Cost and Performance Summary Report
Soil Vapor Extraction at the Intersil/Siemens Superfund Site
Cupertino, California

Summary Information [1, 2, 4, 5, 6, 7]

The 12-acre Intersil/Siemens Superfund site is located in suburban Cupertino, California. The site includes two industrial properties used for the manufacture of semiconductors and related wafer fabrication - the Intersil facility, which operated from 1967 to 1988, and the Siemens facility, which has manufactured semiconductors at the site since 1978 and is an operating facility. The facilities used a variety of chemicals and chemical solutions in their manufacturing operations, including etching solutions, organic solvents (for example, trichloroethene (TCE), 1,1,1 - trichloroethane (TCA), methanol, isopropanol, n-butyl acetate, acetone, xylene, freon, and ethylbenzene) and chemical mixtures that reportedly contained phenols and toluene. The facilities had a number of underground waste handling facilities - five waste solvent tanks and an acid dilution basin at Siemens; three acid neutralization systems, two scrubber sumps, and a waste storage tank at Intersil.

During a 1982 underground storage tank investigation conducted by the state, soils contaminated with volatile organic compounds (VOCs) were discovered on each of the sites, as well as outside the property boundaries. The suspected sources of the contamination included spills, leaks from the underground waste handling facilities, and leaks from underground piping. A remedial investigation (RI) was initiated in 1982. Initial subsurface investigations found TCE, TCA, and trichlorobenzene contamination at the Siemens property in the vicinity of former waste solvent tanks 1 and 3. TCA concentrations were reported in the soil as high as 11,000 milligrams per kilogram (mg/kg). Additional site investigations found TCA and TCE contamination at the Intersil property at concentrations as high as 10 mg/kg.

The results of the groundwater investigation of both properties showed on-site and off-site contamination of the groundwater. Groundwater TCE concentrations were found as high as 26,000 micrograms per liter (μg/L) at the Siemens property and as high as 33,000 μg/L at the Intersil property. The groundwater contamination plumes from both properties in the upper hydrogeologic unit, or A-zone, had commingled, migrated to the lower unit, or B-zone, and migrated off-site.

The RI continued over a period of eight years. During this time, several interim remedial actions occurred. At the Siemens property, a soil vapor extraction (SVE) system and a groundwater pump-and-treat system were installed in 1983. At the Intersil property, the east underground acid neutralization system and a waste solvent tank were removed in 1986 and an SVE system and a groundwater pump-and-treat system were installed in 1987. In the fall of 1988, additional potential source areas of contamination were removed from the Intersil property. These included the north neutralization system, the scrubber sumps, and an above-ground waste storage area. A groundwater pump-and-treat system was installed by both companies to treat the off-site groundwater contamination.

The site was proposed for the NPL in June 1988 and was listed in August 1990. A Record of Decision (ROD) was signed in September 1990. The selected remedy in the ROD incorporated the interim response actions described above. The ROD specified continued operation of the SVE and groundwater pump-and-treat systems at both properties, continued operation of the off-site groundwater pump-and-treat system, excavation and off-site disposal of soil contaminated with greater than 10 mg/kg semivolatile organic compounds (SVOCs) at the Siemens property, continued monitoring of the soil at both properties, and continued on- and off-site groundwater monitoring.

This report focuses on the completed SVE application at the Intersil property. The SVE application at the Siemens property was on-going at the time of this report and, therefore, is not addressed in this report.

From May 1988 to August 1993, approximately 280,000 cubic yards (yd^3) of contaminated soil were treated by the SVE system application at Intersil. The volume of soil requiring treatment was based on an estimate of the quantity of soil which contained TCE in excess of the remedial goal (1 mg/kg of total VOCs).

CERCLIS ID Number:	CAD041472341
Lead:	California Regional Water Quality Control Board (CA RWQCB)

Timeline [2, 3, 4, 7]

1987	Interim SVE system designed and installed at Intersil
May 1988	Interim SVE system full-scale operation began
January 1990	RI at Intersil site completed
August 15, 1990	Site Cleanup Requirements (SCR) Order No. 90-119 issued by RWQCB
September 27, 1990	ROD for Intersil issued
May 31, 1991	SVE system expanded from four to seven vapor extraction wells as part of the final remedy described in SCR Order No. 90-119
November 2 - December 31, 1992	Confirmation sampling conducted to evaluate cleanup progress
December 28, 1993	SCR Order No. 90-119 amended, reducing groundwater monitoring frequency from quarterly to semi-annually
May 14, 1993	Complete curtailment of soil remediation approved by RWQCB
August 23, 1993	SVE system shut down
August - December 1993	SVE system decommissioned; site backfilling and compaction of excavations conducted

Factors That Affected Cost or Performance of Treatment [4, 7]

Geology at the Intersil site consists of interbedded coarse- and fine-grained sediments which are characteristic of alluvial stream channel and associated floodplain deposits. These deposits extend to between 105 and 120 feet below ground surface (bgs), the approximate depth of the water table.

Listed below are the key matrix characteristics that affected the cost or performance of this technology and the values measured for each.

Matrix Characteristics

Parameter	Value
Soil Classification/ Particle Size Distribution:	Interbedded coarse-grained sand and gravel, and fine-grained silt and clay
Moisture Content:	4.4-21.9%
Air Permeability:	Not available
Porosity:	33-47%
Total Organic Carbon:	6-12%
Nonaqueous Phase Liquids:	Not identified

Treatment Technology Description [2, 3, 4]

The interim SVE system, which began operating in May 1988, included four vertical vapor extraction wells (VE-1 through VE-4). As part of the final remedy, the SVE system was expanded in May 1991 to include three additional extraction wells (VE-5, VE-7, VE-8). As shown in Figure 1, six of the wells were installed in pairs along the eastern portion of the Intersil building. For these pairs, one well was installed in the shallow vadose zone (about 10 to 50 feet deep) and the other in the deep vadose zone (about 60 to 100 feet deep). Well VE-5 was located along the western portion of the building. Three carbon bins were used to adsorb contaminants from the extracted soil vapor.

Data on flow rates, TCE concentrations, and TCE removal rates were collected on a monthly basis at each well head. Table 1 presents available data through March 1993. According to the vendor (Geomatrix), total system flow and TCE concentrations for the total system were not available.

According to the vendor, the SVE system generally operated continuously until it was shut down (August 23, 1993).

Figure 1. Site Plan Showing Vadose Zone Wells [3]

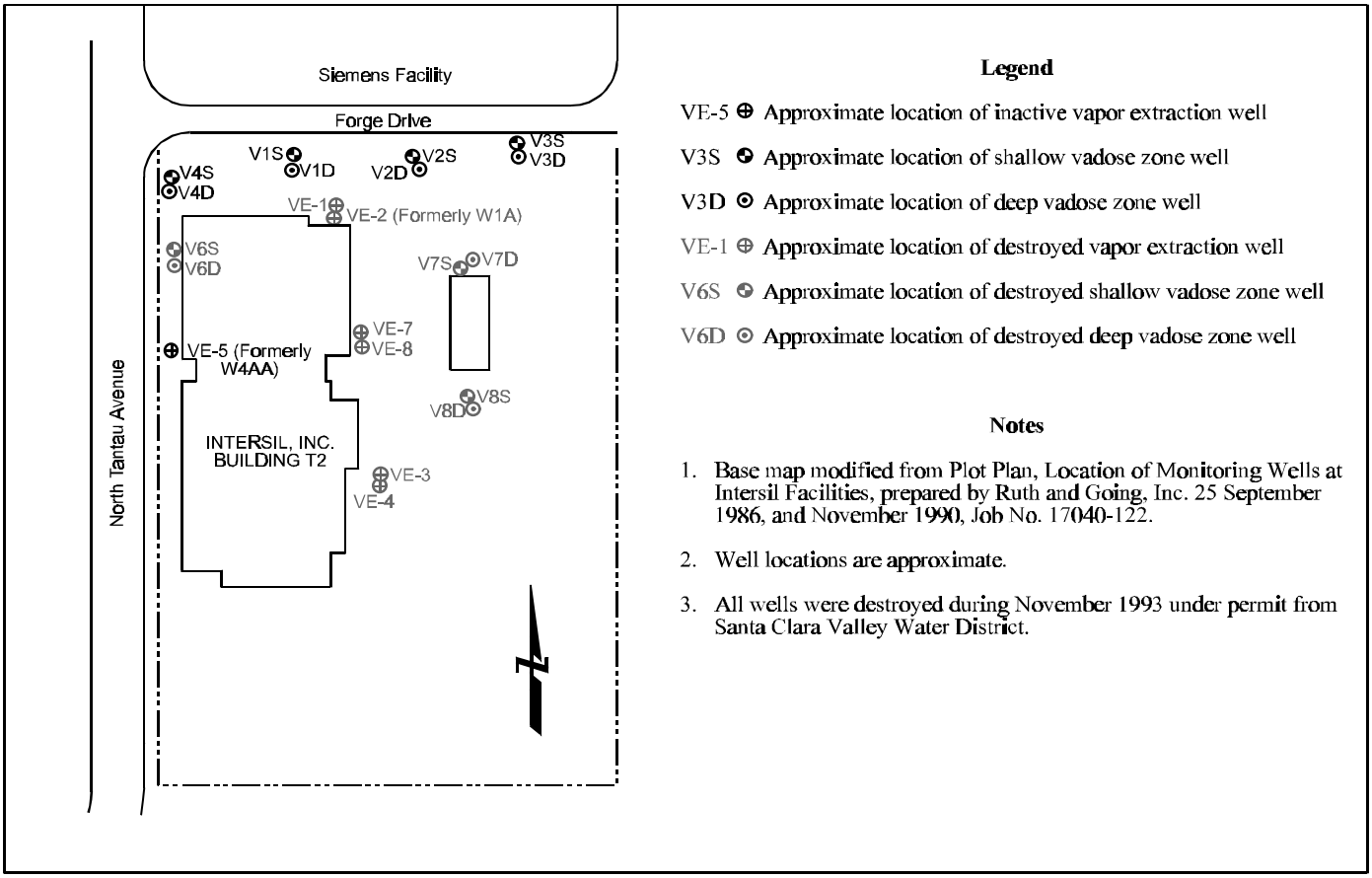


Table 1. Extraction Well Data (Through March 1993) [2, 7]

Well No.	Flow Rate Range (scfm)	TCE Concentration Range (ppmv)	TCE Removal Rate Range (lb/day)
VE-1	11 - 37.9	<0.02 - 590	0.03 - 7.61
VE-2	9 - 21	<0.09 - 548	0 - 5.5
VE-3	6.5 - 30	<0.02 - 161	0.01 - 2.3
VE-4*	NA	NA	NA
VE-5	13 - 26	<0.73 - 24.2	<0.01 - 0.21
VE-7	3 - 7	1.0 - 22.4	<0.01 - 0.06
VE-8	1.6 - 5.4	<0.3 - 33.5	<0.01 - 0.04
Total System	NA	NA	0.27 - 15.41

* Flow rates from VE-4 were lower than could be measured with available instrumentation.
NA = Not available

Listed below are the key operating parameters that affected the cost or performance of this technology and the values measured for each.

Operating Parameters

Parameter	Value
Air Flow Rate:	See Table 1
Operating Vacuum:	Approximately 4.5 inches Hg at blower; approximately 1 inch Hg at SVE well heads

Performance Information [1, 2, 4, 7]

The ROD identified the following remedial goals for soil:

- Total VOCs - 1 mg/kg
- Total SVOCs - 10 mg/kg

Total VOCs was defined as the sum of the detected volatile organic compounds. Total SVOCs was defined as the sum of the detected semivolatile organic compounds.

Air emissions standards for the SVE system were identified as the Bay Area Air Quality Management District, Regulation 8, Rule 47 requirements. The operating permit allowed an annual average of 2 pounds per day (lbs/day) of organics to be emitted.

An estimated 429 soil samples were collected from 50 soil borings during the RI. Table 2 summarizes the range of concentrations measured in selected soil borings during the RI. According to Geomatrix, only 33 of the 429 samples (less than 10 percent) contained total VOC concentrations above 1 mg/kg. The maximum concentration of VOCs detected during RI sampling was 7.0 mg/kg.

A total of 80 soil samples were collected from 16 soil borings during confirmation sampling (November 2 - December 31, 1992). Results from these samples, summarized in Table 2, show total VOCs below the remedial goal of 1 mg/kg for 79 of 80 soil boring samples. For one sample, total VOCs was reported as 1.1 mg/kg. According to Geomatrix, SVOCs were not detected in any samples. Figure 3 shows the locations of RI and confirmation sample borings.

To assess the significance of the single exceedance, Geomatrix analyzed the data using the methodology presented in EPA's *Methods for Evaluating the Attainment of Cleanup Standards, Volume I: Soil and Solid Media*. Results of the analysis indicated that, with a confidence level of greater than 95 percent, the soil remedial goal was met. RWQCB approved curtailment on May 14, 1993.

The concentrations of TCE in the confirmation samples were identical to the concentrations of total VOCs in 15 of the 16 soil boring locations, indicating that TCE was the primary contributor to the total VOC concentration.

According to Geomatrix, the SVE system at the Intersil site met the air emissions standards for this application.

Figure 2 shows the removal rate and cumulative mass removal for TCE from May 1988 to December 1992. During this time, the removal rate for TCE decreased from approximately 15.5 lbs/day to less than 0.5 lbs/day and approximately 3,000 lbs of TCE were extracted.

Removal rate data for TCE were also provided for each well as monthly averages from the start date of well operation through March 1993 (Table 1). TCE removal rates ranged as follows for each well: (VE-1) - 0 to 7.61 lbs/day; (VE-2) - 0 to 5.5 lbs/day; (VE-3) - 0 to 2.3 lbs/day; (VE-5) - 0 to .21 lbs/day; (VE-7) - <.01 to .06 lbs/day; (VE-8) - 0 to .04 lbs/day.

As shown in Table 1, TCE concentrations ranged as follows for each well: (VE-1) - <0.02 to 590 parts per million dry volume (ppmv); (VE-2) - <0.09 to 548 ppmv; (VE-3) - <0.02 to 161; (VE-5) - <0.03 to 24.2 ppmv; (VE-7) - 1 to 22.4 ppmv; (VE-8) - <0.3 to 33.5 ppmv. Extracted vapor sampling data for the total system were not available.

Performance Data Quality [2]

Confirmation soil samples were analyzed by Anametrix, Inc. for Geomatrix in accordance with EPA-approved methods. Samples from borings VB-1 through VB-6 were analyzed in accordance with EPA Methods 8010 and 8020. Samples from borings VB-7 through VB-16 were analyzed in accordance with EPA Method 8010. No exceptions to quality assurance/quality control (QA/QC) protocols were noted in the available references.

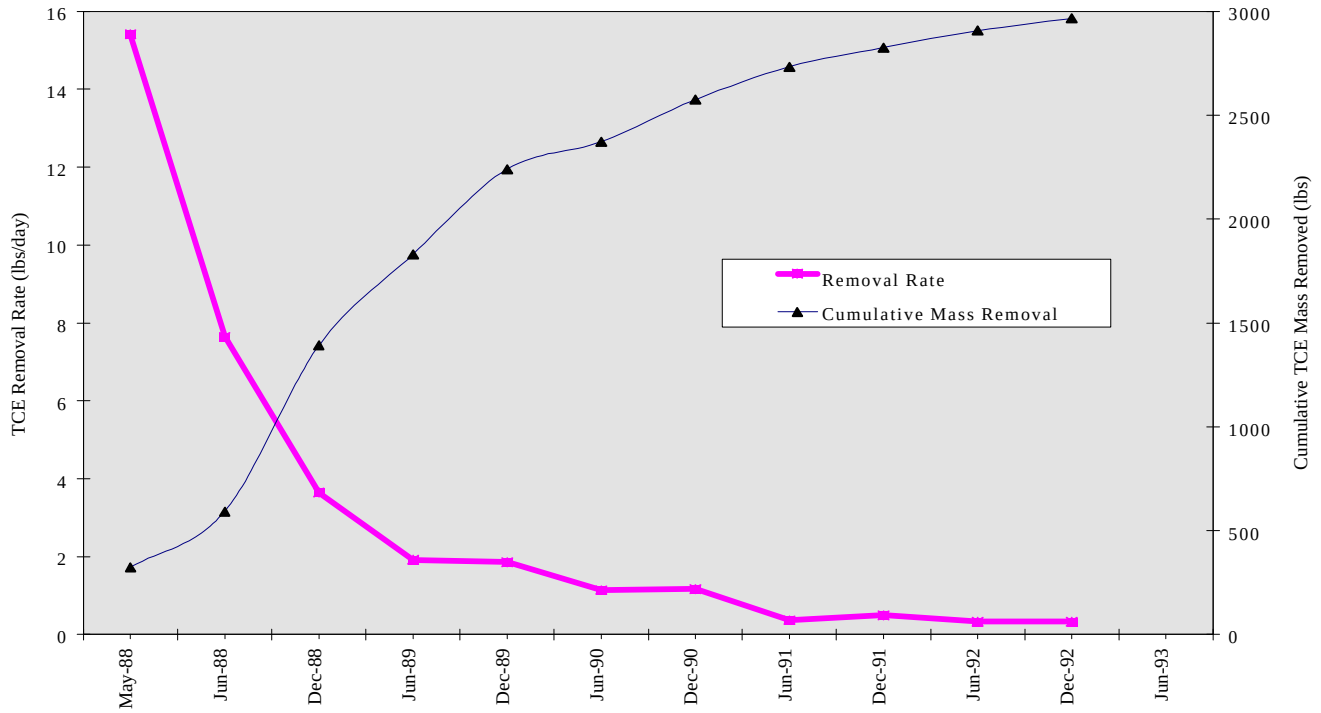
Table 2. Treatment Performance Data [2]

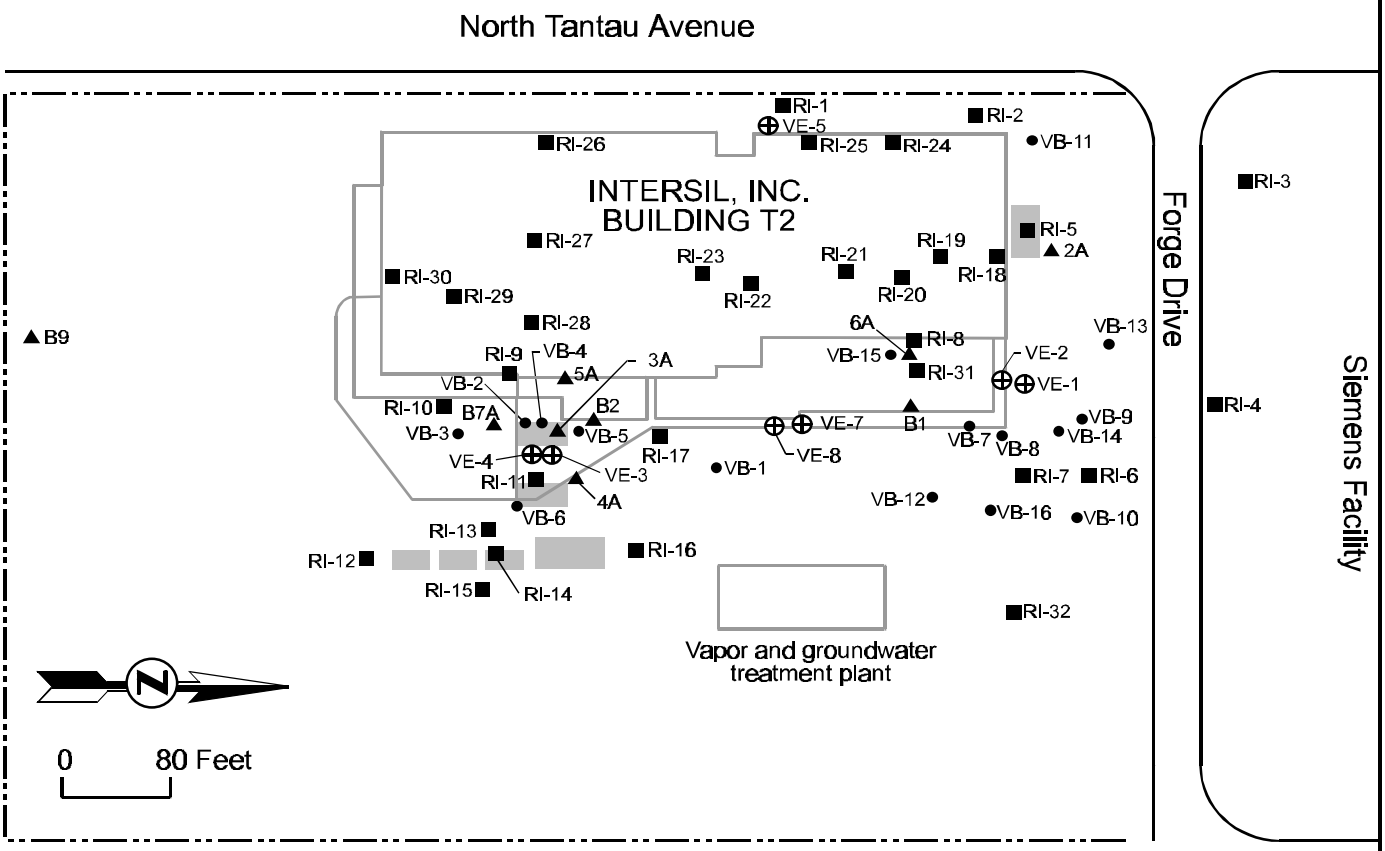
Soil Boring I.D.	Range of Depths Sampled (ft bgs)	Range of Concentrations from RI Sampling (mg/kg)*	Range of Concentrations from Confirmation Sampling (mg/kg)	
		Total VOCs	TCE	Total VOCs
VB-1	6.5 - 40.5	0.015 - 0.172	ND - 0.004	ND - 0.004
VB-2	4.5 - 52.5	<0.5 - 3.3	ND - 0.0081	0.0008 - 0.0081
VB-3	6.5 - 56.5	0.017 - 3.3	ND	ND
VB-4	4.5 - 54.5	0.39 - 1.44	ND - 0.012	ND - 0.012
VB-5	4.5 - 50.5	0.333 - 1.44	ND - 0.011	ND - 0.011
VB-6	8.5 - 52.5	0.009 - 0.063	ND - 0.0034	ND - 0.0034
VB-7	4.5 - 70.5	0.009 - 0.073	ND - 0.015	ND - 0.015
VB-8	4.5 - 66.5	0.095 - 0.750	ND - 0.069	ND - 0.069
VB-9	8.5 - 86.5	0.394 - 1.32	ND - 0.25	ND - 0.25
VB-10	8.5 - 78.5	0.038 - 1.5	0.00056 - 1.1	0.00056 - 1.1
VB-11	4.5 - 82.5	0.056 - 7.0	ND - 0.16	ND - 0.16
VB-12	4.5 - 90.5	0.009 - 0.073	ND - 0.017	ND - 0.017
VB-13	4.5 - 92.5	0.394 - 1.32	ND - 0.019	ND - 0.02
VB-14	10.5 - 86.5	0.394 - 1.32	ND - 0.016	ND - 0.016
VB-15	12.5 - 90.5	0.006 - 0.227	0.0035 - 0.022	0.0035 - 0.022
VB-16	12.5 - 96.5	0.022 - 0.75	0.002 - 0.043	0.002 - 0.043

ND = not detected at 0.0005 mg/kg detection limit.

* A total of 429 soil borings were taken during the RI. The RI data included in this table are from 90 of the soil borings that were closest to the location of the soil borings taken during confirmation sampling.

Figure 2. SVE Total System Removal Rate and Cumulative Removal Mass of TCE (May 1998 - Dec 1992) [2]





Legend

VE-1 ⊕ Approximate location of destroyed vapor extraction well

VB-1 • VES evaluation boring

B9 ▲ Pre-RI soil boring

RI-1 ■ RI soil boring

Former waste-handling area

Notes

1. Base map modified from Plot Plan, Location of Monitoring Wells at Intersil Facilities, prepared by Ruth and Going, Inc. 25 September 1986, and November 1990, Job No. 17040-122.
2. Well locations are approximate.
3. All wells were destroyed during November 1993 under permit from Santa Clara Valley Water District.

Figure 3. Site Plan Showing VES Wells and Smapling Locations [2]

Cost Information [3]

Cost information provided by Geomatrix indicated that a total of $770,000 was expended for SVE activities at Intersil. Prior to remediation, a total of $439,000 was expended on the remedial investigation and feasibility study. All costs were rounded to the nearest $1,000 by Geomatrix. No additional detail on the elements included within capital and O&M costs was provided.

The total cost of $770,000 (capital and O&M) corresponds to a unit cost of $3 per cubic yard for 280,000 cubic yards of soil treated, and $260 per pound of contaminant removed (3,000 lbs removed).

Actual Project Costs

Cost Element	Cost ($ in 1994)
Capital	**550,000**
Operation & Maintenance	**220,000**
Disposal of Residuals	**0**
Analytical (related to compliance monitoring, not technology performance)	**0**
Total Project Cost	**770,000**
Other	
- RI/FS	439,000

Observations and Lessons Learned [1, 2, 4]

The SVE system application at Intersil achieved the remedial goal for this application of 1 mg/kg for total VOCs. TCE, the primary contributor to total VOCs at this site, was reduced from a maximum of 7.0 mg/kg to less than 1 mg/kg, with one exception.

Geomatrix performed a statistical analysis using EPA methodology to assess whether the soil remedial goal of 1 mg/kg for total VOCs was met for this application. For one soil boring analysis, the TCE concentration was slightly higher than the remedial goal; however, it was shown that the goal was met with a confidence level of greater than 95%.

The ROD estimated the time to achieve soil cleanup using SVE to be five years. Based on confirmatory sampling in December 1992, the SVE system at Intersil had met the remedial goal of 1 mg/kg for total VOCs within five years of operation; the system was shut down after 63 months of operation.

The TCE removal rate (lbs/day) for the three wells added in May 1991 as part of the final remedy (VE-5, VE-7, VE-8) was lower than the rate for the original extraction wells. By May 1991, the system had already removed about 2,700 lbs of TCE or 90 percent of the total amount of TCE removed by the system.

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References

The following references were used in the preparation of this report.

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2. Geomatrix Consultants, Inc. 1993. *Proposal to Curtail Soil Vapor Extraction, Former Intersil Facility,* Cupertino, California. Prepared for Intersil, Inc. May.

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