC12	260	36	22	2					200,000	33	69	37	40,000	15,000	101	2
CYCL	950	950	22	1					1,800	24	147	20				
XYLMP	1,500,000	1,000,000	22	2	160,000	11	206	18					10	10	1	1
TCLME	800	180	22	2					3,300	14	207	18				
XYLP													13,000	10	101	10
DCA12	26,000	25,000	22	2												

Table 2-3b
Rarely Detected Analytes (ppbv), < 10% of All Analyzed Samples

Analyte	Method TO-14				Method FPID				Method FECD				Method SGVOC			
	Max	Min	Obs	Det	Max	Min	Obs	Det	Max	Min	Obs	Det	Max	Min	Obs	Det
XYLO	520,000	320,000	22	2	53,000	26	206	11	8,700	300	207	2	5,8000	16	101	3
TCME	800	180	22	2												
TCA111									760	760	27	1	35			
CYHEXANE	82,000	79,000	22	2	3,700	3,400	2	3								
UNK2					2,500,000	720,000	38	3								
UNK3					2,700,000	700,000	40	3								
EBZ	310,000	210,000	22	2												
STY	42,000	28,000	22	2												
TMB135	390,000	170,000	22	2												
TMB124	720,000	390,000	22	2												
BUTADIEN	5,100	5,100	22	1												
MTLNCL	56,000	56,000	22	1												

Table 2-3c
Analytes Never Detected

Analyte	Method TO-14	Method FPID	Method FECD	Method SGVOC
	Number of Observations	Number of Observations	Number of Observations	Number of Observations
TCA111	22		38	
UNK3	22			

Table 2-3d
Additional Analytes Never Detected Using Only TO-14

Analyte				
	ACE	MVC	DCP13C	DCBZ12
	BZLCL	FC114	TCB124	CLEA
	CHLOROPR	FC11	TCA112	CLME
	DCA11	EDB	TBME	CLBZ
	DCBZ13	DCPA12	PROP	C8N
	PCA	DCP13T	DCBZ14	BRME

Section 2

10 percent of analyzed samples), and 15 compounds were detected commonly, regardless of analytical method. Also identified were 3 unknowns (excluded from the above tally), one of which occurs commonly and is sometimes present in high concentrations (maximum reported concentration is 3,300 ppmv). The most commonly observed compounds and those with the highest concentrations are chlorinated VOCs, but some fuel-derived compounds are also present.

A quality review has been performed on the phase I chemical analysis of soil gas data used (Radian, 1993b) and based on quality control sample results, it was concluded that the data are valid, with some exceptions. For the field laboratory determinations, the quality was judged to be within the acceptance criteria for screening of volatile compounds in soil gas.

For the TO-14 results, quality was judged to be within the acceptance criteria for the analysis of volatile compounds in soil gas by that method. The TO-14 results can be used for confirmation of field laboratory soil gas results, and for identification of non-target analytes.

Vinyl chloride (VC) was commonly detected during the first phase of investigation using the FPID method. The phase I data assessment (Radian, 1993b) indicates that VC was misidentified (second column GC conformation was not performed) and that all reported values are qualified as unusable. However, VC results reported as not detected are accurate. In 22 samples analyzed by method TO-14, VC was not detected above the method detection limit of 1,400 ppbv (MVC in table 2-2d). Based on these observations, it is assumed that the positive VC results reported under the method FPID are false positive results.

During phase I, freon 113 was correctly identified, but quantification was inaccurate; all phase I results are qualified as estimates (Radian, 1993).

The phase II quality assurance/quality control report is pending.

Geologic Data Interpretation

The following geological interpretations are based on the 1992 and 1993 data. A geological model was constructed for an area starting north of Building 652 and extending to the northern edge of IC 7. While the model could not be extended to cover all of IC 7 due to lack of data, it does cover the area of most significant contamination.

At IC 7, four silt and three sand units are recognized. Although the units are of variable thickness, they appear to be relatively continuous both in the east-

west and north-south directions (figure 2-3). The geological interpretation is much stronger to a depth of about 40 feet below ground (elevation about 20 feet above sea level) since it uses information from approximately 120 borings located north of Building 652. Below that depth, borings are more widely spaced and the continuity of units is less well established.

In the top 40 feet, two silt and two sand/silty sand units are interbedded with each other and with several clay lenses of limited extent. The clay lenses are present primarily near the surface and generally cannot be traced for more than 40 to 50 feet in any direction. Less than 4 percent of the modeled volume is occupied by clay. In the north-south direction, both the shallow silt and the sand units appear to be continuous for at least 200 to 300 feet. The units are not uniform in thickness, ranging from less than 5 feet to about 15 feet. At depth greater than 40 feet below the surface, a silt unit measuring about 30 feet in thickness is observed in a number of borings that are located just north of Building 652. Below that another sand and another silt unit complete the stratigraphic picture to the water table.

Soil Gas Data Interpretation

Soil gas analyses from 249 sample locations in 135 soil borings comprise the data base for modeling the subsurface soil gas distribution at IC 7. More than 60 percent of the data originates from depths shallower than about 35 feet. Review of raw concentration data for individual compounds based on frequency of occurrence and maximum concentrations indicates that the compounds TCE, PCE, and DCE12C (figures 2-4a, b and 2-4c, respectively) can be modeled. Although other compounds are commonly present, they are of such low concentrations that it would not be useful to make volumetric estimates. Contoured distributions for FC113 (figure 2-4d), methyl benzene, DCE11, and DCE12T are illustrated in figure 2-5. Of these compounds, only TCE and DCE12C show wide dispersion at concentrations greater than 20 ppmv; each appears to be associated with multiple source areas. The compounds PCE and FC113 (estimated concentrations) at concentrations greater than 20 ppmv are more restricted in their distribution; each appears to be associated with a single contaminant spreading center, but not necessarily a known source area (figures 2-4b and d).

It should be noted that the distributive modeling of soil gas concentrations results in isoconcentration lines being displayed both laterally and vertically away from actual data points. Near the edges of the investigated area and at elevations lower than approximately 28 feet (depth of 35 feet below ground) concentrations are projected based on the degree of correlation established for all soil gas samples in the data set.

Section 2

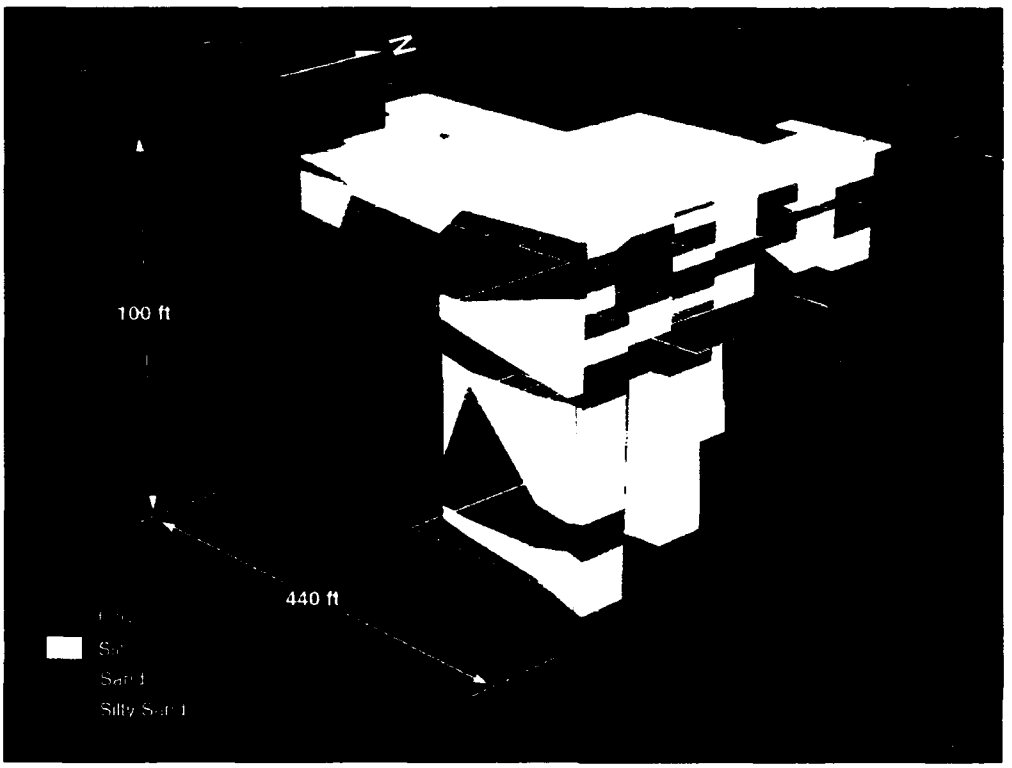


Figure 2-3
IC 7—Three-Dimensional Model of Geology

Section 2

Based on contaminant distributions, the area north of Building 652 was divided into three zones for modeling presumed contaminant spreading centers (shaded areas in figure 2-4a). Two of these spreading centers are located northwest and northeast of Building 652 and their plumes overlap. Within the area of overlapping plumes, there may be additional sources that were not modeled separately. The third center is located south of PRL-S-35 (northern block in figure 2-6).

Figures 2-4c and 2-4d for DCE12C and FC113 indicate that there is a major contaminant spreading center north of Building 652 near the western termination of an underground feeder line to the IWL identified as PRL L-6 and at the approximate location of a degreaser washrack and sump (hereafter called washrack). Although the plume is best outlined by DCE12C and FC113 (suggesting an east-west elongation parallel to the IWL piping), TCE and PCE contribute the bulk of the contaminant mass. Contaminant concentrations decrease with depth, as indicated in the left plume in figure 2-7, this figure shows more detailed information than in figure 2-6; note changes in color-coding. The highest concentrations are generally present to a depth of about 50 to 60 feet. Overall, FC113 decreases more rapidly than the other contaminants modeled and TCE decreases less rapidly than the other compounds.

The second major plume (hereafter called the IWL source or spreading center, right plume in figure 2-7), is located about 100 feet east of the washrack plume and just north of the feeder line from Building 652 and the IWL. The spreading center, so called because it is not near a known or suspected source other than the IWL, is primarily characterized by high concentrations of PCE and TCE (figures 2-4a and 2-4b) with significantly lower concentrations of DCE12C and FC113. The latter two compounds appear to be spreading away from the center near the northwest corner of Building 652, as indicated by the regular decrease in concentrations with distance from that area (figures 2-4c and 2-4d). Locally elevated concentrations of toluene, DCE11, and DCE12T are centered in this general area, but are not coincident with the PCE/TCE plume (figure 2-5); they occur just south of the PCE/TCE plume. Maximum concentrations for any of these compounds rarely exceed 10 ppmv in soil gas, although they are widely present at concentrations below 1 ppmv throughout the investigated area. Within IC 7, these compounds appear to be concentrated only in one area near the junction of the feeder piping with the two main segments of the IWL northeast of Building 652 (figure 2-5).

In the central portion of the IWL spreading center, concentrations of both PCE and TCE remain at or above 1,000 ppmv to the water table. High concentrations of PCE appear to reach their largest areal extent at about 50 feet below ground, whereas TCE remains confined to about the same cylindrical

Section 2

45 Feet

TCE

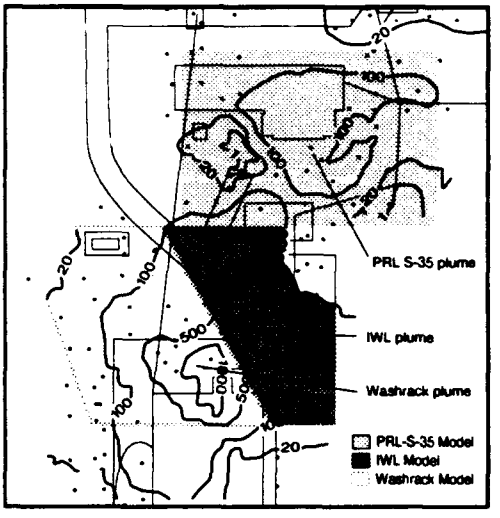


Figure 2-4a
Distribution of TCE (ppmv) in Soil Gas Regardless of Soil Type

PCE

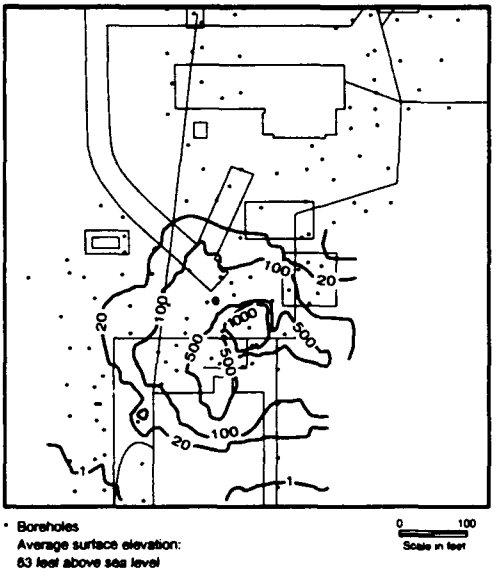
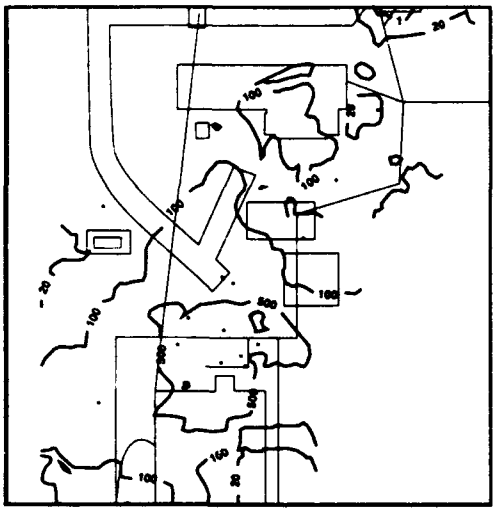


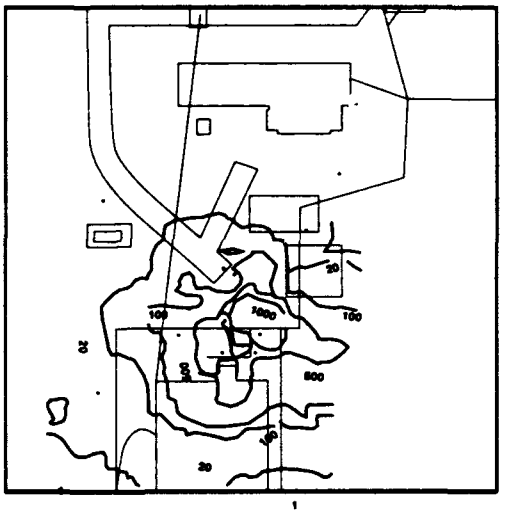
Figure 2-4b
Distribution of PCE (ppmv) in Soil Gas Regardless of Soil Type

Section 2

15 Feet



-25 Feet



Section 2

45 Feet **15 Feet**

DCE 12C

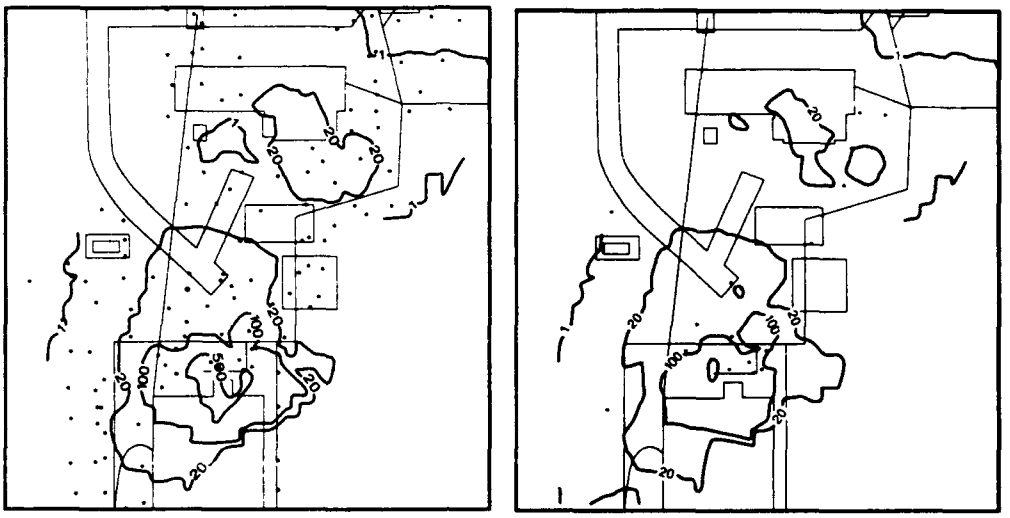


Figure 2-4c
Distribution of DCE12C (ppmv) in Soil Gas Regardless of Soil Type

FC 113

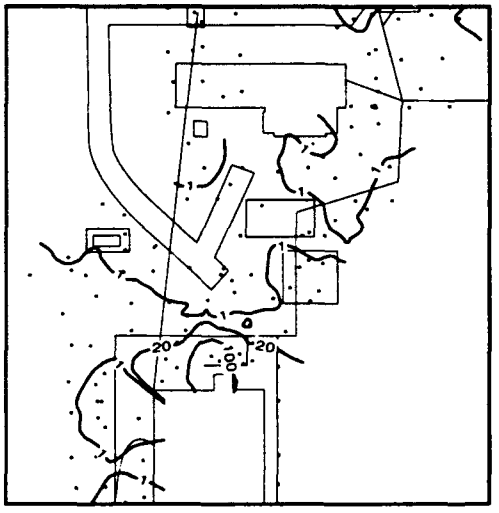
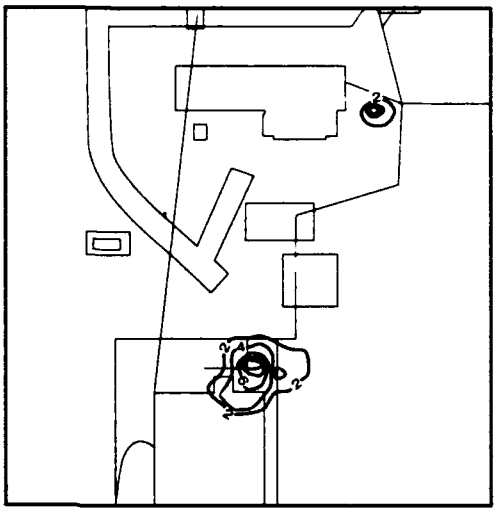


Figure 2-4d
Distribution of FC113 (ppmv) in Soil Gas Regardless of Soil Type

Section 2

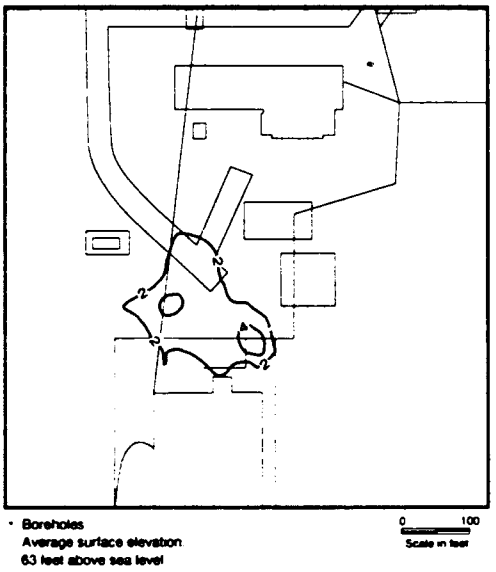
BZ

BZME



DCE11

DCE112T



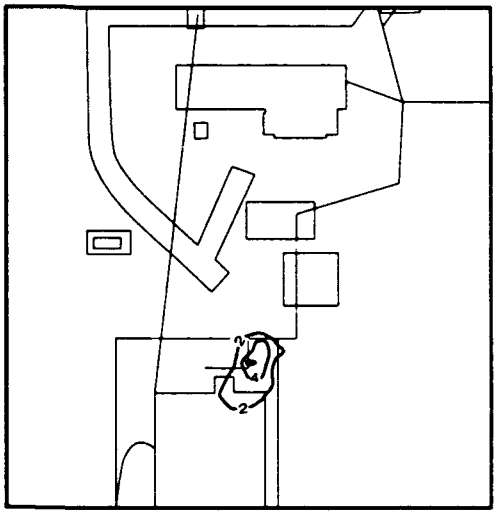


Figure 2-5
IC 7—Distribution of Toluene (BZME), DCE11, and DCE12T in Soil Gas (ppmv) Regardless of Soil Type

volume to this depth. At concentrations below 1,000 ppmv, the dispersion of PCE appears to be more restricted than the dispersion of TCE, and the bulk of the PCE mass may actually be derived from only one spreading center (IWL center).

Outside the central zone of high contamination (>1,000 ppmv) TCE is present at about five times the concentration of PCE; the 100 ppmv isoconcentration line for TCE roughly coincides with the 20 ppmv isoconcentration line of PCE. The shape of the isoconcentration lines for TCE at lower concentrations are elongated in a northeast-southwest direction, whereas the lines for PCE are more nearly circular. The elongation of the TCE isoconcentration lines may be explained, in part, by potential secondary sources, as discussed below.

Outside the central contamination zone, isoconcentration surfaces appear to be nearly vertical and concentration gradients are steep, similar to the situation at IC 1. For example, PCE decreases about 500 to 600 ppmv over a horizontal distance of 100 feet. The patterns for TCE are more complex and less regular, most likely because of two or more spreading centers for this compound. However, the distribution of contaminants suggests the same diffusional mechanism of dispersion, largely independent of observed soil type throughout the investigated area of IC 7. Therefore, the conceptual model for the overlapping washrack and the IWL plumes is the same as for the main plume at IC 1, consisting of a central core zone that very likely contains VOCs dissolved in water and potentially free product of several VOCs, surrounded by a vapor dominated plume that may not be in equilibrium with all the retained moisture and the soil particles. Average concentrations of TCE and PCE near the centers of contamination at both IC 1 and IC 7 are very similar (between 1,000 and 2,000 ppmv).

The contaminant spreading center near the southeast corner of Building 654 (PRL S-35) is primarily defined by the presence of TCE and DCE12C. Only TCE was modeled, as shown in figure 2-8. Contamination at a cutoff of 100 ppmv covers an area of approximately 0.6 acres and results in an estimated mass of TCE of less than 100 kg. The highest average concentrations of DCE12C (20 to 40 ppmv) are coincident with the highest TCE concentrations, but are less widely dispersed. Maximum concentrations are present to about 40 feet below ground (figure 2-8) but a column of TCE containing greater than 100 ppmv reaches the water table. Based on the relatively small estimated quantity of contamination, no new extraction wells will be installed near PRL S-35 at this time.

Other potential spreading centers may be present, as indicated by areas of locally elevated TCE concentrations underneath PRL S-5 and along the west side of Building 652 (data to depth of 35 feet below ground). Cleanup of

Section 2

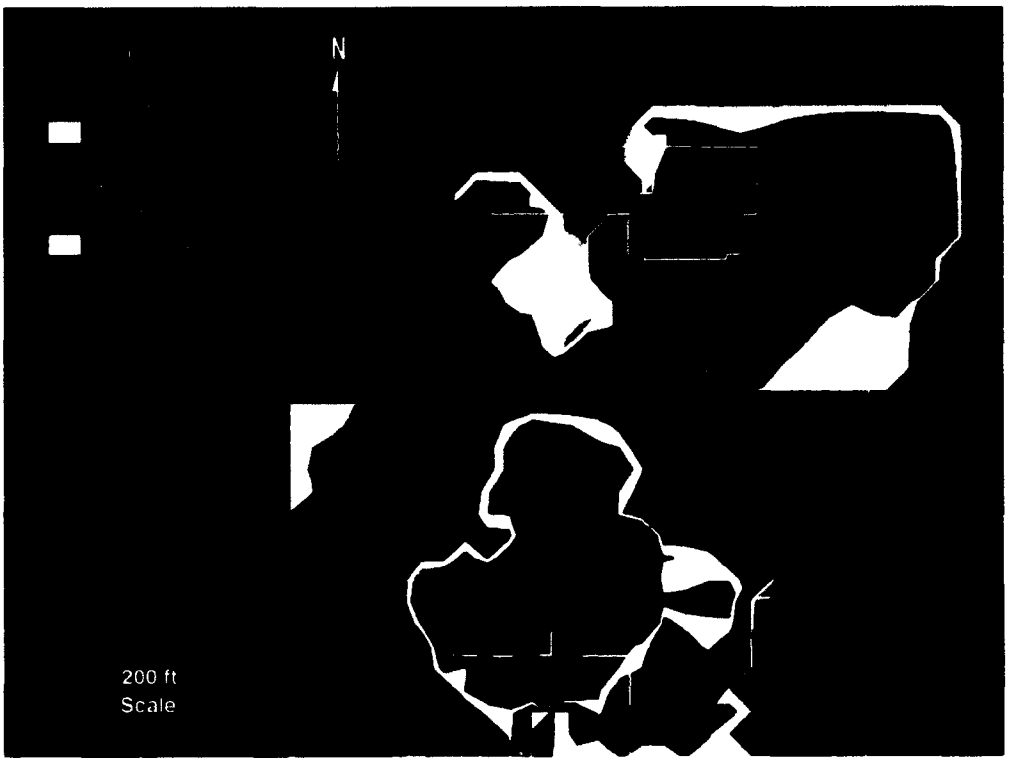


Figure 2-6
IC — Plan View of TCE Plumes at an Elevation of 60 Feet (Southern Portion Contains Washrack and IWL Plumes)

Section 2

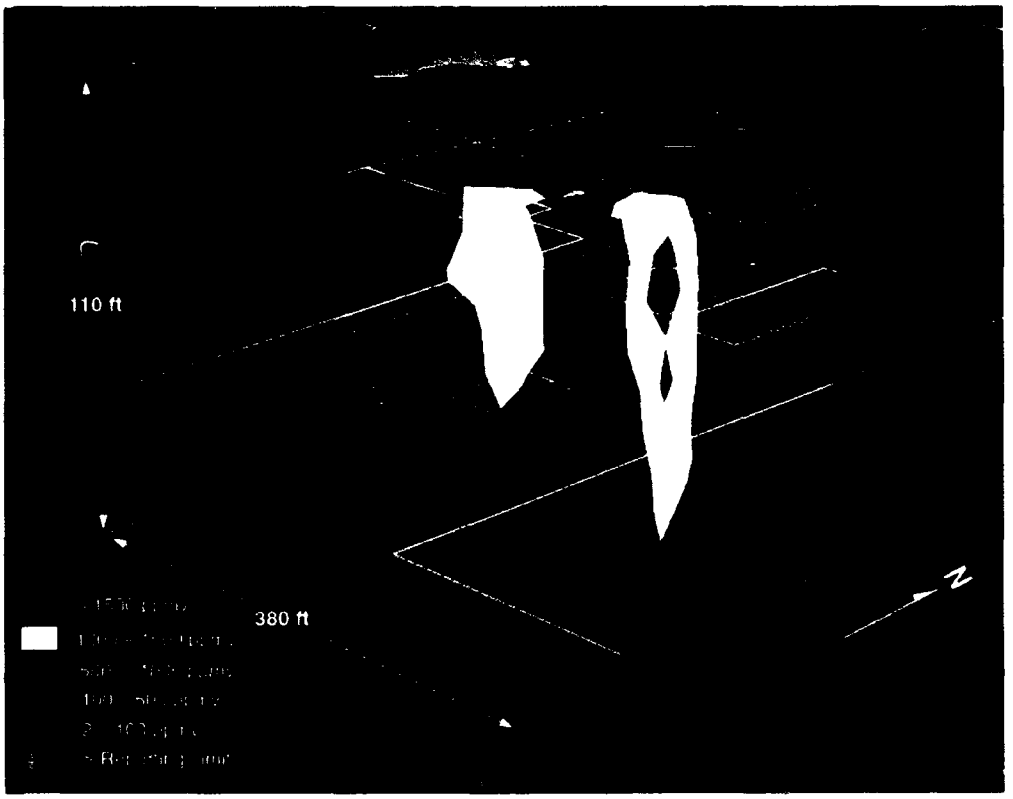


Figure 2-7
IC ... Three Dimensional Model of TCE Plumes (Left Plume at Washrack Right Plume at IWTP)

Section 2

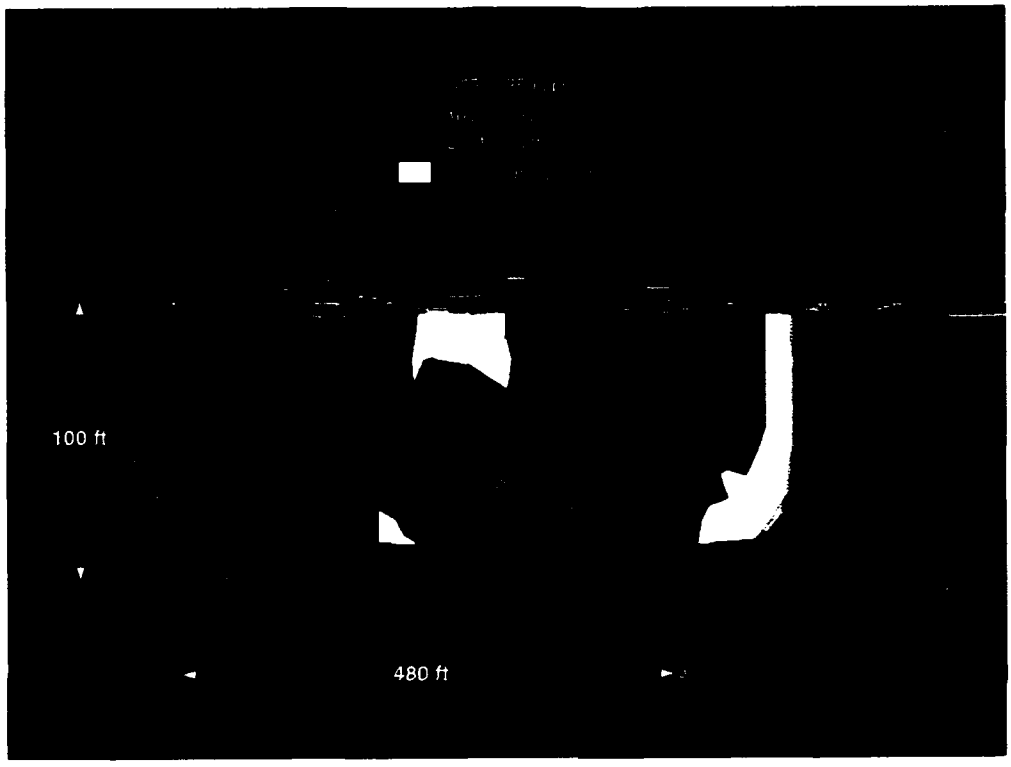


Figure 2-8
PRI-S-35 Plume. Distribution of TCE in an East-West Cross Section

these areas can be considered at a later time, either as separate EE/CA removal actions, or as part of long-term remediation. Contamination associated specifically with the two IWL segments (PRL L-5B and PRL L-6) cannot be isolated in the vicinity of the three major spreading centers discussed previously. However, near the southern extent of IC 7, along both sides of Building 652, and north of SA-18, are borings that are close to the IWL and that contain low concentrations (generally much less than 10 ppmv) of most of the contaminants that are recognized in IC 7.

Contaminant Mass Calculations

Contaminant mass may be estimated for individual compounds using the soil gas concentration of an analyte based on the assumption that in-situ equilibrium exists among the gas, liquid, and solid phases. The equation requires additional parameters that are either measured or assumed (see table 2-3 for parameter list and values used) and volumetric estimates of soil types present. At IC 7, TCE, PCE, and DCE12C were modeled to obtain distributed averaged concentrations (table 2-4). Based on available data from the geological modeling and the appropriate physical and chemical parameters for each of the major recognized soil types, contaminant mass calculations can be made for only two soil types: silt and sand.

Due to differences in the degree to which data can be extrapolated, the volume bounded by the geologic model is considerably smaller than the volume for chemical contaminants. To estimate mass, specific soil type volumes were estimated based on the geologic model. Although clays, silty sands, silts, and sands were represented in the model, only two soil types are used for the mass estimates. Since total organic carbon was not detected in any soils above the detection limit of 0.1 percent, clays and silts were combined, and all sands and silty sands were combined. The total volume of soil north of Building 652 is represented by about 46 percent silt (of which about 4 percent is clay) and 54 percent sand/silty sand. Subsequent contaminant mass calculations by soil type, represented as silt and sand, are based on these percentages.

Volume estimates were made for the washrack plume separately from the IWL plume to the northeast of Building 652. The plane separating the two centers was arbitrarily drawn to separate the northeastern plume characterized by a volume of soil that contains nearly coincident PCE and TCE isopleths of 1,000 ppmv and very low FC113 concentrations (< 10 ppmv). Table 2-5 shows that the three contaminants are more widely dispersed in IC 7 than in IC 1.

Section 2

Parameter	Soil Type	
	Silt	Sand*
TOC	0.10 **	0.03
K_{OC} (DCE12C)	49	49
K_{OC} (TCE)	126	126
K_{OC} (PCE)	364	364
H (DCE12C)	0.123	0.123
H (TCE)	0.297	0.297
H (PCE)	0.546	0.546
$Ø_W$	.34	.23
$Ø_A$	.16	.24
ρ_B	1.36	1.44

Table 2-4 *Soil Volume Estimate and Average Soil Gas Concentrations, Homogenous Geologic Model*

Reference: Radian, 1993c

* Sand includes all samples identified as SP, SW, SM and mixtures (SP/ML or ML/SP, SM/SP, etc.)

** TOC was not detected in any samples above the detection limit of 0.1%

Values for silt and sand were assigned arbitrarily

Definitions:

TOC = Total organic carbon (percent)

K_{OC} = Soil partitioning coefficient (ml/g)

H = Henry's law constant (dimensionless)

$Ø_W$ = Water satuated soil porosity

$Ø_A$ = Air saturated porosity

ρ_B = Bulk density of soil (g/cc)

C_T = Soil VOC concentration, mg/kg

C_G = Soil gas VOC concentration, ng/ml

Equilibrium Equation:

$$C_T = 0.001\, C_G \left[0.01 \times \rho_B \times K_{OC} \times TOC \times 1/H + Ø_W \times 1/H + Ø_A \right] \times 1/\rho_B$$

Section 2

Cutoff Concentration (ppmv)	TCE		PCE		DCE12C	
	Area of Contamination (Acres)	Contained Mass of PCE (kg)	Area of Contamination (Acres)	Contained Mass of TCE (kg)	Area of Contamination (Acres)	Contained Mass of PCE (kg)
1	> 3.9	895	> 3.8	546	3.4	203
100	1.6	597	1.2	487	0.6	131
500	0.5	311	0.3	252	0.1	27
1000	0.2	77	0.06	132	–	–

Table 2-5
Mass for Washrack and IWL Plumes Combined

Only about 70 percent of the mass is accounted for at the 100 ppmv cutoff (table 2-6) in the washrack spreading center, as compared to about 90 percent at IC 1 for the same cutoff concentration. At the IWL spreading center, nearly 80 percent of the contamination is contained inside the 100 ppmv cutoff. When the washrack and the IWL plumes are combined, the total mass of TCE, PCE, and DCE12C is about 1,650 kg at the 1 ppmv cutoff for each compound. The area inside this cutoff concentration is greater than 3.9 acres as determined by the extent of TCE contamination which, at that cutoff, is dispersed through the largest area.

Cutoff Concentration (ppmv)	Contained Mass (kg)				Percent of Total
	TCE	PCE	DCE12C	Total	
Washrack Source					
1	524	182	139	845	100
100	345	147	99	591	70
500	184	50	24	258	31
1000	37	–	–	37	4
IWL Source					
1	371	364	64	799	100
100	252	340	32	624	78
500	127	202	3	332	42
1000	40	132	–	172	22
PRL S-35					
1	181	–	–	181	100
20	127	–	–	127	70
100	63	–	–	63	35

Table 2-6
Mass of Contamination at Three Spreading Centers

Section 2

Three potential surface and near-surface sources have been identified in IC 7 as shown in figure 2-9:

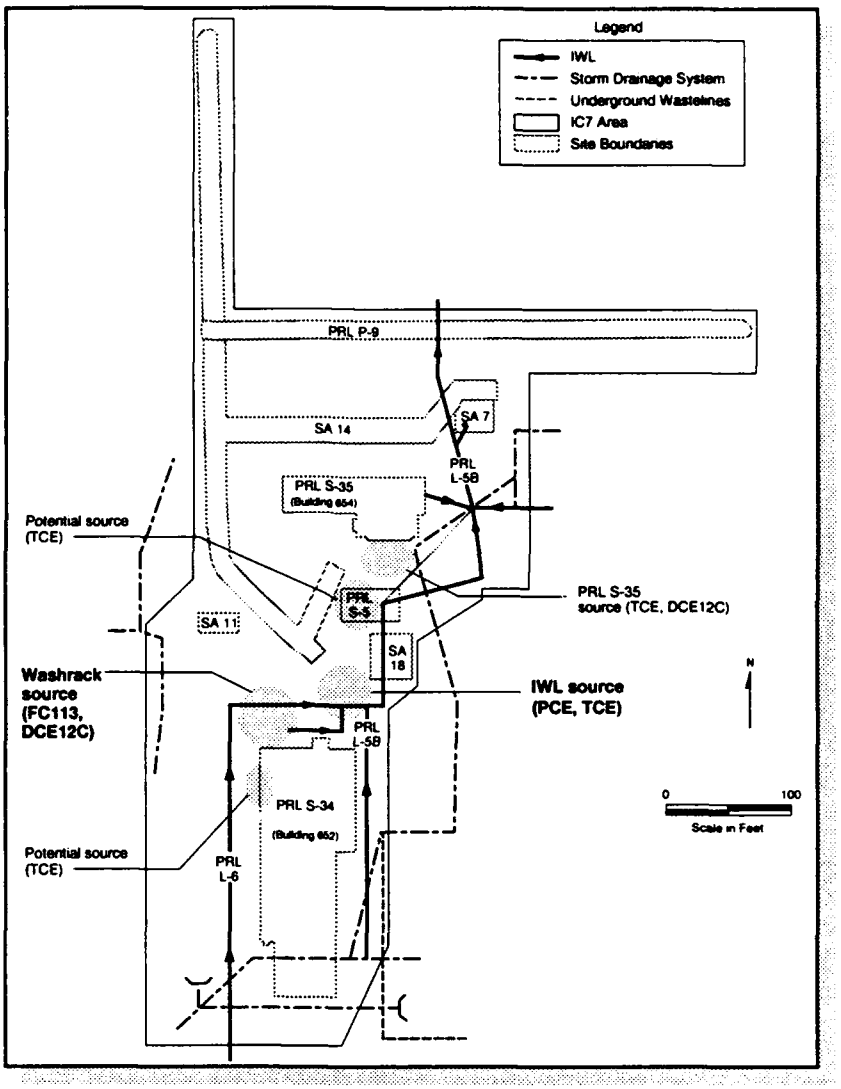


Figure 2-9
IC 7—Location of Potential Sources

- **The washrack drain/sump near the northwest corner of Building 652.** A column of soil containing TCE in excess of 1,000 ppmv and PCE and DCE12C in excess of 100 ppmv is present to the water table. The central area of high contamination is confined to about 0.1 acres. Principal contaminants are TCE, PCE, DCE12C, and FC113.

- **The IWL junction with the feeder line from the washrack area.** A soil column containing PCE and TCE in excess of 1,000 ppmv each extends to the water table. The surface area of the central contamination is confined to somewhat less than 0.1 acres.

- **The TCE plume near the southeast side of Building 654.** Contaminant mass is probably less than 25 percent of that contained in the washrack or IWL sources. Contamination in this plume reaches the water table, but concentrations in the central plume area are generally less than 300 ppmv, primarily TCE and DCE12C. The surface area containing the highest contamination (>200 ppmv TCE) covers about 0.2 acres.

There are two additional areas where contamination locally exceeds 100 ppmv of one or another of the commonly detected VOC contaminants, principally TCE. Contamination was not sampled at depths greater than 35 feet.

Conclusions

The washrack and IWL spreading centers will be the focus of the removal action as IC 7. In both areas, a central core of contamination (not sampled) is postulated to contain VOCs dissolved in water and potentially as free product. The horizontal dimensions of this core zone are unknown. In the washrack area, the core zone is most likely located near the drain/sump associated with the washrack near the end of the IWL feeder pipe. For the IWL plume, the junction of the feeder piping with the main segment of the IWL (PRL L6) is the most likely location for core zone contamination. Borings about 25 feet from the junction of the piping may have sampled soils peripheral to the core zone contamination (PCE exceeding 3,000 ppmv at several depths in both borings). As at IC 1, maximum reported concentrations in all borings are well below expected saturated vapor concentrations for the commonly detected VOCs.

The core zones could contain substantially larger masses of VOCs than those estimated for the vapor-dominated portions of the plumes using equilibrium assumptions. Based on observations at Site S, in OU D, and assuming some free product is present, the mass in the core zone could exceed estimated masses by at least one order of magnitude.

Removal action is recommended initially for the core zone at the washrack and the IWL spreading centers using the existing extraction wells. The extraction well for the washrack area (VW-5) is screened from 20 to 100 feet below ground. The extraction well for the IWL area is screened at three horizons: 48 to 52 feet, 64 to 68 feet, and 89 to 93 feet. Five additional extraction wells are located in zones of intermediate or low soil gas contamination (figure 2-10) and will be used for testing and operation, as appropriate.

Section 2

A number of boreholes in the general area of the two spreading centers contain intervals (generally between 50 and 60 feet below ground) where reported soil gas concentrations were orders of magnitude lower than in either the interval above or below. The reason for these exceptionally large variations in concentrations is not understood. It appears to be unrelated to soil type, but one possible explanation may be that at these sample locations the soil was water-saturated and essentially contained no vapor-filled pore spaces, resulting in low reported soil gas concentrations. The distribution of these zones of low soil gas concentrations should be mapped before considering SVE operations.

Removal of contaminants from the vapor-dominated plume outside the core zone will be phased in, as appropriate. This operation will use existing, widely spaced wells with large screen intervals if it can be demonstrated that the contaminant mass outside the core zone is essentially contained in the soil gas, with a minor fraction of the total mass derived from the sorbed and dissolved phases.

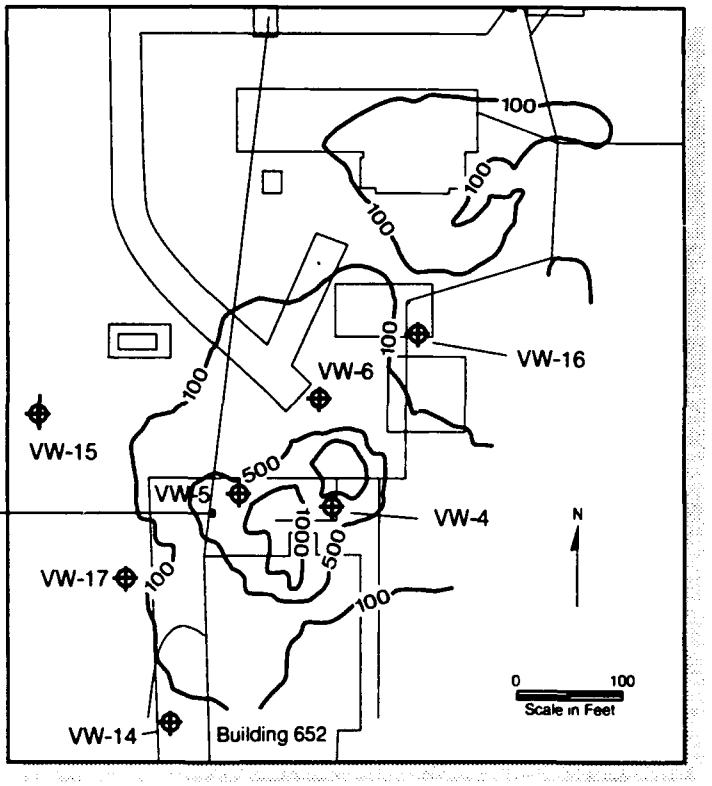


Figure 2-10
Location of Extraction Wells in Relation to the Distribution of TCE

Section 3
JUSTIFICATION OF SVE REMOVAL ACTION

As discussed in section 4 of the General Evaluation Document, justification of a removal action using SVE as the presumptive remedy is dependent upon site-specific information. The first consideration is an evaluation of the feasibility of applying SVE at the site, which is based on satisfying criteria regarding contaminant volatility, air permeability in soil, and depth of contamination.

At IC 7, the primary contaminants are TCE and PCE, both of which meet the physical-chemical requirements to classify them as volatile compounds. A soil gas permeability was recently conducted in IC 7. The average air permeability was estimated to range from 30 to 40 darcies for the fully screened well, and 200 to 280 darcies for the partially screened well. All values exceed the criterion of 10^{-3} darcy by several orders of magnitude; this indicates a very favorable condition for SVE application (Radian, 1993a). Finally, as demonstrated by soil gas measurements, the depth of VOC contamination in the vadose zone is approximately 100 feet; this is greater than the threshold of 5 feet.

The second consideration is an evaluation of the need for removal action. The soil-gas contaminant plumes underlying the washrack and IWL spreading centers include concentrations of both TCE and PCE greater than 1,000 ppmv. These plumes are a continuing source of contamination to groundwater underlying the site. In addition, screening risk analysis indicates there is potential for an unacceptably high level of risk associated with the observed high concentrations of TCE and PCE if these contaminants are not removed (Radian, 1993d). This analysis has produced two screening results: a cancer risk of 1.7×10^{-3} and a hazard index of 11. Screening generally overestimates the actual risk because it relies on conservative assumptions when actual values are not known (MITRE, 1993). Nonetheless, the screening results are significantly higher than the generally accepted values for cancer risk (10^{-6} to 10^{-4}) and hazard index (1). Because of this, the washrack and IWL areas are candidates for removal action.

In summary, using the criteria set out in the General Evaluation Document, the washrack and IWL areas have been determined to be candidate sites for removal actions using SVE as the presumptive remedy.

Section 4
REMOVAL ACTION OBJECTIVES

Scope

The removal action is aimed at removing VOCs from the washrack plume and the IWL plume near Building 652. This includes the initial extraction of VOCs from the core zone, followed by testing and operation of extraction wells in areas outside the core zone.

ARARs

Chemical-specific ARARs: As identified in the General Evaluation Document

Action-specific ARARs: As identified in the General Evaluation Document

Location-specific ARARs: None

Section 5
CONCEPTUAL DESIGN AND COST

Conceptual Design

The initial removal action for IC 7 involves the use of at least two existing extraction wells near the two core zones, which are approximately 100 feet apart. The removal action could involve as many as five additional wells that are outside the core zone. The wells near the core zone reach the top of the capillary zone, thereby limiting this removal action to the vadose zone. Integrated groundwater removal will not be considered.

The vacuum system for IC 7 is sized at 1,500 to 2,000 scfm total flow rate to accommodate any number of extraction wells that may prove to be necessary. For this analysis, two positive displacement blowers, each nominally rated at 800 scfm, were selected. Two blowers permit operating flexibility (e.g., cycling operation in one zone or well pair) and also increase the overall system availability. A maximum applied vacuum of seven inches mercury was identified. Blower turndown will attain optimum vacuum/flow rates.

Site surface characteristics are such that a concrete foundation pad will likely be required for the aboveground treatment equipment. Location of the aboveground equipment to minimize collection system piping and utility hookup requirements would be midway between the IWL and washrack sites.

Site characterization and contaminant mass estimates indicate that the contaminant mass for the combined plumes may be 3,600 pounds or more of VOCs. Using recent experience at the OU D Site S Treatability Study, where over 46,000 pounds of contaminants were extracted in eight weeks of operation, total project duration at IC 7 should not exceed six months, and might be completed in as little as three months. The preferred option for vapor treatment is the base metal, fluid bed catalytic oxidation system. This system will effectively accommodate the expected high initial contaminant loadings along with any vinyl chloride. Experience at Site S also indicates that vinyl chloride is removed quickly, so if vinyl chloride present at IC 7, the thermal system will be able to treat it. Given the potential for limited duration of operation at IC 7, changeover to carbon is not recommended.

Cost Estimate

The itemized cost estimate for remediating IC 7 is shown in table 5-1. IC 7 is located in an industrial area, so utilities should be present near the location of the SVE equipment. Existing extraction wells will be used, so no well construction costs are shown in table 5-1. A base metal, fluid bed catalytic oxidizer with a scrubber is recommended to control emissions and to destroy the chlorinated contaminants. An estimated 30,000 pounds of contaminants is expected to be removed in six months of SVE operation. If the SVE equipment is purchased, the removal project is estimated to cost $1 million.

Section 5

Item	Design Basis	Unit Cost	Item Cost
Site Preparation:			
Gas Connection	200 feet of 2-inch polyurethane line	$7.50/foot	$1,500
Electrical Connection	200 feet of buried 4-inch conduit	$5.00/foot	1,000
Transformer	12 kv to 440 v unit	$13,000	13,000
Water Connection	200 feet of buried 2-inch PVC pipe	$14.00/foot	2,800
Equipment:			
Vacuum blowers	2 blowers rated 500-800 scfm at 7-12 inches of Hg	$17,000	34,000
Air-Water Separator	1 unit 2000 scfm rated at 18 inches of Hg	$4,000	4,000
Manifold and Piping	500 feet of 4-8 inch PVC pipe, fittings and support	$30.00/foot	15,000
Emission Control System	Catalytic oxidizer with scrubber	$355,000	355,000
Engineering	10% of site and equipment cost		42,000
Mobilization	10% of site and equipment cost		42,000
			Total: $511,200
Operation and Maintenance:	90% uptime, 648 hours per month		*Monthly Operating Cost:*
Natural Gas	2,425 scfh	$3.50/1,000 scf	$5,500
Electricity	105 kw	$.075/kWh	5,100
Water	617 gph	$1.00/1,000 gal	400
Scrubber Chemicals	254 pph	$350/ton	28,800
Waste Disposal	500 gph	$3.00/1,000 gal	1,000
Testing and Monitoring	1 stack test per month, 9 well analyses per month	$2,500/sample	25,000
Operating Labor	90 hours for 2 part-time techs and part-time sample collector	$70/hour	6,300
Reporting	1 monthly operations report and prorated summary report	$6,000/month	6,000
		Monthly Operating Cost:	$78,100
		Operating Cost for 6 Months:	$468,600

Table 5-1
SVE Cost Estimate for IC 7

Section 6
IMPLEMENTATION PLAN FOR SVE REMOVAL ACTION

The schedule for preparing the documents to support an SVE removal action at IC 7 is shown in figure 6-1. The IC 7 draft final document was made available for public comment on 1 September 1993. This is followed by a 30-day public review period and a 15-day extension if requested, for a total of 45 days. A 45-day period is planned for McAFB to respond to public comments, finalize the EE/CA, and prepare the responsiveness summary and the action memorandum. The responsiveness summary addresses public comments and the action memorandum is the primary decision document for removal action. All these documents will be placed in the Information Repository and Administrative Record.

A schedule for implementing an SVE system is shown in figure 6-2 to illustrate the sequence of milestone events: design, procurement, off-site equipment assembly, installation, operation, and termination. The SVE design will begin after the date of contract award. An eight-month design period is planned for the traditional design cycle of 10, 40, 90, and 100 percent design submittals and reviews. A one-month interval between the completion of the design and the beginning of equipment installation is allowed for equipment procurement. A three-month period is planned for equipment assembly, which can be done off-site, and a one-month period is planned for on-site installation. The period of operation will be determined as part of the periodic reviews of SVE system performance, currently set for six-month intervals

The SVE removal action for IC 7 is part of a basewide removal action including five areas: IC 1, IC 7, OU C1, OU D/Site S, and OU D/Site 3. SVE equipment will be installed sequentially at these sites rather than at all sites concurrently. McAFB has not developed an integrated schedule for all five areas, but intends to start the SVE system installation for the last of these five areas before 1 October 1994.

McAFB is not liable for delays in any planned activity in the event of Force Majeure, which is an unforeseen condition as described in the Interagency Agreement among the Air Force, Region 9 of the U.S. Environmental Protection Agency, and the state of California.

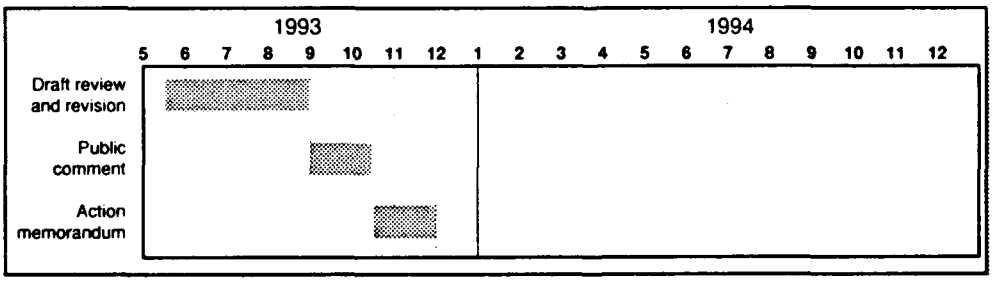


Figure 6-1
Schedule for EE/CA Site Specific Document for IC 7

Section 6

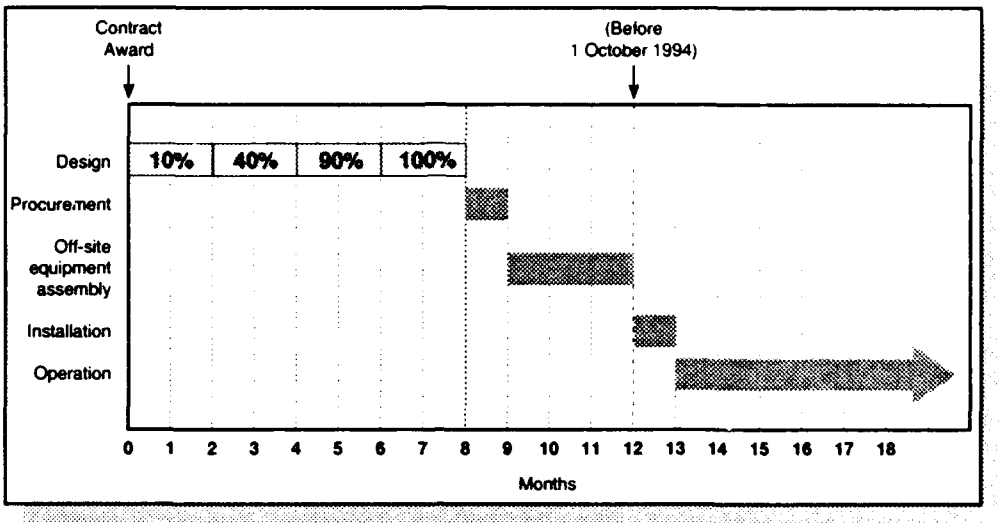


Figure 6-2
Generic Schedule for Implementing an SVE System

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McClellan Air Force Base, *Soil Gas Consensus Statement*, October 1992.

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Radian Corporation, *Installation Restoration Program (IRP) Operable Unit B Remedial Investigation Site Characterization Summary, Appendix A and B*, February 1993b.

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GLOSSARY

Chemical Codes

ACE	acetone
BRME	bromomethane
BUTADIEN	1,3-butadiene, erythrene
BZ	benzene
BZLCL	benzyl chloride
BZME	toluene
C8N	n-octane
CHLOROPR	2-chloro-1,3-butadiene
CLBZ	chlorobenzene
CLEA	chloroethane
CLME	chloromethane
CO	carbon monoxide
CTCL	carbon tetrachloride
CYHEXANE	cyclohexane
DCA11	1,1-dichloroethane
DCA12	1,2-dichloroethane
DCBZ12	1,2-dichlorobenzene
DCBZ13	1,3-dichlorobenzene
DCBZ14	1,4-dichlorobenzene
DCE11	1,1-dichloroethene
DCE12C	cis-1,2-dichloroethene
DCE12T	trans-1,2-dichloroethene
DCP13C	cis-1,3-dichloropropene
DCP13T	trans-1,3-dichloropropene
DCPA12	1,2-dichloropropane
EBZ	ethylbenzene
EDB	1,2-dibromoethane (ethylene dibromide)
FC11	trichlorofluoromethane
FC113 or F113	1,1,2-trichloro-1,2,2-trifluoroethane
FC12	dichlorodifluoromethane
FC114	freon 114, dichlorotetrafluoroethane
MTLNCL	methylene chloride
MVC	vinyl chloride, monovinylchloride
NOx	nitrogen oxides
PCA	1,1,2,2-tetrachloroethane
PCE	tetrachloroethene
PROP	propylene, propene
SOx	Sulfur Oxides
STY	styrene
TBME	bromoform
TCA111	1,1,1-trichloroethane

GLOSSARY

TCA112	1,1,2-trichloroethane
TCB124	1,2,4-trichlorobenzene
TCE	trichloroethene
TCLME	chloroform
TMB124	1,2,4-trimethylbenzene
TMB135	1,3,5-trimethylbenzene (mesitylene)
UNK	unknown compounds
VC	vinyl chloride
XYLMP	m,p-xylene (sum of isomers)
XYLO	o-xylene (1,2-dimethylbenzene)
XYLP	p-xylene (1,4-dimethylbenzene)

General

ARAR	Applicable or relevant and appropriate requirement
cfm	Cubic feet per minute
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
IAG	*Interagency Agreement*
IC	Investigative cluster
IRP	Installation Restoration Program
IWL	Industrial waste line
IWTP	Industrial wastewater treatment plant
MCAFB	McClellan Air Force Base
OU	Operable Unit
ppb	parts per billion
ppm	parts per million
ppmv	parts per million by volume
PRL	Potential release location
scfm	standard cubic feet per minute
SVE	Soil vapor extraction
SMAQMD	Sacramento Metropolitan Air Quality Management District
TOC	Total organic carbon
TRC	Technical Review Committee
VOC	Volatile organic compound